AGRICULTURE SCIENCE AND TECHNOLOGY

Standard XII

The Constitution of India

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties- It shall be the duty of every citizen of India–

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities, to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

(k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

The Coordination Committee formed by GR No. Abhyas - 2116/(Pra.Kra.43/16) SD - 4 Dated 25.04.2016 has given approval to prescribe this textbook in its meeting held on 30.01.2020 and it has been decided to implement it from academic year 2020-21.

AGRICULTURE SCIENCE AND TECHNOLOGY

STANDARD XII

Q1J6A4

Download DIKSHA App on your smartphone. If you scan the Q.R. Code on this page of your textbook, you will be able to access full text and the audio-visual study material relevant to each lesson provided as teaching and learning aids.

2020

Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

First Edition : 2020
Reprint : 2022

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Illustrations and cover
Shri Vivekanand S. Patil
Typesetting
DTP Section, Textbook Bureau, Pune
Paper
70 GSM Creamwove
Print Order
N/PB/2022-23/3,000
Printer
RUNA GRAPHICS, PUNE

Production
Shri Sachchitanand Aphale
Chief Production Officer
Shri Prashant Harne
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Publisher
Shri Vivek Uttam Gosavi
Controller
Maharashtra State Textbook Bureau, Prabhadevi,
Mumbai - 400 025

The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

Preface

Dear Students,

The textbook "Agriculture Science and Technology" is meticulously prepared by Maharashtra State Bureau of Textbook Production and Curriculum Research (Balbharati), Pune with a view to generating an appetite for the XII Standard students aspiring for higher studies in Agriculture and allied disciplines and subjects, Agricultural Entrepreneurship and seeking job opportunities. It is in tune with the new education policy as well as the new syllabi of the Government of Maharashtra.

Agriculture, as an academic discipline, is as interesting and as challenging as other disciplines of science. It deals with food production, processing and empowering the farm-communities of our country. In our country, as in others, the cultivable land is shrinking due to urbanization. Population is growing unceasingly. The pressures and demands of the global community on the farmers are quite telling and exigent. Added to these, the problems such as Global Warming, Climate Change, Healthcare Concerns, Fluctuating Markets and Rise and Fall in the Economies aggravate the complexities of farm production and processing. Nevertheless, the discipline of Agriculture and allied disciplines assuage such challenges clouding food security by generating suitable and sustainable technologies. Besides, it seeks to provide food for the ever growing population of the world through the technologies developed at the agricultural universities, krishi vigyan kendras, and other such research and development organizations and institutions. The production of Food Grains alone is around 285 million tonnes during 2018-19. It is because of the untiring efforts of the Indian Farmers as well as the Agricultural Scientists. Therefore, the contribution of Agriculture is not only significant to the Gross Domestic Product (GDP) of our country but also in generating employment. It is to such interesting challenges and issues, the young Indian students are invited and introduced by Maharashtra State Bureau of Textbook Production and Curriculum Research (Balbharti) through the textbook on Agriculture Science and Technology.

This textbook introduces and seeks to lead the students to the systematic and scientific study of subjects like Agronomy, Entomology, Economics, Plant Pathology, Plant Breeding, Seed Technology, Horticulture, Soil Science and Agricultural Chemistry, etc. In this textbook each subject in the discipline of Agriculture provides theories, definitions, descriptions, explanations, experimental procedures and practicals. In order to train the students in fruitful studies and in enhancing their memory power, reviews, and recalls are also provided through such study-strategies like "Can-You-Recall", "Can-You-Tell", "Observe-and–Discuss", "Try-This", "Think-about-It" and so on. At appropriate places, diagrams, pictorial descriptions and tabular presentations are provided to make the reading interesting and informative. Q.R. code given in the textbook can be used for getting additional audio- visuals as supporting information. This textbook will prove to be a sincere effort in developing an interest and quest for the students who opt for this discipline.

We look forward to a perspective response from the teachers and students.

Our best wishes to all!

(Vivek Gosavi)
Director
Maharashtra State Bureau of Textbook
Production and Curriculum Research, Pune

Pune
Date: 21 February 2020
Bhartiya Saur : 2 Phalguna 1941

For Teachers

Dear Teachers,

Maharashtra State Bureau of Textbook Production and Curriculum Research (Balbharti), Pune has the privilege of introducing the textbook of Agriculture Science and Technology for Std. XII. The textbook is a very earnest attempt to develop a constructive and optimistic approach among the students for effective learning. In continuation of the content and activities in the previous standards, this book also is being equipped with a number of interesting and innovative activities. Sufficient sources for further learning are also provided for students as well as teachers. The curriculum has been restructured to make it more compatible with further higher education and vocational needs. Efforts are made to link up novelty in the field of agriculture. The following guidelines would help enrich the teaching-learning process and achieve the desired learning outcome.

- To begin with, familiarize yourself with the textbook.
- The present book has been prepared for constructive and activity-based learning.
- Teachers must skilfully plan and organise the activities provided in each chapter to develop interest as well as to stimulate the thought process among the students.
- Proper teaching schedule and lesson planning will be of immense help to the teachers.
- Use teaching aids as required for proper understanding of the subject.
- Do not finish the chapter in short.
- Follow the order of chapters strictly, as listed in the contents, because the units are introduced in a progressive manner to facilitate knowledge building.
- Ask questions on information related to trends and patterns. Efforts have been made to provide the latest data available. Teachers must explain to the students the importance of data collection and data analysis.
- Major concepts of agricultural science and technology have a scientific base and they deal with observations. Encourage group work and learning through one another, etc. Facilitate peer learning as much as possible by reorganizing the class structure frequently.
- Teaching-learning interactions, processes and participations of all students are very necessary and so is your active guidance.
- Do not use the boxes titled ‘Do you know?’ for evaluation. However, teachers must ensure that students read this extra information.
- Information provided in the boxes with various titles should be considered for evaluation.
- Exercises provided under each unit are prepared using different parameters such as observation, co-relation, critical thinking, analytical reasoning, etc. Evaluation pattern should be based on given parameters. Equal weightage should be assigned to all the topics. Use different combinations of questions. Stereotype questions should be avoided.
- Use QR Code given. Keep checking the QR Codes for updated information. Certain important links, websites have been given for references. In addtion a list of reference book is also given for extra reading and in-depth understanding of the subject.

Best wishes for a wonderful teaching experience.

Competency Statements

Standard XII

Unit	Competency statements After studying the content in Textbook students would be able to.....
Unit I Cultivation Practices	• Explain the cultivation practices of cereals viz. wheat and paddy. • Understand the cultivation practices of oilseeds viz. groundnut and soybean. • Discuss the steps in cultivation of pulse crop viz. gram. • Decide best varieties for crop cultivation. • Elaborate various practices involved in cultivation of sugar crops viz. sugarcane. • Explain cultivation practices of fruit crops viz. mango, banana and mandarin orange (santra).
Unit II Propagation and Seed Technology	• Explain and differentiate sexual and asexual modes of reproduction. • Practice buddings, grafting cuttings, etc. • Explain tissue culture and techniques involved. • Discuss advantages and disadvantages of this technique. • Understand the methodology of tissue culture and outline of tissue culture laboratory. • Develop awarness about use of tissue culture seedlings. • Understand the genetic and agronomic principles of seed production. • Detailed study of hybrid seed production. • Explain the seed production process of jowar and cotton. • Perform or advice for emasculation and pollination of cotton.
Unit III Agriculture Management	• Explain the objectives of farm management and its importance. • Elaborate various functions of farm manager. • Understand farm layouts and explain cropping schemes. • Prepare calendar of operations. • Explain types of agriculture labour. • Discuss measures of improving labour efficiency. • Maintain different farm accounts and records. • Explain importance of nursery. • Create awareness about planning and layout of nursery. • Understand types of nursery. • Explain the after care of nursery.
Unit IV Applied Agriculture	• Understand meaning, importance and scope of greenhouse technology. • Elaborate types of greenhouse. • Manage installation of Green house. • Understand operation in Green house like climate control. • Explain details of cultivation of gerbera and capsicum in green house. • Explain meaning and importance of processing and objectives of seed testing. • Prepare charts on diagrammatic representation of seed processing of different crops . • Understand a layout of seed processing plant. • Describe seed testing, prepare a layout and design of seed testing laboratory. • Understand records and forms in seed processing plants and seed testing laboratory. • Visit and collect information on seed testing. • Create awareness about seed testing and analysis for quality seed. • Explain the importance and scope of mushroom production. • Describe the types of mushroom cultivated in India. • Explain the production technique of mushroom. • Collect information on preserved products of mushroom. • Guide to new mushroom produers.

Unit V Modern Trends in Agriculture	• Explain concept and feature of Agrotourism. • Discuss the advantages of Agrotourism centres. • Aquiant with fundamental and supplementary facilities of Agrotourism centres. • Prepare Agrotourism model. • Create awareness about organic farming. • Explain meaning , merits and demerits of organic farming. • Explain principles and types of organic farming. • Collect information on different components of organic farming. • Explain the concept of agro information technology and agriculture clinic. • Collect information on agriculture technology information centre. • Try to make automization of agricultural operations.
Unit VI Agriculture Marketing and Preservation	• Explain the process of agricultural marketing. • Understand types of agricultural market based on different aspects. • Collect information regarding meaning and importance of crop insurance and create awareness about crop insurance. • Aquiant with various crop insurance schemes implemented by Govt. • Explain and elaborate food laws and regulations. • Elaborate the role of FSSAI. • Visit and collect information about preserved food products. • Explain methods of preparation of Jam, Sauce and Pickle.

Contents

1. Traditional Crops

Can you recall?

1. Cereals, oilseed crops and pulses are the important constituents of the traditional farming governing rural economy.
2. Cereals provide staple food for a large proportion of world's population. They are consumed in the form of leavened as well as unleavened flat bread.
3. Oilseed crops have great importance in Indian farming. India contributes 14 percent of worlds oil seed area and 8 percent oil seed production in the world.
4. Pulses are rich in proteins and they meet the major share of protein requirements of vegetarian people.
5. Most of the pulses, oil seed crops and cereals are the constituent of crop rotation and mixed cropping with each other.

1.1 WHEAT

Local Name : *Gahu*

Botanical Name : *Triticum* species

Family : Gramineae

Origin : Hard Wheat : Abyssinia

Soft / Bread wheat : North - West India, South West Afghanistan and USSR

Do you know ?

The genus *Triticum* has several species. The species which are commonly cultivated in India are *Triticum aestivum, Triticum duram, Triticum dicoccum, Triticum sphaerococcum and Triticum turgidum.* In India *Triticum aestivum* is most common occupying 90% area.

1.1.1 Uses : Wheat is an important staple food crop, mainly consumed in the form of *Chapati*. Wheat grain contains starch, proteins, fats, vitamins and minerals. Among all cereals wheat is a good source of protein. Soft wheat is used for making *Chapati*, bread, cake, biscuit, pastry and other bakery products. Hard wheat is used for preparation of *rawa*, *suji* and *sewai*. Wheat straw is used as fodder as well as thatching and mulching material. It has good bread making quality among all cereals due to gluten content.

Fig. 1.1 Wheat crop

Fig. 1.2 Wheat ears and grain

Do you know ?

Gluten is a protein (gliadin and glutenin) in wheat dough, a rubbery mass highly essential for manufacturing of bakery products.

1.1.2 Soil : The wheat crop is grown on a wide range of soil conditions. It grows well on soils with reasonable drainage and good water holding capacity. It can be cultivated from light soils to heavy clay soils. Soil should be well drained. The rainfed crop in Maharashtra is generally grown on heavy soils. The optimum range of pH is from 5.5 to 7.5

Try to understand

- Productivity of wheat is higher in Punjab as compared to Maharashtra.
- Note the differences in climatic and soil conditions in both the states.

1.1.3 Climate : It is a temperate crop. It requires cool, dry and clear weather. During early growth stages wheat requires cool climate for proper tillering. Dry sunny weather and cool night favours dew formation, which is essential for growth and development of wheat grains. Optimum temperature range for its growth is 7^0C to 21^0C and temperature above 25 to 30 ^{0}C has adverse effect on growth and yield. Wheat yields well in areas with average annual rainfall of about 750-1600 mm. High humidity is harmful because it favours the spread of fungal diseases like rust and rot. Hot and cloudy, frosty weather is also harmful for germination.

Try this

Collect information regarding different cultivation practices of rainfed and irrigated wheat in your area.

1.1.4 Preparatory tillage : Wheat crop needs a well pulverized but compact seed bed. The practice of land preparation differs with irrigation facilities, soil and climate. For an irrigated crop one deep ploughing with an iron plough is given and is followed by 2 to 3 shallow ploughings by country plough. When wheat follows green manuring crop, the land is prepared by two criss-cross ploughings, followed by 2 harrowings and planking.

For a rainfed crop soil moisture conservation is important. One deep ploughing is given once in three years. Just before sowing, land is given shallow harrowing and light planking. The land which is fallowed during *kharif* season is prepared by 3 to 5 harrowings.

After sowing, 'saras' or flat beds are prepared with the help of *'sara yantra'* or bund former and irrigation channels are opened by ridger.

1.1.5 Sowing season and Time :

Wheat is temperate crop and therefore sown in *rabi* season. Sowing time varies with variety. Tall varieties are sown from last week of October to first week of November. The short durational dwarf varieties are sown in November.

Think about it

Sowing direction : During winter, the direction of sun over India is in south – south east to west – north west. Therefore sowing is done by north – north east or north – south direction. It gives higher yield because it would allow maximum interception (utilization) of sun light and promote vigorous growth.

1.1.6 Sowing

A. Methods :

1. Drilling : One, two or three coultered seed drills are used for sowing wheat in rows at specific distance. The best method is sowing with fertilizer cum seed drill, which places the fertilizer and seed at optimum depth for good germination and uniform crop maturity.

2. Broadcasting : Seed is scattered by hand on the field surface and then mixed in to the soil by working wooden plough or harrow.

B. Spacing : It depends on the factors such as maturity period, tillering habit, time of sowing, fertility status and moisture condition of the field. Early maturing varieties with poor tillering habit are sown at a closer spacing than late maturing and profuse tillering varieties. If sowing is delayed, the spacing should be closer as such crop have reduced growth and less number of tillers. Optimum spacing for irrigated crop is 22.5 cm and for rainfed crop it is about 30cm.

C. Depth of Sowing : It varies with the variety and type of cultivation as follows.

Irrigated crop	: 3 – 5 cm
Rainfed crop	: 8 – 10 cm
Dwarf Variety	: 5 - 6 cm.

Remember this

Wheat seed should be placed in a moist zone for better germination and establishment of seedlings. In high yielding and dwarf varieties seed should be placed only up to 5 cm depth.

D. Seed Rate : Seed rate varies as follows :

Dwarf varieties - 100 to 125 kg / ha

Bold seeded varieties - 125 to 150 kg / ha

Rainfed crop - 75 to 80 kg / ha

1.1.7 Seed treatment :

Fresh harvested seed is dried in sun heat for 2 days to control attack of loose smut. Seed is treated with carboxyl (vitavax) or benlate (Benomyl) @ 1 - 1.25 g / kg seed to control loose smut, foot rot. Seed is also treated with organo mercurial fungicides like agrosan, captan or thirum @ 2 - 3 g / kg seed to control flag smut and foot rot.

Use your brain power

Why it is necessary to – a) use clean seed for sowing. b) use well decomposed FYM / compost.

1.1.8 Varieties : Kalyansona (HDM - 1593), Sonalika (HDM - 1553), Malvika, Sihor, HD - 2189, HD - 4502, HD - 2610, Lok – 1, N – 59, Sharbati, MACS - 2846, MACS - 1967, MACS - 9, NI-5439, etc.

1.1.9 Manures and Fertilisers : Well decomposed FYM / compost is added @ 10 - 15 t/ ha at the time of land preparation before last harrowing. Chemical fertilizers are added as follows.

a. Rainfed : 25 - 50 : 15 - 25 :25 NPK kg/ ha.
b. Irrigated : 75 - 120 : 40 - 60 : 40 - 60 NPK kg / ha

Allotment - For irrigated crop half dose of N and full dose of P,K are applied at the time of land preparation (basal dose) and reaming half dose of N is applied one month after sowing.

1.1.10 Irrigation : When sown under irrigated condition, wheat requires 5 - 6 irrigations. First presowing irrigation is given and remaining irrigations are given at critical growth stages. If soil is light or sandy, 2 - 3 extra irrigations are given. Following are the critical growth stages at which crop should be irrigated.

i) Crown root initiation
ii) Tillering
iii) Jointing
iv) Flowering
v) Grain filling

Rainfed wheat crop is grown on residual moisture of soil and dew formed during winter.

1.1.11 Intercultivation : Weed competition is maximum during first 30 - 40 days after sowing. Hoeing or interculturing few days after first and second irrigation is helpful for breaking the crust and removing the weeds. For small field hand tools like *'khurpi'* or hand hoe, etc. are used. Thus, two hand weedings and hoeings are required for weed control. Chemical weed control is also recommended. The herbicides like isoproturon, bentazone, metasulfuron are effective.

1.1.12 Crop rotation :

It is not desirable to grow wheat year after year on same piece of land. The common crop rotations are -

1. *Mung / udid* / soybean (*kharif*) →wheat (*rabi*)
2. Paddy / bajra / jowar / maize *(kharif)* → wheat (*rabi*)
3. Groundnut / sesamum (*kharif*) → wheat

1.1.13 Intercropping : Inercropping of wheat with mustard, potato, gram and pea is the common practice.

1.1.14 Plant Protection

I. Pest

a. White ants (Termites)

Nature of damage : This pest lives hidden underground and feed on developing roots and stem. It causes wilting or drying of plants. **Control measures :** Locate the termitoria and destroy it by digging or fumigation. Drilling in soil 5% aldrine or heptachlor @ 65 kg / ha or spraying the crop with chloropyriphos 20 EC is also effective.

Fig. 1.3 Termites

b. Cut worms :

Nature of damage: The caterpillars live hidden under soil during day time and cut plants and feed on them during night hours.

Control measures: Apply 5 % aldrine powder @ 125 kg / ha. before sowing

c. Stem (Pink) borer

Nature of damage: The young larva feed on tender parts of plant and later on bore into the stem and causes death of central shoot locally known as dead heart.

Do this

Visit a nearby wheat field and look insects-pest. Identify them and suggest proper control measures for them.

Control measures: Collect and destroy dead hearts. Spray the crop with quinolphos, chloropyriphos.

d. Rat

Nature of damage: Rats cut the stalks, ears and feed on developing grains. They also carry the grains into the burrows. The damage is equally serious in threshing yard and godowns.

Fig. 1.4 Rat

Control measures -

a) Mechanical method : Hunting, trapping, flooding and ultra sonic sound.

b) Chemical method : Use of zinc phosphide and selphos tablet is very effective.

II. Diseases

a. Wheat rust: There are three types of rust

1. Yellow or stripe rust :

Symptoms : Small yellow spots forming stripes appear on leaves which later on turn black.

Fig.1.5 Yellow or stripe rust

2. Black or stem rust :

Symptoms: Reddish brown to dark brown spots appear on leaves and stems, later on these spots turn black. Grains are shrivelled and lighter in weight.

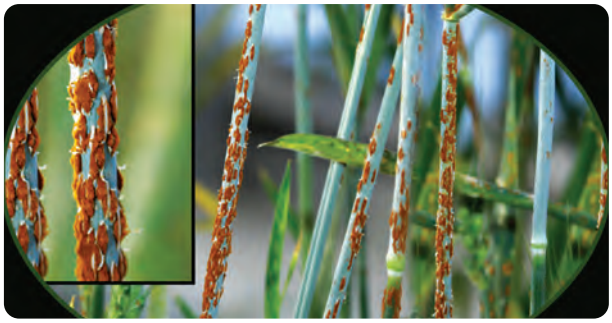


Fig. 1.6 Black or stem rust

3. Brown or leaf rust :

Symptoms : Small, round or oblong orange coloured spots, which later on turn black, appear on the leaves and glumes. These spots appear in clusters or may be irregularly scattered all over the leaf.

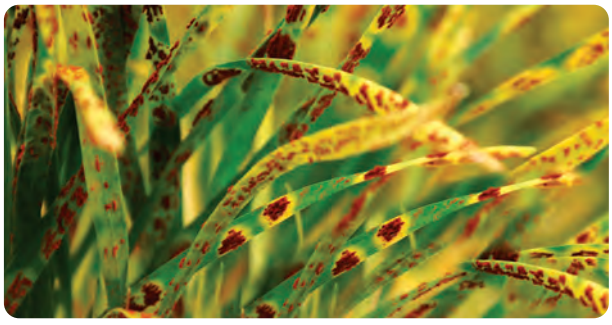


Fig. 1.7 Brown or leaf rust

Control measures :

i. For all kinds of rust prominent control measure is to grow resistant variety.

ii. Spraying the crop 2-3 times with the mancozeb or zineb at an interval of 15 days are effective chemical control measures.

b. Flag smut :

Symptoms : It appears from seedling stage to crop maturity. Gray to grayish black spots appear on the leaves. The infected plants are stunted and bear no grains. Even if grains appear, they are shrivelled and have poor germination ability.

Fig. 1.8 Flag smut

Control measures :

i. Seed treatment with organo mercurial compound like agrosan, captan or thirum @ 2.5 to 3g per kg seed.

ii. Proper crop rotation and early sowing of crop is also effective.

c. Loose smut :

Symptoms : The fungus infect the plants through stigma and establish in developing seed. The grain is replaced by black powdery mass of fungal spores.

Control measures : Sun heat treatment or seed treatment with carboxyl or benlate are the recommended control measures.

d. Foot rot :

Symptoms : In rainfed crop dry soil conditions and temperature around 30°C are conducive for infestation. Specific symptoms are yellowing of foliage followed by death of plant.

Control measures : Growing resistant varieties and seed treatment with organomercurial compound like agrosan, thirum, etc., are the effective control measures.

Try this

Collect information about different varieties, weedicides, insecticides available in the market from nearest *krishi seva kendra.*

1.1.15 Harvesting and yield : This crop is ready for harvesting after 4 – 4.5 months of sowing. The crop is harvested when grain is fully developed, straw become dry and gives peculiar noise with winds and the moisture content in grains is 18 to 22%. Harvesting is done by cutting the plant close to the ground with sharp sickle. Plants are tied in bundles, dried in sunheat and taken to the threshing yard. Threshing is done by trampling the plants under the feet of bullocks or beating them with long wooden sticks or using power thresher. Now a days, mechanical (combine) harvester is used. Grain is dried to about 12% moisture. Then grain is stored in metallic bins, earthen pots, gunny bags and placed in godowns.

Fig. 1.8 B Combine harvester

1.1.16 Yield Yield varies as follows :

Rainfed - (average yield) 6-9 q/ ha.

Irrigated - 25 - 40 q./ ha.

Mexican varieties : 40 - 50 q / ha

1.2. PADDY (Rice)

Local Name : *Sal, Bhat, Dhan*
Botanical Name : *Oryza sativa*
Family : Gramineae
Origin : South and south east Asia

Fig. 1.9 Paddy crop

Fig. 1.10 Paddy grain

1.2.1 Uses : Rice is the staple food of 60% population of the world. It contains carbohydrates, proteins, fats, minerals and vitamins. Rice bran contains 18 - 20% edible oil. Paddy straw is used as manuring, mulching, padding material as well as thatching material of huts. Husk is used as fuel and for making light weight bricks. Rice bran, paddy husk and stalk used as fodder for cattle. It is also used for packing, ripening of fruits and agronomical

products. Inferior quality of rice, broken rice is used as poultry feed. Rice byproducts like murmura (parched rice), lahi (parched paddy) and poha (beaten rice) are prepared. Rice grain have important place in ceremonies related to birth, marriage, funerals and other religious functions .

Remember this

Central Rice Research Institute located at Cuttak in odisha. Rice Research Station is located at Karjat in Maharashtra. India ranks first in area as well as production in the world. In Maharashtra, major rice growing regions are Konkan and Vidarbha. There are 23 species of rice out of which only 2 are cultivated.

1.2.3 Soil : In India major paddy growing areas have alluvial soils. In Maharashtra, paddy is grown in a variety of soils. It is grown on khar land in coastal saline region. Its cultivation is restricted to lateritic soils in south konkan and basalt soils in maval and ghat region. The soil pH should be 5.5 to 7. It prefers acidic condition.

Do you know ?

- Rice contributes 27% of cereal grains production in the world.
- Unhusked grain (seed) and the growing crop is called as paddy.
- Seed is husked or hulled, milled and polished to produce white rice.

1.2.3 Climate : Rice is grown under wide range of climatic conditions. Though it is mainly a tropical crop, its cultivation is also done in sub-tropical and temperate regions. The rice growth is optimum at temperatures between 20° to 37° C. In both tropics and temperate regions the level of solar radiation decides rice productivity. Rainfed rice cultivation is limited to areas receiving an annual rainfall more than 1000 mm.

1.2.4 Methods of cultivation : Different methods of paddy cultivation are as stated below

1. Dry cultivation
2. Semi-dry cultivation
3. Wet cultivation
4. Intensive or Japanese method of cultivation

1. Dry cultivation : This method is followed in regions which do not have irrigation facilities and where rainfall is inadequate and uncertain.

In this method fields are ploughed immediately after the harvest of previous crop or after summer showers. Seed is sown to a greater depth by dibbling behind plough or drilling. Drilling in lines help in proper establishment of plants and also facilitates inter cultivation.

2. Semi-dry cultivation : This is so called because some part of life cycle of crop passes under dry and some under wet condition.

The rain water is impounded when crop is about $1\ ^{1}/_{2}$ to 2 month old and when water gets accumulated to a depth of 10-15 cm, by the end of July the field is worked by giving shallow ploughings. This methods helps in suppressing the weed growth and thinning as well as inter culturing. In short in this system the crop thrives on moisture available in bunded fields.

3. Wet cultivation : In this system land is ploughed thoroughly and puddled with 3-5 cm standing water in the field. The seedlings are raised in nursery and later on transplanted in puddled field. When it is not possible to raise seedlings in time, in such cases seeds are soaked in water for sprouting. The sprouted seeds are then broadcasted directly in the puddled field. Transplanting method has various advantages as follows.

- Plant population is more uniform and seed rate required is comparatively less than the other methods.
- Farmer gets sufficient time for land preparation.
- Weeds are burried at the time of puddling and get controlled.
- Losses due to pest and diseases are minimized by adequate control measures in the nurseries.

- Nurseries when grown in advance facilitates timely transplanting.

4. Intensive or Japanese method of cultivation : This method is followed in the areas of assured water supply and where farmer can adopt plant protection practices and can apply heavy doses of fertilizers for inducing crop production. The following are the specific features of this method:

i. Seedlings are grown in raised beds.
ii. Seed rate needed is less.
iii. The crop is manured heavily.
iv. 3 to 4 seedlings are transplanted at each spot in a row.
v. It facilitates interculturing operations.

Observe and Discuss

- The differences in various methods of paddy cultivation.
- Which method is suitable to your area?

1.2.5 Preparatory tillage : This is different for dry and wet cultivation method. In dry management system land is prepared in the same manner as for other cereal crops. In wet system land is flooded and prepared in submerged soil. In both systems the chief cultivation practices are the summer ploughing after the receipt of rains and repeated harrowing. Compost or F.Y.M. is also added before last harrowing. Perfect levelling is essential in both the systems.

1.2.6 Sowing :

A. Season and time :

The main cropping seasons in India are as stated below :

Season	Sowing time
Aus or Autumn paddy	May to June
Aman or winter paddy	July to August
Boro or spring paddy	December to January
Summer paddy	February to March

B. Seed rate :

It differs with the methods of sowing as follows:
1. Transplanting- 25 to 40 kg/ha.
2. Dibbling- 50 to 60 kg/ha.
3. Drilling - 60 to 70 kg/ha.
4. Broadcasting- 80 to 100 kg/ha.

1.2.7 Seed selection and seed treatment :

Seed should be selected from high yielding varieties. It should be clean and viable. It should be soaked in 1% KCl solution for 12 hours to improve the germination and vigour potential. The seed is also dipped in 3% brine solution for selection of healthy seed followed by treatment with the solution of cuprasan, perenox or cupravit for 10-15 minutes. This will prevent the attack of blast and blight disease. The attack of bacterial leaf blight can be prevented by treating paddy seed with mixed solution of streptocycline and wettable ceresan followed by hot water treatment at 52° C to 54° C for half an hour.

1.2.8 Nursery :

1. Wet nursery :

The land for nursery is ploughed twice during summer season and is then puddled by giving 3 to 4 ploughings in 5 to 6 cm standing water. Well decomposed compost or F.Y.M is added at the rate of 10 tonnes per hectare or green leaf manure may also be added at the rate of 8 to 10 tonnes per hectare. After puddling, the field is levelled and divided into small beds of one meter width and suitable length. Half metre wide channels are used to facilitate drainage. Sprouted seeds are then broadcasted in the field. Based on seed size, the seed rate may be 350 to 450 kg for raising one hectare nursery. The seedlings obtained from one hectare nursery are sufficient for planting 10 to 12 hectare of land. The specific dose of fertilizer is given depending upon the fertility status.

2. Dry nursery :

It is followed in the regions of non assured water supply. The land is prepared by 4 to 5 ploughings and some cross ploughings. Well decomposed F.Y.M is added and raised beds are prepared. The raised beds are 1 to 1.5 metre wide, 8 to 10 cm high and of any convenient length. Drainage is provided by opening 30 cm wide channels. Sowing is done during second week of June and seed is covered with thin layer of soil or compost. The seed rate needed

for growing one hectare nursery is about 250 to 400 kg and it will give rise to sufficient seedlings for planting 10 to 12 hectares of land. The seedlings obtained are hardy and establish early after transplanting.

Try this

- Visit a nearby paddy field and observe the technique of nursery management.
- Strike the differences among the different types of nurseries.

3. Dapog nursery :

This is followed in areas of adequate water supply. Nursery is prepared on concrete floor or on raised beds of soil covered with polythene paper or banana leaves. Pre-germinated seed are used for sowing. In this method seedlings become ready for transplanting in 14 to 16 days after sowing. Nursery of 30 to 40 sq.m. is sufficient for raising seedling for planting 1 hectare land.

1.2.9 Transplanting :

Time of transplanting is based on the factors such as availability of water for planting, maturity period of the variety, etc. The varieties having maturity period of 120, 135 and 150 days are transplanted after about 21, 25 and 30 days respectively.

The seedlings are pulled, tied in bundles and left in water for a night before planting. At each spot 3 to 4 seedling are transplanted. The planting distance for early, medium and late maturing varieties may be 15 ×15 cm, 20 × 15 cm and 20 × 20 cm, respectively. In case of late planting due to paucity of irrigation water, aged seedlings are preferred to younger ones. Nowadays mechanical transplanters are used for paddy transplanting.

Fig. 1.11 A) Meachnical paddy transplanting

Fig. 1.11 B Manual paddy transplanting

1.2.10 Varieties : The popular varieties are Indrayani, Basmati, IR-8, IR-20, IR-22, IR-36, HRI-120 , Sahyadri, sakoli-6, pusa basmati, Ambemohar-157, Ambemohar-159, Krishna, Ratna, Sabarmati, Karjat-3, Karjat-7, Phule Samruddhi, Indrayani, etc.

1.2.11 Manures and Fertilizers : The recommended doses and application depends upon types of variety.

Farm yard manure or compost is added at the rate of 12.5 tonnes/ha, as one of the pre sowing cultivation operations. The nutrient requirement of paddy is as follows .

Varieties	N	P	K	
Local improved	25 to 50	25 to 50	25	kg/ha.
High yielding	100	50	25	kg/ha.

All the quantity of 'P' and 'K' is applied at the time of sowing. Nitrogen is given in two split doses. About 3/4th amount is applied as basal dose and remaining 1/4th sometime during the period of internode elongation. Nitrogen should be given perferably through ammonium sulphate.

1.2.12 Irrigation : The paddy is semiaquatic plant and require more water than other crops.

A lowland paddy crop requires more water than upland crops as land submergence is followed for them. The average water requirement of rice is 1240 mm. The period from primordia initiation to heading is most sensitive to water requirement.

1.2.13 Inter cultivation :

The problem of weed is critical in direct seeded crops from 15 to 30 days and in

transplanted rice from 30 to 45 days. The crop should be inter cultured by using rice rotary weeder. This helps in weeding, stirring and aerating the soil. Inter culturing should be repeated 3 to 4 times at an interval of 15 days. The recommended herbicides are almix, bensulfuron, oryzaline, etc.

1.2.14 Intercropping : Paddy can be intercropped with the crops like green gram, sesamum, black gram, groundnut, etc.

1.2.15 Crop rotation : In tracts possessing irrigation facilities rice is followed by cash crops like sugarcane, potato, wheat or pulses like gram, pea, green gram, black gram, etc.

1.2.16 Plant protection :

I. Pest

a. Yellow stem borer

Nature of damage Larvae bore into the stem to feed and cut the central shoot at the base causing dead hearts.

Control measures Collection and destruction of dead hearts and use of resistant varieties are recommended for the control of stem borer.

b. Swarming caterpillar

Nature of damage Caterpillars appear in big groups and they eat younger plants.

Fig. 1.12 Swarming caterpillar

Control measures Destruction of stubbles of previous crop and use of 3% carbofuron or 5% quinolphos at the rate of 15 kg/ha is effective.

c. Rice bug :

Nature of damage It sucks the juice from the developing grains during milk stage.

Fig. 1.13 Rice bug

Control measures Spraying the crop with chloropyriphos 20 EC is the effective control measure.

d. Rice hispa :

Nature of damage Beetles feed on chlorophyll of leaf lamina, producing white streaks.

Control measures The recommended control measure is to spray the crop with choloropyriphos 20 EC or malathion 50 EC.

e. Paddy gall fly :

Nature of damage Maggots enter the stem and attack the base of growing point and produces silvery shoot. Affected tillers do not produce any panicle.

Fig. 1.14 Paddy gall fly

Control measures: Burning grass and wild rice or applying 10% thimet granules at the rate of 10 kg per ha. after 10 and 20 days of transplanting are recommended.

Among the other insects - pest which affect paddy are grass hopper, jassids, etc. Rats and crabs also cause damage by eating plant parts.

Try this

- List out pest and diseases of paddy which are common in your area.
- Prepare a chart of pest and diseases of paddy with their control measures.
- Whether Integrated Pest and Disease Management is possible in paddy?

II. Diseases

a. Paddy Blast :

Symptoms Spindle shaped brown to reddish brown spots appear on the leaves. The spots on stem and grains are darker. There is rotting of neck resulting in dropping of ears.

Fig. 1.15 Paddy blast

Control measures :

i. Grow resistant varieties.
ii. Treat the seed with cupravit, perenox or cuprasan.
iii. Spray the crop with benlate @ 150g/ ha in 250 Lites of water. 2 to 3 sprays are required.

b. Sheath blight :

Symptoms : Greenish gray and oval spots appear predominantly on leaf sheath. Later on these spots turn grayish white with brown margin.

Fig. 1.16 Sheath blight

Remember this

Upland paddy (rice) refers to paddy grown on both flat and sloping fields that are prepared and seeded under dryland conditions. It is also called as rainfed paddy. Paddy grown on flat land with controlled irrigation is known as lowland paddy(rice) it is also known as irrigated paddy .

Control measures :

i. Grow resistant varieties.
ii. Treat the seed with perenox, cupravit or Cuprosan @ 2 g/ kg seed.

c. Foot rot/stem rot :

Symptoms : Small irregular black spots appear on leaf sheath. The affected plants remain stunted and fail to tiller. Roots become reddish brown and rot. Grains are shrivelled.

Fig. 1.17 Foot rot

Control measures

i. Use disease resistant varieties.
ii. Treat the seed with perenox, cupravit or cuprasan @ 2g/ kg seed.

d. Bacterial leaf blight :

Symptoms Water soaked translucent streaks appear on leaves which later on turn yellow to white in colour. The leaves dry up.

Fig. 1.18 Bacterial leaf blight

Control measures

i. Treat the seed with the mixed solution of streptocycline and wettable ceresan followed by hot water treatment.
ii. Spray the crop with streptocycline or agrimycin.

e. Grassy smut :

Symptoms : The symptoms are characterized by stunting of plants, excessive tillering and erect growth habit. The leaves are green or pale yellow.

Fig. 1.19 Grassy smut

Control measures

Use of resistant varieties is the effective control measure for preventing the attack of grassy smut.

1.2.17 Harvesting and threshing :

The paddy should be harvested when the moisture content of the grain is about 20 to 25%. At this stage ears are nearly ripe and straw is still slightly green. Timely harvesting prevents the loss of yield due to grain shedding. Usually majority of the grains in ears of high yielding varieties ripe 35 to 40 days after full emergence of ear.

The crop is harvested by cutting the plants with a sickle near to the ground level. The plants are left in the field to dry for 1 or 2 days or they are tied in bundles and dried for 2 to 3 days. The drying is continued till the moisture content in grain is reduced to 12 to 13%. The crop is threshed by beating the plants with sticks or under the feet of bullocks. Small sized paddle threshers are also in use. Nowaday's mechanical harvesters are available.

1.2.18 Yield :

It varies from 40 to 50 quintals per hectare for early varieties and 60 to 70 quintals per hectare for late varieties.

Do you know ?

Rice is stored as unhusked rice (paddy) or milled rice. Before storing, it should be confirmed that the moisture content in grain is up to 12-13%. The moist paddy would lead to grain discolouration, bad odour and bitter taste and this should be avoided. For small scale home storage, sacks, metal or wooden containers are used. For large scale storage, special storage rooms with proper fumigation facility are useful.

1.3 GROUNDNUT

Local name: *Bhuimung*

Botanical Name: *Arachis hypogaea*

Family: leguminosae

Origin: South America (Brazil)

Fig. 1.21 Groundnut pods

Fig. 1.20 Groundnut crop

Do you know ?

The name groundnut is derived from Greek word *Arachis* means legume and *hypogaea* means below ground with reference to formation of pods in to the soil.

1.3.1 Uses :

Groundnut is predominant among oilseed crops grown in India. Its oil content varies from 45 to 55%. Refined oil and vegetable ghee are used as cooking medium. Kernels are rich in protein and vitamins-A, B, B2. Kernels are eaten as raw, roasted or sweetened. Oil is also used for the manufacture of soaps, cosmetics, toilet requisites, etc. Groundnut cake is used as cattle feed as well as manure. Groundnut is also consumed in the form of confectionery products. Vines are fed to the livestock.

1.3.2 Soil :

Groundnut prefers loam and sandy loam soils. Well drained light sandy loams with ample calcium and moderate organic matter are most suitable. It is acid tolerant crop with pH range of 5 to 5.5. Heavy and stiff clay soils are not suitable as such soils become hard during dry climate and affect the pod formation and also create problems in harvesting.

1.3.3. Climate :

Groundnut is usually cultivated in tropical and subtropical regions. It performs well in temperatures ranging from 24° to 33°C. It can not withstand frost and drought conditions. It can be grown well in places receiving an annual rainfall of about 500 mm to 1250 mm and up to 1600 mm with good drainage facility.

1.3.4 Preparatory tillage :

Groundnut requires deep, loose and fine seed bed. Land is prepared by giving one deep ploughing and 2-3 harrowing. Medium deep soils are ploughed twice followed by several harrowing till the monsoon rains are received.

Remember this

Groundnut is also known as peanut, monkey-nut and *moong fali*.

1.3.5 Sowing

a. Season and time :

In Maharashtra *kharif* crop is sown from last week of June to first week of July. During summer season the time of sowing is January to February.

b. Sowing methods and spacing : It depends on the type of variety grown. The erect varieties are either dibbled at 25×15cm distance or drilled with four coultered seed drill in rows 25 to 30 cm apart. Semi spreading varieties are dibbled at 45 ×15 cm distance and spreading at 60 ×15cm distance.

c. Seed rate :

It depends on the test weight of seed, spacing and type of variety. It is as follows.

i. Erect varieties-100 to 120 kg/ha.

ii. Semi-spreading - 80 to 100 kg/ha.

iii. Spreading varieties 60 to 80 kg/ha.

1.3.6 Seed selection :

Only healthy kernels from high yielding varieties should be selected. Broken and decoated kernels should be avoided. Yellow or black coloured (diseased) and kernels damaged by insects, should not be taken for sowing.

1.3.7 Seed treatment :

The attack of root grub is prevented by treating the seed with chloropyriphos 20 EC at the rate of 6 ml/ kg seed.

Treatment of 1 percent organo-mercurial. Fungicide like agrosan or thirum 2g/kg seed is given for controlling collar rot and root rot disease.

Treatment of *rhizobium* culture is done @ 250g/10 kg seed to increase nitrogen fixation.

1.3.8 Crop rotation :

Groundnut is rotated with cotton, jowar, bajra, gram and paddy. It is also rotated with garden crops like potato, chilli, garlic, ginger, onion and turmeric.

1.3.9 Intercropping :

Jowar, bajra and maize are important cereal crops which are grown as intercrop with groundnut. Long durational crops like cotton, pigeon pea and short durational like sesamum, sunflower, green gram etc., are also grown as an intercrop with groundnut.

1.3.10 Varieties :

Erect (Bunchy) : S.B.-11, AK-12-24, Kopargaon No.3, TMV-2, TMV-7, TMV-9, TMV-11, JL-24, ICGS-37, ICGS-44, JL-220, Konkan Gaurav, etc.

Semi spreading : Kopargaon No-1, AK-8-11, TMV-6, TMV-8, TMV-10, ISGS -5 ICGV-86325, etc.

Spreading : Karad 4-11, TMV-1, TMV-3, TMV-4, CSMG-84-1, TAG-24, TAG-303.

Remember this

- In India, research on groundnut improvement was started during 1980-81 through the All India Co-ordinated Research Project on oil seeds.
- Now a days, National Research Centre of Groundnut, Junaghad in Gujarat is co-ordinating the groundnut improvement programme in the country.

1.3.11 Manures and Fertilizers : The doses differ with method of cultivation as follows :

For rainfed crop well decomposed farm yard manure or compost is added @ 10 tones/ha. About 10 kg nitrogen and 20 kg phosphorus per ha. is also added as basal dose.

For irrigated crop F.Y.M or compost is added @ 12.5 tones/ha. About 20 kg nitrogen and 40 kg phosphorus is added per ha. as a basal dose.

1.3.12 Irrigation :

Average water requirement ranges between 450 to 650 mm. For a *kharif* crop there are only one or two occasions during which crop needs irrigation on account of long dry spell. A good summer crop can be grown with 8 to 10 irrigation turns. The most critical stages of growth for irrigation are flowering, pod formation and maturity during which adequate supply of water is a key factor for obtaining good yields.

1.3.13 Intercultivation : In groundnut weed infestation is highest up to 35 days from sowing. The crop is generally given one hand weeding and two hoeings till pegging begins. Herbicides such as fulchloralin, alachlor are effective for weed control.

1.3.14 Plant protection :

I. Pest

a. Aphid :

Nature of damage : Aphid sucks the sap from leaves and other tender plant parts. In case of heavy attack plants become chloratic and leaves curl.

Fig. 1.22 Aphid

Control measures :

Spraying the crop with phosphamidon is the recommended control measure for aphid.

b. Root grub :

Nature of damage : Grub feeds on rootlet and nodules and destroy entire root leading to death of plant.

Fig. 1.23 Root grub

Control measures :

Seed treatment with chloropyriphos 20 EC or soil application of carbofuron granules found effective against root grub.

c. Leaf roller :

Nature of damage : The caterpillar rolls the leaves and remains feeding on green tissues.

Fig. 1.24 Leaf roller

Control measures :

Chloropyriphos 20 EC or profenophos 50 EC are effective in controlling leaf roller.

II. Diseases :

a. Leaf spot (Tikka) :

Symptoms : Circular to irregular dark spots surrounded by yellow ring appear on the leaves. In the case of late spot the lower surface of the spots is carbon black in colour.

Fig. 1.25 Leaf spot

Control measures :

The control measures include use of resistant varieties, proper crop rotation and dusting the crop with sulphur @ 15 to 25 kg/ha.

b. Collar rot :

Symptoms : Attack of this disease is common in light sandy soils. Attack on seed soon after sowing results into pre-emergence rotting of seed.

The symptoms in emerging seedling are yellowing and drying either of entire seedling or its branches.

Fig. 1.26 Collar rot

Control measures :

The most effective preventive control measures are to grow resistant varieties and to treat the seed with organo-mercurial fungicides like agrosan or mancozeb or thirum @ 2 to 4 g/ kg seed.

c. Root rot :

Symptoms : Symptoms are characterized by reddish brown discolouration of the stem and collapsing of plants.

Fig. 1.27 a Root rot

Control measures :

Proper crop rotation practices and seed treatment with agrosan, thirum or mancozeb, etc. are beneficial in controlling root rot disease.

1.3.15 Harvesting :

The time of harvesting is determined on the basis of the following signs of maturity:

1. Yellowing of top leaves and drying and falling of older leaves.
2. Blackening of inner side of the shell.
3. Hardening of pods.
4. Turning of kernel to its normal size and colour.

5. Crop age- It differs with the types of varieties. The erect,semi spreading and spreading types mature in 100, 120 and 150 days respectively.

After ascertaining the maturity by above criteria, harvesting is done by pulling the vine from the soil with pods in erect and semi spreading varieties. The pods are then separated from vines. In the case of spreading types the harvesting is done by ploughing the field and then searching the pods in the soil. The pods are dried to 10 percent moisture content and stored.

Fig. 1.27 b Groundnut sheller (Hand operated)

1.3.16 Yield :

Under irrigated conditions the average pod yield is about 30 q/ha. Under rainfed conditions the pod yield of erect, semi-spreading and spreading varieties is 8 to 10, 10 to 12 and 15 to 17 q/ha. respectively.

Do you know ?

Groundnut is stored preferably in the form of unshelled pods. Pods are stored mostly in gunny bags and also in earthen pots, mud bins or baskets. Before storage, pods are dried to safe moisture limit (10%) otherwise there may be possibility of development of poisonous moulds. During storage pod should be inspected frequently to see that there is no incidence of any pest and disease.

1.4 SOYBEAN

Botanical Name: *Glycine max*
Origin: Asia (China)
Family: Leguminosae

Fig. 1.28 Soybean crop and grain

Fig. 1.29 Soybean pods

1.4.1 Uses :

Soybean is an important oil seed as well as pulse crop. Average oil content is about 20 percent. It is also rich in protein content 41%. It is used for the manufacture of soaps, paints, plastics, condles, etc. It is used in the form of baked and green beans, flour, candies, cocoa, cooking oil, vegetable milk, etc. It is used as animal feed in the form of hay, pasture, oil,

milk, etc. Being leguminous crop it helps in fixation of atmospheric nitrogen.

Remember this

- Soybean accounts for 50 per cent of oil seed production in the world.
- In India cultivation of soybean on commercial scale was started 1970's onward.

1.4.2 Soil :

Soybean is grown on wide range of soils. In Maharashtra it is usually grown on light to sandy loam soils. In heavy soils crop makes excessive vegetative growth. The soil should be well drained. Optimum range of pH is from 6 to 6.5. Crop is sensitive to water logging particularly during early stages of its growth.

1.4.3 Climate :

Soybean is a tropical crop. However, it is also grown in subtropical and temperate regions. Soybean can thrive low and very high temperature but optimum range of temperature for its growth is 20 to 35° C. It does well in areas receiving an annual rainfall of about 600 to 1000 mm.

1.4.4 Preparatory tillage :

On light to medium type of soil one deep ploughing is given to a depth of 15 to 17 cm and is followed by clod crushing and 2 to 3 harrowings. On heavy soils repeated harrowings only are given to prepare the land for soybean.

1.4.5 Sowing

a. Season and time :

In India soybean is grown as *kharif* and *rabi* crop. *Kharif* crop is sown in the month June to July. When grown as *rabi* crop, it is sown during October to November.

b. Sowing method and spacing :

Soybean is usually drilled but sometimes it may also be dibbled on ridge. The distance between two rows is about 45 to 60 cm and plant to plant distance may be 5 cm. It should be sown to a depth of about 3 to 5 cm.

c. Seed rate:

The seed rate for soybean varies with spacing and test weight. The average seed rate is about 65 to 75 kg/ha.

1.4.6 Seed treatment :

Fig. 1.30 Seed treatment

In order to prevent the attack of fungal diseases, the seed is treated with thirum @ 3g kg/ seed or carbendazim 2g/kg seed. Soybean being a leguminous crop, its seed is treated with *rhizobium* culture for increased nitrogen fixation through increased nodulation on roots.

1.4.7 Intercropping :

Soybean is grown as an intercrop with the cereals like jowar, maize and bajra. It is also intercropped with groundunt and pigeon pea.

Fig. 1.31 Intercropping

1.4.8 Varieties :

Brag, Clark, Punjab-1, Soybean no. 4 J.S. 335, D.S. 228 (Phule kalyani), MACS-13, MACS-57, MACS-58 MACS-124, etc. are the important varieties.

1.4.9 Manures and Fertilizers

Well decomposed farm yard manure is added at the rate of 15 cart loads per hectare. In addition to that 20 to 25kg nitrogen and 50 kg phosphours per hectare are added. Depending on soil test values 20 to 40 kg potash may also be given, if required. Nitrogen, phosphorus and potassium are given as basal doses.

1.4.10 Irrigation :

In Maharashtra soybean is grown as a rainfed *kharif* crop. However, in the case of long dry spell it needs two irrigations, particularly at the stage of flowering and pod formation. The water requirement varies between 450 to 750 mm.

Remember this

- Soybean being leguminous crop is able to fix atmospheric nitrogen through *Rhizobium*.
- Plant starts to fix atmospheric nitrogen about four weeks after sowing.

1.4.11 Intercultivation :

The weed competition is more during first two months after sowing. Normally weed control is done by hoeing or by using herbicides. Under the situation of small land holding two hand weeding are sufficient for controlling weeds. Herbicides such as fluchloralin, alachlor, etc., can be used for weed control.

1.4.12 Crop rotation :

Soybean is rotated with wheat, potato, etc.

1.4.13 Intercropping :

Soybean is intercropped with maize, cotton, jawar, groundnut, bajri,etc.

1.4.14 Plant protection :

I. Pest

Stem borer causes serious damage by tunneling the stem and side branches. It can be controlled by spraying the crop with choloropyriphos 20 EC.

Pod borer is controlled by using chloropyriphos 20 EC.

The other insects-pest which also found to attack soybean are hairy caterpillar, white flies and aphids and should be checked by suitable control measure.

II. Diseases :

a. Bacterial blight :

Symptoms : Reddish-brown spots with yellow margin appear on the leaves and also on pod.

Fig. 1.32 Bacterial blight

Control measure :

Use of resistant varieties and seed treatment with organo-mercurial fungicides like ceresan are the effective control measures.

b. Mosaic :

Symptoms : It is the virus disease causing mottling and curling of leaves. Petioles and internodes are shortened, especially early infection results in to stunted plant growth.

Fig. 1.33 Mosaic

Control measures :

The control measures include spraying the crop with profenophos 50 EC to control vector which spreads virus or using healthy seeds for sowing.

c. Leaf spot :

Symptoms : Reddish brown spots appear on upper surface of the leaves. Spots also appear on all other plant parts except roots. Infestation is severe during November-December months.

Fig. 1.34 Leaf spot

Control measures :

Seed treatment with thirum or carbendazim and spraying the crop with mancozeb, etc., are the recommended control measures for leaf spot.

d. Downy mildew :

Symptoms : Small chlorotic spots which later on become grayish-dark brown appear on upper surface of leaves. Lower side of leaves show whitish downy growth.

Fig. 1.35 Downy mildew

Control measures :

Seed treatment with thirum or carbendazim and growing resistant varieties are the effective control measures.

1.4.15 Harvesting :

Soybean matures in 90 to 120 days. It is harvested when leaves turn yellow and start drooping. The pods also turn yellow and dry. Pods when pressed by hand cracks. At harvesting time, the moisture content in the grain should be 15 to 17%. Harvesting is done either by pulling the plants or cutting them near the ground level. The plants are heaped and dried for 2-3 days. Threshing is done by beating the produce with sticks or by using threshing machines. The produce is then winnowed, dried and stored. Nowadays combined harvester is also used for soybean harvesting.

Think about it

Whether Integrated Pest and Disease Management is possible in soybean?

Remember this

For safe storage of soybean the moisture content in the grain should be brought to 11 percent by drying. Moisture proof gunny bags or seed bins are used for storage. Proper pest and disease control measures should be taken during the period of storage.

1.4.16 Yield :

1. Pure rainfed crop -10 to 15 q/ha.
2. Mixed crop - 3 to 4 q/ha.
3. Irrigated cop (pure) - 35 to 40 q/ha.

Do you know ?

1) Indian Central Oilseeds Committee (ICOC) was established in 1947 to increase oilseed production
2) Oilseeds Development Corporation (ODC) replaced ICOC in 1966
3) All India Co-ordinated Research Project on Oilseeds(AICRPO) was set up in in 1967
4) Technology Mission on Oilseed(TMO) was established in 1986

1. 5. GRAM

Synonym: *Harbhara, Chana*, Bengal gram, Chick pea

Botanical Name : *Cicer arietinum*

Family : Leguminosae

Origin : South – West Asia

Fig. 1.36 Gram crop

Fig. 1.37 Gram grain

Try this

Obtain the information of varieties of deshi, kabuli gram suitable under rainfed, irrigated conditions. Point out the difference between the growth characteristics of deshi and kabuli varieties.

1.5.1 Uses : Gram is important *rabi* pulse crop in India. It contains carbohydrates (62%), protein (21%) and vitamins A and E. Tender leaves of young gram crops used as vegetable. It is consumed in the form of splits (*dal*), flour (*besan*), cooked grain, salted or unsalted grain. It is also used for preparation of sweet product like *puranpoli*, *laddu*, *mysorepak,* etc. Malic acid and oxalic acids (*Amb*) collected from green leaves have medicinal value for intestinal disorders. Grains as well as husk are used as horse feed. Germinated grains are recommended to cure scurvy disease.

1.5.2 Soil : Gram is fertility restorative crop. It is grown on variety of soil ranging from light to heavy black, mixed red, alluvial soil with well drained condition. Sandy loam to clay loam is most suitable soil. Optimum range of pH is 6 to 7.5. Water logging, saline and alkaline conditions are harmful.

1.5.3 Climate : It is grown in cool and dry climate. It is best grown in areas receiving low to moderate rainfall (400 - 700 mm) and mild cold climate. The average temperature required is from 25^0 to 30^0C . If temperature goes below 5^0C and above 30^0C it affects pod setting and seed development. Excessive rainfall after sowing or at flowering and severe cold cause great harm. Cloudy weather and frost conditions during flowering reduce flowering and seed settings.

1.5.4 Preparatory tillage : Gram is a hardy crop. It can be grown on cloded or rough seed bed. One deep ploughing is given after harvest of *Kharif* crop by iron plough. One to two harrowings are given to prepare seed bed. For moisture conservation planking is done.

1.5.5 Sowing

a. Season and Time : It is usually grown in rabi season. The optimum time of sowing is from 15th October to 15th November.

b. Sowing method and Spacing : Gram is sown by drilling, dibbling or plough furrow method. Generally sown by drilling method. Sowing in plough furrow behind *deshi* plough is practiced if there is inadequate moisture in the soil. Optimum row spacing for different varieties is as follows :

Deshi type : 30 × 10 cm

Kabuli Type : 45 × 10 cm

c. Seed rate :

1. Deshi (varieties) : 65 to 70 kg / ha.
2. kabuli varieties : 80 to 90 kg / ha.

1.5.6 Seed treatment : Seed is treated with carbendazim (bavistin) or thirum + bavistin @ 2 to 3 g / kg seed to control wilt disease. Gram seed is also treated with rhizobium culture just before sowing @ 250 g / 10 kg seeds for efficient nitrogen fixation through increased nodulation on roots.

Think about it

Why seed of leguminous crop is treated with *rhizobium* culture?

1.5.7 Varieties : N-31, N-59, Chafa, Warangal, Vijay, Vikas (Phule G-1), Vishvas (Phule G-5), Digvijay, BDN – 9 – 3.

Kabuli Types: Virat, Vihar, PKV kabuli – 2, Sadabahar, Sweta (ICCV-2).

1.5.8 Manures and Fertilizers : 12 – 15 cart loads FYM or compost per ha. is mixed in soil at the time of land preparation. The dose of nutrients for rainfed crop is 10 : 40 : 20 NPK kg / ha. and for irrigated crop is 20 : 60 : 40 NPK kg / ha.

1.5.9 Irrigation : Generally gram crop is grown as rainfed crop on residual soil moisture. Depending upon the soil type, the water requirement is 300 to 400 mm. If irrigation facility is available it is given at sowing, branching, flowering and pod filling time for light soils. Pod formation is the most critical stage for irrigation.

1.5.10 Intercultivation : First 4 to 5 weeks are critical from weed control point of view. Use of pre emergence herbicides followed by one hand weeding and one hoeing at 15 days interval is found to be effective for controlling weeds. Herbicides used are bentazon, pendimethalin etc.

1.5.11 Nipping : Nipping in gram is also called as topping. Tips are nipped off or tips of the young branches are removed is called as topping. It is done when the crop is at grand growth stage or 10 - 15 cm height or 3 - 4 weeks after sowing. It increases number of branches per plant. young shoots are used for vegetable purpose.

Internet my friend

Collect information about *dal* mills used in Maharashtra.

1.5.12 Collection of malic acid (*Amb*) : When plants are 40-60 days old the leaves secretes acid i. e., malic acid and oxalic acid locally known as '*Amb*'. These acids dissolves in dew which accumulates on leaf tips. These acids can be collected by running a cotton cloth on the crop, early in the morning and squeezing it in bucket. It contains 90-95% malic acid and 5-10% oxalic acid. These acids believe to have medicinal value against intestinal disorders. Near about 5-7 lit. of malic acid can be collected from 1 ha. area of gram.

1.5.13 Crop rotation and Intercropping : cereal crops, vegetables in *kharif* are followed by gram in *rabi* season. Gram is mostly grown as sole or pure crop. It is grown as inter crop with wheat, *rabi* jowar, safflower, linseed, mustard, sugarcane, etc.

1.5.14 Plant Protection :

I. Pest

a. Gram pod borer

Nature of damage Initially larvae bores into the buds and flowers results in shedding of buds, flowers. After formation of pods it bores into them and feed on developing seeds.

Fig. 1.38 Gram pod borer

Control measures :

Recommended control measures are deep ploughing, use of light or pheromone traps and dusting the crop with malathion 5 % or carbaryl 5 % or phosalone 4 % @20 - 25 kg / ha. Spraying of chloropyriphos 2 ml / lit. or cypermethrin, neemseed kernel extract 5 % or NPV is also practiced.

b. Cut Worm :

Nature of damages : Caterpillar remain hidden during day time and cuts the plant or its branches during night hours.

Fig. 1.39 Cut worm

Control measures :

Prophenophos 50 EC or dichlorovas 70 EC are effectively used against this pest.

II. Diseases :

Wilt

Symptoms It is a fungal disease. It attacks root system, results in decomposition of roots, stunted growth with pale yellow leaves, dropping of leaves. The affected plants, uprooted easily and later on withers and dies.

Fig. 1.40 Wilt

Control measures : Follow clean cultivation, crop rotation, grow disease resistant varieties. Treat the seed with thirum or captan or bavistin @ 2 - 3 g/ kg or *trichoderma* @ 6 g + 1 g vitavax / kg spray copper sulphate or bordeaux mixture.

Remember this

Pulse crops belong to the family leguminosae. The term pulse is an alternative term used for edible seed of leguminous crop. It is derived from latin word *puls* meaning thick soup. Split cotyledons of dry legume seed is boiled in water , softened, macerated and used as soup. Pulses are useful both as food and fodder besides as green manure crops.

1.5.15 Harvesting :

Crop matures in about $3\ ^{1}/_{2}$ - 4 months after sowing. At maturity leaves turn yellow and the plant dry. Harvesting is done by cutting the plants close to the ground with sickle or by pulling the plants. Plants are dried for one week under sun heat. Threshing is done by trampling under the feet of bullocks or by beating with long sticks or by threshing machine. The seed is cleaned by winnowing and stored in gunny bags, godowns or in the form of splits.

1.5.16 Yield :

Rainfed crop : 5 - 6 q/ha.

Irrigated crop : 10 - 12 q/ha.

The proportion of grain to chaff is 1 : 1.75 or 1 : 2 by weight.

Do you know ?

The success of gram and other leguminous crops in nitrogen deficient soils is due to presence of nodules on its roots. These nodules contain *Rhizobium* bacteria, which fixes atmospheric nitrogen into the soil .The nodulation and nitrogen fixation depends on different factors such as temperature, proportion of Na, Ca, Mo, Mn, etc.The nodulation can be increased by inoculation of seed with specific *Rhizobium* culture.

Exercise

Q.1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. Botanical name of gram is …….
   a. *Triticum* species
   b. *Arachis hypogaea*
   c. *Cicer arietinum*
   d. *Oryza sativa*
2. Tikka is the important disease of ……. crop.
   a. Paddy b. Gram
   c. Wheat d. Groundnut
3. Indrayani is the variety of …….crop.
   a. Paddy b. Groundnut
   c. Soybean d. Wheat
4. Gram leaves contains…….. acid.
   a. HCN b. Carbonic
   c. acetic d. malic
5. Gall fly is the important pest of …….. crop.
   a. Wheat b. Cotton
   c. Paddy d. Groundnut

B. Make the pairs.

Group A	Group B
1. Wheat	a. *Arachis hypogaea*
2. Groundnut	b. *Cicer arietinum*
3. Soyabean	c. *Oryza sativa*
	d. *Triticum aestivum*
	e. *Glycine max*

C. Find the odd one out.

1. Chafa / Kalyansona / Brag /Gluten
2. Pod borer / Tikka / Gall fly / Stem borer
3. Termites / Wilt / Rust / Mosaic
4. Groundnut / Wheat / Paddy

D. Write True or false.

1. Oil content in groundnut seed varies from 45 – 55 %.
2. Sonalika is the important variety of paddy crop.
3. Soybean contain about 41 % protein and 20 % oil.
4. Gram is most important kharif crop in India.
5. Wheat has a good bread making quality among all cereals.

Q.2 Answer in brief.

1. Write short notes on collection of acid (*amb*) in gram
2. Name any four varieties of rice.
3. Write in brief about tikka disease of groundnut .
4. Write intensive method of paddy cultivation.
5. How nipping / topping is carried out in gram?

Q.3 Answer the following questions.

1. Give information on seed selection and seed treatment in paddy.
2. Write the uses of paddy
3. Write about seed rate and seed treatment in soybean.
4. Write in short about dapog nursery.
5. Complete the following chart :

Sr. no	Crops	Botanical name	Variety	Seed rate kg/ha.
1	Paddy	…….	…….	…….
2	Wheat	*Triticum* species	…….	100 - 125
3	Gram	…….	Chafa	…….

Q.4 Answer the following questions.

1. Write information about wet nursery in paddy.
2. List out the diseases of soybean.
3. How groundnut is harvested?
4. Write the uses of wheat.
5. Write the symptoms and control measures of paddy blast.

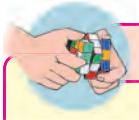
Q.5 Answer the following questions in detail.

1. Describe the wheat crop on following points :
   a. Soil
   b. Sowing methods
   c. Harvesting
2. Complete the following table.

Sr. No.	Crops	Botanical name	Seed rate kg/ha.	Varieties
1	Gram	……..	……..	……..
2	Ground nut	……..	……..	……..
3	Paddy	……..	……..	……..
4	Wheat	……..	……..	……..

Q. 6 Answer the following questions in detail.

1. Provide the information of groundnut crop on following aspects
   a. Climate
   b. Preparatory tillage
   c. List of varieties
   d. List of pest.
2. Give information on following points regarding cultivation of Paddy crop :
   a. List of varieties
   b. manuring
   c. Economic uses
   d. List of diseases



Activity

Complete the following table with information from your surrounding.

Sr. No.	Crop plants	Varieties	Sowing Method	Season	Pest and disease
1	Wheat				
2	Paddy				
3	Groundnut				
4	Soybean				
5	Gram				

2. Commercial Crops

Can you recall?

1. Different traditional crops.
2. Difference between traditional farming and commercial agriculture.
3. What is survival farming?
4. Why commercial approach is essential in agriculture sector?
5. Have you observed the Jaggery plant and sugar factory.
6. Which information will you share about banana chips and banana wafers?

2.1 SUGARCANE

Botanical Name : *Saccharum* species

Sugarcane comprises of following species.

i. *Saccharum officinarum*
ii. *Saccharum barberi*
iii. *Saccharum sinensis*
iv. *Saccharum spontaneum*
v. *Saccharum robustum*

Family: *Gramineae*

Origin:

1. *Saccharum officinarum* - Indo-Myanmar China border with New Guinea as the main center of diversity.
2. *Saccharum barberi* - North India
3. *Saccharum sinensis* - China
4. *Saccharum spontaneum* - India

Remember this

The Indian cane is a result of natural hybridization between *saccharum officinarum* and *saccharum spontaneum* (wild species).

2.1.1 Uses :

Sugarcane is mainly grown for the manufacture of sugar. Apart from sugar, other products like jaggery *(gul) and khandsari* are also prepared from this. Green tops of plant are used as forage for cattle. Stubbles are used as fuel in rural areas. Cane trash is used as thatching material for huts and also used for preparing compost. The factory by- products namely bagass, molasses, pressmud cake and wax are obtained. Bagass is used in paper industry, while molasses is useful in distillery for preparing acetic acid, alcohol, etc., and pressmud cake is used as manure. Wax is used for preparing lubricating material. Sugar itself is used as sweetener in food items, ingredient for hair tonics, shoe polishes, explosives, etc. It is also used in tanning leather, silvering mirrors, etc.

Do you know ?

- Globally 60 per cent of sugar comes from sugarcane and 40 per cent from sugarbeet.
- In India, sugar industry is the largest processing industry next to cotton textiles.

Fig. 2.1 Sugarcane Crop

2.1.2 Soil :

Sugarcane can be grown on a wide range of soils. In Maharashtra, it is grown predominantly on medium black soils. It grows best on well drained, fertile medium to heavy soils having 60-120 cm depth. Soils rich in organic matter and levelled are most suitable. The pH of soil should be between 6.5. to 7.5. It is a heavy feeder crop, hence not grown on light soils. Saline, alkaline and acidic, soils are not suitable for this crop.

2.1.3 Climate :

Sugarcane is a tropical crop but can be grown in subtropical region. It requires warm and humid climate for growth, while cool, sunny and dry climate for maturity. The temperature requirement is 30^{o}C to 35^{o}C for 4 to 5 months

and cooler climate 1.5 to 2 months before harvesting. Germination does not take place when temperature goes below 7^{o}C and plant growth is slowed down below 20^{0}C temperature. Both the extremes of temperature are harmful. Severe cold ceases the growth, while attack of stem borer increases in hot weather. It does best with 750 to 1250 mm annual rainfall. Rainfall deficiency produces fibrous cane, where as too heavy rainfall reduces sugar accumulation.

2.1.4 Preparatory tillage :

Sugarcane stands in the field for more than one year, hence land should be prepared by giving two deep ploughing. First ploughing is given immediately after the harvesting of previous crop with iron plough and the land is exposed to sun for one to two months. The clods are crushed with clod crusher or Norwegian harrow. About 35 – 50 tons of FYM/ha is added to soil. Second cross ploughing is given followed by 2 – 3 harrowings. Thus soil brought to clod free tilth. Land is levelled with the help of planker and beds are prepared.

2.1.5 Planting season and time :

Sr. No.	Planting season	Planting time
1	Seasonal/*Suru*	Jan – February
2	Pre-seasonal	October – November
3	*Adsali*	July – August

2.1.6 Lay out of land for planting and irrigation

1. Small bed with ridge and furrow method :

In this method ridges and furrows are prepared in small beds. Distance between ridges is 105-120 cm. This method does not allow inter cultivation by bullock drawn implements. But farmers like it, because more water can be applied at a time. Water flows from all the directions of the furrows as both the ends of ridge are kept open in the bed.

2. Serpentine method :

On slightly sloping lands, this method is followed. The Ridges and furrows are drawn across the slope in a serpentine way. The distance between ridges is 105-120 cm. This method has same advantages and disadvantages as that of small bed method except water is applied slowly and uniformly. One end (alternative) of the ridges is kept open to flow water in surpentine way in one direction only.

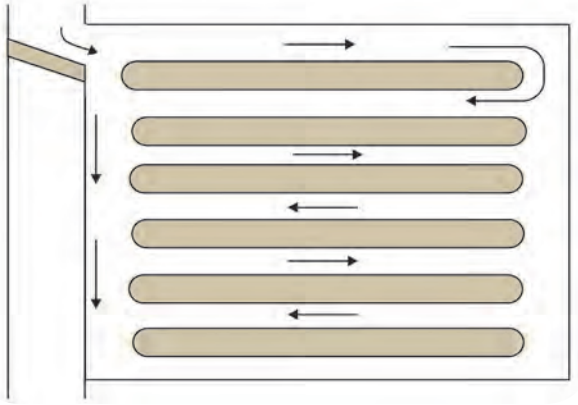


Fig. 2.2 Small bed with ridge and furrow

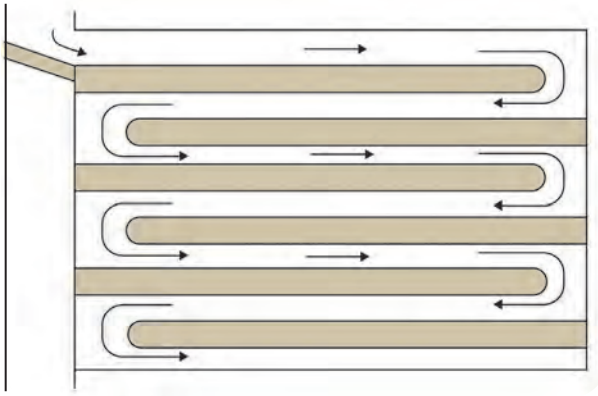


Fig. 2.3 Serpentine method

3. Long Furrow method : In this method distance between two ridges is 120 cm. The ridging is straight. Where land is levelled, this layout is commonly used. It allows inter-cultivation by bullock and tractor drawn implements. The irrigation can be watched at tail ends of furrows.

4. Contour furrow method : In this method furrows are opened along adjusted contour lines and a gradient of 10 to 15 cm per running 33 meters is given depending upon the soil type and topography

- This layout is followed on undulating and sloppy lands.
- It facilitates proper handling of water and reduction in soil erosion.
- Initial cost of this layout is more. By this method more water can be handled at a time.

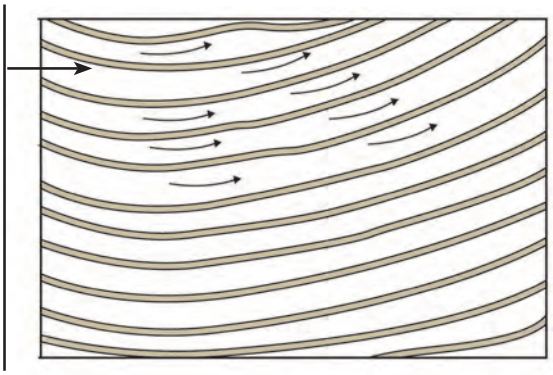


Fig. 2.4 Contour furrow method

5. Paired row (*Patta*) method :

In this method depending on the type of soil two consecutive furrows are opened at 2.5 to 3 feet distance and wide gap (empty space)of 5 to 6 feet is kept before the next set of two consecutive furrows. Cane is planted in consecutive furrows.

Advantages:

- It helps in vigorous crop growth and increased yield due to proper interception of sunlight and air
- Facilitates intercutivation and plant protection measures.
- Helps in saving irrigation water and reducing weed infestation.
- Intercropping is also possible without affecting the growth of sugarcane crop.

2.1.7 Planting methods : There are four methods of planting: 1. Ridges and furrows 2. Flat bed method 3. Rayungan method 4. Trench or Jawa method.

1. Ridges and furrows method : This is the most common method of sugarcane planting followed in Maharashtra. In this method ridges and furrows are prepared in small beds. Ridges and furrows are opened with the help of ridger at 105 cm distance on medium soil and 120 cm distance on light heavy soil. Main and Sub-irrigation channels are opened at appropriate distance. Planting is done by the following methods.

a. **Wet method :** This method is followed in light to medium soil. Irrigation is given to the field before plantation and then sets are planted by pressing them 2.5 to 5 cm deep in furrows with feet. While planting, the sets are placed end to end by facing buds on sides.

b. **Dry method :** This method is followed in heavy soils. Sets are planted into the furrow and covered with soil. After planting, irrigation is given to the field.

2. Flat bed method : This method of planting is followed in U.P., Bihar, etc. Land is ploughed, harrowed, levelled and flat beds are prepared. Cane sets are laid down in the flat bed end to end in rows at distance of 60 to 90 cm. They are pressed into soil with hand or feet to a depth of 2.5 to 5cm. and covered with soil. At the time of planting care should be taken that buds face should be on the sides.

3. Rayungan Method : It is followed in high rainfall areas for *adsali planting*. In Maharashtra this method is followed in river side fields in heavy rainfall areas of Kolhapur district. In these areas usually cane fields get flooded during rainy season. In such cases sets cannot be planted directly in main field. Single bud sets are planted vertically in nurseries in the month of June-July. Nursery should be on high lying area. After six weeks the sprouted sets are transplanted in the main field when the danger of flooding is over.

4. Trench or Jawa method : This method is followed in Jawa and Mauritius Islands. In India, it is practiced in Assam. The land is ploughed and trenches are made about 90 to 120 cm apart and 22 to 30 cm deep. The soil at the bottom is loosened and mixed with manures. The sets are planted in the middle of trenches and covered with soil to a depth of 7.5 cm. to 10 cm. This method produces large clumps of cane which do not lodge when tied together. Thus the damage from wild animals is also less.

2.1.8 Seed rate (Quantity of Sets) :

Sugarcane is propagated by vegetative method i.e. by using stem cuttings called as sets.

Seed rate of sugarcane depends upon type of soil, sources of water, type of varietis and type of planting. Generally 25,000 to 30,000 sets of 3 eye buds per hectare are required.

2.1.9 Selection of seed material (Sets) :

Set should be selected from healthy canes of well manured and cared nursery. Usually cane is cut into three bud sets. Planting with single bud sets is also practiced at some place. Buds on immature tops of cane germinate well and hence priority should be given to top sets. Over mature cane possess dry scaled buds and should not be selected for sets. Thick canes germinate better and produce good number of tillers and should be used for selecting sets than the thin canes. It is desirable for the farmer to raise his own separate seed or nursery crop.

Try this

Practice different methods of planting practically on the field.

2.1.10 Set treatment

- Set treatment with organo mercurial fungicide is necessary for preventing the attack of seed borne diseases.
- Treatment of carbendazim (0.1%) or copperoxichloride is given against leaf spot.

Fig. 2.5 Set selection and Set treatment

- Rotting of sets can be prevented by treating them with agallol or areton (0.5%)
- Hot water treatment at 50^0C temperature for 2 hours or at 52^0C temperature for half an hour is recommended to control grassy shoot and other viral diseases.
- Grassy shoot and leaf scald can be controlled by Moist-Hot Air Treatment at 54^0C and 99% humidity for 2 to 5 hours.
- Attack of Mealy bugs can be prevented by treating the sets with 1% fish oil rosin soap.
- Chloropyriphos or heptachlor @ 1kg/ha can be used for preventing the attack of termites and shoot borer. It is applied on cane sets at the time of planting

2.1.11 Varieties : CO-740, Co-775, Co-798, CO- 419, CO-421, CO-678, CO-475, CO-92005, CO-7125, (Sampada), CO-7219 (Sanjivani), CO- 8011, CO- 7527, CO- 671, CO- 86032, CO- 8014, CO- 85061, Phule - 265, CO - 10001, CO - 8005 etc.

Internet my friend

Collect information regarding sugarcane varieties and their important characteristics.

2.1.12 Manures and fertilizers : Sugarcane is a heavy feeder and long duration crop so, it requires more manures. Requirements of manures and fertilizers also depend on the variety of sugarcane. The recommended dose of organic and inorganic fertilizer for *adsali*, pre seasonal and seasonal sugarcane crop is used. At the time of preparation of land the organic manures i.e. FYM or compost is used for *adsali*, Preseasonal and seasonal cane crop 50, 35 and 25 tonnes per ha, respectively. Inorganic fertilizers for *adsali*, preseasonal and seasonal cane crop are given in table 2.1

Use your brain power

What are the advantages and disadvantages of application of urea to the sugarcane crop at the stage of maturity?

Table 2.1 : Recommended dose of fertilizers and its distribution

Sl. No.	Time of Application	Adsali				Pre-seasonal				Seasonal/Suru			
		FYM tones /ha	N kg/ ha	P kg/ ha	K kg/ ha	FYM tones /ha	N kg/ ha	P kg/ ha	K kg/ ha	FYM tones /ha	N kg/ha	P kg/ ha	K kg/ ha
1	At planting	50	45	85	85	35	35	85	85	25	25	62	62
2	6-8 weeks after planting	--	180	--	--	--	140	--	--	--	100	--	--
3	8-12 weeks after planting	--	45	--	--	--	35	--	--	--	25	--	--
4	At earthing up (22) weeks after planting	--	180	85	85	--	140	85	85	--	100	63	63
	Total	**50**	**450**	**170**	**170**	**35**	**350**	**170**	**170**	**25**	**250**	**125**	**125**

2.1.13 Intercultivation : The intercultural operations followed in sugarcane crop are as follows:

1. Gap filling

It is done after complete emergence of crop to fill up the gaps in the crop stand. It is done about 6-8 weeks after planting. Gap filling should be done using sets having sprouted eye buds from cane field.

2. Weed control

Depending on the intensity of weeds, 2 to 5 hand weedings should be given. It can also be controlled by weedicide with one pre-emergence spraying of atrazine or alachlor and post emergence spraying of prosulfuron, etc.

3. Hoeing

About 2-3 hoeings are given by two tyned hoes worked in the furrow to stir the soil and to remove weeds. This operation is done at one month interval.

4. *Tagarni or Bal bandhani*

Tagarni means a partial hilling up of soil against crop rows. This operation is done when the crop is at 3-4 months old, and starts rapid growth. It is done twice at an interval of one month for loosening the soil and pruning non-functional roots. In small bed this operation is done by manual labour with (pickaxe) and in long furrow, it is done by bullock drawn or tractor drawn implements.

5. Earthing Up

Earthing up means breaking of ridges and converting them into furrows. It is done when the crop is 5 to 5.5 months old and 2-3 internodes are visible. It is done to support the plants with soil and to avoid the direct contact of water to plants.

6. Detrashing

Removal of some of the older leaves from cane crop is known as detrashing. It is done to avoid the attack of insects and pest.

7. Mulching

Large quantities of cane trash are stored along the boundaries of cane field which can be used as mulch in furrows for conserving moisture. This helps in reducing requirement of water and adding organic matter into the soil.

8. Propping or tieing of cane plants

This operation is done to prevent lodging of cane crop. Some canes of two adjacent rows are brought together and tied by sugarcane leaves, rope. It also provides covenience while irrigating the field.

Observe and Discuss

Visit the sugarcane field and discuss with farmers regarding intercultural practices like gap filling, earthing up,detrashing, mulching, propping, etc.

2.1.14 Irrigation :

- Irrigation requirement depends upon type of soil, season, growth stage and duration.
- Shortage of water results in stunted growth, pith formation in cane and low yield.
- First irrigation is given as pre-planting, irrigation. Second light irrigation is given 7 days after planting. Up to germination subsequent 2-3 light irrigations are given at 10 days interval. Other irrigations are given depending on type of soil and season. In case of heavy soil irrigation is given at 10 days in summer and 20 days in winter season.
- In case of light to medium soil, it is given at 7 days in summer and 15 days in winter.
- Tillering, grand growth and earthing up stages are critical for irrigation.

Remember this

1. Now a days drip irrigation method is popular as it increases sugarcane yield by 20 to 25%.
2. Drip irrigation saves 50 to 60% water.
3. It reduces 30 to 40% fertilizer cost.
4. By using drip irrigation there is less chance for weed infestation.

2.1.15 Crop rotation :

- In low rainfall areas, sugarcane is rotated with cotton and in heavy rainfall areas it is rotated with paddy. For long rotation, sugarcane is rotated with banana and turmeric.
- The common rotations are:
  a. Paddy - Sugarcane - Ratoon
  b. Cotton - Sugarcane –Ratoon -Wheat
  c. Paddy - Groundnut - Jowar -Sugarcane
  d. Cotton - Sugarcane - Rabi Jowar
  e. Sugarcane - Green manure.

Try this

Visit the sugarcane field to acquaint the students with the different cultivation pracitices. Try to prepare a schedule of an intergrated pest and disesase management for sugarcane.

2.1.16 Intercropping : Onion, garlic, coriander, potato gram may be taken as intercrops in sugarcane which gives additional income to the farmers.

2.1.17 Plant Protection :

I. Pest

a. Top shoot borer :

Nature of damage :

i. Caterpillar initially feed on the leaves and later on bore into the shoot from the top.

ii. As a result of this, the main shoot stops growing and too many lateral shoots arises from the top internodes.

Fig. 2.6 Top shoot borer

Control measures :

i. Collect and destroy egg masses.

ii. Remove and destroy infected shoots.

b. Sugarcane stem borer :

Nature of damage :

The infected plant dries up as a result of injury caused by larvae to the stem.

Fig. 2.7 Stem borer

Control measures

Remove dead hearts (infected plants)

c. Pyrilla :

Nature of damage

i. It sucks up the sap from the leaves.

ii.The infected leaves become yellow and dry up.

Fig. 2.8 Pyrilla

Control measures :

i. Remove and destroy lower most leaves bearing egg masses.

ii. Spray the crop with Malathion (0.1 %)

d. Mealy bugs :

Nature of damage :

i. These are the small insects which remain adhering to the buds and sheaths of the cane and suck up the sap.

ii. Infected canes are shrivelled and remain stunted.

Fig. 2.9 Mealy bugs

Control measures :

i. Treat the sets with 1% fish oil rosin soap solution.

ii. Spray the crop with 1 % fish oil rosin soap solution or Malathion (0.1%).

e. Termites :

Nature of damage : White ants feed on buds of the planted sets.

Fig. 2.10 Termites

Control measures :

Application of chloropyriphos @ 1 kg/ha. at the time of planting is effective against termites.

f. Mites :

Nature of damage :

i. Mites suck up the sap from the lower surface of leaves.

ii. The infected leaves turn red and dry up.

Fig. 2.11 Mites

Control measures :

i. Give lime-sulphur spray in the proportion of 1:2.

ii. Spray the crop with monocrotophos.

g. Field rats

Nature of damage : A rat nibbles out the cane and reduces the yield.

Control measures :

Poison baiting with Zinc Phosphide and Selphos tablet is effective against rats.

Fig. 2.12 Field rats

h. Wooly aphid :

Nature of damage : Its outbreak occurs in area where rainfall is less and climate is hot and extremely humid. Infestation starts beneath the leaves along the midrib and later on spread to entire lower surface. Aphids suck the cell sap. In a case of severe infestation crop becomes stunted resulting into reduction in yield to greater extent.

Fig. 2.13 Wooly aphid

Control measures :

i. Spray the crop with the mixture of malathion and dimethoate. Repeat the spray after 15 -30 days, if necessary.
ii. Apply balanced nutrients on soil test basis and avoid excess use of nitrogenous fertilizers.
iii. Clipping and disposing of affected leaves when pest problem is rare on limited area.

II. Diseases :

a) Whip smut :

Symptoms : Whip like structure arises from the top of infected cane. It is surrounded by powdery mass of fungal spores. The infected plant may survive but remains stunted.

Control measures :

i. Remove the whip with thick cloth, without allowing the spores to fall on the ground and destroy it.
ii. Use healthy sets for planting.
iii. Use resistant varieties.

Fig. 2.14 Whip smut

b. Rust :

Symptoms : Numerous small but long yellow coloured spots appear on both the surfaces of leaves. These spots later on turn dark brown to black.

Fig. 2.15 Rust

Control measures :

i. Grow resistant varieties and avoid excessive irrigation.
ii. Spray the crop with 0.05 % zyrum.

c. Red rot :

Symptoms : The leaves turn yellow and dry up. Internal portion of cane becomes red and when cane is split up, uneven red stripes with occasional white strips are observed.

Fig. 2.16 Red rot

Control measures

i. Use healthy sets for planting.
ii. Avoid ratooning of affected crop.
iii. Grow resistant varieties.
iv. Treat the sets with aretan or agallol.

d. Grassy shoot :

Symptoms : From the base of affected plant too many lateral tillers arises, which are light to dark green in colour.

Fig. 2.17 Grassy shoot

Control measures :

i. Treat the sets with hot water at 50^0C temperature for two hrs or at 52^0C temperature for half an hour or with moist hot air at 54^0C temperature.
ii. Use resistant varieties.

e. Mosaic disease :

Symptoms : There is mottling of leaves as dark green or light green stripes.

Control measures : i. Remove and destroy infected plants.
ii. Grow resistant varieties.

f. Twisted top :

Symptoms : The top most leaves become abnormal and intermingled into each other forming knot like structure. Locally it is known as *veni* disease.

Control measures

i. Remove and destroy affected plants.
ii. Change the sets for planting

2.1.18 Harvesting : The sugarcane is said to be mature when the sucrose concentration goes above 16 percent and the purity of juice is more than 85 percent. The parameters which are applied for determining the time of sugarcane harvesting are

a. General yellowish appearance of the entire crop.
b. Metallic sound of cane after being tapped by finger nail.
c. Breaking of cane at the node after bending.
d. Cessation of plant growth and emergence of flowering arrows.
e. Swelling of eye buds.
f. Brix–Saccharometer reading (21 to 24 brix).
g. The average crop age of Adsali, Pre-seasonal and Suru crop is 18, 15 and 12 months respectively.

After ascertaining the maturity by above criteria, the crop is harvested by cutting the cane near to the ground level with the help of sharp chopper or knife. The dry leaves and roots are removed from the cane. The immature tops with leaves are also cut off. Cane is then bundled and taken to the factory for crushing.

2.1.19 Yield :

Sugarcane yield varies with the season of planting as stated below:

1. *Adsali*: 150 tons / ha.
2. Pre- seasonal: 125 tons / ha.
3. *Suru* / Seasonal: 100 tons / ha.

2.1.20 Ratooning :

Ratooning is the practice of allowing stubbles of previously harvested crop to sprout and grow to raise a new crop.

A good ratoon crop can also give quiet comparable yield with seasonal/ *suru* crop. Mid late and late high yielding varieties are better ratooners than early maturing varieties.

a. Importance :

Ratooning is very economical as it saves costs on preparatory tillage, purchasing of seed material and planting of sets. Similarly it gets an advantage of residual manure. In all it is estimated that there is 20- 25 % saving of expenditure as compared to planted crop. It also gives good yield, if same care is to be taken as for the planted cane.

b. Ratoon management

The practices to be followed for ratooning are as follows:

1. The planted cane should be harvested at ground level.

2. Dried canes and trash should be removed. Trash mulching may help in moisture conservation and suppressing weed growth.
3. Emerged shoots and protruding stubbles should also cut at ground level to have uniform stand of crop.
4. The hard soil needs to be loosened. Sides of ridges should be broken by plough and middle portion is loosened by iron grubber or shovel tooth cultivator.
5. The irrigation scheduling may be more or less same as for planted cane. First irrigation should be given 3- 4 weeks after harvesting.
6. The nutrient requirements are same to that of suru crop. Nitrogen is applied in two splits at ratoon initiation and 60 days then after. Whole phosphorus and potassium should be applied at ratoon initiation.
7. Earthing up should be done at the age of 3-4 months.
8. One hoeing and 2-3 hand weedings are required.
9. In India only one ratoon or sometimes two are practiced.
10. Late maturing varieties and *Adsali* ratoon gives more yield.

Remember this

Sugarcane ratoon contributes 50 to 55 % of total sugarcane area and 30 to 35 % of total sugarcane production in India.

2.1.21 Preparation of Jaggery (*Gul*) :

It is second important product after sugar. It is prepared by a number of operations as summarized below:

- Iron crusher operated either with bullocks, oil engine or electric motors are used and cane is crushed to obtain juice.
- The juice is then filtered through wire guage and taken to the boiling pan or stored in metal vessels or storage tank.
- The juice should be boiled within a period of 6 hrs. after its extraction.
- Suspended impurities and colloidal matter are removed by first heating for a period of

Fig. 2.19 *Gul* blocks

30 to 35 minutes. The scum is removed by long handled perforated ladle.

- Bagass, trash or cotton stalks etc., are used as fuel for heating.
- The juice in the course of heating is freed of all impurities by bhendi mucilage. An emulsion made up of groundnut and castor seed in water may also be used.
- Chemical clarificants like super phosphate solution is used in second course of heating for removing impurities and for improving colour of jaggery.
- Kagzi lemon suspension is essential for avoiding saltish taste to the juice.
- Lime water solution is used to avoid problems in solidification of jaggery.
- Striking point of liquid jaggery is 105^{0}C to 107^{0}C temperature and for solid jaggery it is 116^{0}C to 118^{0}C.
- Hot liquid jaggery is then transferred to a cooling pan. The juice is then stirred constantly by long handled wooden spade. When juice reaches in semi solid stage, it is poured in moulding pans of varying shapes and sizes.

Fig. 2.20 Jaggery preparation

2.2 MANGO

Botanical Name : *Mangifera indica*

Family: Anacardiaceae

Synonym : *Amba, Amra*

Origin : Indo-Burma region

Fig. 2.21 Mango fruits

2.2.1 Uses:

Mango is the king of tropical fruits and is pride of India. Wonderful changes are observed in case of its taste from immature to matured stage. Mango fruit possesses a very high nutritive value. It is consumed as fresh table fruit. Many preserved / processed products like jam, squash, canned pulp and slices, pickles, chatneys and amchur are also prepared. Fresh fruits as well as processed products are exported. Konkan is one of the main region where quality Alphonso mango fruits are produced. It is good source of Vitamin A, B and C.

Internet my friend

Find other uses of mango fruit, seed and plant parts.

2.2.2 Soil :

Mango can grow in various types of soil from alluvial to laterite. It prefers slightly acidic, well drained, fairly deep (2m), loamy soil which is rich in organic matter. The water table should be below 2.5 m. The range of pH should be between 5.5 to 7.5. The soils in Ratnagiri are rich in Fe and Al and therefore, there is a typical colour and taste to Ratnagiri alphonso.

Internet my friend

Collect information on propagation methods of mango and find the best suitable method for your region.

2.2.3 Climate :

Mango crop can thrive in wide range of climatic conditions. It grows well in tropical and subtropical climate. It favours a temperature range of 24^0 C to 27^0 C. It can tolerate a very high temperature even up to 48^0 C. High temperature favour fruit development and maturity. Very low (freezing) temperatures and commonly occuring frost during the period of flowering are limiting factors for cultivation. Mango flowers only when temperature start rising after winter. It can do well in an area of average rainfall of 250 cm. During flowering, bright sunny days and low humidity are ideal for mango cultivation. Fairly warm, dry, rainless and frostless weather during flowering ensures heavy and healthy crop.

2.2.4 Propagation :

Mango can be propagated by

i. Sexual method i.e. by using seeds

ii. Asexual method i.e. by means of vegetative propagation

Mango when propagated by seed does not come true to type. Being highly cross pollinated and heterozygous in nature, seed propagation even from the seeds of single tree results in enormous variation in seedlings. Most of commercial mango varieties are monoembryonic.

Commercially mango is propagated by asexual method to get true to type and early yielding plants. It is propagated by grafting on mango rootstock seedling. *In situ method* mango stones (seeds) are planted in field directly and then grafted with desirable type. For this soft wood grafting is mostly used.

As compared to techniques like veneer grafting, approach grafting, side grafting recenty, stone grafting is being adopted efficient. Rootstock seedling are prepared from monoembryonic as well as polyembryonic plants. The seed should be sown within one week after its extraction from ripe fruit. The seeds loose viability within 4 to 5 weeks from extraction. Just germinated stock when leaves are pink the seedling is used for stone grafting. The period suited for stone grafting is July-August.

2.2.5 Spacing :

Planting is done at spacing of 7 × 7 m. for dwarf varieties and 10 × 10 m. distances for tall varieties.

2.2.6 Varieties :

Varieties are classified according to use -

1. **Table varieties** : Alphonso, Kesar, Neelam, Totapuri, Dasheri, Langra, Goa Mankur, Ratna, Amrapali, and Mallika, etc. (should have pleasant, sweet subacid taste with delightful flavour. The stone should be small with firm pulp, and should ripen slowly during storage)
2. **Juicy varieties**: Pairi, Dudhpedha, etc. (Should have soft pulp with or without fibre, fruits should be juicy with agreeable flavour)
3. **Pickle and preserve varieties**: The varieties are, Karel from Sawantwadi for pickles and Gawasji Patel and Amini for preserves. (varieties having sour taste, white firm pulp with even terpentine smell can be used for pickles)
4. **Irregular bearing varieties**: Alphonso, Pairi, Dasheri, Langara, Sindhu (seedless variety – evolved by K.K.V., Dapoli, MS).
5. **Regular bearing varieties**: Neelam, Totapuri, Amrapali, Mallika and Ratna.

Let's discuss

1. What is meant by irregular and regular bearing in mango?
2. What is spongy tissue in mango?

2.2.7 Planting method and materials :

After preparation of land for planting the pits of the size 90 × 90 × 90 cm are dug during summer months. The pits are filled with 20 to 25 kg F.Y.M. or compost and top soil. Phorate 10 G be mixed in the upper layer of soil to avoid termite problem.

Planting should be done during rainy season. In Konkan area planting is done after heavy rains. While planting, it should be seen that the earth ball (rooted ball) of graft does not break. The planting is done generally in the evening. The graft union should not be buried in the soil. The plant should be given irrigation immediately after planting.

After care

After planting uniform moisture level should be maintained and water stagnation should be avoided. Use thatch or lacally available materials to protect the seedling from hot and dry sun. In the initial 2-3 years, the plants are protected from summer heat by covering the stem with dry grass or straw.

2.2.8 Manuring :

The crop should be manured regularly. The manures should be given in the month of June- July, September - October, January-February and efforts are made to develop good framework of the plant. Recommended dose of manure and fertilizer for mango crop on the basis of age is as per the following table.

Use your brain power

What type of bahar treatment is necessary to mango plant.

Manuring Programme of Mango trees

Age of the tree	FYM (Kg)/ plant	N (g)/ plant	P (g)/ plant	K (g)/ plant
1 year	10	20	18	50
2 years	15	50	27	75
3-5 years	25	100	36	100
8-10 years	50	400	144	400
10 years on	75	500	360	750

2.2.9 Irrigation :

Irrigation requirement is high in dry areas and less in high rainfall areas and in heavy soils. First irrigation is given just after planting. Irrigation at the interval of 2 to 3 days should be given in summer in the first year and from the next 2-5 years irrigation should be given at the interval of 4-5 days in summer. As rainfed crop where *in situ* planting is done mango does not require regular irrigation. The frequency and amount of water should be adjusted according to soil and climatic conditions.

2.2.10 Intercropping :

During the first 8 to 10 years intercrops should be taken if irrigation facilities are available. Fruit crops like papaya, pineapple or vegetable crops can be grown as intercrops.

2.2.11 Plant protection :

I. Pest

a. Mango hopper :

Nature of damage : It is very destructive pest of mango during flowering season. Adults and nymphs suck sap from tender shoots and panicles causing drying of the panicles. The fruit setting is affected. Honey dew like secretion on leaves and panicles results in the growth of sooty mould on affected portion.

Fig. 2.22 Mango hopper

Control measures :

i. Hoppers are controlled by spraying Malathion 0.15% or monocrotophos 0.02%.

ii. Sray Carbaryl 10% at the time of panicle emergence and peak fruiting stage.

b. Mango mealy bug :

Nature of damage : The nymphs of mealy bug suck sap from young mango shoots, panicles and flowers and fruits. Drying of affected part of the plant and immature fruit drop occurs. The insects can be identified by white milky powder.

Control measures :

i. The damage can be avoided by digging trench around the trunk during hot months.

ii. Stick bands of grease + coatar in the proportion of 1: 2 and resin + castor oil in the proportion of 4:5, 30-45 cm wide strip should be applied around the tree trunk.

iii) Banding stem with polythene sheet of 400 gauge at 45 cm height from ground

iv) Spray monocrotophos 0.02% on the tree.

Fig. 2.23 Mango mealy bug

c. Fruit fly :

Nature of damage The damage includes feeding of maggots on the pulp leading to appearance of off-smelling. Rotting followed by falling of fruits.

Fig. 2.24 Fruit fly

Control measures :

i. Collection and destruction of the affected fruits.

ii. Hanging traps containing methyl eugenol @ 10 in number/ ha.

d. Bark eating caterpillar :

Nature of damage The caterpillars bore into the bark and feed on it. The dark brown excreta appear in the form of ribbons on the affected portion of the bark. Drying of affected branch can also be seen.

Control measures :

i. Control includes cleaning of tunnel with hooked wire and filling the hole using kerosene.

ii. The hole should be plastered using mud.

Activity

Collect information and samples of physiological disorders in mango.

e. Stem borer :

Nature of damage : The pest tunnel through the main trunk or its branches. Coming out of hard ball of excreta from the tunnel portion, drying of branches in case of severe attack are the characteristic damage.

Control measures :

i) Clean the tunnel with hard wire.

ii) Pour kerosene oil inside the hole and plug it using mud.

II. Disceases :

a. Powdery Mildew :

Symptoms : It is a fungal disease and the mango crop can be completely destroyed in case of severe attack. Grey white powdery blocks appear on the blossom and fruitlets. Affected panicles get dry and turn black. It may cause total failure of the crop.

Fig. 2.25 Powdery mildew

Control measures : Application of wettable sulphur 0.2%/karathane 0.1%/Bavistin 0.1% or Benlate 0.1% are recommended for the control.

b. Anthracnose :

Symptoms : It is a fungal disease. Appearance of black necrotic areas on leaves, shoots, inflorescence and fruits are seen. Dropping of young fruits. Rotting of affected fruits in storage also appears.

Fig. 2.26 Anthracnose

Control measures : Spray Blitox 0.3 %.

c. Loranthus

Symptoms : It is a parasite. It grows on the branches of mango tree and it causes retardation of growth and yield of trees. Degradation of fruit quality.

Control measures : Cut parasite affected branches below the point of invasion.

2.2.12 Harvesting :

In Maharashtra mango starts flowering in the month of November and continues till February. Fruits become ready for harvesting in the month of March-June i.e. 4-5 months are required from flowering to harvesting.

Keep in Mind

Maturity indices of mango fruit

1. Slight colour development on the shoulders of the fruits (yellowish or reddish pigmentation is developed).
2. Dark green colour of immature fruits change to pale green on maturity.
3. When one or two ripe fruits fall from the tree, other fruits are supposed to be matured.
4. When the specific gravity of fruits reaches between 1.01 to 1.02 they are considered ready to harvest.

When fruits are ready for harvesting, fruit picker climbs the tree and collect fruits in bags on his shoulder. Recently, Konkan Krishi Vidyapeeth has developed a mango picker. In this picker, a bamboo pole is fitted with a cutting blade at the end under which fruit collecting net is tied.

2.2.13 Yield :

Yield upto 10 years age - 500-800 fruits/ plant. i. e. 8 to 12 tones / ha.

Yield after 15 years - 1000-3000 fruits/ plant. i.e. 12 to 20 tones/ha.

Try this

Why is packing necessary for transporting of mango to long distance market?

2.3 BANANA

Botanical Name: *Musa cavendish*
Musa paradisiaca
Musa sapientum

Family: Musaceae

Synonym: *Keli, kela*

Origin: The mountain regions of Assam, Burma, Thailand and Indo - China.

Fig. 2.27 Banana

Can you recall?

1. Have you visited any banana plantation?
2. Which is the leading district in banana cultivation?

2.3.1 Uses :

In India banana is the second important fruit crop next to mango. Maharashtra stands first in the country for production and area of banana. The fruit is available throughout the year. Out of the total production of banana 85 per cent is used for fresh consumption and about 14% is used for processing. i.e., powder, dried banana, etc. Banana is a rich source of energy. All the parts of this plant are useful to various products like soft drink, beer etc. It also contains vitamins A and B. Banana is a rich source of minerals like phosphorus, calcium and magnesium, etc.

Try this

Spot the region where banana is mostly cultivated in Maharashtra and note the climatic conditions of that area

2.3.2 Soil :

Banana can be grown in various types of soils in India. The soil suitable for banana should have 1m depth, well drained, fertile, free working, moisture retentive, and containing plenty of organic matter. Fertility of soil is very important for successful cultivation as it is heavy feeder crop. The root system of banana goes up to a depth of 1m with a concentration of majority of its roots (30 to 40 cm depth) in upper layer. Though banana is a water loving plant, it cannot tolerate water logging condition. The range of pH should be 6 to 8.

2.3.3 Climate :

Banana is tropical crop and requires a warm, humid and rainy climate, but has wide adaptability from wet tropical to dry sub- tropical regions. It can be grown in a temperature range of 10 to 40^0 C. The yield is more when temperature is above 24^0 C for a considerable period. Heavy storms, frost, low temperature below 10^0 C or extremely high temperature are limiting factors for successful cultivation. It needs good humidity with an abundant water supply. The total water requirement of banana plant is about 900-1200 mm for its entire lifecycle for satisfactory growth. If rains are distributed over a period of 8 months then it can be taken as rainfed crop. It cannot tolerate water stress at any stage of growth. Maharashtra have the most ideal climate for banana cultivation.

2.3.4 Propagation :

Commercially edible bananas are seedless and propagated exclusively by vegetative means eg. Rhizomes, sword suckers and bits. Sword suckers having narrow sword like leaves are selected as they grow vigorously, faster and bear large size bunches. 2-3 months old sword suckers with 30 cm height and 500 g to 1 kg weight is ideal for planting. Broad leaf sucker or water suckers should be discarded. Narrow

leaf sucker becomes broad leaf soon after its detachment from mother rhizome. Suckers of 2 to 4 months age are selected.

Basrai variety in Jalgoan district is propagated through dormant rhizomes. After cutting the parent plant, the rhizomes are removed from soil, stored in a cool, dry place for about 2 months. During the resting period the remaining part of pseudo stem at the bottom falls off, leaving prominent heart bud. Conical rhizomes should be selected. Flat rhizome should be rejected. The weight of rhizome should be 500 to 800 g. Rhizomes should be 3-4 months age at planting very small rhizomes, will give bigger size fruits with late flowering. While bigger size rhizomes fruit flowers early but bear small size bunches.

Banana is also propagated by bits. It is a small cut piece of rhizomes having at least one bud on it. Now tissue culture technique has been made possible to prepare plants true to type.

2.3.5 Varieties : In Maharashtra the following varieties are commercially cultivated.

1. Dwarf varieties

Basrai, Rasthali, Sonkel, etc.

2. Semi tall varieties

Harichal or Bombay Green, Safed Velchi, etc.

3. Tall varieties

Lal velchi or Champa, Poovan, Grand-9, etc.

2.3.6 Preparatory tillage : It is biennial crop, hence before planting, field should be prepared by ploughing followed by harrowing. FYM at the rate of 40 -50 tones/ha. is added.

Remember this

Sword suckers:

1. Sword shape leaves, pointed at the tip
2. Pseudo stem is strong
3. Strong in growth
4. It is used for propagation gives late crop but yield is more

2.3.7 Planting method : There are two methods of planting.

i. Pit method : This method is very laborious and expensive for planting of banana, pits of 45x45x45 cm are dug and the pits are filled with well decomposed FYM.

ii. Furrow method : This is common method in which furrows of 20-25 cm depth are opened by a ridger at a distance of 1.5 m and rhizomes are planted in a furrow.

Generally June to July is the most common time of planting in India. The suckers are planted in such a way that it will be 20 to 30 cm below the surface of soil.

2.3.8 Spacing :

The distance of planting depend upon the variety, climate, yield and quality expected, and practice of ratooning. According to vigour of the variety the distance of planting varies from 1.25 to 3.00 m.

2.3.9 Planting season :

The planting can be done any time during the year if irrigation facilities are available. It has two main season :

i) **Mrigbaug :** Planting should be done at the end of May to end of June for better sprouting of rhizome and vegetative growth.

ii) **Kandebaug :** Planting should be done from the end of September to early October. It facilitates early quick growth of banana due to October heat. February planting is also recommended to overcome the problem of choking of inflorescence due to low temperature.

2.3.10 Irrigation :

The banana plant with its large leaves and succulent Pseudostem requires adequate soil moisture throughout the year for optimum growth. For one banana crop of 18 months 50-70 irrigation turns are required.

After planting it develops one leaf every week. The growth of plant is very fast from beginning itself. Banana is a water loving plant and thus needs frequent irrigation. Immediately after planting the orchard is flooded with water. Under dry condition it has to be irrigated throughout the year. The frequency of irrigation will depend upon season, type of

soil and location. Generally in rainy season no irrigation is given except long monsoon breaks. In summer season irrigation is required more frequently (4 to 7 days interval) than winter season (10 to 15 days interval).

Think about it

1. Whether drip irrigation method is more beneficial to this crop than flooding method.
2. Whether sprinkler method is suitable for irrigatiing banana crop.

Remind

Irrigation schedules –

i. Beginning of monsoon when rains are scanty – irrigation at 10- 15 days interval.
ii. July to August – normally no irrigation is required.
iii. September – irrigation once or twice a month.
iv. October to end of winter – 10-15 days interval between two irrigation.
v. February to end of May – 4-7 days interval between two irrigation.
vi. The quantity of irrigation should be 75 cm/ha. at each time.

2.3.11 Manures and Fertilizers :

Banana is a very heavy feeder and quickly responds to manuring. It requires plenty of organic matter for excellent growth and producing better crop. The fertilizer application is completed before flower initiation which normally occurs within 5-6 months from planting. The organic manures should be applied before planting, and for higher production the banana plant should be fertilized with 100 g N, 40 g P and 100 g K per plant. Out of this P and K should be applied in one single dose along with 50 tonnes FYM/ha. before planting. Nitrogen is applied in three splits as 40 g, 30 g and 30 g respectively after planting at one month interval. One additional dose of 50 g nitrogen is given after fruit set for better development of fruit.

2.3.12 Special cultural practices :

1. Desuckering : Desuckering is the removal of unwanted suckers from mother plant. These suckers are to be removed from mother plant from time to time as they compete with the mother plant for nutrients resulting in yield reduction. Suckers start appearing from the base of plant after about 3 month of planting.

2. Protection against physiological disorder : Dislodging of bunch is a physiological disorder caused mainly due to uneven irrigation, hot dry wind and inadequate supply of potash. To protect the plant give proper irrigation and good supply of potash is required.

3. Protection against low temperature : Banana is very sensitive to low temperature (below 7^0C) due to this leaves turn yellow and also cause scorching of leaf, growth rate as well as fruit maturity is delayed, and inflorences gets chocked. To protect the plant from low temperature, smudging and covering of bunch is followed.

2.3.13 Plant Protection :

I. Pest

a. Stem borer :

Nature of damage : The insects feed and make tunnel inside the corm. Leaves turn yellow followed by withering and drying of plant.

Control measures : Use carbofuran granules @ 3 g /plant.

Fig. 2.28 Stem borer

b. Banana aphid :

Nature of Damage : The aphid is a vector of viral disease bunchy top of banana. The insects suck the sap from young and tender leaves.

Fig. 2.29 Banana aphid

Control measures : Spray 0.05 % phosphomedon.

c. Burrowing nematode :

Nature of damage : Small dark spots appear on the leaves. The plants do not respond to fertilizer.

Control :

i. Use Furadan at 2 kg/ ha just before or after planting suckers.

ii. It can also be control by application of systemic granular insecticide / neem cake, etc. to the soil.

iii. Dipping of rhizomes at the time of planting in 0.2 % Fenamiphos for 10 minutes.

II. Diseases

a. Panama wilt

Symptoms : It is a fungal disease caused by water stagnation or ill drained soil. Yellowing of lower leaves including leaf blades and petioles. Hanging of leaves around pseudostem and withering are the important symptoms. Turning of fruit to bottle shape also occurs.

Fig. 2.30 Panama wilt

Control measures :

i. Growing resistant varieties like Basrai, Poovan, Robusta and Champa.

ii. Avoid continuous cropping of banana in the same field.

iii. Use disease free planting material and apply quicklime near the base of the stem.

b. Leaf spot or sigatoka disease :

Symptoms : It is fungal disease, light yellow oval spots on the leaves. The centre of the spot dies. Turning leaf light gray surrounded by brown ring and killing of large portion of leaves.

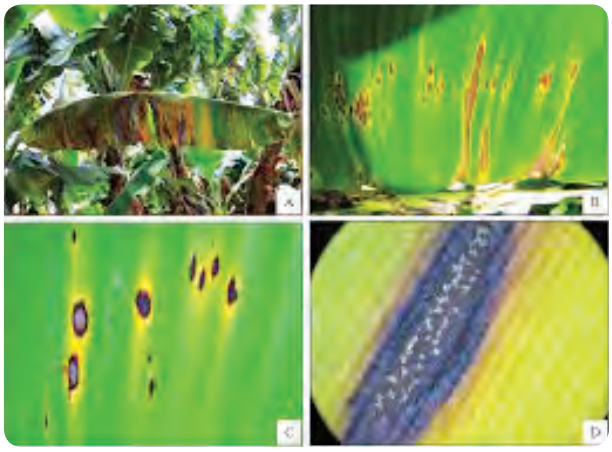


Fig. 2.31 Leaf spot

Control measures : Spray Dithane M- 45 / Captan 0.2%.

c. Bunchy top :

Symptoms : It is viral disease. The leaves develop bunchy like structure.

Fig. 2.32 Bunchy top

Control measures :

i. Application of carbofuran to soil at the time of planting is the effective preventive measure for this disease.

ii. Clean cultivation should be practiced.

2.3.14 Harvesting :

Under favorable conditions banana flowers 230 to 260 days after planting. And fruit mature 100 to 120 days after flowering. Bunches are harvested at 3/4 th maturity for distant markets and for local market they can be harvested at full maturity.

Keep in Mind

Signs of banana maturity

i. Change of fruits colour from dark green to light green.
ii. Tendency of floral end of fruit to fall by slightest touch by hand.
iii. Fruit becomes round shaped and angles are filled in completely.
iv. When tapped, the fruit give metallic sound.

2.3.15 Yield :

The yield varies according to variety. The average yield of banana is 30 tons/ha. The yield of basrai variety is 40 to 45 tons/ ha.

2.4 MANDARIN ORANGE (SANTRA)

Botanical Name : *Citrus reticulata*

Family : Rutaceae

Synonym: *Santri/santra*

Origin: South East Asia (India, China)

Fig. 2.33 *Santra* crop

Can you recall?

1. Which city in Maharashtra is famous for Mandarin orange?
2. State availability time of *santra* fruit in to market?
3. Do you like Mandarin orange fruit? Why?

2.4.1 Uses :

Citrus fruits are commercially important fruits of India. Mandarin orange fruits are rich source of vitamin C. It is the most refreshing and health promoting juicy fruit. It is excellent source of pectin and certain essential oils and also supplies other vitamins, fruit sugars, fruit acids, minerals, and alkaline salts which are needed in diet. Fruits are used as fresh table fruits as well as used for preparing refreshing beverages. The juice of fruit is bottled and canned in large scale. Mostly the juice is advised to patients. The segments of orange are canned and other commercial products are citric acid, pectin, etc.

Remember this

Botanically citrus fruit is classified as modified berry i.e. “Hesperidium” in which the rind is not edible.

2.4.2 Soil :

Mandarin orange trees grow luxuriously in 1.5 m deep well drained soils. Soil which are medium to light loam, deep, well drained, free from excess salts and having adequate content of organic matter are most suitable. Very heavy soils have a problem of drainage. The presence of lime also affects the growth of oranges. Lime should be below 10%. The pH range of soils for orange is 6.5 to 7.5. Soil with water table less than 2 m and soil containing lime nodules should never be selected for Mandarin orange as it is very sensitive to salt accumulation.

2.4.3 Climate:

Mandarin orange require subtropical and tropical climate. However occasional light frost can be tolerated by most of the species. It prefers more humid climate and tropical

summer, warmer winters and more rainfall. Average temperature requirement is from 10^0 to 37^0C. Mandarin orange tolerate extremes of temperatures. In Vidarbha mandarin orange is grown successfully with higher temperature upto 45 to 48^0C. It grows well in areas with annual average rainfall of 875 - 1125 mm.

2.4.4 Varieties :

Nagpur *santra* is grown commercially in Vidarbha region. The important varieties are Coorg Mandarin (Karnataka), Kinnow (hybrid variety) Emperior, Hill orange, Mudkhed seedless, Honey (for kitchen gardening), Satsuma.

2.4.5 Propagation :

Orange commercially propagated by shield or "T" budding by using a rootstock of jamberi or rangpur lime. Rootstock of rangpur lime is suitable for early bearing, more and quality fruits and free from viruses like *tristeza.* Rootstocks are mostly propagated by seed. The seed of rootstock are sown in a bed during October, November and seedlings become ready for budding after a year i.e. during next year in October to December.

2.4.6 Planting method and mateial :

Generally planting is done during rainy season in previously prepared pit at the spacing of 6 × 6 m by square system. The pit of 1 × 1 × 1 m should be dug and filled in with a mixture of good soil and compost. Single super phosphate 1 to 2 kg and phorate 10 G, 75 to 100 g should be mixed in the lower layer of pit. At the time of planting care should be taken to keep the bud joint at 20-25 cm above ground level. After planting of budded plant, irrigation should be given immediately, if there is no rain.

Remind

Sequence of budding operation

Sowing seed for rootstock ==> Transplanting of seedling in poly bag or seed bed ==> Selection of scion bud ==> Budding on seedling rootstock ==> Budded plants ready for Shifting ==> Shifting of plants from seedbed to raised bed for set ==> Shifting of plants from raised bed to nursery bed for sale or planting.

Remember this

In Mandarin orange, Rangpur lime and Jambheri were generally used as root stocks. But now-a-day kinnow is prefered as it improves the quality of fruit.

2.4.7 Irrigation :

After the rainy season is over the orchard is harrowed cross wise and basins are prepared for irrigation purpose. Irrigation is given by ring system with the object to avoid the contact of water with trunk of plant and to avoid gummosis diseases. The size of ring basin should be equal to the canopy or periphery of plant as spreading of root system is more or less equal to the canopy of a tree. Irrigation during winter is given at an interval of 8 -10 days while during summer at 4 days interval. The frequency of irrigation depends on the type of soil, age of the plant and climatic conditions. During rapid growth and flowering stage, the plants are particularly sensitive to water stress. Nowaday, drip irrigation is recommonded for santra plantation which save near about 50% water. Heavy irrigation should be avoided as it may cause accumulation of salt as well as induce collar rot and gummosis.

2.4.8 Manures and fertilizers :

The orchard should be manured twice a year and the main principle is that such application should coinside with growth flushes. Manure should be applied 1-2 month before flowering while fertilizers are applied just before flowering and fruit set. Generally manures and fertilizers are applied during June - July and January - February.

In the month of March and August, trees should be sprayed with micronutrients i.e. 0.2 % Zinc sulphate with the onset of new growth.

Remind

Age of the tree	FYM (kg)/ plant	N (g)/ plant	P (g)/ plant	K (g)/ plant
1 year old	5	120	60	50
2nd year	10	240	120	120
3rd year	15	360	180	180
4th year	20	480	240	240
5th year	25	600	300	300
6th to 9th year	30-40	720	360	360
10th year and onword	40-50	1000-1200	360-400	360-400

0.25 kg and 2 kg of Neem cake can be given to 1 year old crop and 10 years old crop respectively.

2.4.9 Bahar treatment :

The main object of bahar treatment (water stress) is to bring the soil to a temporary wilting stage, thereby reducing nitrogen supply and accumulating carbohydrates content in the branches or twigs resulting in good C : N ratio. Mandarin orange starts commercial bearing from the 6th year onward and produces two main growth flushes or bahars in a year. Bahar treatment should be followed as under :

Bahar	Period of bahar treatment	Period of flowering	Period of harvesting
Ambia bahar	Nov-Dec	Jan-Feb	Oct-Dec
Mrig bahar	April – May	June-July	Feb - Mar

2.4.10 Intercultivation :

- Timely removal of weeds and loosening of soils is regular practice followed in orchard.
- Loosening of basin soil is necessary as it becomes compact.
- Deep ploughing at flowering and fruit stage be avoided.
- Due to heavy weight of fruits there is possibility of bending of branches or splitting of branches. To avoid such possibilities the trees should be supported with bamboo stakes.
- Dried branches, infected plant parts and excessive growth should be timely removed in time.

2.4.11 Plant protection :

I. Pest

a. Lemon butterfly :

Nature of damage : The insects feed on the leaves from the margin toward the mid-rib and defoliate branches. The insect also feeds on fruit stalk resulting in dropping of fruits.

Fig. 2.34 Lemmon butterfly

Control measures : Hand picking of larvae and spraying of Malathion 0.5 % is effective against lemon butterfly.

b. Citrus psylla :

Nature of damage Suck the sap from tender shoots and leaves resulting in curling of leaves. Defoliation and drying of twigs. Secretion of honey dew like crystalline material resulting in growth of sooty mould appears. It also acts as a vector of greening disease and brings citrus decline.

Control measures : Spraying of Nuvacron 0.025% or Monocrotophos 0.02% is recommended.

c. Stem borer :

Nature of damage It is very severe pest of mandarin orange. It bores into the trunk near the tree base and makes tunnel leading to drying of plants.

Fig. 2.35 Citrus psylla

Control measures :

i. Keep the orchard clean.
ii. Treat the soil around the trunk with phorat dust.
iii. Spray the tree with 0.02% methyl parathion
iv. Inject petrol in hole and Plug with cotton balls or mud.

d. White fly and leaf miner :

Nature of damage : It sucks the cell sap from tender shoot and leaves.Yellowish patches are formed on surface of leaf region.

Fig. 2.36 White fly

Control measures : Spraying tree with Nuvacron 0.1% is the effective control measure.

II. Diseases :

a. Foot-rot or collar-rot :

Symptoms : It is a fungal disease. Symptoms consists of appearance of dark brown stain with water soaked lesion on the stem, rotting of rootlets, girdling of tree trunk and defoliation of leaves. Cracking of bark and exuding of gum, yellowing and dying back of limbs above the injured portion of the plants also seen.

Control measures :

i. Scrapping of affected portion.
ii. Application of Bordeaux paste is effective.

b. Citrus canker :

Symptoms : It is bacterial disease. Minute water–soaked lesion appears on leaves, twigs, fruits and mostly occurs in rainy season. Yellow hole appears very distinctly which can be seen by viewing the leaves in light. Brown corking spots appears on fruits.

Fig. 2.37 Citrus canker

Control measures :

i. Pruning of affected portion of plant before monsoon.
ii. Spraying of 1% Bordeaux mixture on newly emerging flush
iii. Spraying Streptomycin sulphate @ 500 ppm or streptocyclin (100 ppm) + copper oxychloride (0.3%)

c. Gummosis :

Symptoms : It is a fungal disease caused by appearance of gum like substance oozing through stem and trunk.

Control measures : Scrapping of oozing portion and application of Bordeaux paste to the affected plant.

d. Kolshi :

Symptoms : White fly is the agent for kolshi. Pest sucks the cell sap from plant and then develops a mould severely on it. It affects the leaves, twigs, as well as the whole plant. Whole foliage appears blackish in colour.

Control measures : Regular spraying of pesticide for controlling white fly and spray Nuvacron + Copper fungicide.

2.4.12 Harvesting :

In mandarin orange all fruits mature at different times therefore, harvesting should be done at proper stage. If harvesting is delayed, there is the possibility of damage of fruits. Mandarin orange starts bearing after 5 to 6 year and time required for flowering to harvesting is 8-9 months. Change in colour of fruits from dark green to pale green is a sign of maturity. The economical life of plant is 25 to 30 years.

2.4.13 Yield :

800 to 1600 fruits/tree or 10 tons / ha.

Internet my friend

Collect information about 'citrus dieback' disease from various links.

Remind

Quality of Mandarin orange fruits

It depends on the type of bahar

Ambia Bahar

1. Fruits are more juicy but less tasty.
2. It may be attacked by fruit sucking moth during rainy season hence there is a possibility of damage by this pest.

Mrig Bahar

1. Fruits develop with good colour, sweet taste and less juicy.
2. Marketed at higher price than the ambia bahar fruits because quality of fruits is better.

Students performing farm activities

Exercise

Q. 1 Answer the following questions.

A) Select the appropriate alternative and complete the following statements.

1. Botanical name of mandarin orange is ----------
   a. *Citrus reticulata* b. *Citrus indica*
   c. *Musa* spp. d. *Saccharum* spp.
2. ---------- is a variety of banana
   a. CO-7219 b. Harichal
   c. Cricket ball d. Ratna
3. Partial hilling up of soil against sugarcane crop row is called as ----------.
   a. Desuckeing b. Harvesting
   c. Tagarni d. ratooning
4. Breaking of ridges and converting them into furrows and furrows into ridges in sugarcane is termed as ----------.
   a. Tagarni b. Earthing up
   c. Topping d. Interculture
5. Banana is grown at a temperature range of ---------- °C.
   a. 5 to 10 °C b. 35 to 55 °C
   c. 10 to 40 °C d. 45 to 55 °C

B. Make the pairs.

Crop	Variety
1. Sugarcane	a) Mandarin
2. Banana	b) Kesar
3. Mandarin orange	c) Co-740
	d) Basrai
	e) Sardar

C. Find the odd one out.

1. Sugarcane, Bannana, Santra, mango
2. Stem borer, Pyrilla, Grub, Redrot
3. Alphanso, Kesar, Harichal, Totapuri
4. Harvesting, Gapfilling, Weeding, Hoeing

D. Write true or false.

1. Mango when propagated by seed is true to type.
2. Banana is a very heavy feeder crop quickly responds to manuing.
3. Removal of some of the older leaves from sugarcane crop is known as detrashing.
4. Pairi is the table variety mango.
5. Pannama wilt is the disease of sugarcane.

Q. 2 Answer in brief.

1. Write the signs of maturty in banana crop.
2. Name any four diseases of sugarcane.
3. Write in brief about gummosis disease of Mandarin orange.
4. Write in brief paired row method of sugarcane layout.
5. Write in brief criteria for judging the proper maturity of mango crop.

Q. 3 Answer the following questions.

1. What are the ceriteria for sets selection for planting of sugarcane.
2. Write in short desuckering in banana.
3. What are the uses of mango fruit.
4. Explain seed rate and seed treatment in sugarcane.
5. Write in short about alternate bearing in mango.
6. Complete the following chart of Mandarin orange crop:

Sr. no.	Bahar	Time of treatment (month)	Time of flowe-ing (month)	Time of harvesting (month)
1	Ambia bahar			
2	Mrug bahar			

Q. 4 Answer the following questions.

1. Describe the intercultivation in sugarcane corp :
2. Give information on following points regarding plantation of Mandarin orange crop on following points:
   a. Propagation
   b. Planting method
   c. Harvesting
   d. Yield
3. Complete the following chart :

Sr. no.	Crop	Family	One pest
1	Sugarcane		
2	Mango		
3	Banana		
4	Mandarin orange		

4. Complete the following chart :

Sr. no.	Crop	Botanical name	Origin
1	Santra		
2	Banana		
3	Sugar cane		
4	Mango		

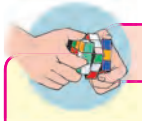
5. What are the characteristics of citrus root stalks?

Q. 5 Answer the following questions in detail.

1. Write the information of mango cultivation on follwing points.
   a. Climate
   b. Planting distance and propogation
   c. Manuring
2. Describe Banana cultivation on following aspects.
   a. Preparatory tillage
   b. Varieties
   c. Harvesting

Q. 6 Answer the following questions in detail.

1. Describe in detail the preparation of jaggery from sugarcane.
2. Describe cultivation practices of *adsali* sugarcane on following points.
   a. Seed rate and spacing
   b. Manuring
   c. Harvesting
   d. Uses



Activity

1. Prepare an album of different seed of crops, grown in your region.
2. Prepare pest and disease album of different crops in syllubus.

3. Modes of Reproduction

Can you recall?

Reproduction is the production of new individuals by sexual or asexual method/ mode. Mode of reproduction determines the genetic constitution of crop plants, i. e., whether the plants are normally homozygous or heterozygous. This, in turn, determines the goal of a breeding programme. If the crop plants are naturally homozygous, *e.g.,* as in self pollinators like wheat, a homozygous line would be desirable as a variety. But if the plants are heterozygous naturally, *e.g.,* as in cross-pollinators like maize, a heterozygous population has to be developed as a variety. Consequently, the breeding methods have to be vastly different for the two groups of crop plant. A knowledge of the modes of reproduction of crop plants is also important for making artificial hybrids. Production of hybrids between diverse and desirable parents is the basis for almost all the modern breeding programmes.

The modes of reproduction in crop plants may be broadly grouped into two categories sexual and asexual.

3.1 SEXUAL REPRODUCTION

3.1.1 Definition : Sexual reproduction means fusion of male and female gametes to form a zygote, which develops into an embryo.

In crop plants, male and female gametes are governed by specialized structure known as flower.

3.1.2 Flower : A flower usually consists of pedicel, calyx (sepals), corolla (petals), androecium and gynoecium (stamens and pistil). It is called as complete flower. A flower containing both stamens and pistil is a perfect or hermaphrodite or bisexual flower. If it contains stamens but not pistil it is known as staminate or male flower, while a pistilate or female flower contains pistil but not stamens. Staminate and pistilate flowers occur on the same plant but at different location in a monoecious species such as maize, colocasia, castor, coconut, banana and cucurbits etc. However, in dioecious species, staminate or male and pistilate or female flowers occur on different plants e.g. papaya, date palm and hemp.

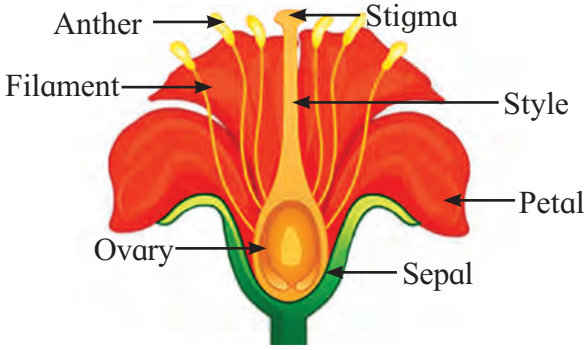


Fig. 3.1 Structure of a flower

Can you recall?

Fertilization

The fusion of one of the two sperms with the egg cell producing diploid zygote is known as fertilization.

3.1.3 Significance of sexual reproduction :

Sexual reproduction makes it possible to combine genes from few or more parents into a single hybrid plant. Recombination among these genes produces a large number of different genotypes. This is an essential step in creating genetic variation through hybridization. Almost the entire plant breeding is based on sexual reproduction.

3.1.4 Advantages of sexual reproduction :

1. Sexual reproduction is simple and easy.
2. Plants produced long live; show greater tolerance to soil and climate.
3. This is the only way to reproduce where asexual means is not common.
4. Introduces variation into a population.
5. The species can adapt to new environment.
6. A disease is less likely to affect all the individuals in a population.

3.1.5 Disadvantages of sexual reproduction

1. Sexually propagated plants require more period for flowering.
2. Two parents are needed in **sexual reproduction**, and the offspring produced are genetically different from the parents.
3. Time and energy are needed to find a mate
4. Not possible for an isolated individual.

3.2 ASEXUAL REPRODUCTION

3.2.1 Definition : Asexual reproduction does not involve fusion of male and female gametes. New plants may develop from vegetative parts of the plant (*vegetative* reproduction*)* or seed may arise from embryos that develop without fertilization (apomixis).

3.2.2 Vegetative Reproduction : Reproduction by vegetative parts of plant. Types of vegetative reproduction is as follows.

1. Natural vegetative reproduction :

In nature, a new plant develops from a portion of the plant body. This may occur through modified underground and sub-aerial stems, and through bulbills.

a. Underground Stems :

The underground modifications of stem generally serve as storage organs and contain many buds. These buds develop into shoots and produce plants after rooting. Examples of such modifications are given in the figure.

Tuber: Potato.

Bulb : Onion, garlic.

Rhizome: Ginger, turmeric.

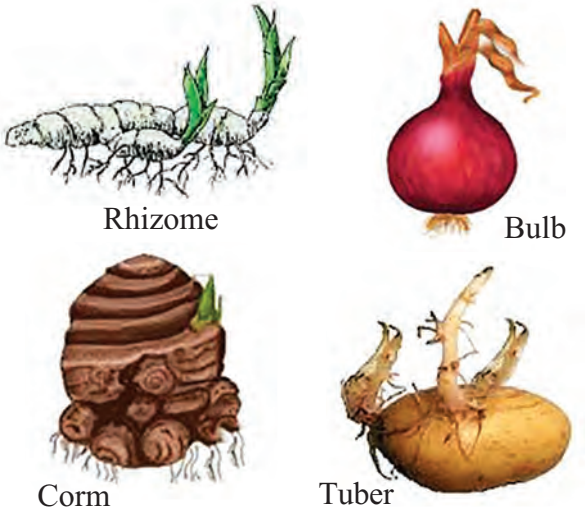


Fig. 3.2 Underground stem

b. Sub-aerial Stems :

These modifications include runner, stolon, sucker etc. Sub-aerial stems are used for the propagation of mint, date palm etc.

c. Bulbils :

Bulbils are modified flowers that develop into plants directly without formation of seeds. These are vegetative bodies; their development does not involve fertilization and seed formation. The lower flowers in the inflorescence of garlic naturally develop into bulbils. Scientists are trying to induce bulbil development in plantation crops by culturing young inflorescence on tissue culture media; it has been successfully done in cardamom.

Visit the field and study the natural vegetative reproduction in your area.

2. Artificial vegetative / Commercial reproduction :

It is commonly used for the propagation of many crop species, although it may not occur naturally in those species. Stem cuttings are commercially used for the propagation of sugarcane, grapes, roses, etc. Layering, budding, grafting and gootee are in common use for the propagation of fruit trees and ornamental shrubs. Techniques are available for vegetative multiplication through tissue culture in case of many plant species, and attempts are being made to develop the techniques for many others. In many of these species, sexual reproduction occurs naturally but for certain reasons vegetative reproduction is more desirable. Following are some important artificial reproduction practices.

a. Cuttings :

Many plants like rose, bougainvillea, croton, coleus, money plants and sugarcane etc., are grown through their stem cuttings. (Fig. 3.2 a) Cuttings of these plants can be grown even in water where they strike roots and develop adventitious buds.

Fig. 3.2(a) Cuttings for reproduction

Internet my friend

Obtain information regarding following types of cutting.
1. Stem cutting : Soft wood, semi-hardwood and hardwood cutting, 2. Leaf cutting, 3. Leaf bud cutting, 4. Root cutting

b. Simple tongue layering :

In this method, a lower branch of a plant is bent down and covered with moist soil leaving the growing tip above the soil. A slanting vertical cut is given on selected pencil size stems in the soil before it is bent down (Fig. 3.2b). In a few weeks time when enough roots have developed on the underground portion above the cut part, it is cut off from the parent plant and grown separately as an independent plant. Example: Guava etc.

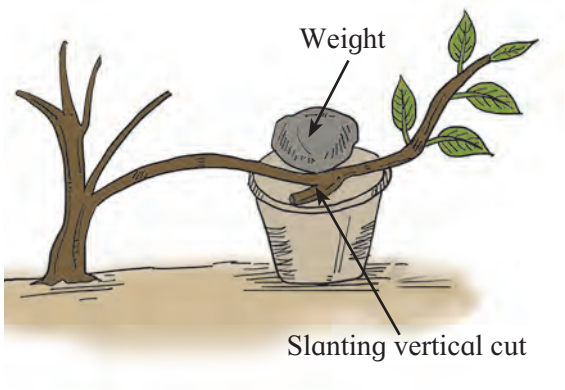


Fig. 3.2(b) Simple tongue layering

c. Air layering or *Gootee* :

It is a similar practice where bending of branches not possible because of the height of plant or due to woody nature of stem. In this method a ring of bark measuring 2-3 cms length is removed from a selected pencil size stem and it is covered with moist sphagnum moss and enclosed with a polythene sheet tightly tied with jute string. When roots appear, the stem is cut below the roots and planted to form a new plant.

Example : Pomegranate, Jasmin, Thuja etc.

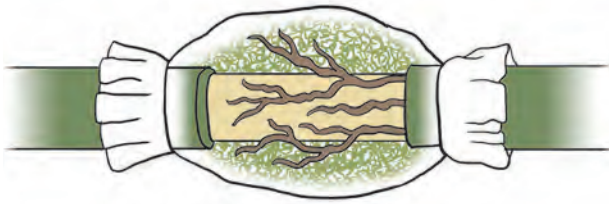


Fig. 3.2(c) Air layering

Try this

Collect information regarding other types of layering such as tip layering, simple tip layering, trench layering, serpentine layering and mound or stool layering.

d. Grafting :

It is especially important for propagation of seedless varieties of plants. It consists of inserting a small branch into a rooted plant. The rooted plant taken as a stock is resistant to disease and is physically sturdy. In this stock a branch is inserted which is known as scion. This scion is the stem cutting from the desired plant. Usually the grafted end of stock and scion fit well with each other and are bound firmly with tape or rubber-band until their tissues unite and vascular continuity is established. Grafting is mostly practiced in dicot plants. Grafting has been found extremely useful in propagating improved varieties of various flowers and fruits like rose, bougainvillea, citrus, mango, *chiku*, etc. The resultant grafted plants are dwarf in nature.

Do this

Searh information regarding following types of grafting :
A. Scion attached methods
B. Scion detached methods
C. Grafting on established trees
D. Methods of rejuvenation

e. Budding

Budding, often called bud grafting, is an artificial method of asexual or vegetative propagation in plants. Like grafting, this

method is employed to convert one plant (the rootstock) into another plant type with desirable characteristics. The bud of desirable plant is removed and inserted into the vertical slit opened on the stem of the rootstock. The resulting plant, in general, have dwarf stature and early maturity as compared to plants propagated from seed. e.g. Rose, Ber, etc.

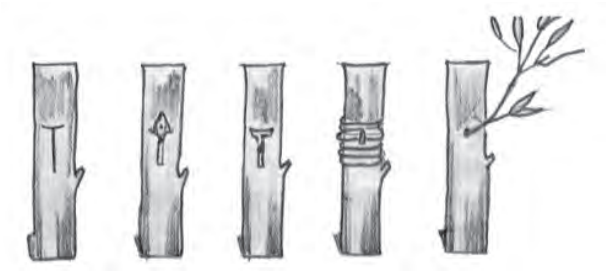


Fig. 3.2(d) T or shield budding

Internet my friend

Obtain information regarding following types of budding
A. T bdding or shield budding
B. Patch budding
C. Forkert budding
D. Flute budding
E. Ring budding
F. Chip budding

Try this

Practice any one of the artificial vegetative reproduction in near by plant nursery.

A. Advantages of vegetative reproduction :

Vegetative reproduction has several advantages. The main advantages are:

1. It is useful for obtaining large number of genetically identical individuals of genotypes , irrespective of the degree of heterozygosity.
2. Promising individuals occurring at any stage in a breeding programme can be easily picked up and maintained by asexual reproduction.
3. It makes use of desirable bud mutations. Mutants can be directly released as varieties.
4. (a) Rapid reproduction and spread. The desired varieties can thus be preserved genetically for further use. (b) Improved varieties of ornamental plants and fruit trees can be multiplied easily.
5. Vegetative propagation is a quicker, easier and a less expensive method of multiplying the plants.
6. Plants developed by this method are smaller in stature and hence harvesting become easy.
7. Using this method noble plants can be created.

B. Disadvantages of vegetative reproduction

1. It requires skilled manpower.
2. It is expensive. Plants have short life.
3. New varieties cannot be produced by this method except by mutation.
4. Diseases of the typical species are rapidly transmitted and can destroy a crop.
5. There is no genetic variation so, plants are less adaptable to enviroment.

3.2.3 Apomixis :

Apomixis refers to the development of seed without sexual fusion (Fertilization). In apomixis, embryo develops without fertilization. Thus, apomixis is an asexual means of reproduction. Apomixis is found in many crop species. Reproduction in some species occur only by apomixis. This apomixis is termed as obligate apomixis. But, in some species sexual reproduction also occurs in addition to apomixis. Such apomixis is known as facultative apomixis. There are four types of apomixis : *viz;*

1. Parthenogenesis
2. Apogamy
3. Apospory
4. Adventative embryony.

1. Parthenogenesis :

Parthenogenesis refers to development of embryo from the egg cell without fertilization. It is of two types 1. Haploid and 2. Diploid.

When the embryo develops from a haploid egg cell, it is known as haploid parthenogenesis. The plants which develop from such embryos are haploid and sterile. Haploid parthenogenesis is found in *Solanum nigrum*. Some times embryosac developes without reduction division. Such embryosac and all cells within it are diploid. It gives rise to diploid embryos. Such parthenogenesis is known as diploid parthenogenesis and has been reported in grasses like *Taraxacum*. In plant species like tobacco and rice, pollen grains may be induced to develop in embryos. This development of embryos from pollens of anthers is termed as androgenesis.

There are several causes of parthenogenesis
The main causes include 1. Inability of the pollen tube to discharge the contents inside the embryo sac 2. Insufficient attraction between male and female gametes 3. Early degeneration of the sperm 4. Very long style 5. Short pollen tube 6. Slow rate of pollen tube growth 7. Stimulation of pollen in the absence of pollen tube and 8. Incompatibility

2. Apogamy :

The origin of embryo from either synergids or antipodal cells of the embryosac is called apogamy. It is of two types viz, 1) haploid apogamy and 2) diploid apogamy. The synergids or antipodal cells may be haploid or diploid. If embryo develops from haploid synergids or antipodal cells, it is known as haploid apogamy. When the embryo develops from diploid synergids or antipodal cells, it is called as diploid apogamy.

3. Apospory :

In apospory first diploid cell of ovule lying outside the embryosac develops into another embryosac without reduction. The embryo then develops directly from the diploid egg cell without fertilization. Apospory is of two types viz., 1) generative apospory and 2) somatic apospory.

4. Adventive embryony :

The development of embryo directly from the diploid cells of ovule outside the embryosac belonging to either nucellus or integuments is referred to as adventive embryony. There is no production of another embryosac like apospory. This is a type of sporophytic budding which is very common in citrus and mango.

3.3 TISSUE CULTURE

Can you recall?

Totipotency is the inherent potentiality of a plant cell to give rise to a whole plant.

This is a capacity which is retained even after a cell has undergone final differentiation in the plant body. In plants, even highly mature and differentiated cells retain the ability to regenerate to a meristematic state as long as they have an intact membrane system and a viable nucleus. This is contradicting to animals, where differentiation is generally irreversible.

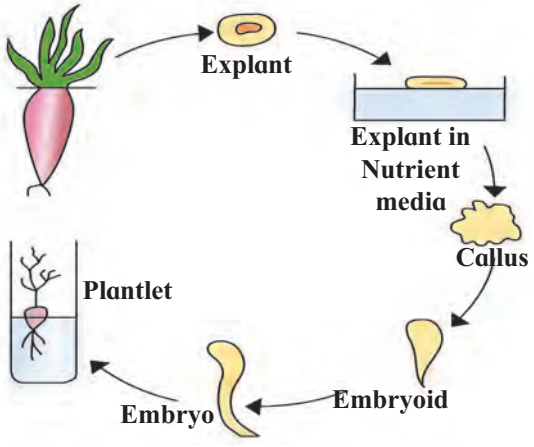


Fig. 3.3 Tissue culture technique (Totipotency)

3.3.1 Tissue Culture Technology :

Tissue culture technology is based on the theory of totipotency i.e. the ability of a single cell to develop into whole plant. The major components of the technology include choice of explant (excised part of plant), growing of explant on a defined medium in glass vessel (*in vitro*), elimination and or prevention of diseases, providing appropriate cultural environment and transfer of plantlets from glass vessel to natural environment (hardening). All these constitutes the protocol for tissue culture. It varies from species to species and variety to variety within the same species. However, it can be standardized through trial and error and ultimately it should be repeatable and reliable.

Plant tissue culture or micropropagation technology has made invaluable contribution to agriculture by enabling the production of disease free, quality planting material of commercial plants and fruit trees, throughout the year.

3.3.2 Definition :

Plant tissue culture is the technique of growing plant cells, tissues and organs in an artificially prepared nutrient medium, under aseptic and controlled conditions.

Tissue culture involves production of plants from very small plant parts, tissues or cells grown aspetically in a test tube or other suitable container where the environment and nutrition can be rigidly controlled.

Plant tissue culture as such is not a separate branch of plant science, but it is actually a collection of experimental methods or techniques. In this technique from isolated protoplasts, cell, tissues, the organs are grown in *vitro*. These are grown on artificially prepared solid or liquid nutrient medium under aseptic and controlled conditions of light, humidity and temperature for achieving different objectives.

Plant tissue cultures are classified according to the type of in *vitro* growth i.e., callus and suspension cultures or the explants used for culture initiation, i.e., embryo culture, anther culture, etc. The plant material used for culturing is called explant. Totipotency is the inherent ability of plant cell to grow, divide, re-divide and give rise to a whole plant. German botanist Haberlandt (1902) developed the concept of *in vitro* culture.

It is essential that explants culture vessels, media, glass wares, working tables used for tissue culturing be made free from microorganisms. To maintain such aseptic condition sterilization is done.

3.3.3 Technique

The technique of tissue culture involves following steps.

1. Cleaning, sterilization of glass ware and instruments in an oven/ autoclave.
2. Selection and preparation of nutrient medium (Murashige and skoog medium MS medium) with known concentrations and proportion of different components.
3. Sterilization of the nutrient medium in an autoclave for 20 minutes under constant pressure i.e., 15 lb/inch^2 at a temperature of 105°C.
4. Preparation of plant material i.e., explants include isolation of explants followed by surface sterilization and rinsing with water.
5. Inoculation of the explant in the culture flask containing sterilized nutrient medium. Inoculation is done in the laminar air flow cabinet unit.
6. Incubation of the inoculated explants-in the flask cells of explants grow, proliferate to form callus, within 2-3 weeks.
7. Sub culturing of the callus (if the callus is to be maintained for longer period, callus is divided into 3-4 segments and transferred to fresh culture medium.)
8. Organogenesis-intitiation of rooting and shooting, that eventually leads to plantlet formation.
9. Hardening- Plantlets are transferred to polyethylene bags containing sterilized

soil and kept under low light and high humidity controlled conditions preferably in greenhouse for suitable period of time.

10. After hardening the plantlets from the polyethylene bag or pots are transferred to the field.

Visit a tissue culture labaratory to know :

- Procedure for establishment of tissue culture laboratory.
- Various instruments used
- Techniques of tissue culture
- Plants generally propagated
- Hygienic condition maintained
- Records and forms maintained

3.3.4 Various techniques in tissue culture :

Micropropagation :

This technique is used for the purposes of developing high quality clonal plants (a clone is a group of identical cells). This has the potential to provide rapid and large scale propagation of new genotypes.

Somatic cell genetics :

Used for haploid production and somatic hybridization.

Anther culture :

Plants produced through anther culture are haploids. Doubling the chromosomes without going into series of backcrossing can produce homozygous plants. This technique has profound application to plant breeder and shortens the time of breeding by half.

Embryo rescue :

Many important plants are difficult to propagate through seeds. They take a long time for seeds to germinate or the seeds do not germinate at all. This can be overcome through embryo culture. The seeds are surface sterilized and split open in aseptic condition and the tiny embryo is excised and planted in a nutrient medium and then grows to a complete plant.

Fig. 3.4 Activities in tissue culture technique

Courtesy : Kshitij biotech corporation, Karad, Dist. Satara

Organelle transfer :

In some cases, it may be desirable to transfer only organelles or the cytoplasm into a new genetic background. This may be achieved through the use of plant protoplasts. Chloroplasts have been transferred, and other organelles including nucleus may be transferred.

Transgenic plants :

Used for expression of mammalian genes or plant genes for various species. It has proved beneficial for the engineering of species that are resistant against viruses and insects.

3.3.5 Methodology involved in plant tissue culture :

This process involves the use of small pieces of a given plant tissue (plant of interest). Once the tissue is obtained, it is then cultured in the appropriate medium under sterile conditions so as to prevent various types of microorganisms from affecting the process.

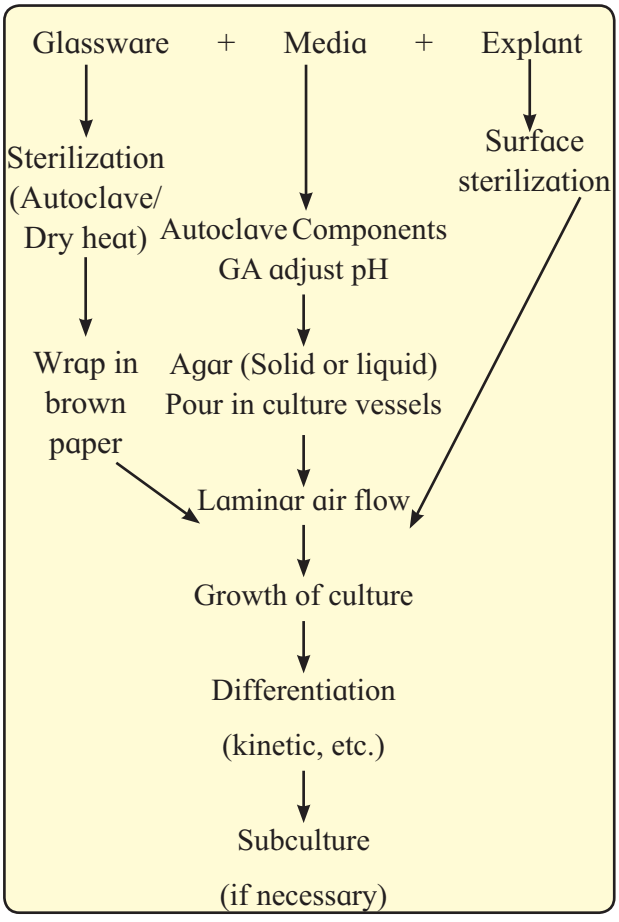


Fig. 3.5 Steps in tissue culture method

The following is a general procedure for plant tissue culture

A. Medium preparation

- The appropriate mixture (such as the MS mixture) is mixed with distilled water and stirred while adding appropriate amount of sugar and sugar mixture. Here, sodium hydroxide or hydrochloric acid is used to adjust the pH. Contents used here will depend on the plant to be cultured and the number of tissues to be cultured.
- Agar is added to the mixture, heat and stirred to dissolve
- After cooling, the warm medium is poured into polycarbonate tubes (to a depth of about 4 cm)
- With lids sitting on the tubes, the tubes are placed in a pressure cooker and sterilized for 20 minutes

B. Plant preparation

- Cut the plant part into small pieces (e.g. cauliflower can be cut to florets of about 1cm across). On the other hand, such parts as the African violet leaves can be used as a whole.
- Using detergent and water, wash the plant part for about 20 minutes.
- Transfer the plant part in to sterilizing Clorox solution, shake for a minute and leave it for 20 minutes.
- Using a lid, gently discard the Clorox and retain the plant part in the container and then cap the container

C. Transferring the plant material to a tissue culture medium

- About 70 percent alcohol should be used for sterilization of the equipment and containers used.
- Open the container and pour sterile water to cover half or the container
- Cover with a sterile lid again and shake the container for 2 to 3 minutes in order to wash the tissue and remove the bleach
- Pour water and repeat this, three times
- Using sterilized gloves, remove the plant part from the container and use a sterile petri dish

- Using a sterile blade cut the plant material to smaller pieces of about 2 to 3 mm across avoiding the parts that have been damaged by bleach
- Using sterile forceps, place a section of the plant in to the medium
- Depending on the plant used, it is important to check and find out how it should be placed in the medium
- Replace the lid/cap and close tightly

This procedure will result in the development of a callus, which then produces shoots after a few week. Once the shoots develop, then the plant section may be placed in the right environment (well lit, warmth, etc.) for further growth.

3.3.6 Advantages and Disadvantages

Advantages

1. Large scale multiplication and developing true plants in lesser time and small space.
2. Production of disease free plants round the year is possible irrelevant of climate.
3. Production of plants is possible.
4. Highly beneficial for plants where regular propagation is difficult e.g., crops like sugarcane, grapes, banana, etc.
5. In diocious fruit plants, production of female plants is possible through micro propagation e.g., papaya.
6. Production of homozygous plants by doubling haploids.
7. Helps in fast multiplication of rare species.
8. Embryo culture to overcome dormancy.
9. Raising plantlets such as orchids, which are difficult to multiply through seeds.
10. It produces disease free, drought resistant and salt tolerant plants.
11. The germplasm can be preserved for a long period of time.
12. This helps in obtaining uniform plant types than the original one.
13. Nitrogen fixation capacity can be introduced in the plants.
14. It helps in producing superior plant type than the original one.
15. The plants which are unable to grow under normal conditions can be grown easily with this technique.

Disadvantages

1. It is a difficult method for propagation and requires special technique and skill.
2. Expensive, sophisticated facilities, trained personnel and specialized techniques are essential.
3. High cost of production results from expensive facilities and high labour inputs e.g., shoot tip propagation requires much hand labour to transfer individual propagates.
4. High volume, more or less continuous distribution systems or adequate storage facilities to stock pile product is required.
5. Contamination or insect infestation can cause high losses in a short time.
6. Variable and off type individual can arise in the products emerging from micro propagation. Careful roguing, prior field testing of new products and continuous research and development are essential to decrease this risk.
7. Economics and marketing are key to the success of commercial production.
8. Decreases genetic variability.

Do you know ?

Plant materials should be sterilized so as to remove any bacteria or spores that may be present.

For plants, the medium culture acts as a greenhouse that provides the explant with the ideal environment for optimum growth. This includes being free of microorganisms, nutrients as well as the right balance of chemicals and hormones. Such media as BAP, TDZ are used while such hormones as IBA and IAA are used to induce growth.

Try this

- Visit the farmer having Bt cotton crop in his field and to know his experiences with such genetically modified crop.
- What are his experiences with non-Bt cotton.

Know the Scientist

Folke Karl Skoog (July 15, 1908 - February 15, 2001) was a Swedish born American Plant physiologist who was a pioneer in the field of plant growth regulators particully cytokinins Skoong was recipient of the National Medal of Science, 1991)

Toshion Murashige (1930) : Professor meritus of University of California. He is most widley known for his efforts in creating the plant tissue culture medium known as Murashigs and Skoog medium

Exercise

Q.1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. Development of seed without sexual fusion refers to ---------
   a. Apomixis b. Parthenogenesis
   c. Apogamy d. Apospory
2. A flower containing both stamens and pistil is a ---------
   a. Staminate flower b. Pistilate flower
   c. Perfect flower d. None
3. Reproduction which does not involve fusion of male and female gametes is called ---------
   a. Apomixis b. Asexual
   c. Vegetative d. All above
4. Plant having male and female reproductive organs present in same flower is known as --------- flower.
   a. Dioecius b. Monoecious
   c. Unisexual d. Bisexual
5. The fusion of one of the two sperms with the egg cell, producing a diploid zygote is known as
   a. Reproduction b. Gametogenesis
   c. Fertilization d. Apospory.

B. Make the pairs.

'A' Group	'B' Group
1. Staminate flower	a. Female flower
2. Papaya	b.Dioecious species
3. Pistilate flower	c. Bisexual flower
	d. Male flower
	e. Monoecious species

C. Find the odd one out.

1. Maize/Caster/Coconut/Papaya
2. Cutting/Layering/Grafting/ Parthenogenesis
3. Parthenogenesis/Apogamy/Apospory/ Budding
4. Budding/Grafting/Cutting/Seed
5. Fertilization/Sterilization/Medium/ Explant

D. Write True or False.

1. Asexual reproduction involves fusion of male and female gamets.
2. In Papaya, male and female flowers are present on two different plants.
3. By sexual reproduction combination of different genes from more parents in single hybrid plant is possible.
4. Bulbils are normal flowers.
5. Inoculation of the explant is necessary in tissue culture.

Q. 2 Answer in brief.

1. What is meant by plant tissue culture?
2. Define fertilization.
3. Name the types of apomixis.
4. Give the types of vegetative reproduction.
5. Define parthenogenesis.

Q.3 Answer the following questions.

1. What are the advantages of sexual reproduction.
2. What are the causes of parthenogenesis?
3. Describe in short apogamy.
4. Explain the techniques in tissue culture.
5. What is totipotency.

Q.4 Answer the following questions

1. What is the significance of sexual reproduction?
2. What is the significance of asexual reproduction?
3. Describe Apospory
4. What is Graffting?
5. What is meant by parthenogenesis?

Q. 5 Answer the following questions in detail.

1. Define sexual reproduction. What are its advantages and disadvantages?
2. Define asexual repreduction. Explain natural vegetative reproduction.

Q. 6 Answer the following questions in detail.

1. Write the stpes involved in technique of tissue culture.
2. Write the advantages and disadvantages of tissue culture.

Activity

- Visit a plant tissue culture lab and understand the various activities carried out.
- Dissect the flower and identify its various parts and draw its diagram.

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

4. Seed Production Technology

Recall a little ?

- Seed Technology is a branch of science which deals with the study of methods of improving genetic and physical characteristics of seed.
- The scientific seed production consists of various activities such as selection of seed source, production of crop, harvesting, processing, storage and distribution.
- Maintaining genetic purity of the seed is of utmost importance. The seed production must be carried out under standardised and well organized conditions.

4.1 PRINCIPLES OF SEED PRODUCTION

Pure seed of good quality is produced only under utmost care and by applying general principles of seed production. The general principles of seed production are broadly classified into two groups as genetic and agronomic principles.

4.1.1 Genetic principles :

Genetic principles are as follows:

1. Deterioration of varieties : Genetic purity of a variety can deteriorate due to several factors during production cycles. The important factors which are responsible for deterioration of genetic purity or trueness are.

a. Developmental variations : These variations are due to change in the environment for seed crops. When seed crop is grown under different conditions of soil, climate, elevations, etc., for too many consecutive generations, this variation may appear as differential growth responses. Therefore, crop should be grown in areas of their adaptation and growing seasons

b. Mechanical mixtures : There are different reasons responsible for the mechanical mixture of seed. The reasons and remedies for them are as given in table 4.1 :

c. Mutations : Mutation means sudden heritable change in the progeny. Mutation is not a major factor and in certain cases, it is even difficult to detect minor mutations.

d. Natural Crossing : It can be an important source of varietal deterioration in sexually propagated crops. The deterioration may be due to natural crossing with diseased plants, off types and undesirable types.

Can you recall?

- What is meant by variation?
- What is the significance of variation in plants?
- What are the kinds of variation?

Table 4.1 : Reasons and remedies for the mechanical mixtures

Reasons causing mechanical mixture of seed	Remedies
• Use of the same seed drill for sowing more than one variety.	• Cleaning of seed drill before sowing new varieties.
• Presence of volunteer plants in the seed field.	• Irrigating the field 3 weeks prior to sowing and deep ploughing.
• Cultivation of different varieties in adjacent field.	• Space isolation should be provided to seed plot.
• Use of threshing floor at a time for different varieties.	• Only one variety should be threshed at a time and threshing yard should be cleaned before next use.
• Use of combining or threshing equipment and gunny bags contaminated with the seeds of different varieties.	• Combining or threshing equipments should be cleaned before use. Gunny bags should be new or old gunny bags should be cleaned and fumigated before use.

e. Minor genetic variations : The varieties appearing phenotypically uniform and homogeneous at the time of release may consists of some minor genetic variations. The yield trials of lines propagated from plants of breeders seed in the case of self pollinated crop and proper precautions during the maintenance of nucleus and breeders seed of cross pollinated varieties are suggested to control these variations.

Remember this

Woody plants tend to have more genetic diversity than the vascular plants like grasses.

f. Selective influence of pest and diseases New crop varieties often are susceptible to newer pest and diseases and thus, cause deterioration. Seed production under clean and disease free conditions is important to overcome the influence of pest and diseases.

Do you know ?

Which precautions are taken for avoiding deterioration of genetic purity or trueness to its type during the seed production ?

g. Techniques of plant breeder : The genetical variations in the variety may occur due to inadequate evaluation of cytogenetic irregularities during the release of variety.

2. Maintenance of genetic purity during seed production :

During seed production, the genetic purity can be maintained by following measures.

a. Control of seed source : The seed to be used for seed production should be from approved authorities and appropriate class of seed.

b. Preceding crop requirements : This should be studied prior to the selection of land for avoiding contamination from volunteer plants and soil borne diseases.

c. Isolation : The isolation of seed crop is essential for avoiding contamination due to natural crossing from neighbour crop, off types and disease infection by wind, insects, etc. from neighbouring fields. It is also required during harvesting and post harvesting process to avoid-mechanical mixtures. The distance should be as per seed certification standards.

d. Roguing : The off type plants i.e., plants of same crop species showing different characteristics from those of the seed crop varieties, should be removed out of the seed fields and isolation area at different growth stages of seed crop. This procedure of removing off type plants is called as roguing. Regular supervision of seed field is necessary for the same.

e. Seed certification : Seeds certification is a legally sanctioned system for quality control of seed multiplication and production. Inspection of seed plot from seed certification agency is necessary to verify that seed crop is of requisite genetic purity and quality. Inspection of seed lot after harvesting and in processing plant is also necessary to verify quality of seed.

Try this

- Point out the importance of roguing and isolation distance in seed production.
- Obtain the information regarding the isolation distance to be kept for seed production of different crops.

f. Grow-out test : These are also done periodically to test genetic purity of variety grown and to ensure that they are being maintained in their true form. This is conducted by seed certification agency.

4.1.2 Agronomic Principles :

- **Selection of suitable Agro-climatic region** The variety proposed to be grown for producing seed should have suitable climate in respect of temperature, photoperiod, rainfall, wind velocity etc. In general, regions of moderate rainfall, temperature and humidity are suitable for

seed production. Most crops require ample sunshine and moderate temperature for flowering and pollination. The seed plot should have suitable soil structure and fertility characteristics as required by a crop. It should be free from volunteer plants and seed of weed and other crop plants.

- **Isolation :** The isolation distance from neighboring field crop should be as per requirement of certification standards. In certain crops as in hybrid maize time isolation is useful. In nucleus and breeder seed production, the isolation is provided by enclosing plant or group of plants in cages or enclosing individual flowers by bags. Isolation is also required during harvesting, threshing and seed handling to avoid mechanical mixtures.
- **Land preparation :** Good land preparation is essential for proper crop growth and irrigation management.
- **Variety :** The variety should suit the prevailing agro-climatic conditions. It should be high yielder and possess characteristics such as disease resistance, grain quality, etc.

Try this

- Select and list the crops which will fit to your agro-climatic conditions.
- Select and list the varieties suitable for your agro-climatic conditions.

- **Seed :** While buying the seed it should be seen that tag and seals of bags are intact and its validity period or expiry date is not over. The seed should be of appropriate class.
- **Seed treatment :** The seed should be treated to prevent the attack of certain pest and diseases, improving germination, increasing nitrogen fixation by legumes, breaking seed dormancy etc.
- **Time of sowing :** The seed crop should be sown at its normal time. However, certain changes in time of sowing need to be done for synchronization of parents and for preventing the incidence of certain pest and diseases. There should be sufficient moisture in the soil at the time of sowing, which will be helpful for proper germination.
- **Seed rate :** For seed crop lower seed rate is desirable for having convenience in roguing and inspection of seed crop.
- **Method of sowing :** The seed crop is generally sown in rows by mechanical seed drill. Broadcasting is followed for thickly sown crops. The seed is sown to a proper depth by mechanical drilling. The seed drill should be cleaned before use. The spacing between two rows should be sufficient to allow proper aeration and penetration of sunlight. For hybrid seed production female and male parent lines are sown in the proportion of 4:2 to 6:2.
- **Depth of sowing :** It should be such that it would allow proper emergence of crop. It depends on size of seed and type of soil. Small seeded varieties are sown shallow, but bold seeded can be sown little deeper. The depth may be kept more in sandy soils than in to clay soils.
- **Roguing :** It is usually done at vegetative or pre flowering stage, flowering and maturity stage. In some crops roguing and sorting of ear heads is necessary to remove off coloured, diseased or malformed ear heads. Adequate and timely roguing is important to prevent all kinds of contamination and it is the responsibility of seed producer.
- **Supplementary pollination :** Artificial or supplementary pollination is necessary for the crops which are cross pollinated by insects. Honey bees are kept in hives in the vicinity of seed crop. In sunflower crop two adjacent flower heads are rubbed on each other or cotton cloth is tied on hand palm and moved in clock wise direction on flower surface. This results in increasing the pollination and thereby seed setting.
- **Weed control :** Production of high quality and quantity of seed depends on effective control of weeds. Weeds reduces yield and

also cause contamination by sheltering diseases and by their mixture in the crop seed. Hand weeding, hoeings and use of herbicides are the methods of weed control. Proper crop rotation and use of clean fallow land for seed production also helps in checking weed growth.

- **Irrigation :** Excessive moisture conditions and prolonged drought will adversely affect seed production. Soil type, season and water requirement of crop decides the total quantity of irrigation and time interval between two irrigation turns. A critical stage of growth is also a criterion for scheduling irrigation.
- **Nutrition :** Proper plant nutrition is essential for good yields and better quality of seed. Along with primary nutrients like nitrogen, phosphorous and potassium certain secondary and micronutrients should be applied in proper quantities and at right stage of crop growth.
- **Insects-pest and disease control :** Effective control of all pest and diseases is essential to produce healthy crop. They should be controlled by using suitable insecticides and fungicides for seed treatment and for spraying on crop. Roguing of diseased plants and ear heads is also necessary.
- **Time of harvesting :** The exact time of harvesting is important in getting maximum seed yield with better quality. The optimum time is when the seed is fully mature and when the seed is easily harvested and cleaned with minimum losses. The optimum moisture content is a good indication of the right time of harvesting. The period of time, for which the seed crop will remain proper for harvesting varies with climatic conditions and the nature of the crop.
- **Method of harvesting :** Harvesting and threshing of seed crop is done manually by hand or by using machines (combiners). Proper care should be taken to avoid mechanical injury to the seed and to avoid mechanical mixtures in seed at the time of harvesting and threshing.
- **Drying of seed :** Drying of seed to safe moisture limit is essential to keep the viability and vigour of seed intact. Care should be taken to avoid mechanical mixing and to keep the identity of seed lot intact.
- **Seed storage :** For short period storage, seed is kept in gunny bags or sacks in godowns. Each bag should be labelled with necessary particulars. Bags should stacked on wooden pallets. The storage structure should be cool, dry and clean. Proper preventive control measures should be taken in godowns against storage pest and diseases.

Try this

Visit nearby seed warehouse to know about :

- The methods of seed storage.
- The methods of insect and pest control in seed storage.
- The methods of moisture and temperature control in seed ware house.

- **Information of variety :** Detailed information regarding pedigree and quality of seed is given on the label attached to the seed bag.

4.2 HYBRID SEED PRODUCTION OF JOWAR

Botanical name – *Sorghum bicolor*
Family – Gramineae
Origin – North East Africa and India

Fig. 4.1 Jowar earhead

Fig. 4.2 Jowar crop

Can you recall?

Jowar is one of the important cereals. It ranks fourth in the world after wheat, rice and maize and third in India as far as area and production is concerned. In India highest area under *Jowar* is in Maharashtra. Its grains are the basic food in India.

4.2.1 Uses :

Jowar is cereal crop. Its grain is eaten in the form of unleavened bread that is roti or *Bhakri.* The grain is also consumed in the form of pop grain and hurda. Grain itself is used as cattle feed, poultry ration, etc. Grain is used in the industries for the extraction of starch, oil, glucose, ethyl alcohol and such other products. The grain is also boiled and consumed like rice. *Jowar* stem with leaves (green fodder, dry fodder i.e. *kadbi*) is used as animal feed. The sweet sorghum can also be used for preparing of jaggery and sugar. Grains have ritual value and used in various ceremonies.

Use your brain power

Why jawar plants are not fed to cattles before 50% flowers stage of crop ?

4.2.2 Climate :

Jowar is a tropical crop. It is cultivated throughout the year in tropics. *Jowar* is also cultivated in temperate region as a summer crop provided that the temperature is sufficiently high. About 7° to 10°C temperature is necessary for germination. The optimum range of temperature for growth is 27° to 32°C. It does not tolerate frost. *Jowar* is well adapted to semi arid region with annual rainfall of 350 to 400 mm. In India it is grown in the regions receiving an annual rainfall of about. 400 to 1000 mm. *Jowar* is drought resistant crop.

4.2.3 Method (principle) :

Hybrid seed of *Jowar* is produced by using cytoplasmic genetic male sterility. This involves crossing of male sterile line i.e. Line 'A' (seed parent) with the restorer line (pollinator) i.e. line 'R'.

The steps involved in hybrid seed production of *jowar* are :-

- Maintenance of parental lines namely male sterile line (line A) carrying cytoplasmic-genetic male sterility; maintainer line (line B) male fertile, non pollen restoring and restorer line (line R).
- Production of hybrid seed i.e., crossing of male sterile line (line A) with restorer line (line R).

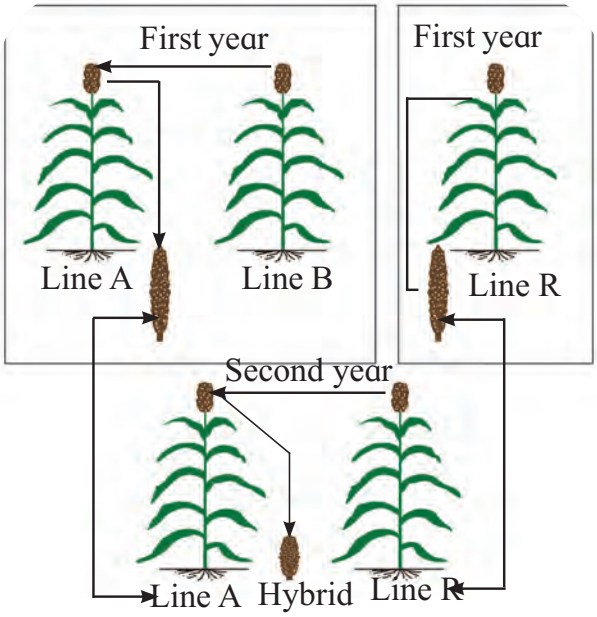


Fig 4.3 Steps in hybrid seed production of *jowar*

4.2.4 Maintenance of Male sterile lines (Line 'A') :

a. Principle : The male sterile line (Line A) carries male sterility due to cytoplasmic genetic factors. It is maintained by crossing with male fertile, non-pollen restoring strain (Line B) which is sister strain of Line A is an isolated plot.

Remember this

Line B is similar to Line A in all respects except that Line B is pollen fertile, whereas, Line A is pollen sterile. Maintenance of parental lines is called as foundation seed production and production of hybrid seed is known as certified seed production.

b. Land requirements : Land to be used for seed production should be free from volunteer plants. There should not be Johnson grass in the seed field as well as within the isolation distance. Medium to deep black soil should be selected for sowing of this lines. The land should be well drained and fertile.

c. Isolation requirements : *Jowar* is self pollinated crop, but cross pollination up to 8 to 10 percent may also occur. The distance of isolation is as shown in the following table.

Table 4.2 Isolation distance of *Jowar*

Sr. No.	Contaminant	Minimum distance (meters) foundation seed
1	Fields of other varieties of grain and dual purpose sorghum and the same variety not confirming to varietal purity	300
2	Johnson grass (*sorghum halepense)*	400
3	Forage sorghum	400

d. Land preparation : The land is prepared to fine tilth by one deep ploughing, three to four harrowing and levelling. The land should be free from weeds.

e. Sowing season and time : In Maharashtra generally crop is sown in *Kharif* season and time of sowing is from fourth week of June to first week of July. If crop is taken in *Rabi* season the time of sowing may be mid September (mostly in South India)

f. Source of Seed : Obtain nucleus / breeders seed from a source approved by the seed certification agency.

g. Sowing Method : Maintenance of Line A consists of sowing of two parents. The female parent (Male sterile line – Line A) and male parent (pollinator parent – Line B) are sown in the proportion of 4:2 row. Four to six border rows of male parent are sown all around the field. The Border rows should be distinctly separated from crossing block by at least one meter.

h. Spacing : Row to Row spacing should be 75 cm and plant to plant is 7.5 cm

i. Seed rate :

Female parent (Line A) – 8 kg / ha.

Male parent (Line B) – 4 kg / ha.

j. Roguing : Following precautions should be taken while roguing.

1. Start roguing before off types, volunteers and pollen shedders in female rows start shedding pollen.
2. All rogues invariably be pulled out, to prevent regrowth.
3. All out crosses (identified by height) should be removed as they soon as appear.
4. The plants which are out of place i.e., plants in between the rows, male plant in female rows and also female plant in male rows should be removed.
5. Proper attention should be given at flowering time. The roguing should be done every day to remove pollen shedding types in the seed rows.
6. Plants of other *Jowar* variety and Johnson-grass, sudan grass should be removed within isolation distance.
7. The diseased heads affected by smut should removed.
8. Roguing should also be done thoroughly before harvesting and after the seed has matured to the stage when true plant and seed characters appear.

k. Fertilizer :

i. Rainfed area

First dose Nitrogen and phosphorus are added each at 40 kg/ha. and potash if recommended at the rate of 35 kg/ha. at the time of sowing.

Second dose Nitrogen is added at the rate of 40 to 60 kg/ha. about 30 days after sowing.

Try this

Collect the information of *jowar* hybrids cultivated in your region. Visit such farm and observe the cultivation practices

ii. Irrigated area

First dose Nitrogen @ 60kg, phosphorus 50kg/ha. and if recommended potash 40kg/ha. is added at the time of sowing.

Second dose Nitrogen is added @ of 60 to 70 kg/ ha. about 30 days after sowing.

l. Irrigation : In *kharif* season first irrigation is given as pre-sowing irrigation and in the case of long dry spell one or two protective irrigations are given as required. If grown in *rabi* season four to five irrigations are given at an interval of 10 to 15 days. The critical stages of *Jowar* growth for irrigation are

1. Seedling
2. Grand growth stage
3. Flag leaf stage
4. Flowering
5. Grain development

m. Inter-cultivation : The weed infestation is more during the period of 15 to 35 days after sowing. About 2 to 3 hoeing and one hand weeding in between them are given to control weed. These operations are also helpful in loosening the soil and improving soil aeration. The inter-culture operations should not be more than 4 to 5 cm deep. Pre-emergence spraying of atrazine (atrataf) at 0.5 kg active ingredient per hectare or propazine at 1 kg chemical (50 per cent wettable powder) in 1000 liters of water can also be applied for controlling weeds.

n. Plant protection : It is the same as given in certified (hybrid) seed production.

o. Harvesting : Male rows are usually harvested first and its produce is kept separate to avoid mixture at later stages. The female rows are harvested, when fully ripe. The harvested heads should be sorted out to remove diseased or undesirable heads. The heads are dried for a week before threshing. Threshing can be done by threshers. Seed should be dried to 10 percent moisture content before storage.

4.2.5 Maintenance of Restorer Line (Line R)

The seed of restorer line (Line R) is produced in an isolated field. The cultural practices are as follows :

Preparation of land, sowing season and time fertilizer, irrigation and intercultural operations are same as in the case of maintenance of line 'A'

a. Method of sowing : The crop is sown in rows. The depth of sowing should be 3 to 4 cm.

b. Spacing : 1. Row to Row - 45 cm

2. Plant to plant - 15 cm

c. Seed rate : 12 to 15 kg / ha.

d. Plant protection : The information is same as given in hybrid (certified) seed production.

e. Roguing : Rogue out off types and volunteer plants before they begin to shed pollen. The plants usually should be pulled out to prevent regrowth. Rogue out all other plants such as Johnnson grass, forage plants and Sudan grass. The diseased plants are also removed from time to time as required.

f. Harvesting : The crop must be fully matured. The harvested heads should be sorted out to remove diseased and undesirable heads from heap. The heads are dried and threshed by threshers. Seed is dried to 10 per cent moisture content before storage.

4.2.6 Production of Hybrid Jowar Seed (Line A x Line R)

Hybrid seed is produced by crossing male sterile line (Line A) with restorer line (line R) in an isolated field.

a. Land requirement : Sorghum prefers medium deep to deep black soils. Land to be used for seed production should be fertile and well drained. It should be free from off types and volunteer plants. The previous crop should not be the other variety of same crop. Land should be free from Johnson grass and other contaminants.

b. Isolation requirements : The isolation distance for fields of other varieties of grain, dual purpose sorghum and same hybrid not confirming varietal purity requirements of certification is 200 meters. Isolation distance for fields of other hybrids having same male parent should be 5 metres. The seed field should be isolated by 400 metres from fields of forage sorghum and Johnson grass.

c. Cultural practices :

i. Preparatory tillage

The land is prepared by deep ploughing,

3 to 4 harrowings and levelling.

ii. Sowing season and time The *Jowar* seed crop is preferably sown in *kharif* season during the month of June to July.

iii. Synchronization of male and female parent

For achieving perfect synchronization in flowering of parental lines, staggered sowing based on difference in blooming time and hardening treatment for late parent to promote germination, etc., are recommended. Generally, male parent is sown 4-6 days earlier than female parent.

iv. Sowing method (ratio) :

Usually four rows of female parent and two rows of male parent are sown alternately. About 4 to 6 rows of male parent are sown all around the field as border rows to prevent out crossing and to supply ample pollen grains to seed plant. At both the ends of male rows 3-4 seed of dhaincha or sannhemp are dibbled for identifying male parent.

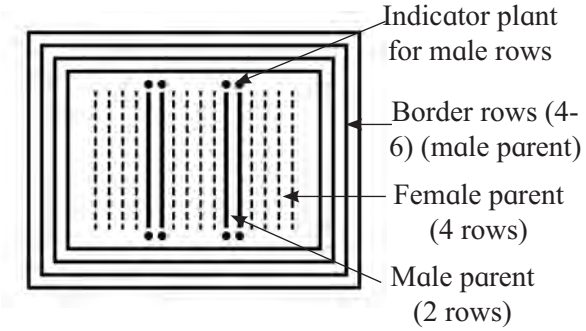


Fig. 4.4 Sowing ratio (Sowing plan) for hybrid seed production of *Jowar* (Line A x Line R)

v. Spacing

The recommended spacing between rows is 75 to 90 cm. The crop may be thinned to retain 7.5 cm distance between two plants in a row.

vi. Seed source

Foundation seed of line 'A' and Line 'R' should be obtained from the source recommended by the seed certification agency.

vii. Seed rate

It may be 8 kg/ha. for female parent and 4 kg/ ha. for male parent.

viii. Hybrids and their parents

	A (Female)		R (Male)
1) CSH-1	CK 60 A	X	IS-84
2) CSH-2	CK 60 A	X	IS-3691
3) CSH-3	MS2219 A	X	IS-3691
4) CSH-4	MS1036 A	X	IS-3924
5) CSH-5	MS2077 A	X	CS-3541
6) CSH-7R	MS-36A	X	CS-168
7) CSH-8R	MS-36A	X	PD-3-1-11
8) CSH-9	MS-296 A	X	CS-3541
9) CSH-16	MS-27A	X	CS - 43

ix. Roguing

It is similar to that for maintenance of male sterile line (Line A).

d. Pest Control

i. Stem borer

Larva initially feed on leaf whorls and later on bore into the stem and feed on inner material. Infected plant dries up.

Control measures

Removal and destruction of dead hearts (infected plants). Collection and destruction of stubbles of previous crop are the effective control measures against stem borer. Spraying the crop with chloropyriphos is also recommended.

ii. Ear head midge or midge fly

The maggot feed on the ovary making it dry. Grain formation may not take place in such dry ovaries.

Control measures

Dusting the crop with melathion 5% D.P. @ 20 kg/ha. and zonal sowing of crop, that is sowing of crop at a time by forming the group of villages has also been proved effective. Spraying the crop with Quinalphos or chloropyriphos may also be followed.

iii. Shoot fly The maggots feed on the growing tip of the plant. As a result of which main shoot stops growing and too many lateral tillers (shoots) arise from the base of infected plants. THese tillers are non-productive.

Can you tell ?

Whether the practice of Integrated Pest Management is possible in hybrid seed production of *Jowar*.

Control measures Drilling in soil 10% phorate or thimet granules @ 15-16kg ha. is useful preventive measure. Spraying of 25% Quinophos 25% EC is also done against this pest.

iv. Aphids Aphids suck up the sap from the leaves and other tender plant parts and interfere with the process of photosynthesis .

Control measures Drilling in soil 10% phorate @ 15 - 16 kg/ha. or spraying the crop with dimethoate 30% EC Imidacloprid 17.8 % SL is recommended.

v. Army worm It feeds on the leaves starting from margin towards the midrib.

Control measures Spraying the crop with Quinalphos, or chloropyriphos are the control measures.

e. Disease Control

i. Grain smut It is a fungal disease. Grains are replaced by elongated cylindrical structures, which are covered by black powdery mass of fungal spores.

Control measures Seed treatment with 300 mesh fine sulphar @ 4 to 6 g/kg seed has been proved effective.

Fig. 4.5 Grain smut

ii. Loose smut It is also a fungal disease. Grains are covered by loose-black powdery mass of fungal spores.

Control measures Seed treatment with 300 mesh fine sulphur @ 4 to 6 g/kg seed is the effective control measure.

iii. Downy mildew It is a fungal disease. Infected plants turn pale yellow. Lower side of the leaves show whitish fungal growth. The plants remain stunted and bear no ear - heads.

Control measures Proper crop cultivation, removal and destruction of infected plants and spraying the crop with mancozeb are the suggested control measures.

Fig. 4.6 Downy mildew

iv. Striga or witch weed (parasite) It is a root parasite and locally known as *Agya* or *talap*. With the help of special penetrating organ known as 'haustoria', it makes connection with *Jowar* xylem and gets water, minerals and manufactures its own food.

Control measures Spraying the crop with dicotox @ 720 g to 1 kg in 500 Lit water 2-3 times at an interval of 15 days has been recommended.

f. Harvesting : Initially male rows are harvested any time after flowering to avoid admixture and later on after maturity the female rows are harvested to collect hybrid seed. The ear-heads are then sorted out to remove diseased, unwanted ear-heads from the heap. The normal ear- heads are then dried for a week and threshed by using threshing machine. The seed is dried up to 10 per cent moisture content and stored.

Seed yield The average seed yield is 4 to 6 q/ha. However, it may be much higher under favourable conditions.

4.3 HYBRID SEED PRODUCTION OF COTTON

Botanical name *Gossypium species.*

Fig. 4.7 Cotton bolls

Fig. 4.8 Cotton green bolls

There are four cultivated species in cotton as stated below.

1. *Gossypium arboreum* - Known as *deshi* or old world cotton.
2. *Gossypium herbaceum* - It is also known as deshi or old world cotton.
3. *Gossypium hirsutum* - Referred as American or New world cotton.
4. *Gossypium barbadense* - Called as Egyptian or New world cotton.

Family : Malvaceae

Origin :

There are two different centers of origin

1. Old world - India, Indochina, Tropical Africa
2. New world - Maxico or Central America

4.3.1 Economic importance / uses :

Cotton is the most important fibre as well as cash crop in the world. Cotton is mainly grown for manufacturing cloth. Cotton seed contains considerable amount of oil, protein, carbohydrates and certain vitamins as well as minerals. Cotton seed cake is used as concentrates for cattle. Cotton oil is used for preparing vegetable ghee, soaps, explosives, cosmetics, etc. Cotton linters have many uses such as dressing or absorbent cotton, automobile and furniture padding, etc.

4.3.2 Method (principle) : Hybrid seed production in cotton is done by individual bud emasculation of female parent and pollination of same by dusting pollen from desired male parent manually. The technique and cultural practices are described below.

4.3.3 Climate : Cotton is a tropical region crop, but can be grown in subtropical region. Cotton favours warm climate. Optimum temperature for germination is 32°C to 34°C. Vegetative growth is well at temperature range 21-27°C temperature. For fruiting and boll development slightly higher temperature ranging from 27°C to 31°C is required. Deshi cotton can tolerate higher temperature. It does not tolerate continuous rain or long dry spell. Rainfed cotton can be grown in regions receiving

500-1200 mm rainfall. Well distributed rain fall of 900-1000 mm particularly during vegetative growth is beneficial. Cloudy and frosty weather conditions are harmful.

Remember this

- Cotton is known as king of fibres.
- The word cotton is derived from Arabic word *qutun* or *kutun*.
- India is the third largest cotton producer in the world

4.3.4 Land requirement : The land to be used for hybrid seed production should be medium deep to deep black, fertile and well drained. It should be free from volunteer plants. The sub-surface should not be hard, free from layer of carbonates.

4.3.5 Isolation : Cotton is often cross pollinated crop. Average cross pollination is 5 to 25%. However in some species it may be upto 50%. In hybrid cotton seed production under controlled emasculation and pollination the isolation distance of 5 m is provided all around the seed plot to avoid mechanical mixture.

4.3.6 Time of sowing : The cotton crop is sown about one week or more earlier than the usual date of on set of monsoon. Irrigated crop can be sown in the month of April.

4.3.7 Land preparation : Land is prepared by giving one deep ploughing, 2 to 3 harrowings and levelling.

4.3.8 Planting ratio : The area under female and male parent should be 4:1 or 5:1. Approximately first 4/5th of the total rows are used for sowing female parent and remaining 1/5th rows for male parent. The sowing of male parent is done in 2 to 3 installments so that pollens are available for staggered period of time.

4.3.9 Spacing : Row to Row distance for both male and female should be 150 cm. The plant to plant distance may be 100 cm in female rows and 50 cm in male rows. This may vary with the growth habit of parents used for crossing.

4.3.10 Seed source : Foundation seed of male and female parents should be obtained from the source approved by seed certification agency.

4.3.11 Seed rate : The seed rate may be 3.75 kg / ha. for female parent and 2.5 kg / ha. for male parent.

4.3.12 Seed treatment :

i. Delinting is the procedure of removing fuzz portion from the seed. It is done by rubbing the seed with mud or paste of soil with fresh cow-dung or by using concentrated sulphuric acid.

ii. Seed of deshi and American varieties are soaked in water for 2-3 hours and 4 to 6 hours, respectively, for enhancing the germination.

iii. Cotton seed is treated with 1% organo-mercurial compounds for preventing attack of fungal diseases.

iv. Seed treatment with *Trichoderma viride* @ 4 g along with thirum @ 3g/kg seed can be given to reduce the attack of wilt.

4.3.13 Crossing programme : It includes emasculation and pollination as stated - below.

1. Emasculation : It is the process of artificial removal of male reproductive organ (Androecium) from bisexual flower without disturbing female reproductive organ (Gynoecium). Initially with the thumbnail whole corolla and androecium are removed. This procedure is started one week after flower bud initiation. It is done each day from 2.00 to 6.00 P.M. or early in the morning before 7.30 AM. on the same day of pollination. The emasculated bud is then covered by butter paper bag or straw tube.

Fig. 4.9a. Emasculation in cotton

2. Pollination : It is the procedure of artificial transfer of pollen grains from desired protected flower of male parent to the stigma of emasculated female flower. It is done in the morning between 9.00 A.M.to 1.00 P.M. After pollination the female flower bud is covered by different coloured butter paper bag or straw tube. For easy identification a thread is tied to the pedicel of pollinated bud. The crossing programme is closed after eleventh week.

Emasculation and pollination of all the buds appearing in the first seven weeks of reproductive phase is essential for better development of bolls and good seed setting.

Fig. 4.9b. Pollination in cotton

4.3.14 Fertilization : At the time of land preparation 15-25 tones/ha. of FYM should added before last harrowing. Apply 50 kg nitrogen, 50 kg phosphorus and 50 kg potash per hectare as a basal dose. Top dress twice at the rate of 25 kg nitrogen per hectare after sixty days and again at ninety days from planting. Foliar sprays at the rate of 20 g of urea or 15 g of DAP per litre of spray may be given during the boll development period, at an interval of 10 days.

4.3.15 Irrigation : As per soil condition and climate, irrigate the crop once in 15-20 days. Heavy irrigation during flowering period should be avoided. For irrigation system of furrow irrigation should be adopted. Square initiation to peak flowering stage is considered most critical for irrigation. In rainy season crop should be irrigated during the periods of long dry spell.

4.3.16 Roguing :

All off-types, diseased plants from seed field area should be removed at seedling stage, square initiation stage and flowering stage

Remember this

- Topping of plant is done to prevent abnormal plant growth and to enhance fruiting branches.
- Light irrigation is given during crossing programme as per requirement.

4.3.17 Harvesting (picking) :

Mature bolls are picked after their full opening and collected in the baskets. Middle pickings are good quality for seed production In second sorting they are again verified and dried for one to two days, and supplied to the authorized ginning unit. Precautions need to be taken to avoid mechanical mixtures during picking and further handling till it is handed over to processing plant.

[Seed yield: Average yield of hybrid seed cotton crop is 1000-1500 kg/ha.]

Hybrids and their parents

Hybrids	A (Female parent)	X	R (Male parent)
1. H4	G-67	X	Americal nectariless
2. Varlaxmi	Laxmi	X	SB 289-E
3. Savitri	Koparaon-203	X	SB 1085-6
4. Godavari	Buri nectariless	X	MCU-5
5. NHH-44	BN-1	X	AC-738
6. DCS-32	DS-28	X	SB -425
7. PKV DH.1	GAK-423	X	HD-110-151
8. PKV Hy.2	AK-32	X	DHY-286-1
9. PKV HY.4	CAK – 23 A	X	AKH-7 R
10. PKV Hy.5	CAK – 53 A	X	AKH-2 R

4.3.18 Plant protection

I. Insects-pests

Insects-pest affecting cotton crop are classified as follows:

1. Insects-pest affecting crop before flowering

Aphids, jassids, thrips and white flies are common in this group. All these are sucking pest which suck the sap from leaves causing yellowing, curling or crinkling resulting in to stunted plant growth.

Control measures

Sl. No.	Name of pest	Control measures
1.	Aphids/ Jassids	Spray Immidacloprid 2 ml /litre of water, acephate 2 g/litre of water
2.	Thrips	Spray Fipronil 3 ml/ litre of water or thiomethoxon 0.5 g/litre of water
3.	White fly	Spraying of Acetamiprid 1 g/litre of water. Spray 5% Neem Seed kernel extract (NSKE)

2. Insects-pest affecting crop after it has commenced producing buds, flowers and bolls.

The important examples of this group are pink bollworm, spotted boll worm and American boll worm.

i. The nature of damage caused by **spotted boll worm** includes shedding of squares and bolls, holes on bolls and rotting of bolls.

ii. The **pink-boll worm** cause shedding of fruiting sqneres, discolouration of lint, holes on bolls etc.

iii. **American boll worm** (*Heliothis*) cause damage to squares, flowers and bolls. Holes appear on bolls.

iv. **Red cotton bug-** Nymphs and adults suck the sap from the buds, flowers and bolls and tinge the lint.

v. **Dusky cotton bug-** Nymphs and adults feed on the sap of premature and tinge the lint.

Control measures

i. All the bollworms can be controlled by using insecticides like acephate 75 SP, thiodecarb 75 WP, chloropyriphos 20 EC, spray spinocide @ 3.5 m*l*/10 lit of water etc

ii. Both the bugs can be controlled by spraying the crop with monochrotophos or quinolphos.

Try this

Collect important insects-pest and specimens of disesase affecting cotton crop, label them along with their control measures.

II. Diseases

1.Wilt

Symptoms :

i. It is soil and seed borne fungal disease.

ii. It consists of yellowing of leaves and gradual drooping and withering of a particular branch or entire plant.

iii. Vascular tissues turn brown.

Control measures :

i. Use of resistant varieties and proper crop rotation practices are the preventive measures.

ii. Seed treatment with organo mercurial fungicides like thirum along with *trichoderma viride* formulation is also effective.

2. Root rot :

Symptoms :

characteristic symptoms are sudden wilting of plant, rotting of roots and shredding of bark.

Control measures :

i. Seed treatment with benomyl or carbendazim @ 2.5 g/kg seed.

ii. Intercropping with moth bean (*matki*) is also effective against root rot.

3. Anthracnose :

Symptoms :

i. It is a fungal disease.

ii. Symptoms are characterized by rotting of bolls and seedling blight.

Fig. 4.10 Anthracnose

Control measures :

Seed treatment with 1% organo mercurial compounds and spraying the crop with copper compound are the recommended control measures.

4. Dahiya :

Symptoms :

i. This is common on deshi varieties.

ii. The older leaves show whitish fungal growth on their lower side.

iii. There is premature shedding of affected leaves.

Control measures :

The recommended control measures are growing of resistant varieties and dusting the crop with sulphur.

Fig. 4.11 Dahiya

5. Black arm :

Symptoms :

i. This is soil, seed and air borne serious bacterial disease of American types.

ii. Bacteria attack all aerial plant parts.

iii. Angular water soaked spots which are later on turn brown appear on leaves.

iv. It also causes rotting of bolls and seedling blight.

Fig. 4.12 Black arm

Control measures :

Treat the seed with streptomycin or vitavax, keep the campaign clean and practice proper crop rotation.

6. Leaf spots :

Symptoms :

i. *Helminthosporium* spots are light brown, circular with holes at the centre at later stage.

ii. *Alternaria* spots are papery, rusty brown of irregualr shape and size.

iii. *Cercospora* leaf spots are small, irregular with purple border and white centre.

Control measures :

Spray the crop with zineb, Copper oxychloride, etc.

Fig. 4.13 Leaf spots

Exercise

Q. 1 Answer the following questions.

A. Select appropriate alternative and complete the following statements.

1. General principles of seed production are broadly classified as genetic and ---------- principles.
   a. agronomic b. physical
   c. chemical d. biological
2. The parents of H4 are --------
   a. G-67 and American nectariless
   b. BN-1 and AC-738
   c. AK-32 and CS-2
   d. laxmi and BN-1
3. Hybrid Jowar seed is produced by using -------- male sterility.
   a. genetic b. cytoplasmic
   c. cytoplasmic-genetic
   d. none of these
4. *Sorghum bicolor* is the botanical name of -------- crop.
   a. Jowar b. bajra
   c. wheat d. cotton
5. Zonal sowing of crop is recommended to control -------- pest of jowar.
   a. midge fly b. shoot fly
   c. aphid d. jassid

B. Make the pairs.

Group 'A'	Group 'B'
1. CSH-7R	a. CK-60A×IS-84
2. CSH-8R	b. CAK-23A×AKH-7R
3. PKVHy.4	c. laxmi× SB-289-E
4. Varlaxni	d. MS-36A×CS-168
	e. MS-36A×PD-3-1-11

C. Find the odd one out.

1. Vishal, Varlaxmi, Savitri, Godavari.
2. Stemborer, Shoot Fly, Midge Fly, Downey mildew.
3. Shoot fly, Aphid, Army worm, Striga.
4. Processing, Gapfilling, Weeding, Hoeing.

D. Write true and false.

1. Cleaning of seed drill before sowing is the remedy for avoiding mechanical mixture of seed.
2. While buying the seed it should be seen that tag and seals of bag are intact.
3. Hybrid *jowar* seed is produced by crossing male sterile line (Line A) with restorer line (Line R).
4. Shoot fly is the major pest of cotton.
5. The seed to be used for seed production should be of appropriate class.

Q.2 Answer in brief.

1. Give two reasons causing mechanical mixture of seed.
2. Why isolation of seed crop is necessary?
3. What is supplimentary pollination?
4. What are the uses of cotton?
5. Write the parents of godavari.
6. What is the nature of damage of stem borer affecting *jowar*?
7. What are the control measures of cotton wilt?

Q.3 Answer the following questions.

1. Draw and label the sowing plan for hybrid seed production of jowar.
2. Complete the following chart.

Sr. No.	Hybrid	Female parent	Male parent
1	CSH-5	---------	---------
2	---------	Buri nectariless	MCU-5
3	PKVHY.5	---------	---------
4	CSH-16	MS-27A	---------

3. Describe the isolation requirements for maintenance of male sterile line (line A)
4. List the pest affecting *jowar* crop.
5. Explain the symptoms and give control measures of cotton wilt and anthracnose.
6. Describe the economic importance of *jowar* crop.
7. List out the cotton species.

Q. 4 Answer the following questions.

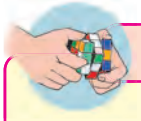
1. Write in brief about minor genetic variations.
2. What is the procedure of emasculation in cotton?
3. Write the parents of savitri and NHH-44.
4. What is the principle of hybrid seed production of jowar?
5. What are the critical stages of jowar growth for irrigation?
6. Which treatments are given to cotton seed before sowing hybrid crop?

Q. 5 Answer the following questions in detail.

1. What are the reasons for mechanical mixture of seed ?
2. What are the measures for maintenance of genetic purity during seed production ?

Q. 6 Answer the following questions in detail

1. Describe maintenance of male-sterile line in *jowar* seed production (Line 'A') on following points
   a. land requirement
   b. land preparation
   c. spacing
   d. seed rate
2. Elucidate hybrid seed production of cotton on following points.
   a. Time of sowing
   b. Land preparation
   c. Planting ratio
   d. Spacing



Activity

Collect the seed of different hybrids of *Jowar* and Cotton; label them and mention their parents.

5. Farm Management

Can you recall?

- At present agriculture is the largest supporting component of Indian economy.
- Majority of the Indian population still depends on agriculture and related enterprises.
- In India farm management is not properly adopted due to small land holdings.
- Farm management, is useful tool for exploring thoughts stimulating farming enterprise and to assess their resources and develop a whole farm plan.

5.1 DEFINITION, OBJECTIVES AND ASPECTS OF FARM MANAGEMENT

5.1.1 Definition of farm management :

Farm management means making and implementing the decisions involved in organizing and operating a farm for maximum production and profit.

Farm management is also defined as organizing and managing one or more enterprises on scientific and business lines for continuously getting maximum net profit from the farm as a whole.

Farm management is a branch of agricultural economics, which deals with investing and earning of money from farm activities by the farmer for securing the maximum possible net income.

5.1.2 Objectives of farm management :

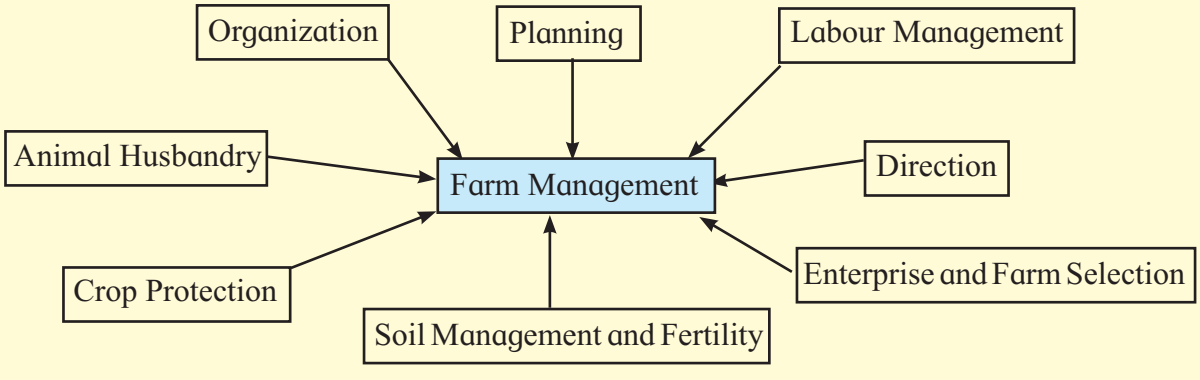
The main objectives of farm management are :

1. To make effective planning regarding land utilization, cropping system, labour and weather.
2. To decide more profitable cropping systems and animal husbandry.
3. To calculate expenditure required per unit area for evaluation of agricultural production.
4. To provide programs and services that develop skills and knowledge in financial management and planning legal issues, tax laws, technical production, leadership, sustainable agriculture, human health and the environment.
5. To increase the agri-business by efficiently using sources and resources available.
6. To earn maximum profit from different agricultural enterprises.
7. Have comparative study of economics with other agricultural enterprises.
8. To study effect of different changing technologies on agri business.

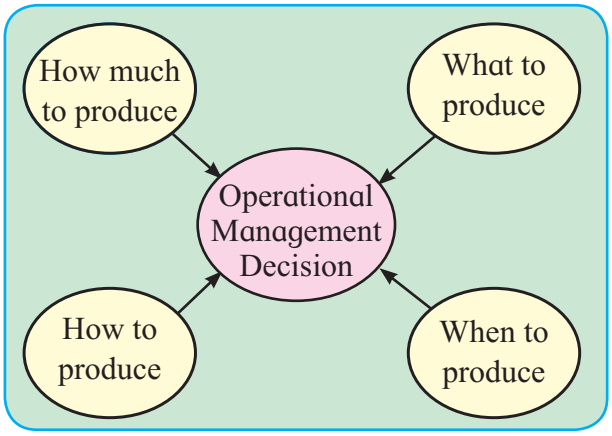
5.1.3 Aspects of farm management :

The important aspects of farm management are:

1. Selection of farm
2. Choice of an enterprise
3. Preparing a suitable layout for the farm
4. Formulation of cropping scheme and calender of operations
5. Equipping the farm with necessary inputs
6. Management of farm labour



7. Maintain farm records to work out cost of cultivation of major crops, profit and loss statement of the farm.
8. Maintain recordes for seeking certificates for export.
9. Resource conservation



Remember this

Farmer as a businessman should know

- How to produce more.
- How to reduce cost of production.
- How to secure high price for his produce.

5.2 DEFINITION AND FUNCTIONS OF FARM MANAGER

5.2.1 Definition

A farm manager is an employee who is paid to manage a farm or a group of farm.

Or a farm manager is a responsible person employed to manage and carry out duties associated with the day-to-day and long term management of the farm.

5.2.2 Functions of a farm manager

1. Directs and coordinates activities such as planting, irrigation, fertilizer application, harvesting, grading, pay-roll, and record keeping.
2. Coordinates growing activities with those of engineering , equipment maintenance, packing houses, and other related departments.
3. Analyzes market conditions to determine acreage allocations.
4. Confers with purchasers and arranges sale of farm produce.
5. Records information such as production, farm management practices and parent stock and prepares financial and operational reports.
6. Determines procedural changes in drying, grading, storage, and shipment for greater efficiency and accuracy.
7. Analyzes soil, determines types and quantity of fertilizer required for maximum production.
8. Inspect equipment to ensure proper functioning.
9. Determines maturity period of crops and estimates potential crop damage from weather.
10. Purchase of machinery, equipment, seed, fertilizer and chemicals.
11. Negotiates with banks to obtain credit.
12. Evaluation of financial statements and makeing of budget proposals.

Qualities of Farm Manager

- Command over Basic Facts
- Relevant Professional Knowledge
- Skill and Attributes
- Decision making skills
- Creativity
- Mental Ability
- Self confidance
- Proactivity
- Emotional Resilience

5.3 CHOICE OF AN ENTERPRISE AND SELECTION OF FARM

5.3.1 Choice of enterprise

The important decision which one has to take in farming is the choice of enterprise or the specific line or lines of farming one would like to pursue *viz.* one crop or diversified farming,

vegetable cultivation, fruit culture or mixed farming. Further development of the farm will depend on this crucial decision.

Sometimes a farmer produces just one major crop *viz*, sugarcane, cotton or tobacco, when there is a good demand. He can then specialize in that commodity and utilize all his resources to get the maximum production and profit with the minimum of expenses. In crop farming, management is easier and the equipment and other necessities will be minimum.

Sometimes, it may be better to develop diversified farming. The land, labour, equipment and other factors are used efficiently throughout the year. It will also reduce the risk of complete loss of income due to drought, pests and diseases.

When more than one farm enterprise or business is combined e.g. dairying and fodder cultivation with crop production or raising of cattle or poultry with crop production, the enterprise should be complementary to each other and result in saving expenses and increase the profit. Sometimes, it pays to combine a cooperative handling of a few or all farm operations such as plant protection, tractor ploughing etc., or combine a village community crop protection service.

Fruit, vegetable or flower cultivation, poultry keeping or dairying is always a profitable enterprise if the farm is near a town. Each system has its own advantages and disadvantages and in the farm business the farmer has to consider how far it will be beneficial if he takes up one system or another.

5.3.2 Selection of a farm

The selection of farm is important in farm business as the land is the costliest item amongst all the factors of production. Moreover, once the capital is invested in the purchase of farm land, it gets locked up. The selection will depend upon various considerations like the availability of contiguous area, the amount of money that the farmer can invest and the area he can manage himself conveniently. Normally, bigger the farm, greater are the advantages for such as a farm, capital and labour are most efficiently used and overhead charges are kept low. There is also a scope for mechanization and improved marketing of produce. However, if the farmer has minimum holding, he should produce sufficient for him and his family members with full employment to get sufficient profits to make a good living. Factors normally considered while selecting a farm are classified as Physical, Economic , Socio and personal.

Try this

Visit a near by modern farm to study different aspects.

1. Physical factors : The physical factors are as follows:

a. Climate : It should be suitable for the enterprise and the crops intended to be grown and allow maximum number of working days. It should be congenial to one's health.

b. Topography : Topography is important from the point of view of soil erosion, drainage, water logging conditions, irrigation and use of machinery, etc. The farm should be levelled and not undulating. A farmer can change the topography or the general lay out of the land to some extent but that may involve very heavy expenditure.

c. Soil It should be studied in respect of structure, texture, soil depth, nature of lower strata of soil, types of natural vegetation growing on it, etc. For ascertaining the soil fertility, it may be necessary to take soil samples from different depths for soil testing and also to dig pits for examining the soil profile.

d. Distribution of farm area : Before slection of farm proportion of cultivable land, waste land, pastures, rivulets, etc. should be studied.

e. Layout and arrangement of the existing fields : If there are any intervening fields belonging to other farmers, they may have to be purchased to have a compact area. It will save expenditure on equipment and improve efficiency in management.

Fig. 5.1 Farm enterprises or business

f. Study of exisiting structures : Condition of the fencing, drainage system, bunds and farmstead, if any.

g. Water supply : Sources of water supply and depth of water table in different seasons.

h. Location : Proximity to a town, market, town approach road, railway station, airport etc.

2. Information on the following items may be helpful in making a proper selection of the farm and striking a bargain.

a. Current prices of land in the locality.

b. The amount of money the farmer can invest. The availability of loan and the rate of interest to be paid.

c. Taxes to be paid.

d. Labour, their availability, wages, types, usual working hours in the area, etc.

Do you know ?

Economic Factors : The economic factors are concerned with i. the capital to be invested in purchasing the farm, ii. the annual expenditure for running the farm efficiently and iii. expected returns.

3. Social and personal factors :

a. Social : It includes type of neighbours and their attitudes towards a newcomer should be studied.

b. Personal : These factors consists of facilities such as schooling, medical, transport and banking should be available.

5.4 FARM LAYOUT, FARM PLANNING, FARM BUDGETING AND INPUTS

5.4.1 Farm Layout :

A farm layout includes

a. Farmstead or farm buildings

b. Number, size, shape and arrangement of fields and

c. Other structures including threshing floor, farm roads, bunds, manure pits irrigation and drainage channels, farm fencing, etc.

a. Farmstead or Farm Building : A farmer can manage his farm better, if he has a home-stead on the farm. There is a growing tendency among the new generation of farmers to live on the farm itself. For this purpose, a small home is to be constructed where he can stay during the season and supervise the labour and all the farm operations.

A farmstead consists of many types of buildings, *viz,* residential buildings for the farmer and his labourers, cattle shed, implements shed, grain godown, fodder shed etc. As a general practice, about 2 % of the farm area is devoted for the construction of farmstead.

The size of various farm structures should be according to the need of the farmer and the farming business. Future expansion programme should also be taken into account. On an average, a room of 4x3 meters along with a *varandah* will be sufficient for a labourer's accommodation whereas 3x1.75 meters space may be required by an adult animal. A godown of 15x7 meters may be sufficient for a farm of about 20 hectares.

b. Number, size, shape and arrangement of farm field On the farm, it is better to have fields equal to or multiple of the number of crops in different rotations planned for the farm. This will facilitate in operating properly the cropping programme in different years.

Remember this

The following considerations should be made while constructing various farmstead buildings:

i. The farmstead should be located on high ground and should have easy approach. If on the hill, it should be so located that it receives sunlight and is sheltered from winds. As far as possible it should be at the center of the farm. Trees should be planted at suitable places to provide shade, green leaf manure, fuel and timber.

ii. Buildings should be near the source of water and those having some relationship with each other should be so located that the various farm operations can be done efficiently and without any westage of time and labour. *Viz,* Cattle shed, fodder storage and manure pits should be adjucent to one another. Similarly, grain godown and threshing floor should be near to each other.

The field boundaries should preferably be regular, to avoid any wastage of land. Large fields save labour, particularly when large scale farm machinery is to be used. The field should be preferably, rectangular in shape with the length to breadth ratio of about 2 or 2.5:1. The size of farm fields is also governed by factors *viz,* a. topography of the farm to avoid erosion, b. source of irrigation e.g. well or canal c. the nature of the farm enterprise e.g. cotton, sugarcane or dairying.

The field should be arranged in relation to the farmstead, and should be easily approachable and not in a random manner.

c. Other structures : These include farm roads, manure pits, threshing floor, irrigation and drainage channels and farm fencing.

i. Farm roads : The farm road should be of sufficient width to allow easy transport of carts, trucks and or tractors as the case may be. One main road, about 5 meters width may be constructed at the centre of the farm. It should be joined by secondary roads of 3 meters wide in sufficient numbers, at right angles. Mainly boulders are used for construction. There should be shallow channels on both sides of the road for facilitating drainage of rain water.

ii. Manure pits : The manure pits should be near to the cattle shed and their sizes may be 7x1.5x1 meters or 5x1.2x1 meters. Two pits of the former size or three pits of the latter size are sufficient for 4 to 5 heads of cattle on the farm. They should be dug in a row, keeping a distance of about one meter in between two pits with sufficient area on one side for the movement of a cart or a truck to be used for removing the manure.

iii. Irrigation and drainage channels These should be constructed by considering the topography of the land. Field bunds should be constructed not only to demarcate the fields but also to check erosion. These bunds maybe planted with grasses like blue panic, dwarf castor, green manuring crops, which will provide some economic returns and also help in stabilising bunds

iv. Fencing : Generally fields growing cash crops like vegetables, fruit trees, etc., are only protected by constructing a fence around them. The cost of fencing will be proportionately low in case of big sized field. Fencing may be of many types *viz.*

a. Dead stumps of thorny bushes,
b. Wooden posts matted with bamboo poles,
c. Mud or stone walls,
d. Live fencing,
e. Barbed wire fencing
f. Wooden pole cement pole wire fencing and
g. Electric wire fencing

Fig. 5.2 Types of farm fencing

Certain quick growing live hedges serve the purpose of fencing *viz. karwand, mehendi,* ingadulcis chichbillai, *babhol,* ketki. These plants are thorny and their leaves withstand drought conditions; propagated easily and put up a rapid growth.

Barbed wire fencing, electric or solar fencing is most effective against stray cattle and wild animals like jackals, wild boar, etc. but it is very costly. These wires are supported by either wooden, iron, cement concrete or stone posts fixed at a distance of about 3 to 5 meters. The total number of parallel wires may be 4 to 6 or more depending upon the type of protection needed. Vertical distance between these parallel wires may be 15 cm towards the ground and about 25 to 30 cm at the top.

5.4.2 Farm planning

A. Meaning :

Farm planning is a deliberate and conscious effort on the part of the farmer to think about the farm programmes, technological developments, changes in physical and economic situation, price structure, etc. It is the major economic content in the farming business.

B. Advantages of farm planning :

1. **Income improvement** Farm planning approach is an integrated, co-ordinated and advance programme of action which provides an opportunity to cultivators to improve their income level with maximization of the profit.
2. **Educational process** Knowledge of the latest technological advances in agriculture is a pre requisite for better farm planning. It helps to keep the information up to date. This acts as a self educating tool for farmers.
3. **Desirable organizational changes** This approach introduces desirable changes in farm organization and operations and make the farm a valuable unit. It may include farm business or any change in the method or practices followed on the farm.
4. **Planning minimizes uncertainty** Planning helps in reducing the uncertainties of future events.
5. **Planning facilitates co-ordination** There is an integrated effort throughout the enterprise in various departments and groups.

C. Objectives of good farm plan

- Efficient use of farm resources such as labour power and equipment.
- Balanced combinations of various enterprises.
- Avoidance of excessive risk and provision of flexibility.
- Use of farmer's knowledge, training and experience.
- Use of efficient marketing facilities.

- Use of latest agricultural methods and practices.

D. Characteristics of good farm plan

1. Plan should aim at efficient utilization of all available resources on the farm.
2. It should be flexible as per changing environment.
3. It should be simple and easily understood.
4. It should ensure balanced production programme.
5. It should aim at maintaining and improving soil fertility.
6. It should facilitate efficient marketing of farm products.
7. It should take into account up-to-date technology.
8. It should avoid too risky enterprise.
9. It should consider the goals, knowledge, training and experience of the farmers.

5.4.3 Farm budgeting and inputs :

A. Meaning :

Farm budgeting is a process of estimating costs, returns and net profit of a farm or a particular enterprise.

B. Types of farm budgeting :

There are three types of farm budgeting:

1. **Partial budgeting :** It refers to estimating the outcome or returns from a part of the business. Partial budgeting analysis is a simple, quick and easy method for deciding how far expense and yield of a particular enterprise should be increased. It does not allow substitution between resources. This is short duration budget. It is easy for specific work and management.
2. **Complete budgeting :** It refers to preparing out a plan for the farm as whole for all decisions about an enterprise. It considers all the crops and livestocks producing methods and estimates cost and returns from the farm as a whole. It brings progressive change in the income. It draws attention to a variety of factors contributing to the farm income the total enterprise and activities are included in this budget.
3. **Enterprise budgeting :** It is to estimate inputs required, costs involved and expected returns from a particular business. The purpose of budgeting enterprise is to aid in selection of inputs and enterprise consistent with the resources available and to show combinations that helps to increase farm income.

C. Farm Inputs

Successful farm management depends upon how the various inputs required to run the farm are properly organized.

Types of inputs :

Recurring inputs :

There are certain inputs which are oftenly required known as recurring inputs. These are

a. Manures and Fertilizers
b. Seed
c. Inscticides and Pesticides
d. Labours

The requirement of these will depend upon the size and kind of farming and cropping scheme.

Non-recurring inputs :

These are capital in nature and purchased once in a while. They are,

a. Farm bullocks
b. Implements and machinery
c. Plant protection appliances
d. Electric motor/oil engine, pump set
e. Hand tools
f. Live stock
g. Bullock cart
h. Bins/Basket/Chains/ropes etc.

Remember this

The cropping scheme is not only a systematic crop rotation but something more than that. It also makes the best possible use of all the resources of production available with the farmer.

Fig. 5.3 Various farm operations

5.5 CROPPING SCHEMES AND CALENDER OF OPERATIONS

5.5.1 Cropping scheme: It is the basis on which the farm budgetting is framed and farm management practices are decided or it is a plan according to which crops are grown on an individual plot of the farm with an object of getting maximum returns from each crop without impairing the soil fertility.

5.5.2 Characteristics of good cropping scheme

1. It should satisfy food requirements of farmer and his family and the fodder requirements of his cattle.
2. It should give the good cash returns from cash crops. It should have sufficient area under most profitable cash crops.
3. It should maintain or even increase the productivity of the farm by proper crop rotation.
4. It should engage the farm labours properly throughout the year.
5. It should comprise green manuring crops, which will help in maintaining the condition of soil.
6. It should reduce the cost of cultivation of succeeding crop.
7. It should be helpful in improving the standard of living of the farmer.

5.5.3 Considerations for selecting crop and area under cropping scheme

1. The availability of labour throughout the year and whether there are any period of acute shortage of labour which can be avoided.
2. How far the period of peak load of labour for different crops can be avoided and crops which will allow more even spread of labour can be selected.
3. The relative cost of production and expected market prices of crop to be cultivated.
4. The capital required for growing of cash crops.
5. Requirement for other farm enterprises like dairy, poultry, etc.
6. Availability of storage, transport and market facilities for perishable produce.
7. The cropping plans adopted on the neighbouring farms.
8. Utililse land, 70-75% of farm for *kharif* crop and remaining 25-30% area is to be utilized for *rabi* crops under rainfed region.
9. Shallow soils used for raising minor crops or grasses and under heavy soils follow double cropping.

10. Financial condition of the farmer for meeting the recurrent expenditure on the farm.

5.5.4 Calendar of operations :

Definition :

It is a tabular information indicating the type of work to be done on each crop during its life cycle.

Steps in preparation of calendar of operations

The steps are as follows:

1. Firstly, prepare a list of crops and enterprises on the farm.
2. Prepare a list of all operations to be conducted for each crop and enterprise.
3. Indicate the time limits during which the operations are to be completed.
4. Estimate the labour, bullock power, machine power required for each operation in terms of unit.
5. Finally, prepare a consolidated and comprehensive work schedule.

5.6 LABOUR MANAGEMENT

5.6.1 Definition :

Agricultural labour is the person who undertake physical work at the farm for wages and generally, 50 percent or more of his total income is from such work.

5.6.2 Types of agricultural laboures :

A. According to source :

1. **Farmer family labour :** Family members are quite often engaged on his own farm. The value of this unpaid family labour is known as labour income of the farmer.
2. **Out of family :**
   - **a. Permanent labour :** These are hired permanently for a year on contract.
   - **b. Temporary labour :** These laboures are hired during peak period for work. They are on daily basis and paid as per market rate.
   - **c. Contract labours :** These labours are employed by making fixed contract e.g. digging of pits, construction of bund, particular work, etc.
   - **d. Piece rate labours :** A worker is paid a fixed piece rate for each unit produced or action performed, regardless of time eg. Picking of cotton.

B. According to skill :

1. **Skilled labour :** A worker is called as skilled labour when he has a special skill and knowledge, Trained skilled labour gets high wages eg. tractor driving, sowing, etc., need skill.
2. **Unskilled labour :** When a worker does not have any particular skill he is unskilled labour and utilized for carrying easy jobs like digging of pits, prepartion of beds, etc.

5.6.3 Measures of improving labour efficiency :

Definition : It is the amount of productive work done on the farm per labour.

The labour efficiency can be improved by adopting the following measures.

i. **Diversification :** There should be sufficient diversification in farm business so as to keep the labour fully engaged throughout the year.

ii. **Work Program :** Programme of work should be prepared well in advance to plan proper labour utilization.

iii. **Size of field :** Field size should be large.

iv. **Implement and machinery :** Efficient implements and machinery and proper attention to their repairs and servicing is essential.

v. **Farmstead arrangement :** Arrangement of farmstead should be suitable to avoid wastage of labour in unnecessary movements.

vi. **Time of work :** Get the work done at proper time e.g. weeding in early stages, or deep ploughing immediately after the harvest of *kharif* crop or when post harvest showers are received.

vii. **Working hours :** Daily working hours should be according to season e.g. in summer season, start the work very early, while in winter, it may be started late.

viii. **Facilities for labour :** Provide drinking water and make arrangements for carrying food, etc., at the spot of working.

ix. **Distrubution of work :** Put right type of men on jobs suitable to their capability.

5.7 FARM ACCOUNTS AND RECORDS

5.7.1 Farm accounts

Necessity of accounts and records : 1. Farm accounts will help farmer to know whether the farm is in profit or loss. 2. It will help to identify the weak points in his farming practices, and thereby show ways of strengthening them. 3. He can plan the future work. 4. He can also work out the cost of cultivation of major crops and judge whether his cropping scheme needs any modification.

The following accounts and records are to be maintained by a farmer. They are simple and can be easily maintained.

1. Diary : It is a useful daily record of operations conducted, equipment used, labourers employed and money received and paid. Weather conditions and important events are also noted in the diary.

2. Cash Register : It is a record of cash received and cash paid.

3. Production Register : It is a record for entering the produce of crops including fodder of a given area.

4. Feed Register : It is a record for entering all the cattle feeds.

5. Wages Register : It is a register for the permanent labour force employed and the casual labour hired.

6. Seed Register : It is a record showing the kind, quantity and value of seed purchased or stocked on the farm.

VILLAGE FORM VII

Record of Rights

(Adhikar Abhilekh Patrak)

(Rules 3,4,5 and 7 of the maharashtra Land Revenue Record and Registers (Preparation and Maintenance) Rules, 1971

Village : Taluka

Survey No.	Sub division of	Tenure	Name of the occupant	Khata No.
	–	Occupant Class		

Local Name of the field

Cultivable area H. A.

Total

Pot-Kharab

Class (a)

Class (b)

Total

Assessment .....
Judi or special
Assessment

Name of the	Rent
–	

Other rights :

Charai

Boundary and survey marks

VILLAGE FORM XII

Register of Crops

(Rule 29 of the Maharashtra Land Revenue Record of Rights and Registers)

(Prepartation and Maintenance) Rules, 1971

Year	Season	Details of cropped area									Land not available for Cultivation		Source of irrigation	Remarks
		Mixed crops area						Pure crops area						
		Code No of Mixture	Irrigated	Unirrigated	Constituent crops with Name of Crop	Irrigated	Unirrigated	Name of crops	Irrigated	Unirrigated	Nature	Area		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Fig. 5.4 7/12 extract

7. Yield Register : It is a record for entering details regarding yield obtained from different crops and enterprises on the farm.

8. General Register : It is a record of miscellaneous items of expenditure such as land revenue, water rates, replacements of machines and tools, manures and fertilizers.

9. Inventory : It is a record of all the property the farmer owns. It shows the number and value of each item such as land, building, water supply, livestock, equipment, machinery, farm produce, feeds, fertilizers and cash in hand and in the bank and the amount to be paid or received.

5.7.2 Farm Records :

1. **Revenue records 7/12 extract :** The extract consists of two parts i.e., extract no 7 and extract No. 12. The extract 7 consists of survey number of the land, name of the land owner and the area of the land. It also consists of name of tenant, records of loan extended by government agencies etc. Extract 12 consists details of crops grown on the land, type of cultivation i.e., irrigated or rainfed. It is one of the documents that provides evidence of ownership of land, and is also called as 'Record of Rights or Record of Land Right'.
2. **6 -D Extract :** It is a record of transferring the title of ownership (record of right) of property or land from one to another person after sale or division.

   It can be obtained from the Mahabhulekh of Maharashtra. It is maintained by the Talathi. After purchase of new property the name of owner transfered on 7/12 extract by using this record.
3. **8A Extract :** It is called as *Khate Utara* and provides details of total holding of owner. Therefore it is used to calculate the total holding of the present owner.

Exercise

Q.1 Answer the following questions.

A. Select appropriate alternative and complete the following statements.

1. Organising and managing one or more enterprises on the farm on scientific and business lines is called as ----------
   a. Farm management
   b. Agro informatics
   c. Agro-tourism
   d. Farm accounts
2. An employee who is paid to manage a farm is known as ----------
   a. Labour
   b. Worker
   c. Farm manager
   d. Clerk
3. Width of the main road at the centre of farm should be ---------- meters
   a. 1 b. 3
   c. 5 d. 7
4. Pump set is example of ---------- inputs.
   a. Recurring
   b. Non recurring
   c. Partial
   d. Complete
5. Tabular information indicating type of work to be done on each crop during its life cycle is called as ----------.
   a. Cropping Scheme
   b. Cropping pattern
   c. Crop rotation
   d. Calender of operations

B. Make the pairs.

Group 'A'	Group 'B'
1. Climate	a. Chemical factor
2. Current price of land	b. Physical factor
3. School facility	c . Economic factor
	d. Personal factor
	e. Social factor

C. Find the odd one out.

1. Topography, soil, location, banking facility
2. School, medical facility, transport facility, climate.
3. Labour, taxes to be paid, current price of land, topography.
4. Permanent labour, temporary labour contract labour, skilled labour

D. Write true or false.

1. Farm steads consist only residential buildings.
2. In diversified farming land, labour, equipments are used efficiently.
3. Seed, manure, pesticides, labours are recurring input.
4. Tractor driver is a skilled labour.
5. 8A extract gives us an idea about total holding of owner.

Q. 2 Answer in brief.

1. Write the definition of farm management.
2. List out non-recurring inputs of farm.
3. What is a cropping scheme ?
4. What types of buildings are required in a farm stead.
5. What are types of agricultural labours.
6. What do you mean by 8 A extract.
7. Why is a diary essential?

Q. 3 Answer the following questions.

1. Explain 7/12 extract.
2. What are the different components of farm management.
3. What are the characteristics of a good cropping scheme.
4. What are the types of fencing? explain in brief
5. Write a short note on manure pit./Describe manure pit in brief.
6. What are the qualities of farm manager.
7. Explain physical factors considered while selecting a farm.

Q. 4 Answer the following questions.

1. What are the objects of farm management.
2. What are the advantages of farm planning.
3. Define calender of operations and give the steps to be considered in preparation of calendar of operations.
4. Define agricultural laboures give their types.
5. What kinds of farm accounts and records are required on a farm.
6. Which points to be considered while selecting crop in a cropping scheme?

Q. 5 Answer the following questions in detail.

1. Define labour efficiency and explain measures of improving labour efficiency.
2. What is farm budgeting ? Explain the types of farm budgeting.

Q. 6 Answer the following questions in detail.

1. What are the functions of a farm manager.
2. List out the factors considered in selecting farm and explain any one.

Activity

- Prepare a farm budget considering all factors for 5 acres land.
- Prepare a cropping scheme and calendar of operations for your own farm.

6. Nursery Management

6.1 INTRODUCTION TO NURSERY

Can you recall?

1. What is meant by plant propagation?
2. Do you know the difference between plant propagation and natural reproduction?

6.1.1 Definition : A nursery is a place where plants are propagated and grown to a desired age for transplanting in main fields or for sale.

A nursery is the place where young plants are raised and taken care of until they reach the right size for transplanting.

It includes retail nurseries which sell their plants to the general public, while the wholesale nurseries which sell the plant only to businesses such as other nurseries and to commercial gardens and private nurseries which supply the needs of institutions or private estates.

Do you know ?

1. Nursery activities.
2. Propagation media.
3. Propagation structures.

Vegetable growers, floriculturists, foresters, orchardists and various plant growers largely depends on the availability of nursery plants in nearby market but such plants may be raised without much care and less attention given towards genetic purity. The main aim of the nursery owner is to earn profit and hence the plant material raised is mostly of average quality. Many growers and producers have gained awareness about quality and it has opened the field of nursery management for profit and production of quality plants.

Nursery management includes raising and selling of nursery plants which is an art and a skill. It needs experience, practice, foresight and technical knowledge about nurseries.

Nurseries may supply plants for raising gardens, for planting in agriculture fields, for forest purposes and for conservational biology.

6.1.2 Objectives of a nursery :

- To raise healthy and disease free parent material (seedlings/plants).
- To distribute plant material in masses who have little knowledge about the techniques of raising plants.
- To introduce exotic species.
- Planting of nursery grown seedlings is the assured method of developing poor and barren sites.
- Replacement of casualties.

Remember this

In general, plant reproduce to maintain their identity which is the law of nature but the nurserymen multiply plant material for earning money as those plants have the following uses:

- Food material like fruits, vegetables, cereals, roots, tubers, bulbs, etc.
- Fibres like jute, flax, cotton, etc.
- Fuel and timber
- Medicines
- Beautification and landscaping
- Soil covering to check, avoid or minimize erosion
- Improving the ecological balance.

6.1.3 Importance : Establishment of nurseries is important for following advantages

1. **Purity** – Purity of the plant in respect of species and variety is very important. Valuable and precious material, cross-bred or imported plant material need to be grown in a nursery. It requires strict supervision, use of certain techniques for maintaining purity which is possible in reliable nurseries.
2. **Surety** – Assurance about the genuineness (purity) of the plants is very essential. Quality of the nursery produce can be

maintained by controlling all the activities in standardized manner.

3. **Quality -** Nursery grower has full control over the quality of the plant material raised so far as the requirements of various categories and classes are concerned.
4. **Economy** – Nurseries provide genuine planting material at cheaper rate as all the inputs and technical know-how is readily available. If the requirement is small, it is economical to purchase from the big nursery and if the requirement is in large quantity one can produce those by himself.
5. **Easy availability** – To reduce cost on packing, carriage and transport, plants grown in own nursery are better. But to get specific planting material purchasing is done by commercial nurseries.
6. **Timely availability** – Number and type of plants needed at particular time and place can be met by nurseries.
7. **Freedom from diseases and insects** – Since plants are raised under strict supervision of the nursery grower, proper and timely treatment to control diseases and pest are possible in nurseries. Plants which are healthy during their early period of growth are usually more vigorous since they establish rapidly.
8. **Other benefits** – Proper utilization of land and farm resources are also possible. Nursery activities provide opportunities for employment. Production of seedlings in nursery provides sufficient time for preparation and cultivation of land.

Remember this

Types of medium used for propagation depends on the species and the materials available. The following common rooting media are generally used:

Water: Can be used for easily rooting species. Its disadvantage is the lack of aeration. Artificial aeration promotes rooting and impedes rotting.

Sand: The sand used should be fine enough to retain some moisture around the plant cuttings and coarse enough to allow free draining and aeration. The sand should be washed and sterilized before use.

Soil: Well aerated sandy loam soil is preferable. Due to the possible presence of Soil-borne diseases soil may need to be sterilized.

Peat moss: Used together with other materials in order to increase the water holding capacity.

Coconut husk: Widely used in humid tropical environments where it has the same use as peat moss.

Industry manufactured material such as vermiculite, perlite are used separately or in combination with some other rooting media. Their advantage is their lightness, cleanliness and high water holding capacity. Sphagnum moss, saw dust, charcoal powder are the examples of other media.

6.2 TYPES OF NURSERY

Nurseries may be classified according to the time, size of production and kind of material raised.

6.2.1 Types of nursery on the basis of period:

On the basis of period nurseries are classified as Temporary nursery and Permanent nursery -

a. Temporary nursery – This type of nursery lasts for a limited period or few months. In this type of nursery, plants are raised for a specific requirement for a shorter period of time. Vegetable seedlings, flower plant seedlings or forest plants are raised in such type of nursery with specific objectives.

This type of nursery is developed only to fulfill the requirements of the season or a targeted project. The nurseries for production of seedlings of transplanted vegetables and flower crops are of temporary nature. Likewise, temporary arrangement for growing forest seedlings for planting in particular area can also be done in temporary nursery.

Fig. 6.1 Temporary rice nursery

Features of temporary nursery :

1. It is constructed for a short period and in small size.
2. Intensive manuring and fertilization is not necessary in such a nursery as it is constructed at a site which is rich in humus.
3. As it is located near a planting site, the distance between the nursery and the actual planting site is minimum.
4. No major transportation is required.
5. Special supervision is not required in the maintenance of such a nursery.

Advantages :

1. Mortality or injury due to shock of uprooting and transportation of seedlings is negligible due to less distance between the nursery and actual planting site.
2. Initial investment in a temporary nursery is less as compared to a permanent one.

Limitations :

1. Basic facilities like irrigation may not be adequate.
2. Special arrangements need to be made in order to keep the plants and seedlings in healthy condition.

b. Permanent nursery – This type of nursery is established in permanent fields for longer period. In such type of nursery, production of plants is done year after year particularly to supply genuine planting material e.g. fruit nursery. These nurseries may be commercial nursery or small scale nursery. This type of the nursery is placed permanently so as to produce plants continuously. These nurseries have all the permanent features. The permanent nursery has permanent mother plants. The work goes on continuously round the year in this nursery.

Fig.6.2 Permanent nursery

Features of permanent nursery :

1. It requires a large area and must be well connected by road.
2. Such type of nursery requires intensive management and supervision.
3. High initial cost is involved in the establishment of such a nursery.
4. Permanent nursery comprises office, store, mother blocks, nursery beds, protected structures, irrigation source, electricity, transportation facilities, packing yard, manure, cattle and machinery shed.

Advantages :

1. Greater range of planting stocks, such as seedlings, grafted plants, budded plants, layers, rooted cuttings, etc are available.
2. It becomes a perpetual source for the supply of planting material for many years.
3. As these are concentrated at one place, it's supervision and management is better due to the availability of permanent staff.
4. The initial production cost is reasonable but profit goes up in the long run.

Limitations :

1. The initial investment cost is high.
2. The transportation cost is more.
3. Such a nursery needs intensive labour management.

4. It must be backed by a large market for the sale of plants and seedlings.
5. It requires skilled human resource round the year.

6.2.2. Types of nursery on the basis of the kind of plant material raised :

On this basis the nurseries can be of following types

a. Fruit plant nursery : In this nursery, seedlings and grafts of fruit crops are developed. Fruit crops are mainly propagated vegetatively and need special techniques for propagations as well as maintenance. Mango, guava, pomegranate, sapota, oranges, etc. are propagated with vegetative method. Fruit nurseries are essential for production and maintenance of grafts as well as the mother plants of scions and rootstocks.

Fig. 6.3 Fruit nursery

b. Vegetable nursery : In this nursery seedlings of cauliflowers, cabbage, brinjal chilli, onion, tomato, etc. are prepared. All vegetables except few like potatoes, sweet potato, bulbous vegetables and some other are raised by seedlings. Very few vegetables are perennials like little gourd, drumsticks, calocasia, etc. Seedlings are to be produced on a large scale in a short period.

Fig. 6.4 Vegetable nursery

c. Flowering plants nursery : The seedlings of flowering plants like merigold, carnation, petunia, salvia, rose, chrysanthemum, coleus, aster, dianthus, etc. are developed in these nurseries. Ornamental and floricultural crops are numerous and are propagated vegetatively, like gladiolus, carnation, roses, lilies etc. There is a large group of ornamental plants. It is propagated by seeds and seedling; eg. asters, marigolds, salvias, etc.

Fig. 6.5 Ornamental and flower plant nursery

d. Forest nursery : The seedlings of plants useful for forestation like pine, oak, teak, eucalyptus, casurina, etc. are prepared and sold.

Fig. 6.6 Forest nursery

e. Miscellaneous nursery : In such type of nurseries, plants with great economic value, rare and medicinal, herbal plants are propagated. In this nursery plants like geranium, sandal wood, calendula, and bamboo are propagated.

f. Medicinal and aromatic plant nurseries There is considerable increase in people adopting ayurvedic medicines which reflects

in more demand for medicinal plants, e.g. shatavari, alovera.

Fig. 6.7 Medicinal plant nursery

Do you know ?

Hi-Tech Nurseries: There is a sudden increase in the demand for certain commercial plants, e.g., tissue culture banana, gerbera and carnation, etc. It is not possible to fulfill this requirement by ordinary or common nursery practices. There is a necessity to have special techniques and methods to meet the demand and only hi-tech nurseries can satisfy this type of demand. These nurseries grow plants in greenhouse, glass house or a plastic tunnel, designed to protect young seedlings from harsh weather, while allowing access to light and ventilation. Modern greenhouses allow automated control of temperature, ventilation, light, watering and fertigation. Some also have fold-back roofs to allow "hardening-off" of plants without the need for manual transfer of plants to the outdoor beds (tissue culture plants) .

6.3 PLANNING AND LAYOUT OF NURSERY

6.3.1 Selection of site :

Following points are considered while selecting site for nursery :

1. **Location :** A nursery must be located in a pollution-free environment away from brick kilns, smoke-emitting industries and rough motorised roads as dirt and dust settle on plants, covering the foliage, which not only reduces the photosynthetic efficiency of plants but also gives them a dull look. It must be ensured that the nursery site gets adequate sunlight. However, care must be taken in that the plants are protected against severe heat.
2. **Topography of land :** The topography of land at the nursery site must be even. If it is undulating, it must be levelled. In hilly areas, it may be divided into levelled terraces.
3. **Soil :** The soil must be preferably loamy or sandy loam with large quantity of organic matter. The pH of the soil must be near neutral (6.5 – 7.5). It must have adequate water retention capacity and aeration.
4. **Water :** The quality of water used in a nursery is important for the growth of plants. Saline and polluted water must not be used. It must be ensured that there is an adequate water supply for irrigation. Besides, the nursery must be located near a water source so that there is no water scarcity at any time in the course of raising plants.
5. **Drainage :** The nursery site must have adequate drainage facility and be free from water logging. Water must not stagnate at any time.
6. **Transportation :** The nursery site must be accessible by road. It must not be far from potential markets so that there is no damage to the seedlings during transportation.
7. **Labours :** As nursery work is labour-intensive, the nursery site must have enough number of labours.

Keep in Mind

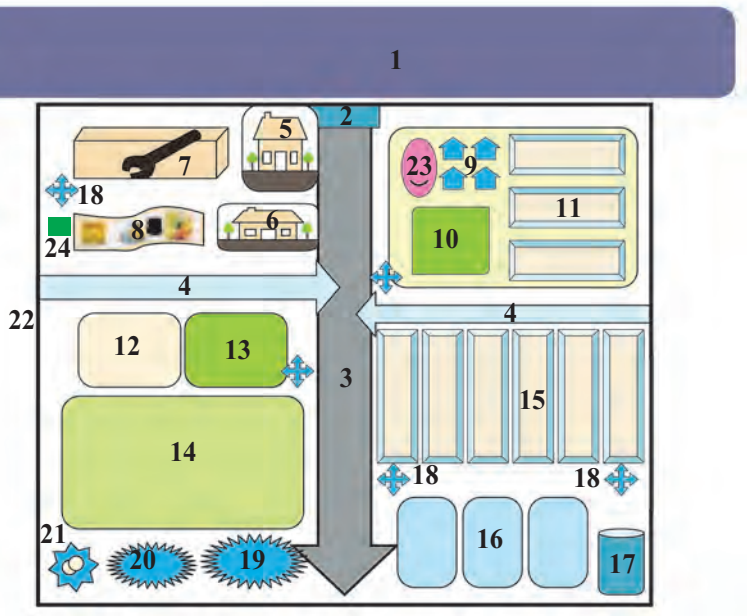
Qualities of a good site for nursery :

i. Nearness to road
ii. Near a habitat
iii. Suitable climate
iv. Neither shady nor exposed area
v. Sufficient sunlight
vi. Avoid windy and hail prone areas
vii. Good irrigational facilities
viii. Levelled land
ix. Soil characteristics
x. Means of transport
xi. Availability of labour

8. **Protection :** The nursery area must be protected by fencing so as to prevent damage by stray animals.

9. **Market and size :** Market plays an important role in the success of nursery business. Various types of inputs like seeds, fertilisers, pesticides, fungicides, plant growth regulators, poly bags, agricultural implements, different type of spare parts and other miscellaneous items required in the nursery must be available in the nearby market. The nursery must be located near the city or an area from where people can purchase the plants. Alternatively, a mechanism to explore domestic and international markets must also be worked out for the success of nursery business.

6.3.2 Layout of nursery :



1. Main road
2. Gate
3. Nursery road
4. Path
5. Office
6. Labor shed
7. Store room
8. Vehicle shed
9. Potted plants
10. Saplings
11. Seedlings
12. Propagation
13. Shade net house
14. Poly house
15. Seedling/beds
16. Mother beds
17. Well water source
18. Water pipeline
19. Soil dumping
20. Compost area
21. Mother plant
22. Fencing
23. Plant library
24. Generator

Fig. 6.8 Layout of nursery

A perfect master plan is required otherwise improper layout plan will cause considerable problems to nursery manager in future.

Roads and paths within the nursery should be carefully planned.

Layout should be in such a way that enables operations to carry out smoothly in the nursery so as to save labour and time. Usually, a room/ shelter is required for staff and the watchman, and where equipment can be securely stored.

An open area is needed at one end, where work such as sieving of soil and filling of containers can be done easily.

A nursery is easily arranged in a series of beds with pathway between them. There should be proper provision for road and path, irrigation and drainage channels, mother block, nursery beds, growing structure, store, compost pit, display site-cum-sale counter, etc.

The nursery should be connected by main road for better approach and disposal of produce.

6.3.3 Major steps in nursery layout :

A. Mother block :

The planting stock that maintained as a source for commercial propagation is referred to as a mother block.

Once a superior type of mother plant has been identified, it should be multiplied and maintained under conditions that prevent recontamination and allow detection of any significant change from the original source.

Mother plants are very important constituent of a nursery. There should be proper record and certification of planting stock. As far as possible, mother block should be in the close proximity of the nursery site. The scion shoots should be taken only from mother plants. Therefore, for preservation of pathogen free planting stock; proper isolation, sanitation, periodical inspection and testing and maintenance are very important.

Remember this

- Water should be available throughout the year
- Area should be large enough to accommodate the required seedlings and facilities
- Area could be flat or slightly inclined to allow sufficient drainage
- Area must be accessible or close to the road
- Area must have good soil condition, i.e. dry sandy loam or loam, topsoil of about 30 cm, with 5.5 to 6.5 pH and high quantity of organic matter
- Area must have good exposure to sunlight
- Area must be protected from strong winds with temporary windbreakers using local materials.
- For permanent windbreakers, establish a green belt (trees that can withstand strong winds) around the nursery.

Following are examples of mother plant :

1. Mango: Keshar, Alphonso, Sindhu, Ratna
2. Sapota: Kalipatti, Cricket ball
3. Guava: Sardar (L-49)
4. Pomegranate: Ganesh, (G-137), Bhagawa

Fig. 6.9 Mother plants

5. Ber: Umran, Kadaka, Sannur, Punjab Chuhara, Mehrun.
6. Cashew nut: Vengurla – 4, 5, 6, 7 and 8
7. Coconut: Banavali, T X D, Pratap
8. Grapes: Sonaka, Sharad Seedless, Thompson Seedless
9. Fig: Poona fig, Dinkar
10. Aonla: Banarasi, Krishna.
11. Sweet orange: Nucellar.
12. Mandarin Orange: Nagpuri
13. Rose
14. Champak
15. Hibiscus

B. Seed beds : Seed beds can be accommodated in a comparatively smaller area. They should be nearer to a source of water and to the office so that they can be kept under proper vigilance. The beds should be raised enough to avoid water stagnation due to rain and excess watering. Seed beds should be located in an open place for better germination of seeds and to avoid infection of 'damping off ' disease. Nursery beds can be prepared in three different ways as sunken beds, level beds and raised beds.

Fig. 6.10 Nursery bed

C. Pot yard - The pot yard is generally used for tender plants, which requires shade as compared to hardy plants. Therefore, pot yards should be in shade and near to water source for frequent watering. Trenches can be provided for keeping the potted plants closely packed together.

Fig. 6.11 Pot yard

D. Packing yard and working shed : The packing yard is used for packing the plants before sale or dispatch to outstations. The yard can be combined with working shed. In packing yard, there should be plenty of space to enable a number of workers for sorting out and packing the plants with ease.

E. Compost pit : Nursery production of horticultural and forestry plants require huge amount of organic manures like F.Y.M, compost, leaf mould, etc. for different purposes. Therefore, arrangements should be made at nursery level to produce enough quantity of compost. One compost pit of permissible size should be located at any corner of nursery layout. At the same time several waste products of nursery can also be utilized for the same.

F. Irrigation : Design and installation of an irrigation system includes several stages or phases, each of which requires different kind of expertise. The main line of irrigation system is taken the from source to seed beds and are generally located along the road between nursery blocks. The main lateral openings are placed at each block followed by sub mains to individual nursery beds. The sprinklers are arranged at each block wherever necessary.

G. Roads and drainage : An adequate road and drainage system carefully planned and constantly maintained, is essential for the efficient operations in the nursery. Outer and internal roads should be permanent and stable. Frequently, roads within seed bed area also serve as drainage channels. Therefore, they should provide access to seed bed for equipment and drain the surface water rapidly. Roads or channels at ends of the beds should be 5 to 6 feet wide to enable tractor and attached equipments to turn without damaging seed beds.

H. A rest room : A break room and rest room are needed for the nursery staff. Depending on the size of nursery and number of working staff, size of rest room can be varied.

I. Store room : Fertilizers and chemical, require careful storage and should be stored in a separate building. Pesticide requires special security and protection from freezing. Well designed pump house is usually needed to protect pumping equipment.

J. Administration office, lab and working space : One or more offices for staff are needed for the nursery and for records and files. They should be located on the wind ward sides of fields and parallel to seed beds. Working space should be cleanly maintained well ventilated along with good sunlight.

K. Fencing : Nurseries should be fenced if there is potential damage from cattle, dog, sheep, or people. Fences around administrative sites may be needed to protect equipment and building from theft.

6.4 AFTER CARES OF NURSERY

6.4.1 Disinfection of beds :

A. Sanitation : Sanitation is defined as "the formulation and application of measures designed to protect plant health".

Maintenance of sanitation is necessary in any plant propagation work. If all the necessary sanitary precautions are taken at the out set, the problems would be less in magnitude and its management can be done effectively. It is necessary to use clean growing media, sterile containers, a sanitized bench and pathogen free planting materials in all plant propagation processes. However, soil borne pathogens may contaminate the soil mixture and media even when all precautions are taken. Small outbreaks of diseases can be controlled by using appropriate fungicides.

Sanitation practices in nursery include:

1. Prevention of insects, pest and diseases
2. Inspection for insect, pest and disease incidences
3. Environmental control leading to protection from harmful environment factors like hot sun, freezing temperatures, storms, etc.
4. Eradication of pest, diseases and weeds.

B. Sanitation Treatments :

1. Sterilization of the propagation media, tools, and implements used is necessary in nursery plant production. Propagating media and tools can be easily sterilized by heat or by chemicals. A temperature of about 71^0C for 30 minutes is considered to be sufficient to kill almost all disease producing pathogens.
2. Chemicals used for sterilization are chloropicrin, formaldehyde, methyl bromide, etc.
3. Fumigation with chemicals is useful for destroying harmful bacteria, fungi and nematodes in a relatively small quantity of soil that is used for propagation of plants.
4. Drenching the medium with certain fungicides is also useful in eliminating pathogens from the soil, coco peat and other media.
5. Cleanliness of all the implements along with nursery area (inside and outside) is necessary.

C. Methods of sterilization :

i. Temperature method :

It is an environment-friendly method to control soil-borne plant pathogens, including bacteria, fungi, nematodes, insect-pests and weeds. Solar energy increases the temperature of the soil, which helps to control various soil-borne pathogens. The most appropriate time for soil solarisation is May−June when the temperature reaches 40ºC or above. This treatment causes physical, chemical and biological changes in the soil.

Procedure : Dig soil at a site where seedbeds are to be prepared. Remove all weeds, stumps, stones, pebbles, etc., from the soil. Crush the clods and bring it to fine tilth. Level the plot for preparing seedbeds. Irrigate the site thoroughly and cover it with a black polythene film of 200 gauge for 5–6 weeks during summer as wet soil conducts heat better than dry soil and makes soil organisms vulnerable to being killed by heat generation. Make the covering airtight by covering the margins with compressed wet mud to check the loss of moisture and prevent the entry of air from beneath the polythene sheet. The nursery bed may be prepared at the treated site or soil may be used for filling pots or poly bags.

ii. Chemical treatment :

Formalin solution treatment

Formalin solution is used to sterilize the soil. It is prepared by adding 2.5 ml commercial grade formaldehyde per litre of water and the soil is drenched @ 45 litre of solution per m^2 to saturate the top soil surface upto a depth of 15–20 cm. The drenched area is covered with a black polythene sheet of 200 gauge so that the fumes of formalin penetrate into the soil to kill the pathogens. The polythene cover is removed after 48 hours. The soil is raked so that the fumes of formaldehyde gas escape from it. In poly-house, if the soil is treated with formalin, the doors and side covers of the poly-house must be opened to allow formaldehyde gas to escape. The bed is kept open for 7–10 days prior to seed sowing. It must be ensured that there are no fumes of formaldehyde gas prior to seed sowing.

iii. Soil treatment by fungicide :

Fungicides like Captan or Thirum @ 5 g/m^2 are used to control soil-borne pathogens. These fungicides can also be used as soil drench by preparing a solution of 2.5−3 per cent and drenching @ 4−5 litre/m^2.

iv. Soil treatment by insecticide :

Insecticide, such as chloropyriphos @ 2 ml/litre of water is applied to a depth of 15−20 cm in the soil to kill insects including ants, white ants and their eggs, nematodes, etc.

v. Use of bio-agents

Certain biological agents like trichoderma

are used to control soil-borne pathogens. Bio-agents @ 10–25 g/m^2 are mixed in the soil, and after 2–3 days, the seeds are sown.

6.4.2 Watering :

Irrigation either in the nursery beds or watering the pots is an important operation. For potted plants hand watering is done and for beds low pressure irrigation by hose pipe is usually given. Heavy irrigation should be avoided.

6.4.3 Manuring :

Generally, sufficient quantity of nutrients is not available in the soil used for seedbed. Hence, well rotten F.Y.M / compost and leafy humas is added to soil. Rooted cuttings, layers or grafted plants till they are transferred to the permanent location, require fertilizers. Addition of fertilizers will give healthy and vigorous plants with good root and shoot system. It is recommended that each nursery bed of 10 X 10 m area should be given 300 gm of ammonium sulphate, 500 gm of single super phosphate and 100 gm of muriate of potash.

6.4.4 Provision of shade :

The young and tender seedlings are susceptible to direct sunlight. They are required to be protected from hot sun light by providing shade. Shade may be provided using thatches or by using shadenets.

Remember this

Filling pots and bags : Different kinds of pots and polythene bags are used in nursery. They are filled with soil mixture. This is an important activity in the nursery. Other activities like shifting plants, labelling, potting and repotting, packing, selling, keeping records, etc. are performed in the nursery.

6.4.5 Protection from adverse climate :

The younger seedling is susceptible to strong sunlight and low temperature. For protection from strong sunlight, shading with the help of timber framework of 1 meter height may be used. Net house and green house structures can also be used.

Do this

Note down quantity of material required for filling pots or bags.

Sr. no.	Pot or bag	Size	Volume
1			
2			
3			
4			

6.4.6 Protection from pest and disease :

Adoption of plant protection measures, well in advance and in a planned manner, is necessary for the efficient raising of nursery plants. For better protection from pest and diseases regular observation is essential.

6.4.7 Disease control in seedbed : The major disease of nursery stage plant is "damping off". For its control good sanitation conditions are necessary. Preventive measures of drenching like treatment with 50% ethyl alcohol, 0.2% calcium hypochloride and 0.01% mercuric chloride is done. These treatments are given for 5 to 30 minutes. Some of the seed treatments are as follows:

i. **Disinfection :** The infection within the seed is eliminated by use of formaldehyde, hot water or mercury chloride.

ii. **Hot water treatment :** Dry seeds are placed in hot water having a temperature of 48^0C – 55^0C for 10-30 minutes.

iii. **Protection :** In dry seed treatment organo mercuric and non-mercuric compounds like agallal, aretan –6, and tafasan-6 are used. For this, the seeds are shaken within the seed container. While in wet method, the seeds are immersed for certain period in liquid suspension.

iv. **Soil treatment :** Soil contains harmful fungi, bacteria, nematodes, insects and even weed seeds, which affect the growth and further development of plant. These can be eliminated by heat, chemical treatment etc. For that soil is disinfected by heating to the temperature of about 60°C for 30 minutes.

v. **Chemical treatment :** The chemicals like formaldehyde, methyl bromide, chloropicrin, etc. are used. Other diseases like rust, powdery mildew, leaf spot, bacterial blight, yellow vein mosaic are also observed. For control of these diseases bordeaux mixture, carbendazime, redomil can be used. *Trichoderma viride,* a bio-fungicide can also be tried out.

6.4.8 Pest management in nursery :

Infestation symptoms like cuttings on leaf margins, holes in leaves, chewed and damaged parts of plants, spots on leaves, etc. are observed. They are due to the attack of pest. The major pest of nursery plants are -

a. **Insect pest :** It cause heavy damage to crops. Amongst the one million species of insects, about 200 species can be termed as serious pest in agriculture.

b. **Microbes :** Fungi, bacteria and viruses cause diseases in plants and insects. Nematodes are also sometimes classified as pathogens.

c. **Garden snails :** They are called as molluscs. It is common pest in home gardens, lawns, greenhouses and ornamental plantings.

d. **Weed :** These are the plants that competes with the main crop which affects yield and quality, and may interfere with the use of land and water resources.

e. **Vertebrate pest :** These are mainly rodents, birds and some other mammals like bats, rabbits, etc. that cause damage to crops and stored products, agriculture produce.

f. **Pest control :** In the present day context, pest control includes the use of all those methods which are employed for preventing pests and diseases without disturbing the environment. i.e., IPM and IDM.

6.5 PACKING AND TRANSPORT OF NURSERY PLANTS :

A. Packing : It is defined as placing the nursery plants or propagated materials into a suitable container for maintaining their viability and vitality during storage and transport. Time to time packing of nursery material is to be done and emphasis should be given on packing plants which are transported over a longer distance. To have a better price of the products, a nurseryman should pay high attention to the packing of the planting material.

B. Advantages of packing : Packaging protects the planting material from hazards caused during transport and keeps them away from microbial and insect attack. It minimizes the physiological and biological changes occuring in the planting material during transportation. Packing must maintain the natural condition of seedlings of nursery plants and increace the shelf life of seedlings. Necessary information like name of seedling, name of nursery, age of seedling, etc. can be mentioned on packing boxes.

C. Principles of packing :

It should deliver the plants conveniently without affecting the quality and also look attractive to the indenters.

It should provide protection against drying out and mechanical injury.

It must be convenient and economical to handle.

It should be well adapted to transport, loading with security and economy in volume and weight.

Fig. 6.12 Packing nursery plants

Remember this

Common possible errors in nursery activities-

- Containers not filled properly.
- Shape of container is not maintained.
- Some times position of container is not maintained in upright direction.
- After each production cycle in nursery used soil and sand in germination beds are not changed.
- Too deep sowing results in poor germination.
- Improper handling of seedlings before transplanting.
- Improper and delayed transplating of seedlings.
- Inadequate attention to root pruning.
- Improper root pruning while transplating.
- Improper compaction of the soil around the seedling after transplanting.
- Use of same sprayers for application of weedicides and fungicides.
- Hardening off process is started late or sometimes neglected.
- Dumping of seedlings in nursery is not practised

Exercise

Q. 1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. Drenching with ---------- is useful in eliminating fungus from the soil medium.
   a. Captan b. Lindane
   c. Chloropyriphos d. Endosulfan
2. The place where plants are propagated and grown to desired age for planting in is called as ----------
   a. Nursery b. Pack house
   c. Field d. Forest
3. Seedlings of brinjal are raised in ---------- type of nursery.
   a. Permanent nursery
   b. Forest nursery
   c. Temporary nursery
   d. Medicinal plant nursery
4. The planting stock that maintained as a source for commercial propagation is known as ----------
   a. Nursery b. Mother block
   c. Pot yard d. Playhouse
5. The major disease of plant at nursery stage is ---------- .
   a. Blight
   b. Virus
   c. Damping off
   d. Dowrey mildew

B. Make the pairs.

A	B
i. Fruit plant nursery	a. Rose plants
ii. Vegetable nursery	b. Teak plants
iii. Forest nursery	c. Mango plants
	d. Paddy nursery
	e. Tomato plants

C. Find the odd one out.

1. Chloropicrin, Formaldehyde, Methyl Bromide, Soil
2. Soil, Sand, Coco peat, Urea
3. Brinjal, Tomato, Santra, Cabbage
4. Croton, Aglonema, Chilli, Hibiscus
5. Vegetable nursery, Forest nursery, Temporary nursery, Fruit plant nursery

D. Write true or false.

1. Fruit plant nurseries do not require license.
2. Onion seedlings are raised in permanent nursery.
3. For getting desired quality fruits of mango use mango seedlings raised from mango stones.
4. In the big cities ornamental nurseries are getting popularity.
5. A temperature of about 71°C for 30 minutes is sufficient to kill almost all the pathogens in soil.

Q. 2 Answer in brief.

1. Define medium used for propagation.
2. Enlist characteristics of good propagation medium.
3. What is vermiculite?
4. Define packing of nursery plants
5. Give examples of soil fumigants

Q. 3 Answer the following questions.

1. Complete the table.

Unit	Plants raised	Basis of classification
Temporary nursery		
Permanent nursery		
Fruit nursery		

2. Explain flowering plant nursery.
3. List out types of nursery on the basis of kind of planned raised.
4. Explain temporary nursery.
5. Write principles of packing.

Q. 4 Ansswer the following questions.

1. Differentiate temporary nursery and permanent nursery.
2. Write the limitations of nursery.
3. Explain the mother block.
4. State the features of permanent nursery.
5. Describe after cares of nursery.

Q. 5 Answer the following questions in detail.

1. Explain in detail layout of nursery.
2. Explain the points to be considered in selecting the site for nursery.

Q. 6 Answer the following questions in detail.

1. Explain in detail different type of nurseries.
2. Mention different features and advantages of permanant nursery.

Activity

Practice grafting of fruit or ornamental plant. Practice transplanting of seedlings in pots or polythene bags.

7. Green House Technology

Can you recall?

1. Green house effect
2. Changing climate scenario
3. Protection from adverse climate
4. Propagating structures

7.1 MEANING, IMPORTANCE AND SCOPE

7.1.1 Meaning : Green houses are protected structures useful for cultivation of certain crops. These structures are erected for protection of crops from adverse climatic conditions and for growing various horticultural crops irrespective of their growing season under controlled conditions. The crops are provided with required CO_2, light, temperature, humidity and air movement which are the most essential components for plant growth. Different types of green houses and polyhouses are used in temperate, tropical and subtropical regions.

The structures made of galvanized material are covered by various types of transparent material which is known as cladding material. Accordingly following different types of greenhouses are used for crop production.

1. **Glass house :** Glass is used as covering material for roof and sides of a frame
2. **Polyhouses :** Polythene sheet is used for covering the frame as cladding material.
3. **Shade house :** A frame is covered with shade nets to protect plants from direct sunlight

The glass houses are used in temperate countries to protect the crops from snow fall and colds. There are several types of green houses and the size of green house also varies according to the requirement. The polythene covered framework is economical. Polythene of 0.10 to 0.15 mm in thickness, which resist to ultraviolet radiation is found most suitable and economical for covering polyhouses. Sometimes, instead of polythene sheet, fiber glass sheets are used for durability but it is more expensive than polythene. In tropical and sub-tropical regions naturally ventilated polyhouses are popular.

7.1.2 Importance of green house technology :

Advantages of greenhouses :

1. The yield may be 10-12 times higher than that of outdoor cultivation depending upon the type of greenhouse, type of crop, environmental control facilities.
2. Reliability of crop increases under greenhouse cultivation.
3. Ideally suited for vegetables and flower crops, especially cut flowers.
4. Year round production of vegetable and floricultural crops.
5. Off-season production of vegetable and fruit crops.
6. Disease-free and genetically superior transplants can be produced continuously.
7. Efficient utilization of chemicals, pesticides to control pest and diseases.
8. Water requirement of crops is very limited with higher efficiency.
9. Maintenance of stock plants, cultivating grafted plant-lets and micro propagated plant-lets.
10. Hardening of tissue cultured plants.
11. Production of quality produce, free of blemishes.
12. Most useful in monitoring and controlling the instability of various ecological system.
13. Modern techniques of Hydroponic (Soil less culture), Aeroponics and Nutrient film techniques are possible only under greenhouse cultivation.
14. Shade net houses are most suitable for nursery.

7.1.3 Scope for green house technology :

As green house technology has lots of advantages, it can be used for profitable commercial cultivation of some crops.

There is a scope for using green house technology for the following reasons

1. Lot of barren land is available which can be deployed for erection of green houses.
2. Low rainfall results in lack of irrigation water. Green house technology could be utilized by storing rain water and using it by drip system (Low evaporative loss of water in green houses).
3. There is a continuous demand for vegetables and flowers throughout the year.
4. There is a scope for propagation and raising nursery.
5. Government schemes are available for promoting green house technology and subsidized rates for plastic and polythene.
6. Large number of unemployed youth could be diverted towards sophisticated farming in green houses.
7. There is a vast scope for export of produce.
8. There is a scope for production of exotic crops as their demand is increasing in the domestic markets.
9. Diverting educated young students towards rural area for using greenhouse technology.
10. Generating employment in erection, maintenance and marketing of greenhouse technology.
11. Ideal technology for marginal farmers.

7.2 TYPE OF GREENHOUSES

Greenhouse structure of various types are used for crop production. Although there are advantages and disadvantages in each type for a particular application, in general there is no single type greenhouse, which can be constituted as the best.

Different types of greenhouses are designed to meet the specific needs. The different types of greenhouses based on shape, utility, material and construction are briefly given below:

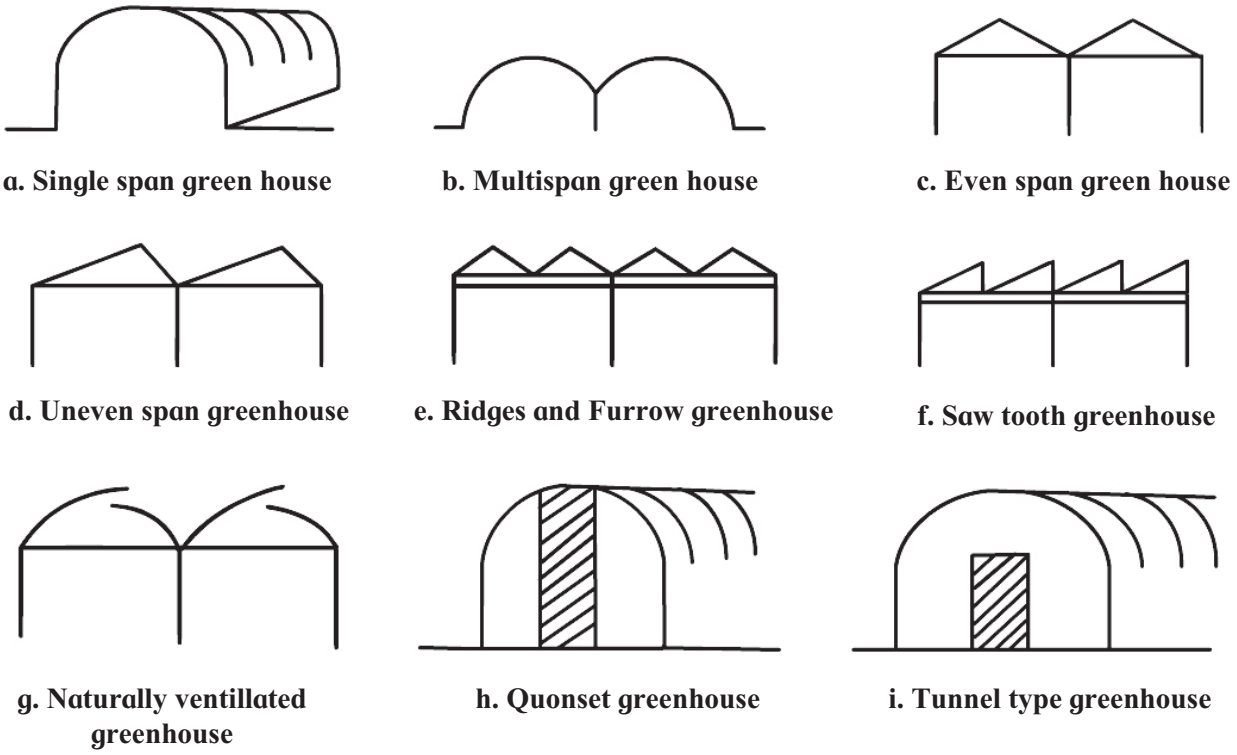


Fig. 7.1 Types of greenhouse based on shape of structures

7.2.1 Greenhouse types based on shape : For the purpose of classification, the uniqueness of cross section of the greenhouses can be considered as a factor. The commonly followed types of greenhouses based on shape are:

a. Single span greenhouse
b. Multi span type
c. Even span type greenhouse
d. Uneven span type greenhouse
e. Ridge and furrow type
f. Saw tooth type
g. Naturally ventilated greenhouse
h. Quonset greenhouse
i. Ground to ground greenhouse or Tunnel type greenhouse

7.2.2 Greenhouse types based on Utility : Classification can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating are more expensive and elaborate. Hence based on this, they are classified into two types:

a. Greenhouses for active heating
b. Greenhouses for active cooling

7.2.3 Greenhouse types based on construction : The type of construction predominantly is influenced by structural material, though the covering material also influence the type. Based on construction, greenhouses can be classified as :

a. Wooden framed structure
b. Pipe framed structure
c. Truss framed structure

7.2.4 Greenhouse types based on covering material i.e. cladding material : Covering materials are the important component of the greenhouse structure. They have direct influence on greenhouse effect, inside the structure. The type of frames and method of fixing also varies with covering material. Hence based on the type of cladding material they may be classified as

a. Glass house
b. Poly house
c. Shade net house

7.2.5 Greenhouse types based on the cost of construction involved :

a. **High cost Green House :** (Rs. 2000-3000/m^2) – Automatic and fully climate controlled structures
b. **Medium cost Green House :** (Rs. 1000-1200/m^2) – Partially controlled structure
c. **Low cost Green House :** (Rs. 600-800/m^2) – Naturally ventilated polyhouses

The naturally ventilated polyhouses (NVPH) are the most popular in Indian conditions for crop cultivation preferably flowers and vegetables.

Cost Economics of High cost green house: The cost estimates may vary considerably due to crop, cladding material and environmental control system. The additional cost involved per sq. m. is stated below.

Sr. No	Specifications	Cost Rs/m^2
1	When double layer polyethylene used	100
2	CO_2 generation and distribution	150
3	Evaporative cooling	200
4	Heating system	100
5	Humidification system	100
6	Lighting	200
7	Night curtain / Shading system	150
8	Drip system	20
9	Nutrient application system	100
10	Porous flooring	100
11	Benches	150
12	Structural cost	300
	Miscellaneous	180

Average cost of High Cost Greenhouse per square metre is Rs. 2000.00.

7.3 Installation of Green House

7.3.1 Selection of site for green house :

Any type of land could be used for green houses. The site should be away from industrial area to avoid pollution injury to plants. Shade

of building or trees around green house is also harmful. The site should be at a reasonably high level from the ground. Proximity to cities or probable markets is most preferred. Sufficient water supply, labour availability, electricity supply are the other factors of prime importance. There should be a direct approach road.

7.3.2 Design of frame :

G.I. pipes or steel angles are used to make frames. Design and layout of frame varies according to crop, climatic conditions, cost, etc.

The following points should be considered while designing frame.

- Frame should be light in weight.
- Use easily available material (Bamboo or wood could also be used for low cost structure)
- Frame should be even from all sides.
- Slope of roof should be such that water will not fall on crop or stagnate on the roof.
- It should be easy to change the cladding material.
- There should be sufficient ventilation.

The U.V stabilized polyethylene film of 200 micron thickness is mostly used cladding material for polyhouse.

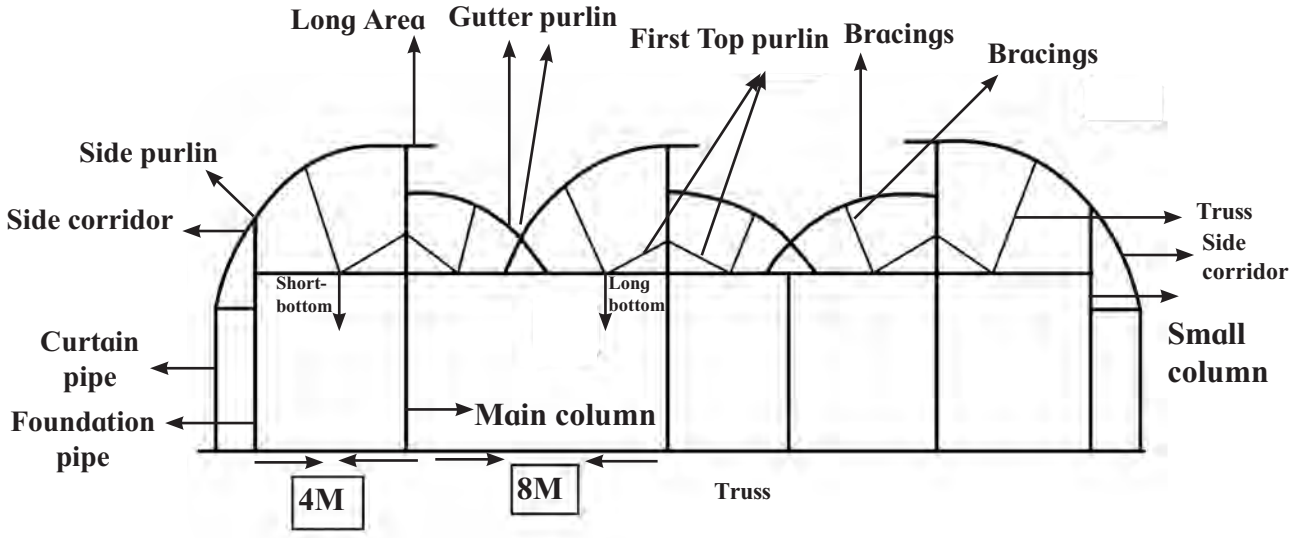


Fig. 7.2 Different parts of greenhouse structure

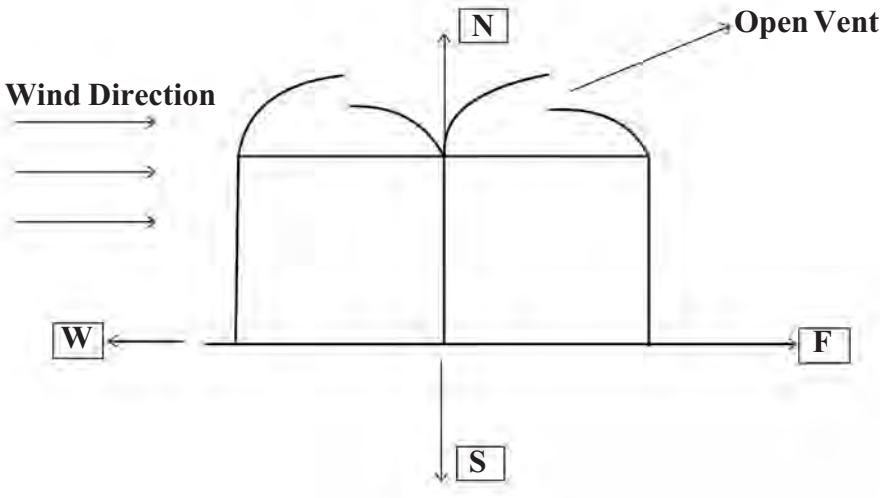


Fig. 7.3 Orientation

7.3.3 Orientation of naturally ventilated green house : The following points should be considered for orientation of NVPH

1. Opening of the top vent should be towards East side.
2. Gutter should be placed in North- South direction.
3. Slope along the gutter should not be more than 2 %.
4. The slope along the gable side should not be more than 1.25 %.

7.3.4 Erection of beds for raising crops :

Cut flowers are generally produced on the ground where as, potted plants are produced on stands. When plants are grown on ground, it is absolutely necessary to sterilize the soil before planting a new crop. Satisfactory sterilization can be achieved by using either chemicals or steam. The process is however cumbersome and time consuming.

Fig. 7.4 Typical naturally ventilated polyhouse (NVPH)

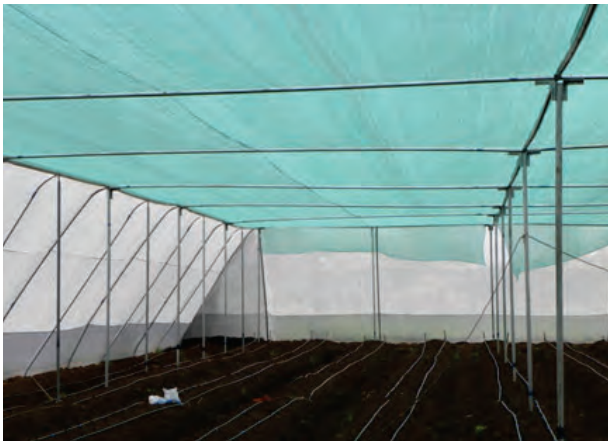


Fig. 7.5 Shadenet house (Flat type for nursery)

So in the recent years greenhouse growers have switched over to soil less growing media, either in polyethylene bags or in troughs. It is always advantageous to grow pot plants on benches. Benches can be either fixed or moveable. With fixed benches we can use sixty per cent of the greenhouse space whereas with moveable benches we can utilize approximately 80 - 85 per cent of the covered area.

7.3.5 Instalation of irrigation system :

Watering in greenhouses can be done through sprinklers and drips. Sprinklers can however be used in the early stages of the crop, before flowering and further to reduce temperature and increase humidity in green house. Drip irrigation can be used in almost all stages of the crop growth. In greenhouse production, it is a usual practice to apply phosphatic and slow release fertilizers as a basal dose to the growing medium. This is supplemented with water soluble fertilizers which are applied along with the irrigation water.

Place one 16mm inline drip lateral at the center of the bed having emitting points at every 30 cm interval with discharge rate of 2 ltr/hr or 4 ltr/hr. Run the drip system to check each emitting point for uniform discharge before covering the beds with polythene mulch.

Can you recall?

Plant requires sunlight, temperature, humidity and CO_2 for its good growth and yield through proper photosynthesis.

7.4 CLIMATE CONTROL IN GREEN HOUSE

The components responsible for plant growth viz. light, temperature, CO_2 , humidity and air circulation can be controlled as under in green house.

7.4.1 Ventilation : It is necessary for proper air circulation in the green houses. For natural circulation keep the sides of green house

(curtains) open during day time only. Exhaust fan may also be used for dragging air out during summer.

7.4.2 Temperature control : Use of fan and pad system, exhausting hot air out, use of screen and using water sprinklers / foggers temperature could be controlled. Shade net of black colour is used at the top below the cladding material to reduce light intensity whenever required.

a. Cooling : Cooling of greenhouse is necessary wherever the outside temperature goes beyond 30º C and also when cool crops are to be grown. Depending upon the cladding material and the ventilation, inside temperature remains 8 to 10º C higher than the outside temperature. In order to create better growing conditions, it will be necessary to cool the greenhouse. This can be done through evaporative cooling method, using horizontal draft fans on one side and cooling pads on the other side. The capacity of the fan and size of the pad depends on the length and width of the greenhouse and also elevation and other parameters. This system is known as fan and pad system which is very effective where the ambient humidity is low, with high temperature.

b. Heating : Heating is required in places where the winter temperature is very low. At higher elevations, where temperatures do not normally go above 30ºC, cooling may not be necessary, only providing proper ventilation will serve the purpose. However, these places may require heating during winter. Greenhouses can be heated with the help of oil burners, hot water (or steam) or propane (or electric) heaters. Heating is a regular process in temperate countries, where temperature goes below 0^0C.

Do you know ?

CO_2 is the main component for photosynthesis which results in good plant growth and yield.

7.4.3 CO_2 control : CO_2 enrichment is done by trapping natural CO_2 in the greenhouse upto 1500-2000 ppm. General level is 300 to 350 ppm whereas at 1200-1500 plant gives good response

a. Enrichment of CO_2 : It can be done by burning mineral oil, paraffin oil or kerosene in gas burners. Produced CO_2 is spread in green house under pressure. If we use 28 litres of gas from such burners on 450 square meter about 1500 ppm CO_2 is generated.

b. Use of liquid CO_2 : Under certain pressure CO_2 is converted in to liquid form which is released in green houses through 3 to 6 mm rubber tubes with minute holes at 10 m distance by regulating valve under low air pressure.

c. Use of solid CO_2 : At low temperature and pressure CO_2 could be converted in to solid form which is known as dry ice. This can be used in green house for enriching carbon- dioxide.

CO_2 enrichment can be done only in fully climate controlled green house. In the naturally ventilated polyhouses side curtains are closed during night which increases CO_2 in Green house. Next morning this stored CO_2 is utilized by plant for photosynthesis then the curtains are opened and excess CO_2 is exhausted.

7.4.4 Control of light intensity : Using UV stabilized sheet and shade net, light intensity is controlled up to 30000 to 60000 lux.

a. Shading : Certain plants are damaged by high light intensities in the greenhouses. Seran cloths with different mesh sizes can be used for providing 25 - 80 per cent shade depending upon the type of crops grown. In the recent years aluminized shade cloth is being used in some of the modern greenhouses. The entire shading system in the greenhouse can be either manually operated or made automatically. Shade nets of various colours are used popularly in NVPH.

Can you recall?

Photoperiodism is the developmental responses of plants to relative lengths of light and dark periods.

b. Photoperiodic control : Several plant species flower only when they are exposed to a specific light duration. On the contrary, these plants species remain vegetative when additional light is given during the dark phase. This phenomenon, which is known as photoperiodism has been effectively utilized in protected cultivation of horticultural crops. Under greenhouse conditions day lengths can be increased by providing artificial light at night or decreased by covering the plants with black polyethylene sheet during day. Most optimum results with artificial lighting can be achieved by night interruption or cyclic lighting with the help of high intensity discharge lights. In contrast, short day condition in greenhouse can be created with fully automatic, semi automatic or manual blackout system using good quality black polyethylene sheets.

For increasing light, incandescent, fluorescent, mercury or sodium vapour lights could be used. Chrysanthemum needs control of photoperiodism for quality flower.

7.4.5 Humidity control : Relative Humidity inside the green house should be 50-80%. It is controlled by using air circulation, using sprinkles and controlling evaporation through opening and closing of side curtains in NVPH.

The environmental conditions to be maintained in greenhouse are :

Climatic Factors	Optimum conditions
Temperature range	During day time - 28^{0}C to 31^{0}C During night time- 15^{0}C to 18^{0}C
Relative humidity	60 to 70%
Light intensity	21500 to 86100 Lux

It can be changed as per crop requirements.

7.5 CULTIVATION OF CROPS IN GREEN HOUSE

Followings different crops are grown in green houses.

Vegetables : Tomato, Capsicum, Lettuce, Broccoli, Celery, Cucumber, Squash, Zukini.

Fruits : Strawberry, Muskmelon

Flower crops : Rose, Gerbera, Carnation, Lilium, Anthurium, Statis, Orchids, crysanthemum etc.

7.5.1 Cultivation of Gerbera : Gerbera is commonly known as Transvaal daisy or Bar berton daisy or African daisy. It is an important commercial cut flower crop. Gerbera flowers have a wide range of colours including yellow, orange, cream-white, pink, brick red, red and various other intermediate colors. In double varieties, bicolor flowers are also available. Gerbera flower stalks are long, thin and have a long vase life. Mini gerbera type bears small sized flowers and standard gerbera are bigger in size which are commercially important.

a. Climate : Bright sunshine accelerates the growth and quality of the flowers, however, in summer this flower needs diffused sunlight. Gerbera plants grown in the locations with insufficient light will not bloom well. The optimum day and night temperature is 27^{0}C and 14^{0}C respectively.

b. Soil : There are two primary factors to be considered while selecting soil for Gerbera cultivation. The soil pH must be between 5.5 to 6.5. The soil salinity level should not exceed 1 ms/cm; For better root growth and better penetration of roots, the soil should be highly porous and well drained. Red lateritic soil is good for Gerbera cultivation as it has all the essential qualities that an ideal soil should have.

c. Preparation of planting bed : In general, Gerbera is grown on raised beds to assist in easier movement and better drainage. The dimensions of the bed should be as follows:

Bed height : 45 cms

Bed width : 70 - 80 cms

Between the beds: 1 feet (30 cm) which is known as path for intercultural operations.

The beds for planting should be highly porous, well drained and airy. Gravel/sand can be added for better drainage. Organic manure is recommended to improve soil texture and

Fig. 7.6 Steps in soil sterilization

to provide nutrition gradually. The soil should be loose all the time and should not be very compact after watering. The upper layer of soil and FYM should be properly mixed. While bed preparation, add Single Super Phosphate (0:16:0) @ 2.5 kg per 100 sq. ft. for better root establishment and Magnesium Sulphate @ 0.5 kg per 100 sq. ft. to take care of deficiency of Mg. Neem cake (@ 1 kg / m^2) is also added for prevention of nematode infestation.

d. Soil sterilization : Soil sterilization is required before plantation of any crop in greenhouse for soil media to manage *Phytophthora* infection and soil borne diseases. There are three main soil sterilization methods available *viz.* steam, solar and chemical out of which chemical method is the most practical method. Formalin is used for soil sterilization @ 7.5/10 lit. of water for 100 sq.m area in the form of spray. The wet crop beds are spread using formalin and covered with black polyethylene mulch sheet. While treating with formalin, care should be taken to wear mask, gloves and apron. Four days after formalin treatment, the polyethylene cover is removed; the beds are raked repeatedly to remove the trapped formalin fumes completely, or washed out by watering prior to transplanting otherwise it may injure the roots of the seedlings. Formalin treatment can be repeated after three crop cycles or whenever necessary.

e. Propagation : Gerbera is commercially propagated by suckers. Side shoots, suckers with some amount of heel are utilized for multiplication.

f. Micro propagation : The plant parts used as explants for micro propagation are shoot tips, leaf mid-rib, capitulum, flower heads, inflorescence and Buds.

g. Varieties : Important varieties of Gerbera are Pre Intenzz, Stanza, Winter Queen, Cacharelle, Jaffa, Sangria, Diana, Thalsa, Sonsara, Paganini, Anneke, Nette, Rosetta, Gloria, Ginna, Ingrid, Pricilla, Alexias, Intense, Sunway, Zingaro, Balance, Rosaline , Dune and Monique. Several new varieties appear every year.

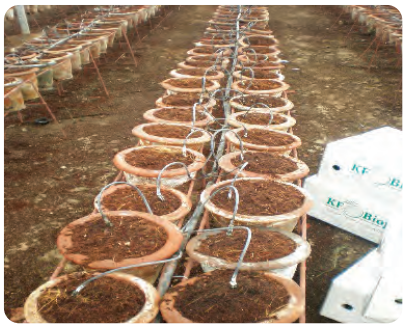
h. Planting : Only tissue cultured plants or seedlings are used for gerbera cultivation under protected conditions. At the time of planting the tissue culture, plant should have at least 4 to 5 leaves. Gerberas are planted on raised bed in two rows.Zigzag plantation system is mostly preferred. While planting, 65% portion of root ball should be kept below ground and rest of the portion i.e. 35% should be kept above the ground for better air circulation in the root

Spreading of laterals for Fertigation on raised beds

Seedling for planting

Planting in soil media

Flowers ready for harvest



Benches with pots for planting in soilless media

Planting in soilless media

Flower harvesting in buckets with adequate amount of water

Box Packing of flowers

Flowers ready for Local market

Fig. 7.7 Cultivation of Gerbera in soil and soilless media

zones. Planting is done either in evening or morning when temperature is low outside.

Ideal planting density and spacing: 8-10 plants/sq.m. or 30 X 30 cm or 40 x 25 cm.

i. Fertilization : Irrigate and fertilize frequently in small quantities for optimum results. Do not fertilize upto three weeks of planting. Always analyze the soil once in 2 - 3 months to decide specific nutrient schedule. Well rotten FYM @ 10-15 kg/100 sq.m. is mixed with soil before sterilization.

Once flowering commences, N:P:K 15:8:35 at the rate of 1.5 g/l water/day is to be given. Micronutrients should be given weekly or fortnightly as per the deficiency symptoms. Boron deficiency causes base of young leaves turn black. Zinc deficiency symptoms can be identified with the C-shaped leaf structure caused by chlorosis on one half of the leaf blade which ceases to expand, while the other half of the leaf is normal.

j. Cultural practices :

i. Weeding and raking of soil : Weeds take the nutrients of the plants and affect the production. Hence, they should be removed from the bed. Due to daily irrigation, the surface of the gerbera bed becomes hard hence raking of soil is done with the help of a raker. It increases soil aeration in the root zone of the plant. This operation should be done regularly, may be once in a week.

ii. Disbudding : Removal of inferior quality flowers at the initial bud stage after plantation is called disbudding. The normal production of gerbera plants starts after 75 - 90 days from the date of plantation. Production of flowers starts 45 days after plantation but initial production is of inferior quality, hence these flowers should be removed from the base of the flowers stalk. this helps in making the plant strong and healthy.

iii. Removal of old leaves : Sanitation helps in keeping the disease and pest infestation below the economic threshold level. The old, dry, infested leaves should be removed from the plant and the production site.

k. Pests and diseases :

i. Diseases : Root rot *(Pythium irregularae, Rhizoctonia solani)* ; Foot rot *(Phytophthora cryptogea)* ; Sclerotium rot *(Sclerotium rolfsii)* ; Blight *(Botrytis cinerea)* ; Powdery mildew *(Erysiphe cichoracearum, Oidium erysiphoides)* ; Leaf spots *(Phyllosticta gerberae, Alternaria spp.)*

ii. Insect-pests : White fly ; Red Spider Mites ; Nematodes ; Aphids ; Leaf miner ; Caterpillars

l. Harvesting : The first harvesting is done after 75 - 90 days after planting. Flowers of most of the varieties are ready to be picked when 2 - 3 whorls of stamens have entirely been developed. The good quality flower has stalk length of 45-55cm, and diameter 4 – 5 cm. Morning or evening is the best time for gerbera flower harvesting. Skilled labours are required for harvesting of gerbera cut flowers. After harvesting the flowers should be kept in a bucket containing clean water. Flowers are very delicate hence they should be carefully handled otherwise can be damaged and their quality gets deteriorated. For harvesting gerbera, no secateurs are required but can be done by just pulling the flower stalk on one side.

m. Yield : 150- 250 flowers/ m^2 / year

Gerbera can be grown in soilless media like coco peat, which is the powdered coco shel commercially available. It requires pots and stands with high initial investment. The uncultivable land, undulated sites can be utilized successfully with this system with higher yields as compared to soil. The commercial life of gerbera is generally 3 years in soil media and 5 - 6 years in soilless media under naturally ventillated polyhouse.

7.5.2 Cultivation of capsicum in green house : Capsicum, also known as sweet pepper, bell pepper or shimla mirch, one of the popular vegetables is grown throughout India. Capsicum is a cool season crop, but it can be grown round the year using protected structures where temperature and relative humidity (RH) can be manipulated. This crop requires day temperature of 25-30^{0}C and night temperature of 18-20^{0}C with relative humidity of 50-60%. If temperature exceeds 35^{0}C or falls below 12^{0}C, fruit setting is affected.

Colored capsicum is in great demand in the urban markets. The demand is mostly driven by hotel and catering industry. The traditionally grown green capsicum, depending on variety and season, usually yields 20-40 tons per hectare in about 4-5 months during winter only. In the greenhouse, the crop duration of green and colored capsicum is about 7 -10 months and yields about 80-100 tonnes per hectare throughout the year.

Cultural and Nursery practices :

a. Selection of varieties :

Growing of capsicum hybrids in green house is useful to obtain continuous and regular flower and fruit setting relatively for a long period of 8 to 10 months. Most of the capsicum hybrids produce green fruits that mature to red, orange or yellow depending on the hybrid. The fruits should have characters such as uniform size and shape preferably four lobes, fruit weight of >150g, uniform coloring after attaining complete maturity, with a better shelf life of more than 5 days under ambient conditions. Selected hybrid should be high yielding, with potential yield of > 40 t/acre. Hybrids should have shorter internodal lengths

Seedling for planting

Planting on raised beds

Supporting the growing plants

Pinching

Vigorous growth after pinching

Coloured fruits

Standing crop

Fig. 7.8 Cultivation of capsicum in greenhouse

(7 to 10 cm), attaining maximum height of 10 feet in a crop period of 10 months. Popularly grown colour wise commercial hybrids in India are:

Green coloured : Indra, Yamuna

Red coloured : Bomby, Triple star, Natasha, Inspiration, Pasarella,

Yellow coloured : Swarna, Orbelle, Bachata.

The capsicum hybrids with high yield potential and uniform size and shape needs to be selected. Generally Red and yellow coloured varieties are selected in the proportion of 60:40 respectively in the same polyhouse. The good quality seedlings of selected varieties with 5 to 6 healthy leaves should be procured from authorised reliable vegetable nursery for planting. Approximately 4000 seedlings are required per acre.

b. Land preparation :

The land should be thoroughly ploughed and soil should be brought to fine tilth. Well decomposed organic manure at the rate of 20-25 kg per sq. mt. is mixed with soil. One application is sufficient to grow three capsicum crops successively. Raised beds are formed after bringing soil to fine tilth. The bed size should be 90-100 cm wide and 15-20 cm height. Between the beds walking space of 45 cm to 50 cm need to be provided for intercultural operations. Soil beds should be sterilized properly, as mentioned earlier.

Do you know ?

Training is done to control direction, shape and size of plant with proper support to have good quality produce.

c. Fertilizer application :

A basal fertilizer dose of 20:25:20 Kg NPK is required per acre and is applied to the beds uniformly before transplanting in the form of 80 kg calcium ammonium nitrate, 125 kg super phosphate and 32 kg muriate of potash or 40 kg sulphate of potash.

d. Application of neem cake and Microbial Bio-control Agents :

Fifteen days before transplanting, neem cake has to be enriched with bioagents like *Trichoderma harzianum* and *Pseudomonas lilacinus*. Neem cake of about 200 Kg is powdered and slightly moistened. *Trichoderma harzianum, Pseudomonas lilacinus* and *Paecilomyces chilmdosporia* each of two kg are mixed thoroughly to the neem cake. The mixture is covered with wet gunny bags or dry grass and left for 8-10 days. Avoid direct exposure to sunlight and rainfall. After 10 days, this enriched mixture of neem cake and bio-agent along with 600 kg of neem cake has to be applied uniformly to the beds for an area of one acre. This is highly useful to reduce the problem of soil borne pathogens and nematodes. It gives quality yield.

e. Laying of drip line :

Place one 16 mm inline drip lateral at the center of the bed with emitting points at every 30 cm interval with discharge rate of 2 ltr/hr. or 4 ltr/hr. Run the drip system to check each emitting point for uniform discharge before covering the beds with polythene mulch.

f. Mulching and Spacing :

Black polyethylene non-recycled mulch film of 30-100 micron thick, 1.2 m wide, is used to cover the planting beds. Holes of 5 cm diameter are made on the polyethylene film as per the recommended spacing (45cm x 30cm). The planting beds are covered with the film by securing the edges of the sheet firmly in the soil. Mulching practice conserves water, controls weeds, and reduces infestation of pests and diseases and results in higher yield and good quality produce.

g. Transplanting :

The planting beds are watered to field capacity before transplanting. Seedlings of 30-35 days old are used for transplanting without any damage to the roots, while taking out the seedlings from individual cells of pro-Trays. Seedlings are transplanted into holes made in polyethylene mulch film at a depth of 5 cm. After transplanting, seedlings are drenched with 3 g/L copper oxychloride or 3 g/L captan or 2 g/L copper hydroxide solution at the base of seedlings @ 25-30 ml per plant. Watering the mulched beds daily during afternoon by using hose pipe for a week continuously is essential to avoid mortality due to heat trapped by mulch sheet.

h. Pruning :

Capsicum plants are pruned to retain four stems. The tip of the plant is pinched after 30 days of transplanting which then splits into two at 5^{th} or 6^{th} node and are left to grow. These two branches again split into two giving rise to four branches. At every node the tip splits into two giving rise to one strong branch and one weak branch. Pruning results in bigger fruits with better quality and high productivity. The capsicum plants can also be pruned to two stems and same level of yield can be maintained.

i. Training :

The main stem of plant is tied with four plastic twine to train along and tied to GI wire grid provided on the top of the plants. This is practiced after four weeks of transplanting. The new branches and plants are trained along the plastic twines.

j. Drip irrigation and Fertilization :

Drip irrigation is given to provide 2-4 litres of water per square meter per day depending on the season. Water soluble fertilizers are given through fertilization for entire crop growth period, starting from third week after transplanting . Fertilization is to be given twice a week as recommended in the table below.

Sr. No	Required fertilizer	Fertilizer dose per fertilisation (kg/ acre)
1.	19:19:19	4 kg
2.	Potassium Nitrate	1.5 kg
3.	Calcium Nitrate	1.5 kg

Capsicum crop is sprayed with water soluble fertilizers like potassium nitrate and calcium nitrate at every 3 week interval after 2 months of transplanting @ 3g/ l as foliar application.

k. Pests and Diseases :

Capsicum being relatively long duration (9-10 months) crop in a polyhouse, the plant parts (vegetative, floral and fruit) are more exposed to adverse conditions which affects the yield, quality and market value of the produce. Hence their identification and management at right stage of the crop should be given importance. The major pests and diseases are:

I. Insect Pest :

i. Thrips
ii. Mites
iii. Aphids
iv. Fruit borer
v. Nematodes
vi . Leaf miner

II. Diseases :

i. Damping off
ii. Powdery mildew
iii. Cercospora leaf spot
iv. Phythopthera

l. Harvesting and yield :

Early morning hours are the best suited for capsicum harvest. Green capsicum can be harvested at 55 to 60 days after transplanting, yellow capsicum at 70-75 days whereas red capsicum at 80-90 days after trnasplanting. Fruits can be harvested once in 3 to 4 days. Yellow and red fruits can be harvested when they have gained 50-80 per cent of the colour development. After harvest fruits should be kept in cool place and avoid direct exposure to sunlight. The capsicum fruits are shrink wrapped with decomposable thin plastic and placed for marketing or packed in boxes. The average yield of capsicum per acre is 30-40 tons.

7.6 PEST AND DISEASE MANAGEMENT IN GREENHOUSE CROPS

7.6.1 Chemical control measures for major pests and diseases :

Sl. No.	Name of pest	Control measures per lit. of water	
1	Spider mites	Abamection or wettable sulphur	0.4 ml
2.	Caterpillars	Methomyl or cypermethrin	1.5 gm 0.5 ml
3.	White fly	Acephate	1.0 gm
4.	Thrips	Acephate or Imidacloprid	1.0 gm 0.4 gm
5.	Aphids	Acephate or Decis	1.0 gm 0.5 ml
6.	Powdery Mildew	Pencozole or Copper oxy-chlorides	0.25 ml 1.5 gm
7.	Nematode	Phorate	6 gm/ sq.m
8.	Leaf miner	Acephate or Abamectin	1.0 gm 0.5 ml
9.	Damping off	Copper Oxy-chloride	1.0 gm

7.6.2 Integrated pest management for greenhouse crops :

Integrated Pest Management is the system that utilizes all suitable techniques in a compatible manner to reduce pest population and maintain them at levels below those causing economic and health injury.

The following steps should be considered to control pest and disease in greenhouse.

1. Use resistant varieties
2. Use pest and disease free healthy planting material.
3. Practice good sanitation techniques.
4. Monitor crop on daily basis
5. Monitor and suppress insect population.
6. Modify the environment
7. Avoid plant stress
8. Use pheromen trap, light trap, sticky cards, etc.

Exercise

Q. 1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. A frame covered with shade nets to protect plants from direct sunlight is known as …….
   a. Polyhouse b. Shade house
   c. Glass house d. Pack house
2. In the tropical and sub-tropical region ……type of greenhouse is popular.
   a. Naturally ventilated polyhouses
   b. Glass house
   c. Shade net house
   d. Tunnel type
3. Cooling of greenhouse is necessary whenever outside temperature goes beyond ……
   a. 40^0C b. 30^0C
   c. 10^0C d. 20^0C
4. ……. is known as African Daisy.
   a. Carnation b. Gerbera
   c. Capsicum d. Merigold
5. Shrink Wrapping technology is most suitable for packing of ……
   a. Gerbera b. Carnation
   c. Capsicum d. All crops

B. Make the pairs.

A	B
1. Glass house	a. 200 micron
2. UV stabilized polyfilm	b. Capsicum
3. Prunning	c. Glass
	d. Gerbera
	e. 150 micron

C. Find the Odd one out.

1. Soil, Sand, Coco peat, Urea
2. Single Span, Even span, Saw tooth type, Tunnel
3. Temperature, Humidity, Light, CO_2, Irrigation
4. Thrips, Mites, Phytopthera, White fly

D. State true or false.

1. The shade net houses are popular in temperate countries.
2. The temperature under polyhouses is always higher than outside temperature.
3. The covering of the any greenhouse structure is known as cladding material.
4. Seed propagated gerbera is commercially grown outside the green house successfully.

Q.2 Answer in brief.

1. List out any four varieties of gerbera.
2. Explain the use of ventilation for climate control in green house.
3. List out the types of greenhouse on the basis of cost of construction.
4. State how pruning is done in capsicum.
5. Write about harvesting and packing in gerbera.

Q.3 Answer the following questions.

1. Write about installation of irrigation system in greeen house.
2. What are the different types of Greenhouses based on shape?
3. State temperature management in Green house
4. Outline the schedule of fertigation for capsicum cultivation under green house
5. Describe pest disease management for gerbera in greenhouse.

Q. 4. Answer the following questions.

1. Expain different types of greenhouses based on construction.
2. Describe soil sterilization for gerbera cultivation in green house.
3. Describe harvesting and post-harvest management of colored capsicum.

4. Explain the orientation of naturally ventilated poly house.
5. Describe fertilizer application in Capsicum.

Q. 5 Answer the following questions in detail.

1. Describe the cultivation of coloured capsicum under polyhouse condition on following points :
   a. Land preparation
   b. Pruning
   c. Training
2. Explain site selection for Green house.

Q. 6 Answer the following questions in detail.

1. Write the advantages of green house.
2. What is the scope of greenhouse technology under Indian conditions?

Activity

Arrange a visit to a nearby Green house or poly house and study in detail structure, cladding material and different crops grown under green house.

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

8. Seed Processing and Testing

Can you recall?

1. What is the difference between seed and grain?
2. How will you recognize good seed?
3. Do you know different types of seed?
4. Why seed is cleaned and dried before storage?
5. Is any processing required before sowing seed?

8.1 SEED PROCESSING PLANT

8.1.1 Meaning and Importance of seed processing :

• Seed processing means improving the quality of harvested seed through a series of operations, viz. cleaning, drying, grading, testing, shelling, treating, bagging and labelling.

• Seed processing may be defined as the process of removal of dockage in a seed lot and preparation of seed for marketing.

Seed processing may be understood to comprise all the operations after harvest that aim at maximizing seed viability, vigour and health.

Remember this

- Seed processing is a vital part of the total technology involved in making available high quality seed.
- It assures the end users, seed of high quality with minimum adulteration.
- In agriculture, the term seed processing includes cleaning, drying, seed treatment, packaging and storage.

Importance :

1. It helps in taking such preventive measures that maintain seed viability. These measures include drying of seed.
2. It helps in improving the seed quality by removing adulterants and unfit seed.
3. It provides information about seed quality standards to the buyers. These quality standards are determined by purity test, moisture test, germination test, etc.
4. Processing makes seed handling easier. Use of appropriate bags prevent seed damage during handling and storage.
5. It helps in keeping healthy seed. The seed treatment not only reduce the seed borne infection but also protect seed in storage. It also protects seed and seedlings from attack of pest and diseases.
6. Use of designated tags facilitates seed identification and handling.
7. It helps in getting higher yield as the proportion of pure seed is higher in processed seed, that will give rise to vigorous and healthy plant stand.
8. Processed seed is uniform in size due to removal of seed appendages. Hence machine sowing becomes easier.
9. It helps in preventing spread of weed seed.
10. It helps in improving storage life of seed.

Keep in Mind

Seed processing is based on differences in physical properties between the desirable seed and the contaminants.The physical properties are size, shape, length, weight, colour,surface texture, affinity for liquid and electrical conductivity

8.1.2 General processing Sequence for complete cleaning of seed of different crops :

A. General processing sequence :

The normal processing sequence involves the activities such as receiving, drying, pre conditioning, precleaning, cleaning, separation and upgrading, treating, weighing, bagging, storage or shipping.

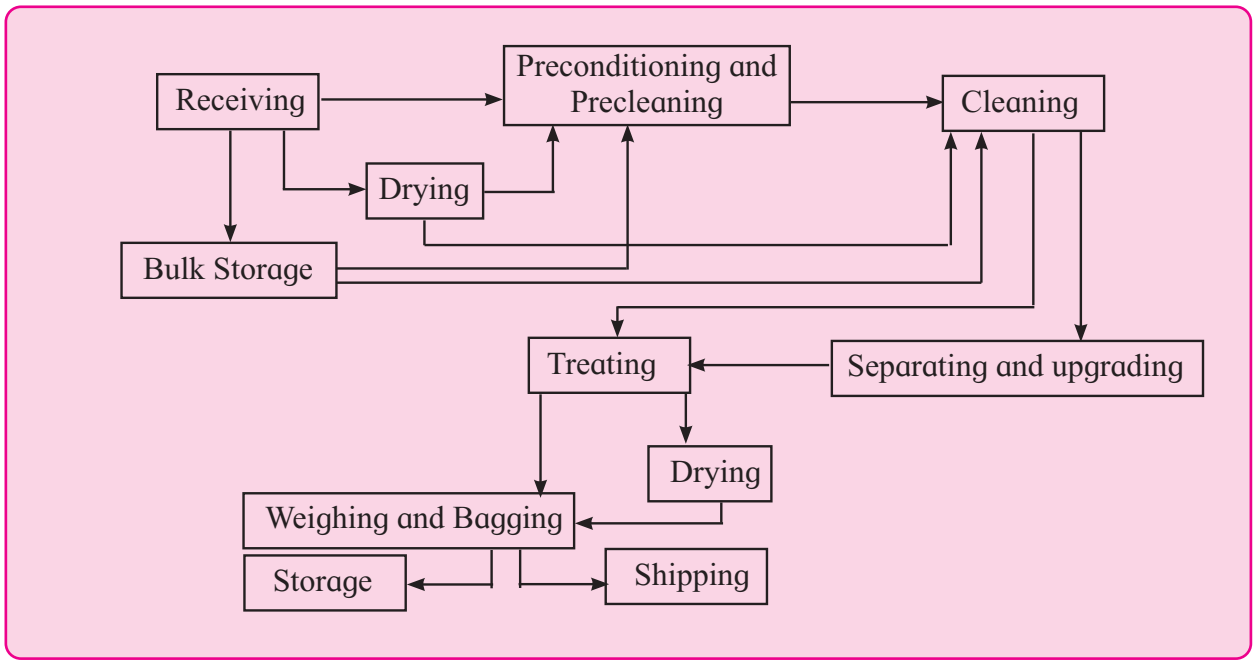


Fig. 8.1 Basic flow diagram showing essential steps in seed processing

Observe and Discuss

Material removed from harvested seed

- Threshed
- Shelled
- Dried

Inert material

- Noxious weed seed
- Deteriorated seed
- Damaged Seed

- Common weed seed
- Other crop seed,
- Other variety seed
- Off size seed

Marketable seed

- Cleaned
- Graded
- Treated
- Packagged
- Tested

Think about it

- What will happen when harvested seed is directly used for sowing?
- Harvested seed is stored without drying.
- Harvested seed is not cleaned and treated.

1. Drying : Drying of seed means lowering the seed moisture content to safe moisture limits. At harvesting, the seed normally contain high per cent of moisture. In order to avoid any negative effects of high moisture, the seed has to be dried to 8 to 12% moisture. If the seed is stored at high moisture content, it affects germination quickly and seed is affected with pest and diseases. The two common methods of seed drying are sun drying and forced air drying.

2. Preconditioning and precleaning :

Pre-conditioning means operations such as shelling, debearding, etc. that prepare seed lot for basic seed cleaning and also removal of trash stones, clods, etc. larger in size than crop seed. Precleaning remove particles that are lighter in weight and smaller in size than the crop seed.

3. Cleaning : Seed impurities like weeds, immature seed, inert matters, infected seed, other crops seed, damaged seed, etc. are removed from seed lot on the basis of differences in physical properties.

4. Upgrading : The various processing operations conducted after basic cleaning for further improvement of seed quality are called as upgrading. After cleaning the seed requires grading. The grading is of two types viz length grading and gravity separating. The clean seed

is further graded in this process on the basis of length of seed. The immature or infected seed that may not have been removed in the cleaning process are removed in this process.

Gravity separating is followed after length grading and is helpful in removing light and immature seeds.

5. Seed blending : Blending is an attempt to produce more unifirm seed lot. Seed blending refers to combining two or more varieties of the same species. Seed mixing denotes combining two or more species.

6. Treating : This process is followed after grading. In this process a suitable fungicide/ pesticide is used to protect the seed from pest and various diseases.

7. Weighing and Bagging : Processed seed may be handled either in bags or in the bulk. When seed is being bagged a small platform is commonly used to weigh the filled bags which are then sewed by hand or machines.

8. Storage : The seed is stored to maintain it in good physical and physiological condition from the time they are harvested untill they are planted.

Try this

Visit near by seed processing plant and observe layout and instruments used in it.

B. Processing sequence for complete cleaning of Jowar, soybean, groundnuts and cotton seed

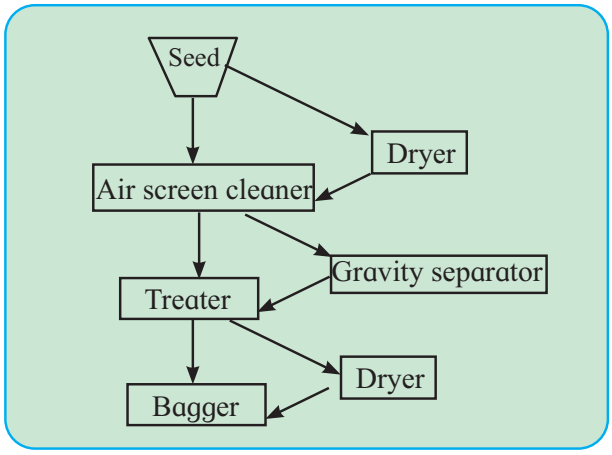


Fig. 8.2 Processing sequence for complete cleaning of Jowar seed

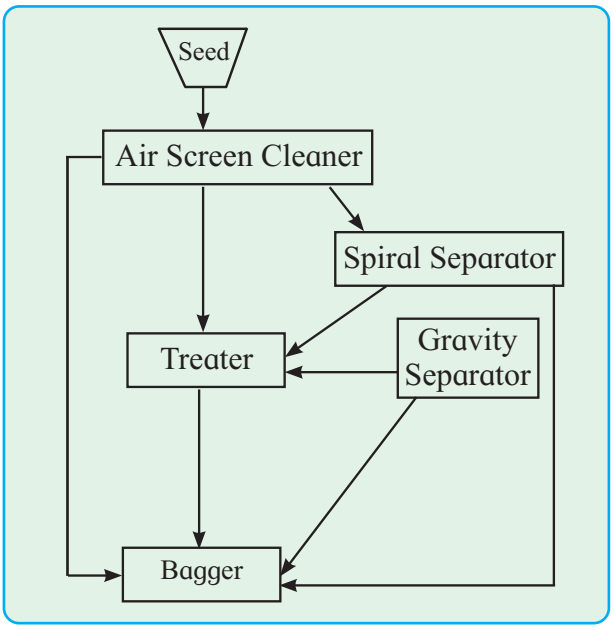


Fig. 8.3 Processing sequence of Soybean seed

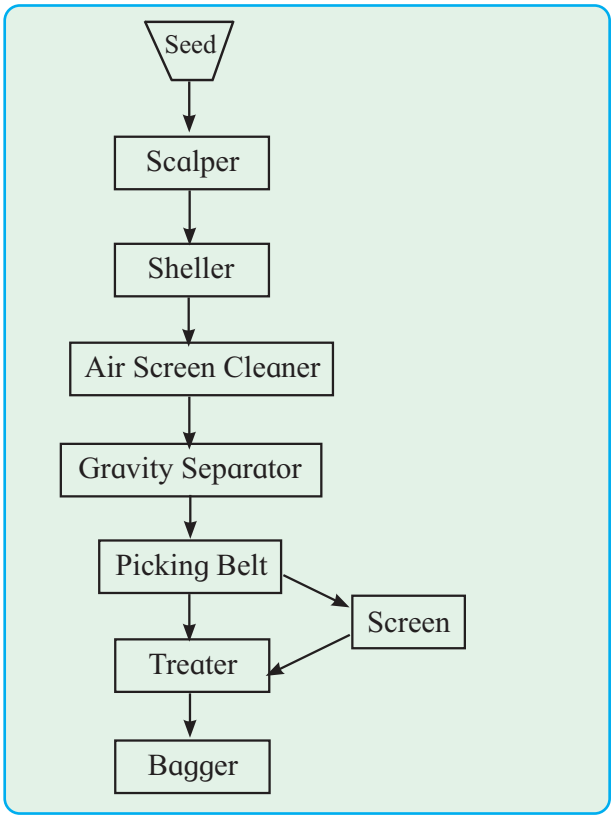


Fig. 8.4 Processing sequence for complete cleaning of Groundnut seed

Internet my friend

Search for uses of following equipments

Air screen cleaner, sheller, scalper, gravity separator, dryer, treater, bagger, spiral separator, washer, etc.

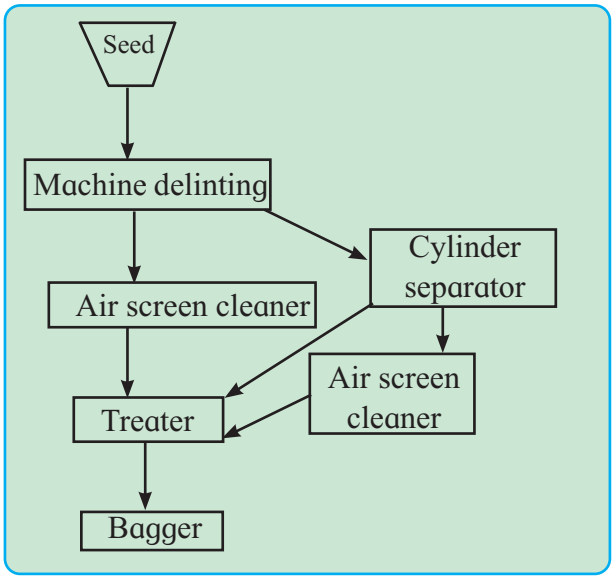


Fig. 8.5 Processing sequence for cotton seed (machine dilinting)

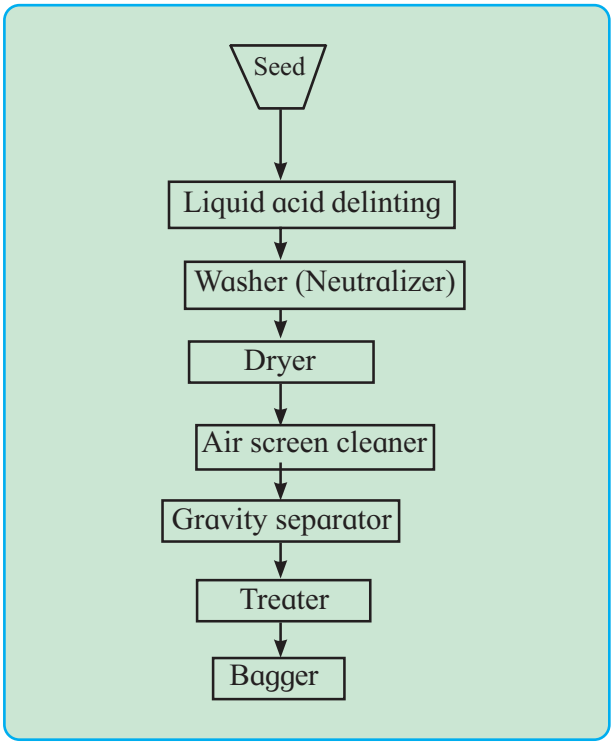


Fig. 8.6 Processing sequence for complete cleaning of cotton seed (acid delinting)

8.1. 3 Layout and planning of seed processing plant :

A. Factors to be considered while planning and designing seed processing plants

The following points should be considered in laying out a seed processing plant.

1. Size of operation, sequence of operations.
2. Kind of crop seed to be handled, Kind of contaminating crop.
3. Kind of weed seed usually present in seed lots.
4. Selection of equipment and expenditure needed.
5. Location of the plant, area required.
6. Type of drying facilities required.
7. Facilities required for seed cleaning and storage.
8. Facilities for transport of seed to and from processing plants.
9. Source of power for electricity machinery.
10. Availability of labour and their wages and training.
11. Competition from the other processing plants.
12. Appointment of manager for plant - Priority should be given to education, experience, curiosity and locality.
13. Facilities for seed sell - Market should be near to the proposed project area.

The layout planner must have detail knowledge of the seed to be processed, its physical characteristics and contaminants in it. He should know about selection of machines used to bring the seed to marketing standard.

B. Planning : After the selection of proper machines, elevator capacities, cleaning sequences and layout design have been selected, detailed lay out planning can begin. Careful layout planning is useful to identify and prevent trouble spots before the plant is built. As the layout or design develops, it should be drawn on paper. First, draw lines of flow and then convert these flow lines into machine lines. After revisions, detailed drawings can be made to show exact locations of equipment and distances. Scale drawings are the most widely used method of layout planning. Scale models and scale templates are also vey effective, but are more expensive.

C. Analysis of operation :

I. **Processing sequence :** After the selection of machines, the next step is determination of proper processing sequence. The seed separators, elevators, conveyors and storage bins should be so arranged that seed flow continuously from receiving to end, and yet be flexible enough to bypass a machine or return to a part for recleaning.

II. **Machine capacity :** Equipment capacity must be carefully planned to prevent bottlenecks. When the overall operating capacity needs have been determined, machines should be able to handle the capacity with some reserve capacity. Surge bins can handle variations in individual machine capacities. In case of great differences either larger models or more than one machine be installed in parallel flow.

III. **Conveying :** The type of conveying system is a very important factor. The conveying system must be able to handle the capacity needed in a particular spot.

8.1.4 Types of layouts

There are three main types of processing plant layouts viz. multistorey, single level and combined design.

1. **Multistorey :** In this type, seed is carried by elevators to the top floor and emptied into large bins. Cleaning machines are then arranged in a vertical series on the lower floors. Seed flows from one machine down into the next by gravity.
2. **Sinlge level :** In the single storey plant, seed is moved from one machine to the next by elevators placed between the machines. The advantage of this system is that one man can supervise the processing without running up and down stairs.
3. **Combined designs :** A compromise between the single and multistory system could also be adopted.

Do you know ?

The following five types of seed processing units are approved by the director of seed certification to carry out the certification works.

1. Seed processing and tagging unit.
2. Ginning unit
3. Ginning, processing and tagging unit
4. Delinting unit
5. Cleaning and tagging unit.

Fig. 8.7 Single storey layout of seed processing plant

8.1.5 Records and forms in seed processing plant

Following records and forms are maintained in seed processing plant.

1. **Inward (raw seed) register :** It is a register for entering information of seed lots received for processing. In order to identify the seed lots ,they should be given a number as soon as seed are brought in the the processing plant .While registering entry following information is recorded.
   a. Name of farmer (seed grower) with address.
   b. Name of crop and variety,
   c. Stage/class of seed.
   d. Number of gunny bags and weight of seed lot.
2. **Receipt book :** Processing plant manager issue the receipt of concerned seed lot to seed grower.It consists of name and address

of seed grower ,stage of seed produced, no.of gunny bags and weight of the seed lot.

3. **Seed processing Register :** It contains all kinds of entries regarding the types of processing done to get right type of quality to the seed. It consists of following information. Name of seed producer with address,number of gunny bags and weight of seed lot,date of processing and weight of good seed, Number of packed bags and weight , seed lot passed or failed ,number of tags used for tagging
4. **Analysis record and File :** Before tagging seed by appropriate tags, sample has to be drawn from the processed seed lot and sent to seed testing laboratory for different tests such as germination, purity,etc. The entry should contain following information
   a. Name of the testing laboratory
   b. Test number
   c. Name of the crop ,variety and stage of seed.
   d. Name of the person or organisation giving the sample.
   e. Date of testing.
   g. Pure seed percentage.
   h. Percentage of other crop seed
   i. Inert matter percentage.
   j. Percentage of weed seed.
   k. Seed germination percentage.
   l. Percentage of hard seed,dead seed and fresh un-grminated seed
5. **Seed control ragister :** It consists of information regarding results from seed testing lab.,weight of seed passed or failed and low grade seed .
6. **Bill book :** This is used for making seed processing bill which contains
   a. Charges for all kinds of seed tests
   b. Tag and label charges
   c. Shift charges
   d. Seed certification fee
   f. Other charges
7. **Bill register :** This register consists of all information regarding bill of processed seed grower wise and season wise .Details of payment received is also recorded.
8. **Outward or Shipping (Packed and low grade seed) record :** Information is recorded as follows.
   a. Date of handing over seed to seed grower or seed company.
   b. No.of total packed bags and weight of packed seed.
   c. Quantity of fail seed.
   d. Quantity of low grade seed handed over to seed grower.
   e. Release order of concerned seed lot.
9. **Seed processing report file :** Processing plant manager prepare a seed processing report and handed over to seed grower.It contains information regarding number of gunny bags of raw seed and total weight of raw seed,no.of bags and total weight of good seed, quantity of low grade seed,quantity of fail seed if any,no.of tags used,etc.

Can you recall?

1. How planting value of seed is determined ?
2. Give names of some laboratory instruments
3. What are the objectives of seed testing?
4. Can you observe seed borne pathogens?

8.2 SEED TESTING LABORATORY

8.2.1 Meaning and objectives of seed testing :

Seed testing is the science of evaluation of planting value of seed. Seed testing is essential to achieve following objectives.

A. Objectives of seed testing:

1. To determine seed quality i.e their suitability for planting.
2. To identify seed quality problems and their probable causes.
3. To determine the need for drying, processing and specific procedures that should be used.
4. To determine if seed meets established quality standards or labelling specifications.

5. To establish quality and provide a basis for price and consumer discrimination among lots in the market.

Try this

Visit a near by seed testing laboratory to study its planning and functioning.

B. ISTA : The International Seed Testing Association (ISTA) was founded in 1924. It is an association of laboratories which are authorized to check on the marketability of seed as defined in the laws of different countries. It has more than 100 members worldwide. The permanent secretariat of ISTA is in Norway.

The primary object of ISTA is to develop, adopt and publish standard procedures for sampling and testing seed. It promotes uniform application of rules and methods of testing for the evaluation of seeds. It also promotes research in all aspects of seed science and Technology including sampling, testing, storing, processing and distribution. It encourages cultivar certification, participates in conferences and training courses. The technical and scientific work of the association is carried out by fifteen special committees. It publishes scientific and technical papers in the associations journal, (seed science and Technology).

One of the foremost achievements of ISTA is the adoption of the International Rules for seed testing. These rules prescribe testing techniques based upon scientific evidence. International seed analysis certificate, widely used in seed trade, is another achievement.

In developing the rules for seed testing following objectives serve as guidlines.

1. To provide methods by which the quality of seed samples can be determined accurately.
2. To explain methods so that seed analysts working in different laboratories in different countries throughout the world can obtain uniform results.
3. To relate the laboratory results regarding planting value.
4. To perform the tests in the most economical manner.
5. To complete the tests within the shortest period of time

C. Seed Testing Laboratory: Seed testing services are required to gain information regarding planting value of seed lots. The seed testing laboratory is the premises where seed quality testing work is effectively made. To carry out responsibilities effectively, this is necessary that seed testing laboratories are established, managed and equipped in a manner

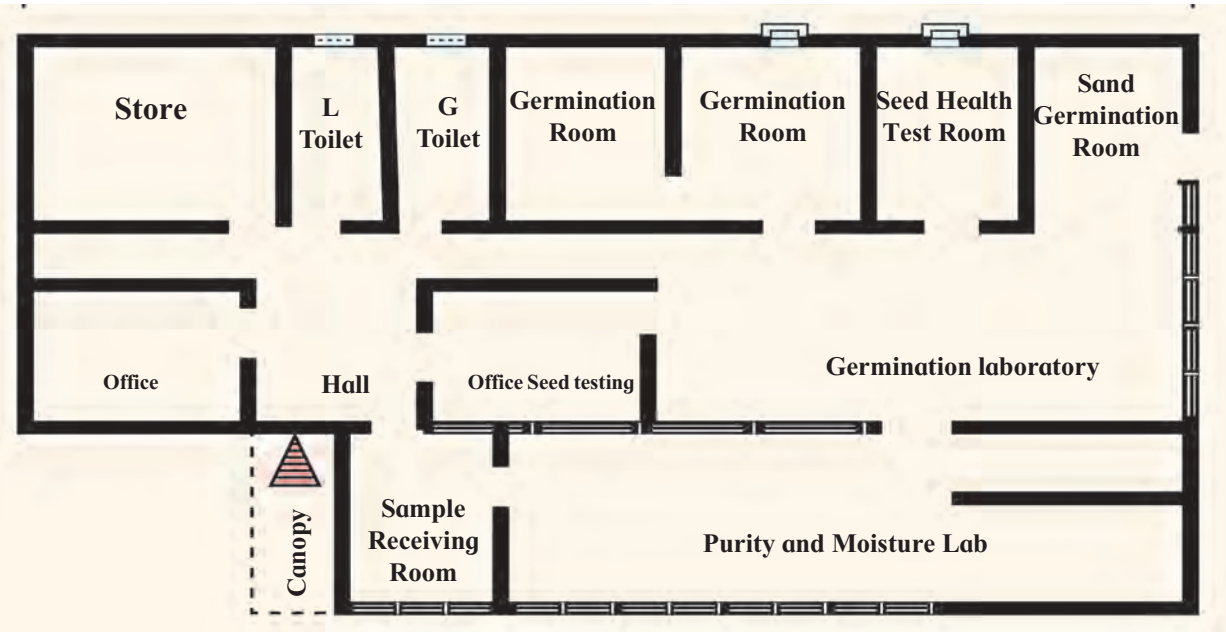


Fig. 8.9 Layout of seed testing laboratory

such that whatever samples are received should be analyzed in the least time.

Seed testing laboratories are essential in seed certification and quality control of seed. These results may cause rejection of poor seed or low grade seed in account of law.

8.2.2 Layout and design of Seed Testing Laboratory(STL) :

The layout and design of a seed testing laboratory would chiefly depend on two factors viz. capacity and type of tests required to be conducted. Therefore, at the time of design of building apart from considering the capacity and type of tests, other requirements should also be considered to maximize the use of all available space, to minimize the cost of construction, to prove good working atmosphere, safely and to minimize the cost of maintenance.

Points to be considered while preparing layout and design.

A. General Principles :

1. The layout should be such that movement of samples from one section to another is rapid and easy.
2. The room of the officer-in-charge is located in such a way that supervision becomes easy and effective.
3. There should adequate working space and arrangement for light.
4. The space can be divided into separate rooms for office, sample reception, dry room, health testing room, etc.
5. The germination room and storage room should not face direct sunlight.
6. The design should permit extension in future.
7. Arrangement of water and drainage should require minimum plumbing work.
8. The decent furnishing, light arrangements and other necessities should be provided.

B. Building :

A testing laboratory can be housed as a separate building or it could be a part of large building. A minimum of 1500 sq. ft. working space has been suggested for laboratories handling 10,000 samples annually.

C. Land and other structre :

For cultivar purity test the provision for green house is required. In addition small plot (1 acre) for grow out test is also essential.

D. Staff :

The number of workers in seed testing laboratory should be related to number of samples, crop species to be handled and kind of tests performed. For laboratory handling 10,000 samples per year required staff is given in the below table.

Table 8.10 Staff requirement for STL

Sr. no.	Post of person	No. of person/staff
1.	Officer incharge	01
2.	Senior seed analysts	04
3.	Junior seed analysts	06
4.	Laboratory assistants	10
5.	Laboratory attendants	04
6.	Account officer	01
7.	Account clerk	02
8.	Store keeper	01
9.	Foreman	01
10.	Peons	02

E. Equipments :

The rules for testing seed includes the type of equipments and its specifications. The equipments should be selected accordingly.

8.2.3 Records and forms in STL :

Records and forms in seed testing laboratory : The record in seed testing laboratory will show important facts, the dates of various tests and reports about seed samples. It will give information about seed condition regarding planting value. It shows ways of improving quality aspects. The following records and forms are maintained in seed testing laboratory.

Remember this

Seed testing started more than a hundred years ago to avoid unscrupulous practices prevalent in the seed trade. The first lab for seed testing was established in Germany in 1869. In India, the first seed testing laboratory was established in 1961.

1. **Letter file :** In this file all those letters received from agricultural universities, seed companies and seed growers, etc. are maintained.
2. **Sample entry register :** As soon as the seed sample is received from seed grower or seed processing plant at the seed testing laboratory, its first entry is made in the register as follows.
   a. Name of the seed grower or seed processing plant with address.
   b. Name of crop and variety.
   c. Stage/class of seed
   d. Weight of seed sample.
   e. Date of sample received.
   f. Seed tests required.
3. **Sample slip file :** The samples received from Seed grower or seed processing plant are accompanied with sample slip. These sample slips are kept in this file.
4. **Sample coding register :** After the entry is made in the sample entry register, specific code is given to the sample and same are recorded in this register.
5. **Receipt book :** In seed testing laboratory receiving clerk prepare payment receipt according to service sample or certified sample and hand over one copy to concerned seed grower or seed processing plant.
6. **Allotment register :** Before sending sample to different sections for carrying different quality tests(analysis), lot wise allotment groups are made up to 25 samples.Entry of these allotment lots is made in allotment register .After that sample lot is handed over to purity section.
7. **Purity register :** After the completion of purity test following information is recorded in this register.
   a. Code number of seed sample
   b. Weight of working sample
   c. Weight of remaining seed sample (handed over to storage section)
   d. Pure seed percentage.
   e. Percentage of other crop seed.
   f. Percentage of weed seed.
   g. Inert matter percentage
8. **Purity work card :** Purity work section prepare purity work report on card and submit to reporting section. Pure seed is handed over to mounting or germination section.
9. **Mounting or germination test register :** In this register following information is recorded.
   a. Code number of seed sample
   b. Number of seed used in each replication used .
   c. Date of putting seed sample for germination and method of germination used.
   d. Date of first count.
   e. Date of final count.
   f. Normal seedling percentage.
   g. Abnormal seedling percentage.
   h. percentage of hard seed.
   i. Percentage of dead seed.
   j. Percentage of fresh ungerminated seed
10. **Germination work card :** Mounting section prepare germination card according to sample and submit to reporting section.
11. **Report register :** Result regarding all the tests from purity and Mounting / Germination section are recorded in this register. Then seed testing report is prepared by reporting section and sent to the concerned seed grower or seed processing plant through post.
12. **Sample storage register :** This register is maintained by seed storage section according to code number of seed sample. (Generally seed sample is stored for three years)

Exercise

Q. 1 Answer the following questions.

A. Select the appropriate alternative and complete the following statement.

1. Lowering of moisture in seed to safe limit means …….
   a. Drying b. Mixing
   c. Conditioning d. Treatment
2. The International Seed Testing Association was founded in ……
   a. 1924 b. 1926
   c. 1824 d. 1826
3. The processing operations conducted after basic cleaning for further improvement of seed quality are called as……
   a. drying b. upgrading
   c. cleaning d. treating
4. A minimum of 1500 sq. ft. working space has been suggested for laboratories handling …… samples annually.
   a. 100 b. 1000
   c. 10,000 d. 1,00,000
5. In ……type of processing plant layout one man can supervise processing work.
   a. single level b. multistorey
   c. combined design d. none of these

B. Make the pairs.

Group 'A'	Group 'B'
1. Preconditioning	a. Removal of particles smaller than crops seed
2. Pre-cleaning	b. Ploughing
3. Drying	c. Shelling
	d. Lowering of seed moisture contents
	e. Harrowing

C. Find the odd one out.

1. Seed handling, drying, cleaning, seed coat.
2. Scalper, sheller, air screen cleaner, plough.
3. Multistorey, single level, tower, combined design.
4. Receipt book, seed control register, bill book, seed processing register, sample slip file.
5. Later file, sample entry register, purity register, note book.

D. State true or false.

1. Seed processing comprises drying of seed.
2. Seed processing makes seed handling easier.
3. Sheller is important in groundnut seed processing.
4. Seed testing identify seed quality problems and their probable causes.
5. The design of seed testing laboratory should not permit extension in future.

Q. 2 Answer in brief.

1. Draw flow chart of processing sequence for complete cleaning of soybean seed.
2. Write short note on preconditioning and pre-cleaning.
3. Write definition of seed processing
4. With the help of suitable flow diagram give processing sequence for complete cleaning of jowar seed.
5. Write the names of layout of seed processing plant.

Q.3 Answer the following questions.

1. Describe types of seed processing plant.
2. List out records and forms in seed testing laboratory.
3. Write in brief about seed processing register.
4. Explain planning of seed processing plant
5. Write short note on ISTA

Q. 4 Answer the following questions.

1. Write in brief about analysis of operation in seed processing plant.
2. Draw basic flow diagram showing essential steps in seed processing.
3. Enlist records in seed processing plant.
4. Draw a flow diagram of processing sequence for complete cleaning of groundnut seed.
5. Make a report on your visit to seed testing laboratory or seed processing plant.

Q. 5 Answer the following questions in detail.

1. Explain the importance of seed processing.
2. Write objectives of seed testing.

Q.6 Answer the following questions in detail.

1. Which factors should be considered while planning and designing a seed processing plant?
2. What are the general principles considered at the time of preparing layout and design of seed testing laboratory.

Activity

1. Collect information about cotton seed processing.
2. Visit a seed processing plant near your place and submit visit report.
3. Suggest necessary changes to process seed.

Students activity - visit to a seed processing plant and seed testing laboratory

9. Mushroom Production

Can you recall?

1. Harmful and beneficial fungi
2. *Bhuchhatra or* mushroom in rainy season

9.1 IMPORTANCE AND SCOPE

9.1.1 Mushroom : The Mushroom is a fleshy, spore bearing fruiting body of a fungus, typically produced above ground, or on its food source. All edible fungi are saprophytes. The edible species are commonly known "Mushrooms" while those, which are poisonous, are known as "Toadstools".

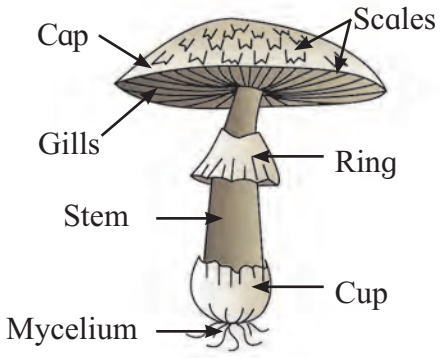


Fig. 9.1 Parts of mushroom

Various types of mushroom occur in nature are different in sizes and colours. Mushroom is a fungus lacking in chlorophyll and obtains nutrients from organic compounds mainly available in organic waste. We see mushrooms on woody material, compost and decomposing plant, etc. in rainy season. Near about 4000 varieties of mushroom are found but very few varieties of mushroom are edible. So many varieties of mushroom are partial or highly poisonous and allergic. In India, 150 varieties of mushroom are found, out of them only five edible species are cultivable.

Do you know ?

India. U.S.A., China, France, Japan, Holland, England, South Korea, etc. are major mushroom producing countries in the world. India among those is a small scale mushroom producer.

Remember this

'Guchhi' type of mushroom found in Jammu and Kashmir and hilly area of U.P. is the best counted variety in the world. Common mushrooms are button, shiitake, pleurotus and paddy straw mushroom.

In India, button and pleurotus mushrooms are very popular for cultivation. In Maharashtra edible button, pluerotus and paddy straw mushrooms are commercially cultivated on large scale.

Importance and potential of mushroom is well known in all aspects of human life as well as ecosystems. Mushroom solves many problems such as quality food demand, unemployment, economical issues and human health. The importance of the mushroom is as follows.

1. Mushrooms are being used as food and medicine since time immemorial.
2. Mushrooms are popular for their delicacy and flavor rather than food.
3. Mushrooms are great source of protein (veg. mutton) fiber, vitamin B, (specially niacin, folic acid) C and D.
4. It is a source of minerals like P, K, Cu, Zn, Fe, Mn and Mg.
5. It contains antioxidants that are unique to mushroom such as eargothionine and glutathione which is highly powerful antioxidant.
6. Raw materials for cultivation of mushrooms are very cheap and easily available.
7. Agricultural wastes can be used for production of mushrooms.
8. Cost of cultivation of mushrooms is very low and require small area for cultivation.
9. It enhances the income of farmer.
10. It cleans environment by decomposing organic waste.

Mushroom contains near about 17.00 % to 37.50% protein, these are easily digestible and good quality compared to vegetable proteins.

It is a complete quality and healthy food suitable for all age group. Nutritive value of mushroom depends upon numerous factors such as species, variety, stage of development and environmental condition. Mushrooms are rich in proteins, dietary fiber, vitamins, and minerals.

Do you know ?

ICAR has established all India coordinated mushroom research project at College of Agriculture, Pune for technical support and training to interested candidates.

9.1.2 Nutritive value of different mushroom (dry weight basis g/100 g) :

Mushroom type	Carbohydrates	Fibre	Protein	Fat	Ash	Energy (K cal)
Button (*Agaricus bisporus*)	46.17	20.90	33.48	3.10	5.70	499
Oyster/Dhingri (*Pleurotus* spp.)	63.40	48.60	19.23	2.70	6.32	412
Paddy straw (*Volvariella volvaceae*)	54.80	5.50	37.50	2.60	1.10	305
Milky (*Calocybe indica*)	64.26	3.40	17.69	4.10	7.43	391
Shitake (*Lentinula edodes*)	47.60	28.80	32.93	3.73	5.20	387

Source Manjit Singh et al, 2011

Vitamins value (mg/100 gm)

Vit- B_1 (Thiamin) : 1.1 to 4.8 mg

Vit- B_2 (Riboflavin) : 3.3 to 5.0 mg

Vit- C (Ascorbic acid) : 0.0 to 81.9 mg

9.1.3 Scope for mushroom cultivation :

Day by day the unemployment is increasing very fast in urban as well as rural areas. Therefore, mushroom cultivation is the best tool for farmers, unemployed youth and rural women for enhancing their per capita income. Mushroom cultivation requires inexpensive raw material, which is easily available at farm, as paddy, cotton, cashew, wheat, etc. are the common cultivable crops in Maharashtra. Now a days, many more people are turning towards mushroom cultivation in Maharashtra due to low input cost requirement in it. It can be grown in places like huts, small room tunnels, sheds or shelter, etc. It can be grown almost by anyone, anywhere and has a great market demand due to its medicinal, vegetative and nutritional value.

9.2 TYPE OF MUSHROOM : TYPES CULTIVATED IN INDIA AND THEIR PRODUCTION TECHNIQUE

9.2.1 Types of mushroom :

1. Button mushroom
2. Oyster mushroom
3. Paddy straw mushroom
4. Milky mushroom
5. Shitake mushroom

1. Button or European mushroom (*Agaricus bisporus*) : This mushroom is commonly known as "White button, European or temperate mushroom". It is cultivated in temperature range of 16-24^{0}C. In winter season found naturally in Himachal Pradesh, J & K, Nilgiri and Kumaon hills and can be cultivated any-where under artificial conditions.

Fig. 9.2 Button mushroom

2. Oyster mushroom (*Pleurotus* spp.) : This mushroom is also known as "wood fungus" and in India it is commonly known as "Dhingri". It requires 20-30^{0}C temperature for growth and grows under natural conditions on trees or dead woody branches of trees. Some common species of Pleurotus are *P. sajor caju* (grey coloured), *P. florida* (white), *P. eous* (pink), *P. ostreatys* (blue), *P. flabellatus* (white or turning red), *P. citrinopileatus* (golden yellow).

Fig. 9.3 Oyster mushroom

3. Paddy straw mushroom (*Volvariella* spp.) : It is commonly known as "Paddy straw mushroom or Chinese mushroom". Very fast growing mushroom (15 to 18 days from spawning). Grows at higher temperature 25 to 35^{0}C and relative humidity (RH) of >85 per cent. Most widely cultivated in Odisha, West Bengal and some other parts of India. Commonly cultivated species is *Volvariella volvaccea.*

Fig. 9.4 Paddy straw mushroom

Internet my friend

Collect information on mushroom types in the world.

4. Milky mushroom (*Calocybe indiaca*) : It is milky white coloured and hence commonly known as "Dudh chatta". Widely grown in South India and West Bengal. Grows at higher temperature 25 to 35^{0}C and RH of > 75%. It is robust mushroom and has a firm consistency.

Fig. 9.5 Milky mushroom

9.2.2 Mushroom production technique :

Requirements for mushroom production are infrastructure, equipments and materials.

A. Infrastructure : For oyster mushroom production partially ventilated covered area of specific size is essential. Materials like bamboo, grass, poly-ethylene, fiber sheets, etc. can be utilized for building the structure. For button mushroom cultivation composting yard, pasteurization chambers (Bunkers and tunnels), spawning room insulated A. C. cropping rooms are essential.

B. Equipments : Air conditioner, exhaust fan, spray pump, steam boiler, compost turner, humidifier, weighing balance, humidity and temperature recorder of hygroscope.

C. Materials :

i. **Agro waste raw material :** Wheat, paddy, jowar or soybean straw, sugarcane trash, dried cotton plants, hay, etc. are generally used as raw material. It should be sufficiently dried and stored carefully.

ii. **Container :** For mushroom production poly ethylene bags are used widely. It's thickness should be 80 to 100 gauge and size 18 to 22 inch in length.

iii. **Spawn :** Seed for production of mushroom.

iv. Soil, sand, FYM; coir pith, thread, polytherne bags, bucket.

v. **Other material :**

a. Drum - for soaking raw material

b. Heater - for water heating

c. Foggers - for humidity generation and maintenance

d. Dryer - for drying mushroom

e. Thermometer - temperature measurement

f. Hygrometer - humidity measurement

D. Chemicals : Formalin; insecticides like malathion and fungicides like carbendazim.

E. Water : Cultivation of mushroom requires clean and pure water in sufficient quantity.

9.2.3 Button mushroom cultivation technique:

Cultivation of the white button mushroom is a complex process and requires special technical skill for raising a successful crop. It requires different temperatures, 22^{0}C to 28^{0}C for spawn and case run and 15^{0}C to 18^{0}c for fruit body formation. Besides specific temperature it requires proper humidity (85-95%) and enough ventilation during fructification. Cultivation of white button mushroom is accomplished in three basic steps like production or procurement of spawn, compost prepartion and cultivation.

I. Production or procurement of spawn : The spawn of required the strain can be prepared in the laboratory or purchased.

II. Preparation of growth medium (compost) : Button mushroom is cultivated on specially prepared compost. The compost is prepared as follows.

1. Long method of composting (LMC) compost prepartion duration is 28 to 30 days.
2. Short method of composting (SMC) compost prepartion duration 18 days.

The following ingredients are required to fill 50 bags of compost @ kg/bag as mentioned:

Sr. No	Ingredients	Long method	Short method
1	Wheat straw	300kg	300kg
2	Wheat bran	30 kg	21.6 kg
3	Ammonium sulphate	9 kg	----
4	Urea	3.6 kg	4.5 kg
5	Sulphate of potash	3.0 Kg	----
6	Super phosphate	3.0 Kg	----
7	Gypsum	30.0 Kg	9.0 Kg
8	Lindane	1.0 Kg	----
9	Chicken manure	----	120.0 Kg

At present, short method of composting is being adopted on large scale.

Short method of composting

Days Stage I/ Phase I	Activity	Work to be done
0	Spreading + wetting straw and mixing of ingredients	Spread the straw on the floor. Sprinkle sufficient amount of water on it. After 24 hrs mix all other raw ingredients, moisten them and follow the following procedure.
2	Stacking/Pile prepartion	Stack the straw and other ingredients except gypsum, the size of stack can be kept up to 5' x 5' in length (anaerobic fermentation).
4	First turning	Turn the stack, watering should be done if required (anaerobic condition).

Stage II/ Phase II	Activity	Work to be done
6	Second turning	At this stage moisture content should be 75-77%.
8	Third turning	Adjust water content to 70-72% and required quantity of gypsum is added.
10	Forth turning	Turn the stack; watering should be done if required. Moisture content is 70-72%
11	Filling in phase II/ Pre-pasteurization	Load the compost in bulk chamber for phase II after confirming that compost colour is dark brown. Moisture content is 70-72%. The door of the tunnel is closed and the entire compost mass is brought to uniform temperature of 45^{0}C by use of blower.
12	Pasteurization	Raise the temperature slowly by 1-2^{0}C per hr up to 54^{0}C to 59^{0}C by adjusting the air flow by blower. Maintain it for 6 to 8 hrs for peak heating of the compost.
13	Post pasteurization	Lower the temperature slowly by 1-2^{0}C per hr up to 45^{0}C to 48^{0}C.
14-16	Conditioning	The temperature is maintained at 45^{0}C - 48^{0}C for conditioning the compost, 20% aeration is also provided. During this, the thermopiles develop very fast in the compost.
18	Cooling of compost	Compost is allowed to cool to 25^{0}c to 28^{0}C by increasing the speed of blower and giving fresh air and spawning.

III. Cultivation : Different steps in cultivation are as follows.

a. Spawning : Spawning means mixing of spawn in the fully prepared compost. Thorough spawning is adopted in button mushroom. In this case mix the grain spawn evenly and throughout the compost. Rate of spawning is 0.5 to 0.75 per cent of fresh weight of compost. Maintain relative humidity at about 80 to 90 per cent and temperature at 25^{0}C ± 1^{0}C in the spawning room. The spawn run (period from spawning to full development of mycelium in the compost) is completed within 15-20 days showing whitish strands of mycelium.

b. Casing : The process of covering the compost with a thin layer of soil or soil like material after the spawn run is known as casing. The purpose of casing is to provide necessary stress for induction of fruiting. It also provides support to the mushroom. It is also known to supply water for growth and development of fruit body and maintain humidity and temperature in cropping room by evaporative cooling and gaseous exchange.

The casing material is prepared by mixing sandy loam soil with neutral reaction + one year-old FYM in 1:1 proportion or coir pith + soil (5:1 ratio). Casing material is treated either by steam at 65-70^{0}C for 6-8 hrs. or sterilize the mixture in an autoclave at 30 lbs pressure for 1 hour or with 2 L formalin (40%) in 40 lit water per m^3.

c. Crop management : After casing maintain the temperature at 20^0 to 24^{0}C for about one week and R.H. 85-90 per cent. After this period lower down the temperature to 15-18^{0}C and supply fresh air.

The pinhead starts appering after 12-15 days of casing and cropping continues for about 2 months. After appearance of the pinhead it requires 8 to 10 days when they are 3-5 cm in diameter. Take out the mushroom by twisting and without much disturbance to the casing soil. During casing and cropping period give light watering by spray to prevent the casing soil from becoming dry and hard. Avoid heavy watering.

The proper air exchange is necessary to replace excessive carbon dioxide with fresh air. Maintain the relative humidity at 85-90 per cent and temperature at $16^0C \pm 2^0C$ throughout the cropping. The every 7 to 10 days cleanup campaign should be adopted after bloom cutting.

9.2.4 Oyster mushroom cultivation technique:

A. Medium/Substrate : This mushroom is cultivated on waste dried straw of threshed crops of field. These medium should be dried and from current season only.

B. Preparation of substrate and pasteurization : Dhingri can be grown on various substrates like wheat, cotton waste, paddy and rye straw, soybean husk, sugarcane bagasse, banana leaves, etc. Cultivation on wheat/paddy straw is more economical as these are easily available. The straw should be chopped in to small pieces of 2 to 3 cm size and then soaked in tap water for 8 to 10 hours. Drain out excess water. Pasteurize the same straw by any one method as follows:

1. **Steam pasteurization :** In steam pasteurization the substrate is exposed to steam at 80^0C temperature for one hour.
2. **Hot water treatment :** In hot water treatment, the substrate is kept in hot water (80^0C temperature) for one hour. Then take out it, drain excess water and cool the straw.
3. **Chemical sterilization :** Take dried straw and fill it in gunny bags. In chemical pasteurization, the substrate is soaked in the solution of formalin (125ml) and carbendazim (7.5gm) mixed in 100 litre of water for nearly 18 hours. Then take out it, drain excess water and carry out spawning.

C. Bed preparation : The polythene bag method is used for bed preparation that is to be carried out in a close disinfected room. The polythene bags of 35 x 55 cm size is disinfected in 5 per cent formalin solution. The beds are prepared by layer method. First layer of straw measuring about 2-3 cm at the bottom is given. Then spread the spawn evenly over the surface of straw. Likewise fill up the bed by giving 3-4 layers by pressing the straw lightly after every layer. The rate of spawning should be @ 2% on the wet weight basis of straw. Tie the neck of the bag with thread tightly. Make 30-40 pinholes on the surface of bag. The bags are then kept for incubation (spawn run) at $25^0C \pm 2^0C$ and 70-80% R.H.

D. Crop management : The spawn run is completed within 12-17 days depending on species and climatic conditions. After completion of spawn run in the substrate, remove the polythene bags and the beds are kept in partially ventilated growing room where provisions for moderate light and high humidity are made. Light watering should be done for 2 to 3 times in a day. The temperature of growing room should be in the range of 25 ± 2^0C with relative humidity of 80-90 per cent. After removing the plastic bags, pinheads start appearing within 3-5 days and become ready for harvest in a week. Harvest all mushroom crop at a time. Remove rotted, loose layer of straw by hand. After that regularly spray water 2-3 times in a day. In 45 to 50 days 0.8 to 1.0 kg of fresh mushroom can be obtained from a bed of one kg dry straw. These beds can be used as manures for plants and feed for cattle.

9.2.5 Paddy straw mushroom cultivation :

Paddy straw mushroom being 3rd most important cultivated mushroom in India is well known for its pleasant flavour and taste. It is a mushroom of the tropics and subtropics. It is considered to be one of the easiest mushrooms to cultivate and is very fast growing that takes about 10-12 days from spawning to harvesting. Three species of Volvariella are grown in India viz., *V. Volvacea*, *V. diplasia* and *V. esculanta.*

A. Cultivation technique : For cultivation of paddy straw mushroom shelter (thatched house) is required for protection from light, wind and rain. In addition, it can also be done under the shade of tree. The bamboo or wooden stands are required for placing square beds. Now days, it is cultivated inside poly houses by maintaining the temperature of around $25-35^0C$ and relative humidity of 75 to 80%.

		
Spawning with gram floor	**Criss-cross arrangement of paddy bundles**	**Spawned beds of paddy straw**

Fig. 9.6 Traditional Technique

The paddy straw mushroom can be cultivated by following methods :

a. Traditional technique and

b. Modern technique

a. Traditional technique : Clean, fresh, dried and un-chopped paddy straw is required for successful cultivation. The paddy straw is tied in to bundles each weighing about 1.0 kg. These bundles are then soaked in clean fresh water for 16 to 20 hrs followed by draining of excess water by placing the bundles on a sloppy surface so as to attain 70% moisture level. First, it is advised to sterilize the paddy straw by soaking in 80^{0}C temp water or fumigate under tarpaulin with 5% formalin solution to prevent contamination. These bundles are laid in the form of bed on a slightly raised bamboo platform. Each bed consists of 22 bundles arranged in four layers of 5 bundles each in a criss-cross fashion with two loose bundles at the top. The beds are spawned in between the layers with 5 to 7 days old grain spawn @ 1.5% on the basis of dry weight straw. The red gram or gram floor can be used @ 150 g/bed below the spawn. The spawn is placed 8 to 10 cm from inside the edges and all-round the bed. The beds are pressed from the top and covered with plastic sheet. No ventilation in the room is required till the buttons appear. Beds are watered regularly till the end of the crop by sprinkling water once or twice a day. During cropping period the temperature should be 28^0 to 32^{0}C with relative humidity of 80-90%. Maintain moisture level of 65-70% in beds.

Mushrooms start appearing in clusters from all the sides after 10-12 days of spawning and are harvested after about 3 weeks. Each bed of 22 bundles would yield about 2.5 to 3.0 kg mushroom.

Remember this

Mushroom processing : Mushrooms are highly perishable and they start deteriorating immediately after their harvest. They develop a browning discolouration on the surface of the mushroom cap due to enzymatic action and it quickly become soft at high temperature.

b. Modern technique : Cotton waste and rice straw 2:1 or 1:1 proportion, chicken manure @ 5% and lime stone (3 to 4%) are mixed together, moistened with water and piled on a concrete platform with the help of a wooden frame (90 cm x 90 cm x 30 cm) for fermentation. One pile of compost usually consists of 4 to 6



Fig. 9.7 Modern technique

such layers and is about 70 to 90 cm high. The process of fermentation is completed within 2 to 4 days. At least one turning is necessary during fermentation. After preparation of bed, the pasteurization is done at 60-62°C for 4-5 hours followed by conditioning for 2-3 days at 45-50°C temperature. Then, gradually the temperature is lowered to 32 - 34°C after about 8 to 12 hours, when the straw / compost is ready for spawning. The amount of spawn used is 1.5% of the dry weight of compost. About 4 days are required for completion of spawn run. No water and light are needed but little ventilation is necessary. On the fifth day after spawning primordia of fruit bodies appear on the surface of the bed. It usually takes about 4 days for these tiny bodies to develop to the stage of harvesting. Maximum two flushes can be harvested.

9.3 HARVESTING AND PACKING OF MUSHROOMS

9.3.1 Harvesting :

a. Button mushroom (*Agaricus bisporus*) :

Harvest the fully developed buttons of 3 to 5 cm diameter. Pick up mushrooms in the early hours of day by light twisting. Clean the harvested mushrooms by cutting the bases of stalks adhering casing soil. Generally, the yield of mushroom is about 15 to 20 kg/100kg compost.

b. Dhingri *(Pleurotus spp.)* mushroom :

First harvesting is done in 20-25 days after filling of bags. This is done when it attains full size by twisting of fruits before edges of mushroom turn inside and before spore shading. Clean the harvested mushroom with dry cloth before packing. Send fresh mushroom to market. The expected yield is about 750 to 800 g of fresh mushrooms from one kg of dry straw.

c. Paddy straw mushroom (*Volvariella* spp.) :
Harvest the mushroom at button stage or when volva is about to rupture. If allowed to open, stem turns a bit hard which is not preferred. Harvest mushroom by twisting. Each bed of 22 bundles gives about 2.5 to 3.0 kg mushroom in traditional method and 3.5 to 4.0 kg in modern method of cultivation. It can be dried as like oyster mushroom.

9.3.2 Mushroom packing : Before packing pay full attention towards cleaning of mushrooms. Generally plastic bags or punnets with holes are filled in with 200 gm of mushroom. Then they are sent in market for selling as early as possible. If market is at long distance, then fill the mushroom packets in boxes with ice blocks.

9.4 PRESERVATION OF MUSHROOM

9.4.1 Drying

A. Dehydration of mushrooms :

If process of canning is not possible then dehydration is beneficial. For dehydration purpose mushrooms are harvested at a maturity stage. They can be dried in the sun or in a mechanical dehydrator at 60^0 to 70^0C. After complete drying the mushrooms are reduced to nearly 1/10th of their fresh weight. Mushrooms can also be dried after steam or water blanching at 60^0 to 70^0C. Dipping in aqueous solution of chlorine followed by sulphiting [processing with sulphur dioxide (SO_2) and citric acid] retains the whiteness of the product. Dried mushrooms should be stored in airtight containers in a cool dry place.

B. Freeze drying :

It is done by immersing the sliced mushroom in solution of 0.05% sodium metabisulphite and 2% common salt for about 30 minutes. These are then blanched in boiling water for 2 minutes followed by cooling. The product is frozen at -22^0F for one minute. The frozen mushrooms are dried to a moisture content of 3% in freeze drier and packed in cans under vaccum.

9.4.2 Canning of mushroom :

Button mushrooms can be canned either whole, sliced or in smaller pieces. Mushrooms are washed gently to remove any adhering soil. Fresh mushrooms are then dipped in boiling water for 2 to 3 minutes and put in cold water to prevent leaching losses. Blanching can also be done in steam for 2 to 3 minutes. Blanched and cooled mushrooms are then filled in cans.

Brine solution consisting of 2% common salt, 2% sugar and 0.3% citric acid, is boiled, filtered and added into the can to fill just up to the brim (125ml solution per can of lb capacity). After placing the lid the can are exhausted in boiling water till the center temperature reaches 80 - 85^{0}C. Cans are then sealed on a seamier to get an air tight seal. These cans are later steamed at 115^{0}C for 25 to 30 minutes. Soon after sterilization, the cans are kept in fresh water for cooling. Later they are wiped dry and kept in cool, dry place.

9.4.3 Pickling of mushroom: Components of pickle are as follows :

Fresh mushroom(buttom)	-	500gm
Salt	-	20gm
Ginger (ground)	-	05gm
Onion (chopped)	-	20gm
Mace (ground)	-	02gm
Fenugreek/methi seeds (ground coarsely)	-	10gm
White paper (powder)	-	20gm
Red chilli powder	-	10gm
Vinegar	-	10 ml
Mustard seed oil	-	100ml
Sodium benzoate	-	200mg

Use button mushrooms for pickles. Immerse them in cold water for a few minutes and drain. Put clean mushrooms in a pan and mix with salt, pepper, mace, fenugreek, red chilies. Fry onion and ginger in oil to a light brown colour and mix with mushroom. Add vinegar (0.01 %) and cook for 10 minutes. Pour the whole mixture into small glass jars, taking care that all the spices are divided equally in the jars. Seal the jar with lid and label it. Leave it for a few days at room temperature and use after one month.

Exercise

Q. 1 Anwer the following questions.

A. Select the appropriate alternative and complete the following statement.

1. ---------- is the most widely cultivated mushroom in the world.
   a. Button b. Milky
   c. Oyster d. Paddy straw
2. Mushrooms are great source of ----------
   a. Fats b. Carbohydrates
   c. Proteins d. Minerals
3. Seed of mushroom is called ----------
   a. Spawn b. Weed
   c. Spore d. Conidia
4. Foggers are used in mushroom production for maintaining ----------
   a. Humidity b. Temperature
   c. Soaking d. Drying
5. In India, among the following mushrooms only ---------- is not cultivable.
   a. *Pleurotus sajor caju*
   b. *Agaricus bisporus*
   c. *Volvariella volvacea*
   d. *Morchella esculenta*

B. Make the pairs.

Group A	Group B
1. Button mushroom	a. Dhingri
2. Oyster mushroom	b. *Dudh Chatta*
3. Paddy straw mushroom	c. Temperate
	d. Shitake Mushroom
	e. Chinese Mushroom

C. Find the odd one out.

1. Paddy straw/wheat straw/soybean husk/ sugarcane trash/ *dal*.
2. Ammonium sulphate/urea/foggers/sulphate of potash/ super phosphate.
3. Button/oyster/bhuchatra /paddy straw/ milky.

4. Formalin/Carbendazim/Steam/Vinegar.
5. Dried mushroom/Fresh mushroom/Pickled mushroom/Canned mushroom.

D. Write true or false.

1. Mushroom is fleshy fungus spore bearing fruiting body.
2. Button mushroom is insensitive to high temperature.
3. Mushroom seed is called as button.
4. Straw sterilization is not required in oyster mushroom cultivation.
5. Paddy straw mushroom requires low temperature (15 to 20^0C) for its growth.

Q. 2 Answer in brief.

a. List out methods of pasteurization for oyster mushroom.
b. Write in short the preparation of bed for paddy straw mushroom.
c. Explain spawning.
d. Enlist chemicals used for sterilization of paddy straw.
e. Name the value added products prepared from mushroom.

Q. 3 Answer the following questions.

1. Describe milky mushroom.
2. Explain morphology of mushroom with suitable diagram.
3. Explain in short the method of compost preparation for button mushroom.
4. Discuss the harvesting and packaging of mushroom.
5. Enlist ingredients used in short and long method of composting .

Q. 4 Answer the following questions.

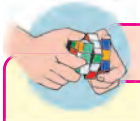
1. Explain freez drying of mushroom.
2. Discuss about materials requirement for mushroom production.
3. Expain casing are the modern techniques in cultivation of paddy straw mushroom.
4. Write note on dehydration of mushrooms.
5. Explain casing.

Q. 5 Answer the following questions in detail.

1. State cultivation techniques for button mushroom.
2. Explain traditional method of paddy straw mushroom cultivation.

Q. 6 Answer the following questions in detail.

1. Explain the method of pickling of mushroom.
2. Write the importance of mushrooms.



Activity

1. Prepare wheat straw for mushroom production.
2. Visit local mushroom production unit and participate in production.

10. Agrotourism

Can you recall?

1. Why some urban people plan to go on weekend tours?
2. Why people living in big or metropolitan cities come to their native village with whole family during festivals and vacations?

10.1 CONCEPT AND FEATURES

10.1.1 Concept of agrotourism :

A term agrotourism is a farm based business that is open to the public particularly to farmers. These specialized agrotourism destinations generally offer site seeing, things to do or gifts to buy and are open to public. Agrotourism is not only a farm visit to get knowledge, but also includes good information to study, research, sales, activities, etc. Now a days urban people's awareness towards such activities is increased and they are interseted in gaining the knowledge of agriculture.

Agrotourism is an innovative agricultural activity related to both tourism and agriculture. It has a tremendous capacity to create additional source of income and employment opportunities to the farming community.

Several countries have transformed their economies by developing their tourism potential. Today the concept of traditional tourism has been changed. Some new areas of the tourism have been emerged like Agrotourism. Promotion of tourism would bring many direct and indirect benefits to the people particularly the farming community.

10.1.2 Definition :

Agrotourism refers to any enterprise or business that links agriculture with products, services and experience in tourism.

Agrotourism can be defined as activities that brings visitors to farms. Some examples of activities associated with agrotourism are farm resorts, leisure fishing, hunting grounds, unique lodging, food restaurants, farmers, makers of local handicrafts, home industries and other leisure activities devoted to the revival of the local people lifestyle.

Agrotourism is defined as "travel that combines agricultural or rural settings with products of agricultural operations – all within a tourism experience."

Agrotourism is that agri business activity, when a native farmer or person of the area offers tours to their holdings to allow the persons to view the growing, harvesting and processing of locally grown crops, such as coconut, pineapple, sugarcane, corn, etc. or any other produce, to which they would not unknown earlier in their city or home country. Often the farmers would provide a honey-stay opportunity along with education.

Keep in Mind

MTDC : It is a abriviation of Maharashtra Tourism development corporation. It is responsible for developement of tourism in Maharashtra state.

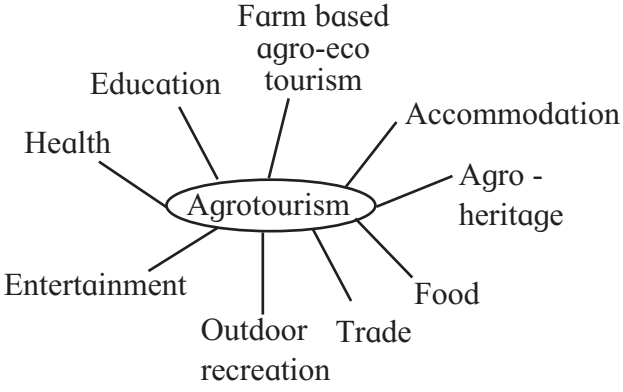


Fig. 10.1 Objects of agrotourism

Remember this

Maharashtra is the pioneer state to develop and promote Agrotourism in the country. Agrotourism Development Corporation (ATDC) is incorporated in 2005 at Palshi-wadi, Tal- Baramati, Dist - Pune This ATDC acts as umbrella organisation for Agrotourism in Maharashtra.

Agrotourism and Eco-tourism are closely related to each other. Eco-tourism is provided by the tourist companies, while in agrotourism farmers offer tours to their agriculture farm premises and provide entertainment, education and fun filled experience to urban people.

Agrotourism is a form of alternative to tourism based on sustainability, restoration of culture, heritage and traditions in rural areas.

10.1.3 Features of agrotourism

1. The agrotourism activity takes place in the accessible locations and the community participation is the pre-requisite.
2. The architecture of a village is promoted by locally developed accommodation and food facilities. More focus should be given on cleanliness and hygiene in the accommodation services.
3. A tourist shopping centres of local and organic products can be opened.
4. The focus should be on something to see, something to do and something to buy.
5. Tours to production centre like fruit gardens, goat, poultry and dairy farms, etc. Also visit to local places like gram panchayat, school, village river, old religious places, etc. should be arranged.
6. Family and village games like gilli – danda, kabbadi, wrestling, high jump, long jump, pebble playing, etc. should be arranged with evening entertainment like camp-fire, local and folk dance songs should also be provided. Some women arrange religeous religious organization.

Remember this

Safety features on the tourism center

- Safety from snakes
- Safety from wild as well as pet animals
- Safety from social environment around the center
- Safety of tourists and their valuable belongings
- Safety during enjoying different activities on farm, like - swimming
- Safety during medical emergency etc.

10.2 ADVANTAGES OF AGROTOURISM CENTERS

Agrotourism has the potential to change the economic face of traditional agriculture. The advantages of agrotourism development are manifold. It would bring direct and indirect benefits to the farmers and rural people. Some of the benefits are as follows:

1. Agriculture tourism allows people (tourists) to stay close to nature and experience different functions or operations, that are carried out on the farm. They can monitor the work and all those activities.
2. It brings the major and primary sector which is agriculture; closer to major service sector.
3. Cultural transformation between rural and urban people including social and moral values.
4. Agrotourism, which involves villages and agriculture, has the capacity to satisfy the curiosity of the urban segment by providing scope for re-discovering the rural life, which is rich in diversity.
5. Agriculture sector has the capacity to absorb expansion in tourism sector.
6. Agrotourism creats employment opportunities to the farmers including farm, family members and youth.
7. It provides additional income source for the farmers to protect against income fluctuations.
8. The urban people can understand the rural life and know different agricultural activities.
9. Educational value - Agrotourism spreads knowledge about agricultural science among urban people.
10. Strong family oriented recreational activities through rural games, festivals, food and dresses e.g.. Village gram in Rajasthan.

11. Help to reduce burden of the other traditional tourist centers.

10.3 TYPES OF AGROTOURISM

Remember this

Most types of tourism give us enjoyment, energy for coming days, experience of thrill, nature's beauty, natural as well as pure air and water. It also removes dullness in daily life.

Agrotourism can be classified into following fundamental types :

1. Direct-market agrotourism :

One of the most popular example of this form is a road-side produce station. The farmer or owner sells a wide range of goods such as farm produce, organic and porcessed products or packed or canned food items direct to the custmors either at fair, exhibition, market or on the farm itself.

2. Experience and education agrotourism :

This form of agrotourism includes hand picking of fruits from orchad, bed and break-fast facilities, farm tours and a package of providing farm working to urban peoples or tourists. Once the visitor or tourist acquainted with farm working closely, they also feel the value of purchasing organic farm products.

3. Event and recreation agrotourism :

This form is still regarded as agrotourism. It offers generally utilising the farm land for various other marketable purposes like, *hurda-parti*, harvest festival like *Irjeek*, weddings that held on farm, mela, jaggery preparation, bee keeping, sericulture, etc.

Different recreational activities such as archery, summer camp, horse riding, cart riding, etc. are also made available for attracting guests for buying organic items that are produced on farm. Once a strong connection has been established between the farm and the consumer, it can easily build long term relationships.

Try this

Collect information regarding various Agro Trade Tourisms.

10.4 Facilities for agrotourism

A. Food : Eating is a compulsory activity of humans and farming is an activity oriented to food production hence there are two dimensions in the field of food agrotourism.

B. Restoration :

- Break fast
- Home made meals

C. Trade : Creating trade partnerships with the tourism sector for farmers, artisans and ag-roprocessors.

D. Culinary :

- Culinary workshops
- Food Festivals
- Buying packaged local products
- Farmer's market
- Tour to food factory
- Direct - On farm sales
- Agricultural - Roadside stands
- Sales - Agriculture related crafts/gifts

E. Out door recreation

- Horse riding
- Wildlife viewing
- Wildlife photography
- Fishing
- Picnicking
- Cross-country skilling

F. Entertainnment

- Agricultural fairs
- Local festivals
- Special events
- Petting zoo
- Dog training

Do you know ?

- Now a days tourism has become a change from the routine hectic life of urban people.
- School educational tours can also be arranged at agro tourism centers.
- Agro tourism provides employment to the farmer, his family members and youth from rural area.

Keep in Mind

Different types of General tourism

- Religious Tourism
- Medical Tourism
- Fort Tourism
- Nature Tourism
- Adventure Tourism
- Cultural Tourism
- Water Tourism
- Foreign Tourism
- Educational Tourism

Fig. 10.2 Agrotourism Activities

Courtesy : Aroha srushti agrotourism, Bhimasheth, near Dhanore, Talegaon Dhamdhere, Pune

Exercise

Q. 1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. Agrotourism is …….
   a. to stay at farm
   b. to do farm acticities
   c. to buy farm product
   d. all the above
2. Handpicking of fruits is an example of ……. agrotourism
   a. experience and education
   b. event
   c. direct market
   d. non of these
3. In agrotourism ……. offers tours to their agriculture farm.
   a. Travel agent b. Farmer
   c. Scientist d. Social worker
4. Which of the following is not included in fundamental facilities?
   a. Accomodation b. Bus
   c. Food d. River
5. Which of the following is not a type of agrotourism?
   a. Experience b. Direct market
   c. Urban d. Recreation

B. Make the pairs.

Group 'A'	Group 'B'
1. Rural huts	a. Play facility
2. Badminton	b. Health facility
3. Yoga	c. Class room
	d. Food
	e. Accomodation

C. Find the odd one out.

1. Archery, summer camp, riding, jogging tracks
2. Health, newspaper, education, food.
3. Education tourism, event tourism, direct market agrotourism, fort tourism.

D. Write true or false.

1. Agrotourism does not include educational activities.
2. Roadside produce station is an example of direct market agrotourism.
3. Agrotourism is a developing industry.
4. Agrotourism provides emplyoment to the farmer and his family members.
5. *Hurda* party is a type of event and recreational agrotourism.

Q. 2 Answer in brief.

1. Define Agrotourism.
2. Enlist types of general tourism.
3. Name two agrotourism centres near your city.
4. Write down the full form of MTDC.
5. State any four village games.

Q. 3 Answer the following questions.

1. Classify fundamental types of agrotourism.
2. List out outdoor recreation facilities available in agrotourism.
3. Give list of culinary facilities at agrotourism.
4. Write about safety features at the tourism center ?

Q. 4 Answer the following questions.

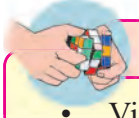
1. Write short note on direct market agro tourism.
2. Explain event and recreation agrotourism.
3. Draw concept diagram of objects of agrotourism.
4. Give different types of tourism.

Q. 5 Answer the following questions in detail.

1. State features of agrotourism.
2. Describe in detail fundamental facilities for agrotourism.

Q. 6 Answer the following questions in detail.

1. Explain fundamental types of agrotourism.
2. State advantages of agrotourism.



Activity

- Visit nearby agrotourism centre.
- Experience bullock- cart drive.

11. Organic Farming

Can you recall?

In earlier studies we have understood the importance of organic carbon in soil properties. Most of the soil properties are benefited by soil carbon. Hence, organic farming is most suited for soil health.

11.1 ORGANIC FARMING

11.1.1 Meaning : Organic farming is the crop production system which avoids or largely excludes the use of chemical fertilizers, pesticides (chemicals) and growth regulators. It also depends on crop rotation with leguminous crops, addition of crop residues, animal manures, green manuring, biofertilizers and biopesticides.

Organic farming works in peace and friendship with nature rather than going against nature and thus, organic farming involves the use of distinct methods to achieve the best and sustainable yields of a crop. In this, the good yield of the crop is achieved without harming the health of the people who live and work in those farms and also it does not harm the natural environment. (Eco-system)

Do you know ?

Plants require nutrients for their growth. These essential nutrients are absorbed from soil.

11.1.2 The practices of organic farming also involve the following :

- Good Animal Husbandry Practices
- Careful use of Natural Water Resources
- Good Agricultural Practices.

11.1.3 A Modern Approach to Farming : Practicing organic farming does not mean that we are going back and using the old and traditional methods, because there are many old techniques of farming which are still used today. Organic farming picks up the best techniques and combines those with the new scientific techniques. Farmers who practice organic farming do not leave their farms totally upon nature, instead, they avail the complete knowledge, methods, and material to work with nature. By doing like this, the farmers maintain a balance to grow animals and crops together. Organic farmers do not see every insect as a pest and they don't solve every problem of the farm with the chemical inputs. Many insects are considered as friends of farmers and helps the farming.

Can you tell?

Fertilizers are expensive and their indiscriminate use causes problems to soil health and hazards to human life.

Aims of organic farming

The organic farming furnish long-term benefits to the environment because organic farming has the following aims:

- Enhance the long term soil fertility
- Control the diseases and pests without harming the environment
- Make sure that the water is clean and safe
- Avail the resources which the farmers already have, becomes affordable to the farmer to buy the necessary inputs of the farm. Sustainability is must.
- Generate nutritious, chemical free food to human beings and feed for animals and also sell the high-quality produce at the good price.

11.2 PRINCIPLES OF ORGANIC FARMING

11.2.1 Principle of health :

Organic agriculture should sustain and enhance the health of soil, plant, animal, human beings and planet as a whole.

The role of organic agriculture is to sustain and enhance the health of total ecosystem.

11.2.2 Principle of ecology :

Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help to sustain them.

Fig. 11.1 Principles of organic farming

Organic management must be adapted to local conditions, ecology, culture and scale.

Organic agriculture should attain ecological balance through the establishment of habitats and maintenance of genetic and agricultural diversity.

11.2.3 Principle of fairness :

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties : farmers, workers, processors, distributors, traders and consumers of the locality.

It aims to produce a sufficient supply of good quality food and other products.

Natural and environmental resources that are used for production and consumption should be managed in such a way that is socially and ecologically justified and should be held in trust for future generations.

11.2.4 Principle of care :

Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations along with environment and ecosystem.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.

11.2.5 Types of organic farming :

1. Pure organic farming where the inorganics, both fertilizers and chemical pesticides are completly excluded. It advocates the use of organic manures and biological pest control methods only.
2. Integrated green revolution organic farming techniques are developed and are combined with the high input technology in order to create integrated system such as INM, IPM and IWM, etc.
3. Integrated farming system (IFS), is the low input organic farming in which dependence is on local resources and ecological processes, recycling of agricultural waste and crop residues.

Observe and Discuss

Observe and discuss :

1. Management of farm resources in such a way that hormonises rather than struggle with natural systems. (insects, microbes, all habitats, etc.)
2. Use of appropriate technologies based on biological system.
3. Achieve and maintain soil fertility for optimum production.
4. Use diversification to achieve optimum production.
5. Aims for optimum nutritional value of chemical free staple food.
6. Decentralize structures for processing, distribution and marketing of organic products.
7. Strive for suitable relationship between those who work and live on the field.
8. Maintain and preserve wild life and their habitat.

Remember this

Organic farming is different from old and traditional farming.

11.3 REQUIRMENTS AND COMPONENTS OF ORGANIC FARMING

11.3.1 Requirements of organic farming :

1. Crop production plan :

The producer seeking certification under the National Standards for Organic Production NSOP, here in after, referred to as 'standards'

shall be required to develop an organic crop production plan. This plan shall include description of the crops in the production cycle (main crop and intercrop) as per the agro climatic situations.

i. Description of practices and procedures to be performed and maintained.

ii. List of inputs used in production along with their composition, frequency of usage, application rate and source of commercial availability.

iii. Source of organic planting material (seed and seedlings).

iv. Description of the record keeping system implemented to comply with the requirements.

2. Conversion requirements :

i. The establishment of an organic management system and building of soil fertility.

ii. A farm may be converted through a clear plan of how to proceed with the conversion.

iii. The requirements prescribed under these standards shall met during the conversion period.

iv. The start of the conversion period may be calculated from the date of first inspection of the operator by the Certification Body.

3. Duration of conversion period :

i. In case of annual and biennial crops, plant products produced can be certified organic when the requirements prescribed under these standards have been met during the conversion period of at least two years (organic management) before sowing (the start of the production cycle).

ii. In case of perennial plants other than grassland (excluding pastures and meadows), the first harvest may be certified as organic after at least thirty six months of organic management according to the requirements prescribed under these standards.

iii. The Accredited Certification Bodies shall decide in certain cases, for extension or reduction of conversion period depending on the past status/use of the land and environmental conditions.

iv. Organic products in conversion period shall be sold as "produce of organic agriculture in conversion" or of a similar description.

4. Landscape :

i. Organic farming shall contribute beneficially to the ecosystem. The certification programme shall set standards/procedures for a minimum percentage of the farm area to facilitate biodiversity and nature conservation.

ii. Areas which are managed organically shall facilitate biodiversity.

5. Choice of crops and varieties :

i. All seed and plant materials shall be certified organic. Species and varieties cultivated shall be adapted to the soil and climatic conditions and be resistant to pest and diseases.

ii. When organic seed and plant materials are available, they shall be used.

iii. When certified organic seed and plant materials are not available conventional seed and plant material which is not treated with chemical shall be used.

iv. The use of genetically engineered seed, transgenic plants or plant material is prohibited.

6. Diversity in crop production and management plan :

i. The basis for crop production in organic farming shall take into consideration the structure and fertility of the soil and the surrounding ecosystem, with a view to minimizing nutrient losses.

ii. Where appropriate, the organic farms shall be required to maintain sufficient diversity in a manner that takes into account pressure from insects, weeds, diseases and other pest, while maintaining or increasing soil condition as regards to, organic matter, fertility, microbial activity and general soil health.

iii. Soil fertility shall be maintained through the cultivation of legumes or deep rooted

plants and the use of green manures, along with a suitable programme of crop rotation.

7. Nutrient management

i. Sufficient quantities of biodegradable material of microbial, plant or animal origin produced on the organic farms shall form the basis of the nutrient management programme.

ii. Nutrient management should minimize nutrient losses. Accumulation of heavy metals (salts) and other pollutants shall be prevented.

iii. The certification programme shall set procedures which prevent animal runs from becoming over manuring where there is a risk of pollution.

iv. Mineral fertilizers shall only be used in a supplementary role to carbon based materials. Only those organic or mineral fertilizers that are brought in to the farm (including potting, compost) shall be used when, the circumstances demand

vi. Permission for use shall only be given when other fertility management practices have been optimized

vii. Manures containing human excreta (faeces and urine) shall not be permitted to prevent transmission of pest, parasites and infectious agents.

viii. The certification programme shall lay down restrictions for the use of inputs such as minerals potassium, magnesium, fertilizers, trace elements, manures and fertilizers with a relatively high heavy metal content.

8. Pest, disease and weed management

i. Organic farming systems ensures that losses from pest, diseases and weeds are minimised. Emphasis is placed on the use of a balanced fertilizer management, use of crops and varieties well-adapted to the environment, fertile soils of high biological activity, adapted rotations, intercropping, green manuring, etc. Growth and development shall take place in a natural manner.

ii. Weeds, pest and diseases shall be controlled through a number of preventive techniques, mulching, mechanical control and the disturbance of pest development cycles, etc.

iii. Pest management should be regulated by understanding and disrupting the ecological needs of the pest. The natural enemies of pest and diseases should be protected and encouraged through proper habitat management by hedges, nesting sites, etc. An ecological equilibrium must be created.

iv. Products used for pest, disease and weed management, prepared at the farm from local plants, animals and microorganisms, may be allowed

v. Thermic weed control and physical methods for pest, diseases and weed management should be permitted.

vi. All equipments from conventional farming systems should be properly cleaned and free from residue before being used on organically managed areas.

vii. The use of synthetic herbicides, fungicides, growth regulators, synthetic dyes, insecticides and other pesticides are prohibited.

viii. Commercial products used as inputs shall always be evaluated.

ix. The use of genetically engineered organisms or products is prohibited.

9. Contamination control

i. All relevant measures may be taken to minimize contamination from outside and within the farm.

ii. Buffer zones should be maintained to prevent contamination from conventional farms.

iii. In case of reasonable suspicion of contamination, the certification programme shall take place to determine the level of contamination.

iv. Polyethylene and polypropylene or other polycarbonates coverings shall be removed from the soil after use and shall not be burnt *in situ*.

10. Soil and water conservation :

i. Soil and water resources shall be handled in a sustainable manner. Measures to be taken to prevent erosion, salination and improper use of water and the pollution of water.

ii. Cleaning of land through the means of burning organic matter, should be restricted to the minimum. The cleaning of primary forest is prohibited.

iii. The certification programme shall require to check the land degradation and pollution of ground and surface water.

11. Collection of non cultivated material of plant origin / forest produce :

i. The collection of wild plants and parts grown naturally shall be certified as organic provided the collection areas have not received any treatment with products other than those authorized for use in the organic production.

ii. In case of cultivation when it is carried out in the forest area, the operators shall follow similar procedures.

iii. Organic collection management should ensure that in case of minor forest produce collection, the State Government Act shall be applicable and should not exceed sustainable yield of the collected species or otherwise threaten the local ecosystem.

iv. Products can only be certified organic if derived from a designated area for collection.

V. The collection area shall be at an appropriate distance from conventional farming, pollution and contamination.

vi. The producer managing the harvesting or gathering of the products shall be clearly identified.

11.3.2 Components of organic farming :

Fig. 11.2 Components of organic farming

A. Organic manures : which include FYM, biogas slurry, compost, straw or other crop residues, biofertilizers, etc.

B. Non chemical weed control measures : All physical, mechanical and biological methods are followed to reduce the weed without the use of herbicides/weedicides.

Biological insects/ pest and disease management. This includes the conservation of natural enemies of pest and pathogens and use of botanical and microbial pesticides.

Non chemical weed control

Weeds are causing great economic loss to the main crop yield. Weeds are having fast reproduction capacity and massive recycling potential. As there are many kind of weeds with varying germination periods and high differing life cycles, weed management requires an integrated approach based on biology and ecology of the species. The major components of integrated weed management (IWM) include:

1. Monitoring weeds.
2. Emphasis on ecological, biological and bio-technological methods.
3. Low cost agronomic strategy.
   - Balanced nutrition use.
   - Higher plant population (high seed rate for dense population)
   - Inter-cropping, relay cropping, mixed cropping, etc.

- Use of competitive cultivars.
- Use of dense vegetative crop

C. Ecological Management :

Ecological management (cultural practices) aims by attacking ecological weak points of weeds during field operations such as ploughing, water management, crop season, crop rotation, intercropping, soil solarization, etc. Ploughing operation helps in reducing the emerging weed seedlings which are buried or exposed to hot sun for drying. Intensive puddling is very effective for weed control in low land rice crop. Water management practices are very effective for weed control especially in low land rice.

Crop rotations which are effective against weeds in pulse crop (soybean) rotation with cereal crops (sorghum, maize).

D. Biological control :

Biological weed control involve the use of insects, pathogens, fish and snails (bio-agents) which appears to be ideal for reducing the inputs of herbicides. In biological control method, it is not possible to eradicate weeds, but weed population can be reduced.

Insects - In Australia, *Lantana camara* was controlled by two beetles viz. *Octotoma scabripennis* and *Uroplata giraldi*.

Prickly-pear weed *(Opuntia)* was controlled in India by *Dactylopius tomentosus*-a scale insect. Alligator weed (*Alternanthera philoxeroides*) which is an aquatic weed was controlled by *Agasicles hygrophyla (flea beetle)*.

Fish : Common carp *(Cyprinus carpio)* and chinese carp control aquatic weeds.

Mammals : Manetee or sea cow is very effective in controlling water hyacinth.

Snails : *Marisa sp*. and other fresh water snails feed on submerged weed like coontail and algae.

Fungi : Water hyacinth can be controlled by *Rhizoctinia* blight.

Mites : A spider mite (*Tetranychus* sp.) is found to be useful in controlling prickly pear.

Plants : Cow pea sown in between sorghum rows effectively reduces the growth of weeds.

E. Physical/ mechanical methods

Physical force either manual, animal or mechanical power is used to pull out or kill weeds. The different methods used are:

a. Hand weeding
b. Hand hoeing
c. Digging
d. Mowing (cutting weeds to the ground level)
e. Cutting
f. Dredging and chaining
g. Burning and flaming
h. Mulches
i. Intercultivation

11.4 MERITS OF ORGANIC FARMING

1. Organic farming create optimal conditions in soil for high yields and good quality crops. (improve health of soil)
2. Organic manures supply all the nutrients both macro and micronutrients required by the plants.
3. Soil physical properties like bulk density, hydraulic conductivity, total porosity, etc. are improved. The water holding capacity, permeability, aeration and aggregation of soil are also enhanced with organic matter application which is declining day by day with ignorance.
4. Improves soil chemical properties such as supply and retention of soil nutrients and promote favorable chemical reaction like cation exchange capacity. Particularly the soil organic carbon is increased which is a key nutrient (organic manures have high CEC).
5. Improves biological activities like earthworms, insects, micro-organisms, enzymatic activity and biological nitrogen fixation in the soil.
6. Organically grown crops are believed to provide more healthy and nutritionally

superior (good quality) food for human and animals than those grown with commercial chemical fertilizers.

7. Organic farming helps to prevent environmental degradation and can be used to regenerate degraded areas (maintain ecosystem).
8. It is low cost farming and controls erosion.
9. It reduces human and animal health hazards.
10. It helps in maintaining agricultural production at the sustainable level.
11. It ensures optimum utilization of natural resources.
12. It helps to maintain symbiotic relationship or environmental factors related to soil, minimizes environmental pollution, degradation of soil, etc.
13. It helps to reduce the crop pest and disease incidence.
14. The cost of production of organic produce is comparatively low.

11.5 DEMERITS OF ORGANIC FARMING

1. Comparatively low production potential
2. Lack of natural resources (limitations)
3. More time is required for stabilization.

Now, there is a need of **'Organic Revolution'** after green revolution through organic farming or IPNS.

The components of Integrated Plant Nutrient Supply (IPNS) are given further:

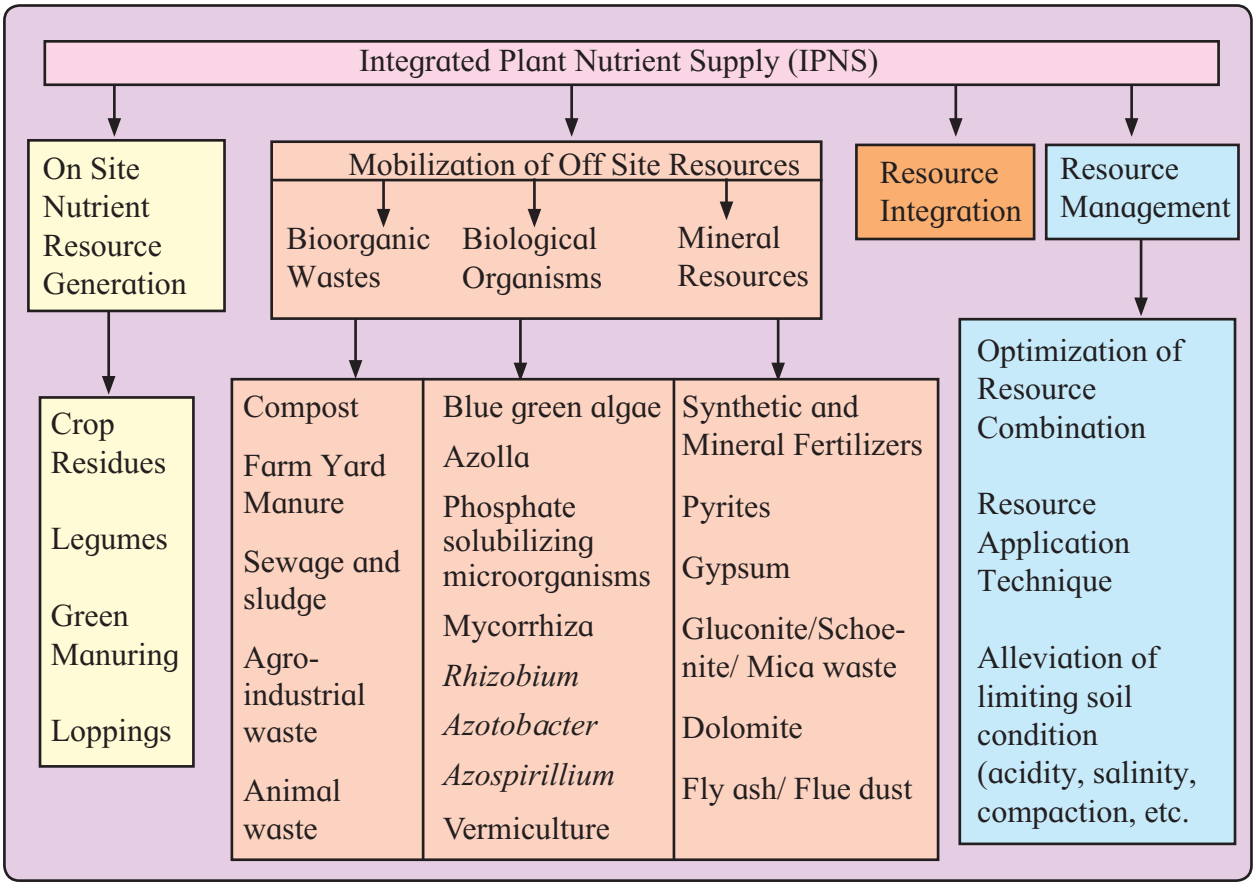


Table 11.3 Components of Integrated Plant Nutrient Supply (IPNS).

Exercise

Q.1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. Organic farming is the production system which avoid the use of ----------
   a. pesticides b. organic manures
   c. bio-agents d. none of these
2. Principles of organic farming are releated with of ----------
   a. health b. fertilizers
   c. herbicides d. growth regulators
3. Biological weed control involve the use of ----------
   a. pathogens b. herbicides
   c. chemicals d. none of these
4. Hand weeding is an example of ---------- method of weed control.
   a. physical b. biological
   c. chemical d. none of these
5. The examples of organic manure is --------.
   a. compost
   b. urea
   c. single super phosphate
   d. muriate of potash

B. Make the pairs.

'A' Group	'B' Group
1. Mulches	a. Chemical weed control
2. Farm yard manure	b. Physical weed control
3. Sea cow	c. Organic manure
	d. Biological weed control
	e. Nitrogenous fertilizer

C. Find the odd one out.

1. FYM, compost, sewage, dolomite
2. Rhizobium, azzola, azotobactor, gypsum
3. Ecology, care, fairness, vermicompost
4. Pyrites, gypsum, dolomite, sewage

D. State true or false.

1. Organic farming enhance long term soil fertility.
2. Organic manures include compost.
3. Biological weed control involve use of insects.
4. Organically grown crops provide nutritionally superior food.
5. The cost of production of organic produce is comparatively high.

Q.2. Answer in brief.

1. Define organic farming.
2. What is the principle of health?
3. What are the conversion requirements of organic farming?
4. List out any four physical methods of weed control.
5. What are the demerits of organic farming?

Q.3. Answer the following questions.

1. What are the objectives of organic farming?
2. Describe the types of organic farming.
3. What is a crop production plan?

Q. 4. Answer the following questions.

1. What are the major components of integrated weed management.
2. Describe the duration of conversion period in organic farming.
3. How does contamination controlled in organic farming?

Q.5 Answer the following questions in detail.

1. Describe the principles of organic farming.
2. Write in detail about nutrient management in organic farming.

Q.6 Answer the following questions in detail.

1. Describe biological weed control in organic farming.
2. What are the merits and demerits of organic farming?

Activity

- Visit any agricultural farm and take observations of organic as well as chemical inputs used.
- Obtain information regarding beneficial as well as harmful effects of the inputs used.

12. Agro Informatics

Can you recall?

You have a number of electronic gadgets like cell phones, laptops, computers, etc., at home or at school. You are aware of their multiple uses in day to day life and in your studies. Do you know their use in the field of agriculture?

12.1 AGRO INFORMATION TECHNOLOGY

An huge amount of innovations are awaiting adoption. Agriculture is at the peak of research and development. Information Technology is the best way for fast and effective dissemination of agricultural technology.

Use of electronic gadgets and software for storage, analysis, transfer and retrieving information is termed as informatics. Informatics in agriculture has a tremendous scope and potential in converting resources in to prosperity. Agro-informatics is the application in agriculture with innovative ideas, techniques and scientific knowledge to expand horizons of computer. It is information technology applied to management and analysis of agricultural data. It is well recognized that the digital images and video clips of actual application of agriculture technology have greater impact on the minds of the farmers than the textual descriptions of the technology.

Flow of information from the source to receiver should be faster, effective and economical. Modern devices and systems like computer, mobile (cellphone), internet, etc., are capable to store, process, communicate and regenerate the information at a highest speed with lowest cost.

12.1.1 Meaning and use of modern devices and systems in agriculture

A. Computer :

It is a magic box which can accept information through different input devices in various media like visual through camera and scanner, audio through microphone, analog/ digital through keypad or mouse. Capacity of a computer to store information is just unlimited. It can process huge data within a fraction of a second. We can obtain output from computer by various ways like display on monitor, sound through speaker, hard copy from printer, visual from projector, etc. When a computer is attached with internet system, it is empowered by the ocean of information in the world wide web (www).

Computer can be used at each level in the process of communication. At the source, a scientist or expert/ subject matter specialist can use computer to shape the information in written, pictorial, movie or audio form. Then it can be spread/ disseminated to the extension workers through CDs, VCDs, micro SD cards, USB storage devices or through internet in any audio, visual or audiovisual form. Extension worker can load the information in his computer and use it in the process of communication with the farmers. If available, farmers can also use their computers or any electronic gadget to store and use information. Computer is also helpful to obtain feedback from the receivers at each level. Farmers can easily access required information on crops, stored systematically using a network of computers. Some farm management software can help farmers to maintain their farms more efficiently and increase productivity of inputs used.

Examples of operating systems are Microsoft Windows, Ubuntu Linux and examples of web browsers are Microsoft Internet Explorer, Mozilla Firefox, Google Chrome, Apple Safari, etc.

B. Internet :

Internet is a global network that connects the computers across the globe. The long form of Internet is international net work.

Specially in the science of agriculture, there is a vast gap between advanced countries and that of undeveloped countries. Internet

facilitates developing countries to get direct access to the research and experience of developed countries and use it for improvement in the field of agriculture. Internet is also used in searching market information about particular input as well as output of the agriculture. Online marketing has opened new horizons of national and international market down to bunds of the farm.

Internet facility can be availed/ obtained on the computer, laptop, tablet computer, mobile (cellphone), etc. The devices can be connected with internet by optical fiber cable, telephone landline, WiFi, cellphone service providers, etc.

According to available device, compatible internet service can be used. Government agency- BSNL is providing internet through cable and cellphone on concessional rates, particularly to the rural community and farmers.

For operating the concerned websites through internet, softwares like - Microsoft Internet Explorer, Google chrome, Firefox, Mozilla, etc. are used. If the name of a particular website is not known, search engine can be used. Commonly Google.com, Yahoo. com, bing. com, msn.com, aol.com, etc. are opened and words related to the information to be searched are typed in the search box. The search engine displays thousands of related websites. From which, we can select the most relevent and reliable one and click it to open.

The websites are provided by government or non government organizations, private companies or advertising agencies. Websites can be classified based on their domain names. A domain name is the last part of the website e.g. com. gov.in, org.A com website is usually operated by a commercial company while gov.in domain is operated by government departments. Non government organizations use org. domain. The domain name also helps us in identification of the country e.g. in is reserved for India, nl is for the Netherlands while .us is for USA.

Some of the improtant websites useful for the farmers are listed below try to open and get interesting information.

www.maharashtra.gov.in,
www.mahaagri.gov.in,
www.mcaer.org,
www.agricoop.nic.in,
www.icar.org.in,
www.nhm.gov.in,
www.nhb.gov.in,
www.apeda.com,
www.vsisugar.com,
www.msamb.com.

C. E-mail :

It is a process of sending and receiving messages in electronic (digital) form with or without attached files to other service user. E-mail has high speed of communication and respondent can view or refer it at his convenience and by multiple times. It saves paper thus classified in eco friendly practice. It is an integral part of the concept – 'paperless office'.

D. Cellphones :

Cellphone is a devise with access to a cellular radio system so it can be used over a wide area without physical connection to a network. Cell phones are used to send or receive phone calls, text messages, e-mails, photos and video as well as access the internet, use GPS for getting agriculture information.

Remember this

Cellphones are popularly used by most of the farmers and labourers. India is the second largest user of cellphones in the world. About 91.35 crores cellphones are used in India.

E. Smartphone apps :

Most of the farmers are now handling smart phones. It is the easiest and cheapest gadget of information technology. If used wisely, a flow of knowledge will appear in the hands of farmers. Need is to educate them how to search information from reliable websites.

Try this

Install some of these apps in a cellphone and see its utility. You can also guide a farmer to obtain benefits through such apps.

Some of the most popular applications (Apps) and their uses

Sr. No	App	Uses
1		**Indian Council of Agricultural Research** Information regarding agricultural education and research. Different training programs related to agriculture and allied business. ICAR has different centers for research and education for example, Central Institute for Cotton Research (CICR). Relevant information can be obtained in regional languages also.
2		NCDEX app has instant access to prices, news, updates, market data and analysis for commodity of their choice. It helps dealers, investors, traders, hedgers and corporate managers. This app provides real time features/ spot prices and commodity news. It is a smart, more personalized and intelligent tool to make it easier than ever for investors to stay in touch with the market and with each other. The dealers and wider trading community can now make important trading decisions anywhere and at anytime on their devices.
3		**Maharashtra State Agricultural Marketing Board *(Panan Mandal)*** The Maharashtra State Agricultural Marketing Board (MSAMB), has done pioneering work in the field of Agricultural Marketing in the State and achieved success in various areas. MSAMB has an important role in developing and coordinating agricultural marketing system in the State of Maharashtra.
4		"**IFFCO**" *Kisan* is an Indian farmer *suvidha* App. which helps the Indian farmer/ *Kisan* to take informed dicisions by accessing customized agricultural information related to their need. It has following features. **Weather :** This section provides instant access to weather forecast for next 5 days in the set preferred location. **Market or *Mandal* :** Farmers can get instant access to *mandi* prices for their produce, market status and prevailing trade prices along with quantities. **Agricultural Advisories :** This is a crop specific advisory service for various agro-climatic zones. **Ask our Experts :** Farmers can just take a photo of the plant or concerned area/ disease and send it to the experts who will provide personalized solutions through voice call. ***Gyan Bhandar* :** An Agricultural information library for the farmer to get neassary information. **Market Place :** This feature is the buyer and seller meeting platform, where a buyer or a seller can register his/ her buying or selling requirement/s. It will help them to buy or sell faster, with higher profitablity

5		**Startup India :** Startup India is a flagship initiative by the Government of India, intended to build a strong eco-system for nurturing innovations and startups in the country that will drive sustainable economic growth and generate large scale employment opportunities. The Government through this initiative aims to empower startups to grow through innovation and design. This is the official mobile application for startup India developed to assist users to easily source information from the official startup India website at http://startupindia.gov.in. Be in touch with Startup India initiative and get the latest news, events, information about Startups, Incubators, IMB, State wise information, action plan and FAQs, etc. right in your hand. The app will allow users to apply for Recognition of Startups and Incubators and also allow users to validate Recognition of Startups and Incubators.
6		**Indian Meteorological Department :** It is the National Meteorological Service of the country and the principal government agency in all matters relating to meteorology, seismology and allied subjects. This app provides authentic information related to weather conditions, forecast and alerts.
7		**Weather Bug** Local weather conditions and predictions, alerts to take decisions in planning of agricultural practices.
8		**Accu Weather** Local weather conditions and predictions. Weather alerts to take decisions in planning of agricultural practices.
9		***Kisan Yojana*** Information regarding the different schemes of government in the field of agriculture.
10		***Sehetkari Magazine*** "Shetkari Masik" is one of the most popular low price monthly magazine since 1965. The main purpose of 'Shetkari Masik" is to provide information about agriculture and agro-suite modern technology to reader. It provides guidance for all field crops, animal husbandry, poultry, fishery, forestry, agro industry, biotechnology and much more. **Core features** • Shetkari Masik App is available in 'Marathi' language. • Downloaded magazine can be easily read anywhere, anytime and in offline mode. • All previous magazine editions are also available for download.

Try this

Call a farmer friend through video call by cell phone or laptop. Discuss about agricultural practices he is adopting now.

Very useful apps are made available by government and private agencies. It facilitates easy access to information, communication and expert advice, buying of inputs, trading of agricultural produce and much more. Weather reports and forecasting are other important facilities available on mobile apps.

F. Video conferencing :

It is an audiovisual communication between two or more persons from different locations through the videophone or Internet. Devices required in this system are videophone or cellphone (preferably with dual camera) or computer/ laptop with web camera. Highspeed Internet connection is required for clarity and smoothness in conferencing.

This system enables to obtain guidance of experts located at any place. As the expert has no need to travel and be physically present at the receiver's location, it saves valuable time of the expert and unnecessary expenses on traveling and other facilities.

Videoconferencing may be of two types-

a. Farmers are called at a specific location and time so that they can virtually see and discuss with the expert on screen.
b. Farmers are informed to call a particular expert on predecided time. Here the farmers are calling from different location and expert is at specific place.

G. Global Positioning System (GPS) :

Fig. 12.1 GPS Receivers

GPS is a system that uses signals from satellites to find out position of an object.

Global Positioning System (GPS) is being applied in agriculture facilitating benefits in geo-fencing, map-making and surveying. By using GPS, one can prepare simple yet highly accurate digitized map without the help of a professional.

GPS enabled tractors, drones and much more mechanisms are now manufactured in India and becoming popular in farmers. By GPS mapping, these machines can be used without any operator. It enhances accuracy and efficiency in automization of agricultural practices.

Fig. 12.2 GPS Enabled Tractor

Wild animals are now being tagged with GPS tracker. When the animal crosses a geo-fence, forest authorities are alerted by SMS, they track the animal and scare them to protect civilized as well as agricultural zone.

H. Geographic information systems

Geographic information systems, or GIS, are extensively used in agriculture, especially in precision farming. Land is mapped digitally, and accurate and detail data such as topography and contours are combined with other statistical data for easier analysis of the soil. GIS is useful for planning such as what to plant and where to plant using historical data and sampling.

I. Agricultural clinics

Agricultural clinics are envisaged to provide expert advice and service to farmers on various aspects to enhance productivity of crop/ animals and increase the income of farmers.

Agricultural clinics provide support in the following areas.

1. Soil health
2. Cropping practices
3. Plant protection
4. Crop insurance
5. Post harvest technology
6. Clinical services for animals, feed and fodder management
7. Prices of various crops in the market.

A special training program is being implemented by National Institute of Agricultural Extension Management (MANAGE). It is 45 days free of cost residential training program. Candidates can avail bank loan up to 20 lakhs with subsidy of 36% (for general category) and 44% (for SC, ST category and women).

Do you know ?

After completion of H.S.C. with agriculture subject, you can participate AC and ABC training as mentioned above. Minimum 55% aggregate marks are necessary to qualify for admission.

Fig. 12.3 Automization in agriculture

I. Agricultural Technology Information Centre (ATIC)

It is a "single window" support system linking the various units of a research institution with intermediary users and end users (farmers) in decision making and problem solving exercise.

Services provided by ATIC

- Diagnostic services for soil and water testing, plant and livestock health
- Supply research products such as seeds and other planting materials, poultry strains, livestock breeds, fish seed, processed products, etc, emerging from the institution for testing and adaptation
- Sale of publications and communication materials as well as audio-visual aids produced by the research organisation

ATIC in Maharashtra

Name of ATIC	Contact Details
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri	02358280238
Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Dist. Ahmednagar	02426243861 02426243373
Dr Punjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola	07242259262
Vasantrao Naik Marathwada krishi vidyapeeth (VNMKV),Parbhani	02452223801

Exercise

Q.1. Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. --------- is a process of sending and receiving messages in electronic (digital) form with or without attached files to other service user.
   a. e-mail b. letter
   c. document d. parcel
2. For convenience of finding proper source and information on the world wide web, ---------- are used.
   a. search engine
   b. email
   c. MMS
   d.internet explorer
3. The website of ---------- enables access land records like 7/12 extract and property card.
   a. www. icar.org
   b. www. nhb.gov.in
   c. www. vsisugar.com
   d. www.mahabhulekh maharashtra.gov. in.
4. ---------- initiative aims to provide information to the farming community through toll-free telephone lines
   a. shetkari magazine
   b. kisan call centre
   c. startup India
   d. none of these
5. ---------- is an app providing information regarding local weather conditions and forecast.
   a. Startup India b. *CICR*
   c. Accuweather d. ICAR

B. Make the pairs.

'A' Group	'B' Group
1. GPS	a) Information and Communication Technology
2. ICT	b) General post section
3. ATIC	c) Agricultural Technology Information Centre
	d) Global positioning system
	e) Indian crop technique

C. Find the odd one out.

1. Android, Lenux, Windows, Excel
2. SMS, Google, MMS, Email
3. ATIC, Computer, Laptop, Cellphone

D. Write true or false.

1. Conferencing video is time consuming technology.
2. Startup India is an app to encourage Indians especially youngsters to take up entrepreneurship as a career.
3. Irrigation, fertilizer and pesticide application, etc. are automized by using micro processors or computers.
4. Computer can process data within a fraction of a second.
5. Wild animals are now tagged with GPS tracker which help in protection of fields.

Q.2. Answer in brief.

1. Name any two most commonly used search engines.
2. What are the advantages of using weather related apps ?
3. Which web browsers are used to open web pages on internet ?
4. Write the information about MSAMB app.
5. What is the use of information technology in agriculture and allied fields?

Q.3. Answer the following questions.

1. Write in brief about Geographic Information System.
2. Enlist the Agricultural Technology Information Centres (ATIC) in Maharashtra
3. Write about *IFFCO Kisan - mobile app facilities*
4. Name any two Smartphone applications for farmers with their uses.
5. List out important websites useful for farmers.

Q.4. Answer the following questions.

1. Describe Computer and Internet.
2. What is an Agricultural clinic?
3. List out the services provided by Agricultural Technology Information Centre.
4. Write about start up india app.
5. Write in short about MSAMB

Q.5 Answer the following question in detail.

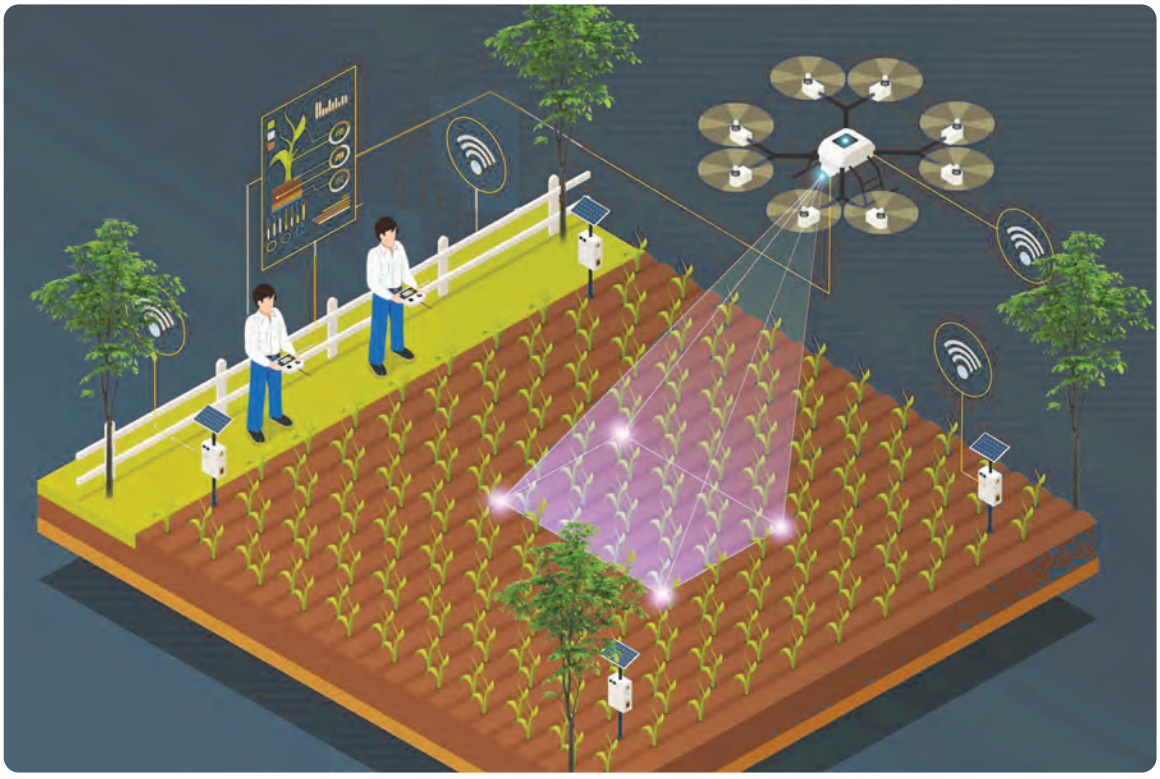
1. What are the uses of Internet in agriculture?
2. Write the information on Global Positioning System (GPS) in agriculture.

Q.6 Answer the following questions in detail.

1. List out most popular apps and give their uses.
2. What are the uses of computer and internet in agriculture?

Activity

- Search websites of different agencies providing information and services related to agriculture.
- Download the applications in Smartphone which are useful for farming, weather alerts, etc.



Agro information technology

13. Agricultural Marketing

Can you recall?

1. The term agricultural marketing is composed of two words agriculture and marketing.
2. Agriculture includes all primary activities of production i.e. from growing or raising crops and live stock.
3. Marketing comprises a series of activities involved in transferring the goods from the point of production to the point of consumption. It includes all activities involved in the creation of time, place, form and possession utility.

Remember this

Market is the sphere within which price determining forces like demand and supply operate.

13.1 AGRICULTURAL MARKETING

13.1.1 Definition : Philip Kotler has defined marketing as a human activity directed at satisfying the needs and wants through exchange process.

American marketing association defined marketing as the performance of business activities that directs the flow of goods and services from producers to users.

Agriculture marketing is the study of all the activities, agencies and policies involved in the procurement of farm inputs by the farmers and the movement of agricultural products from the farm to the consumers.

According to the National Commission on Agriculture (XII Report, 1976) agricultural marketing is a process which starts with a decision to produce a saleable farm commodity, and it involves all the aspects of market structure or system both functional and institutional based on technical and economic considerations, and includes pre and post harvest operations, assembling, grading, storage, transportation and distribution.

Use your brain power

What are the opportunities in agricultural marketing?

Know the Scientist

Philip Kotler (May 27, 1931) was an American Economist who studied at the Hayward University and worked as a Professor of International Marketing at the University of Chicago. His famous book is on Marketing Management : Analysis, Planning and Control (1967).

In a fast growing economy, the agricultural marketing system provides strong linkages between farm and non farm sectors.

Agriculture means a bundle of activities aimed at growing or raising crops and livestock by using natural resources with ultimate goal of society welfare. Marketing is a process of identifying human needs, wants, demands and meeting it at profit or the process of activities involved in moving the goods from the point of production to the point of consumption.

Agricultural marketing occupies a fairly low place in agriculture development policies of developing countries. The National Commission on Agriculture (1976) had emphasised that it is not enough to produce a crop or an animal product, it must be satisfactorily marketed.

Observe and Discuss

Problems in Agricultural Marketing

1. Large number of middlemen
2. Small and scattered holding
3. Forced sales
4. Technologically developed problems in farm production
5. Poor handling and packing
6. Lack of standardization and grading
7. Inadequate storage facility
8. Malpractices in market
9. Multiplicity of market charges
10. Lack of market information
11. Lack of farmers organization
12. Inadequate means of transport
13. Communication problems

Do you know ?

The marketing system gets completed only when the commodities are made available from the producers to the ultimate consumers in his required form, at needed time and place of consumers.

13.2 PROCESS OF AGRICULTURAL MARKETING

There are three processes involved in Agricultural marketing.

1. Assembling (concentration),
2. Equalisation
3. Dispersion (distribution)

13.2.1 Assembling :

Assembling begins with the collection of surpluses of individual farmers. This becomes essential in moving the produce to the consuming markets in sufficient quantities to permit efficient processing, transportation, storage, etc. This process of concentration is called assembling. Assembling takes two forms i.e., primary assembling and secondary assembling.

a. Primary Assembling :

The produce is assembled in the villages and primary markets as the farmers feel it convenient in view of small quantities of produce, pressing demand for cash, lack of transport facilities, paucity of information on the prices, etc., prevailing at other markets. The prominent functionaries are village merchants and itinerant traders or merchants.

b. Secondary Assembling :

It succeeds primary assembling. It is associated with greater concentration. These are initially found in the producing areas and then in the consuming areas. New functionaries like commission agents join in the secondary assembling. These are the wholesale markets. The percentage of marketable surplus that arrives stands around 70 to 75 percent at this stage, before it is dispersed to different consuming areas. In the secondary assembling, the role of commission agents is of paramount importance.

13.2.2 Equalisation :

It is the adjustment of supply and demand as per the requirements based on the time, place and quantity. Equalisation though tends to be confined to the wholesale markets, but to some degree or other, it is also found in marketing channels as well. With demand being spread throughout the year, the supplies should be made available as per the consumption requirements of the people. Storage has an important function here to hold back the stock for timely release. Also certain agricultural commodities are area-specific and there are certain areas with abundant production and some other areas with deficit production. Through the process of equalisation the products are moved from surplus areas to deficit areas. Transportation should be well developed in this regard. Adjustment of quantities as per the requirements is another important aspect of equalisation. The requirements of one market to other market vary. Keeping this in view, the required quantity should be moved from assembling centres to the consumer markets.

3. Dispersion

The produce that is collected from producing areas should be made available to the millions of consumers through the consuming markets. From the major wholesale markets the process of dispersion starts. Dispersion is seen through various marketing channels. In respect of those products which need processing before they are suitable for consumption they are moved to processors. The processed products then are channeled to the consumers. Commodities like paddy, cotton, sugarcane, etc., need to be processed before consumption in the form of rice, yarn and cloth, sugar or jaggery, etc., respectively.

There are some petty traders generally without shops, who move from village to village with their carts, buy from the farmers and sell in the near by markets. It is the continuous activity for them.

Remember this

1. Agricultural market is the place where the seller (farmer or trader) meets a buyer for exchange of agricultural produce with money.
2. There are various dimensions of any specified market, according to which markets are classified.

13.3 TYPES OF AGRICULTURAL MARKETS

13.3.1. Types on the basis of location :

On the basis of location or place of operation, markets are of following types.

a. Village market :

A market which is located in a small village, where major transactions take place among the buyers and sellers of the village is called a village market. Goods transacted are milk, fruits, foodgrains, vegetables, etc.

Fig. 13.1 Village market

b. Primary market :

These markets are located in towns near the centres of production of agricultural commodities. In these markets a major part of the produce is brought for sale by the producer farmers themselves. Transactions in these markets usually take place between the farmers and primary traders. Goods transacted are food grains, cotton, vegetable, etc.

c. Secondary wholesale markets :

These markets are located generally at district head quarters or important trade centres or near railway junctions. The major transactions in commodities in these markets take place between the village traders and wholesalers. These are specialized marketing agencies performing different marketing functions, such as those of commission agents, brokers and weighmen in these markets. Goods transacted are food grains, onion, potato, flowers, etc.

d. Terminal markets :

These markets are located either in metropolitan cities or at sea ports. Delhi, Mumbai, Chennai, Kolkata and Cochin are terminal markets for many commodities.

A terminal market is one where the produce is either finally disposed off to the consumers or processors or assembled for export. Goods transacted are cotton, food grains, processed food, etc.

e. Seaboard markets :

These markets are located near the seashore and are meant mainly for the import

and /or export of goods are known as seaboard markets. These are generally seaport towns. Goods transacted are edible oils, seeds, sugar, tea, etc. These types of markets in India are located in Mumbai, Chennai, Kolkatta and Cochin.

13.3.2 Types on the basis of area of transaction :

On the basis of the area from which buyers and sellers usually come for transaction, markets may be classified into the following four classes.

a. Local or Village market :

A market in which the buying and selling activities are confined among the buyers and sellers drawn from the same village or near by villages. The village markets exist mostly for perishable commodities in small lots e.g. local milk market or vegetable market.

b. Regional market :

A market in which buyers and sellers for a commodity are drawn from a larger area of the local markets. e.g. A class towns. Regional markets in India usually exist for foodgrains.

c. National market :

A market in which buyers and sellers spread at the national level. Located at metrocities and goods like Jute, Tea, Tobacco are transacted.

d. World or International market :

A market in which the buyers and sellers are drawn from more than one country or the whole world. These are the biggest markets from the area point of view. These markets exist for commodities which have a world-wide demand and /or supply, such as coffee, sugar, rice, row cotton, wheat, etc.

13.3.3 Types on the basis of number of commodities

A market may be general or specialized on the basis of the number of commodities in which transaction are completed.

Do you know ?

Specified market

Sangli - Raisins, Turmeric.
Kolhapur : Gul (jaggery)
Lasalgaon (Nashik) : Onion
Nagpur : Orange

a. General market :

A market in which all types of commodities, such as foodgrains, oilseeds, sugar, pulses, and other farm produce are bought and sold is known as general market. These markets deal in a large number of commodities. They are located in towns and cities and transaction between farmers and traders takes place.

b. Specialized market :

A market in which transactions take place only in one or two commodities is known as specialized market. For every group of commodities, a separate market exists. The example of specialized markets are foodgrain market, vegetable market, cotton market, wool market, animal market, etc.

13.3.4 Types on the basis of public Intervention

According to the extent of public intervention, market is classified into two classes.

a. Regulated market :

These are markets in which business is done in accordance with the rules and regulations framed by the statutory market organization representing different sections involved in market. The marketing costs in such markets are standardized and marketing practices are regulated. Markets are located at taluka and district market places. Most of the farm products are transacted here e.g. APMC market.

b. Unregulated market :

These are markets in which business is conducted without any set rules and regulations. Traders frame the rules for the

Keep in Mind

e-trading of agricultural goods : Government and non government agencies are operating the centres for e-trading. In this system a farmer, franchise and traders are required to be registered with the marketing agency e-trading of the agricultural produce may be of two types. Spot trading and Future trading.

Agencies :

- NSEL, Mumbai
- Multi Commodity Exchange of India Ltd, Mumbai
- India Commodity Exchange Ltd, New Delhi.

Do you know ?

Marketing channel :

Marketing channels are the routes or ways through which agricultural produce moves from producers to consumers.

conduct of the business and run the market. These markets suffer from many ills, ranging from unstandardised charges for marketing functions to imperfections in the determination of prices.

In these markets goods like fruits and vegetables are transacted.

13.3.5 Types on the basis of volume of a transaction (size) :

a. Wholesale Market : In this type, commodities are bought and sold in large lots or in bulk. This type transaction generally take place among the traders.

b. Retail Market : In this type agricultural goods are brought and sold to the consumers as per their requirement. Transactions in these markets take place between retailers and consumers.

13.4 CROP INSURANCE

Indian agriculture is highly susceptible to risks like droughts and floods. It is necessory to protect the farmers from natural calamities and ensure their credit eligibility for next season. For this purpose, the Government of India introduced many agricultural schemes throughout the country like Pradhan Mantri Fasal Bima Yojana (PMFBY).

Crop insurance refers to an insurance which insure farmers and crop producers against the loss of crops due to natural disasters, such as hail, drought and floods.

Crop insurance is a type of protection policy that covers agricultural producers against unexpected losses of projected crop yields or profits from produce sales at market.

Crop insurance is purchased by agricultural producers and subsidized by the federal grovernment to protect against either the loss of their crops due to natural disasters, such as hail, drought and floods.

Remember this

1. Insurance is a contract, represented by a policy, in which an individual receives financial protection or reimbursement against losses from an insurance company.
2. There are different types of insurance e.g. Life insurance, property insurance, crop insurance, etc.

Importance of crop insurance

1. **Stability in income :** It protects the farmers against losses caused by crop failure. It acts like a tool that allow farmers to manage their yield and price risks.
2. **Minimal Debts :** Farmers are able to repay their loans even during the time of crop failure with the support of the right insurance partner.
3. **Technological Advancement :** Insurance companies work along with agri platforms who use latest technology. This helps farmers to enhance agricultural practices and reduce farmers losses as well as improve their crop production.

4. **Yield protection :** Crop insurance protect farmers against production loss for crops. It also offers preventive planting and replant security of crops.
5. **Provides awareness :** Insurance companies provide awareness campaigns which help farmers to understand the effect of natural calamities and also protect their farms.

13.4.2 Pradhan Mantri Fasal Bima Yojana (PMFBY) :

Pradhan Mantri Fasal Bima Yojana was introduced in 2016 replacing all the existing crop yield insurance schemes in India. The scheme has extended coverage under localized risks, post harvest losses, etc. and aims at adoption of technology for yield estimation, through increased farmer's awareness and low farmer premium rates.

Farmers can avail crop insurance services using the revamped PMFBY portal. There is a step by step process that farmers need to follow in order to get their crops insured.

Step 1 : Insurance Premium Calculator

The farmer can calculate the insurance premium themselves using the insurance premium calculator available on the PMFBY portal homepage.

Step 2 : Policy Application for Crop Insurance

A policy application form has to be filled in order to avail crop insurance services. Policy form for loanee farmers is filled automatically.

Step 3 : Report Crop Loss and Apply For Claim

If a crop gets damaged, farmers can report crop loss and also apply for claim on the PMFBY portal. Once the claim gets approved the farmers receive the insurance amount directly into their bank account mentioned in the policy application form.

Step 4 : Complaints and Helpline

Farmers can share their portal related grievances through the complaints option present on the PMFBY portal. Complaints registered by the farmers would be acknowledged immediately and would be solved within 24 hours.

Claim Process :

If actual yield (AY) per hectare of insured crop for the insurance unit in insured season, falls short of specified Threshold Yield (TY), all insured farmers growing that crop in the defined area are deemed to have suffered short fall of similar magnitude in yield PMFBY seeks to provide coverage against such contingency.

13.5 Kisan Credit Card (KCC)

The farmers in India have to face much difficulty in arranging short term funds for the planting and harvesting season and to meet other agricultural needs. They are largly dependent on credit from the unorganised sector such as money lenders who charge exorbitant rate of interest. Realizing the need for such short-term credit, the kisan credit card scheme was launched by the Reserve Bank of India and NABARD. Kisan credit card is offered by commercial banks, regional rural banks and co-operative banks.

The kisan credit card is a credit scheme introduced in August 1998 by Indian banks. The model scheme was prepared by the National Bank for Agriculture and Rural Development (NABARD) on the recommendations of R. V. Gupta Committee to provide term loans and agricultural needs.

A kisan credit card works in similar ways as a normal credit card. You can use it at ATMs and merchant post terminals. Under the Kisan credit card scheme, customer can avail two types of credit i.e. cash credit and term loans. A short term credit limit is offered on the kisan credit card for smaller agricultural needs. Term loan can also be taken for cultivation, buying equipment, irrigation, etc. Card holders can use the kisan credit i.e. card for certain domestic needs as well.

The farmers also receive a passbook which contains all the relevant details of land holding, credit limit, validity, etc. The repayment period in kisan credit card is upto maximum of 12 months and card is valid for a period between 3-5 years.

Remember this

1. Cash credit is a facility to withdraw money from a current bank account without having credit balance but limited to the extent of borrowing limit which is fixed by the bank.
2. The interest on this facility is charged on the running balance and not the borrowing limit which is given by the bank.

13.5.1 Features of kisan credit card loan :

- All the farmers are eligible for the benefit from the kisan credit card scheme. This includes farmers who cultivate their own land and tenant farmers.
- The national crop insurance scheme covers the crops eligible for kisan credit card. The scheme offers some protection to the farmers in a poor crop season.
- The biggest advantage of this scheme is the simplicity of the credit process. Quicker and timely availability of funds for the farmers.
- There is minimal paperwork and documentation involved.
- There is a lot of flexibility in the repayment tenure of kisan credit card loan. There is also a possibility of extending the repayment period in case of bad crop turnout due to natural calamities. Farmers are also offered subvention for timely and prompt repayments.
- It ensures assured availability of financial resources at affordable interest rates.
- It provides insurance coverage (personal accident and asset) for the recipient of the kisan credit cards.
- It provides a facility to withdraw cash as per the farmers requirements.
- Specifically targeted at farmers as part of the government scheme for kisan.

Fig. 13.2 Kisan card

Do you know ?

Top Banks offering kisan credit cards in India.

1. National Bank for Agricultural and Rural Development (NABARD)
2. State Bank of India (SBI)
3. Bank of India (BOI)
4. Industrial Development Bank of India (IDBI)
5. Axis Bank
6. Indian Overseas Bank (IOB), etc.

Keep in Mind

What is NAFED?

National Agricultural Co-operative Marketing Federation of India Ltd (NAFED) is an apex organization of marketing co-operatives for agricultural produce in India, under Ministry of Agriculture, Government of India. It was founded on the birthday of Mahatma Gandhi on 2nd October 1958 to promote the trade of agricultural produce and forest resources across the nation. It is registered under Multi State Co-operative Societies Act. NAFED is now one of the largest procurement as well as marketing agencies for agricultural products in India. NAFED is the nodal agency to implement price stabilization measures.

With its headquarters in New Delhi, NAFED has four regional offices at Delhi, Mumbai, Chennai and Kolkata, apart from 28 zonal offices in capitals of states and important cities.

Exercise

Q.1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. ---------- has defined marketing as a human activity through exchange process.
   a. Shekharo b. Philip Kotler
   c. AMA d. Raman
2. The markets meant mainly for the import and export of goods near seashore are called ---------- markets.
   a. Sea board b. retail
   c. wholesale d. terminal
3. Pradhan Mantri Fasal Bima Yojana was introduced in the year ----------.
   a. 2016 b. 2006
   c. 2018 d. 2008
4. The Kisan Credit Card scheme introduced in the year ---------- .
   a. 1975 b. 1990
   c. 2000 d. 1998
5. Village markets exist mostly for ---------- commodities in small lots.
   a. Perishable b. Processed
   c. Unperishable d. all the above

B. Make the pairs.

'A' Group	'B' Group
1. Terminal market	a. District place
2. Local market	b. 'A' class towns
3. Regional market	c. Sea ports
	d. Buyers and sellers from more than one country
	e. Same or nearby village

C. Find the odd one out.

1. Village market, Primary market, Terminal market, Regional market
2. World market, Regional market, National market, Regulated market
3. Assembling, Equalization, Dispersion, Crop insurance
4. General market, Specialized Market, Unregulated market

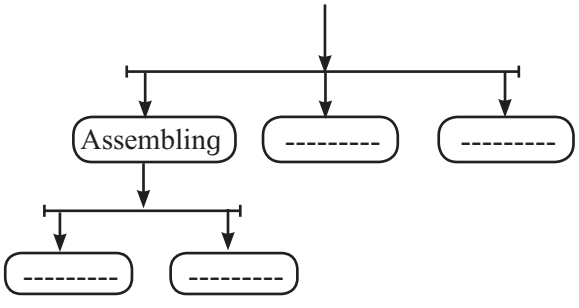
D. Sate true or false.

1. In regulated markets business is done in accordance with rules and regulations framed by organisation.
2. In general market only one or two commodities are transacted.
3. Kisan credit card is valid for a period of one year.
4. Seaboard markets are involved in import and export of goods.
5. In National markets buyers and sellers are drawn from more than one country.

Q. 2 Answer in brief.

1. What are the differences between primary market and secondary market?
2. Write a note on specialized market.
3. What is the insurance claim process for PMFBY?
4. Complete the following chart.

Process of Agriculture marketing.



5. Write a note on the World or International Market

Q. 3 Answer the following questions.

1. What are the problems in Agricultural marketing?
2. Explain process of Assembling in marketing.
3. What is the importance of crop insurance?
4. Write a short note on kisan credit card.
5. Describe terminal markets.

Q. 4. Answer the following questions.

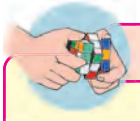
1. What are the characteristics of wholesale markets?
2. What are the important features of kisan credit card loan?
3. What are the different marketing channels for food grains?
4. Write a note on regulated market.
5. Write a note on Pradhan Mantri Fasal Bima Yojna (PMFBY)

Q. 5. Answer the following questions in detail.

1. What are the different steps to be followed in application of crop insurance?
2. Describe the types of agricultural market on the basis of location

Q6 Answer the following questions in detail.

1. Write in detail process of agricultural marketing.
2. Define crop insurance and write its importance.



Activity

Visit the nearby Agriculture Produce Market Committee (APMC) and know about regular activities in the market yard.

Mahatma Phule Krishi Vidyapeeth, Rahuri

14. Preservation

Can you recall?

Food is one of the basic necessities for sustenance of life. Fresh, clean, pure, hygienic and healthy food is highly essential for protection and maintenance of health of the people. Therefore, it is the responsibility of Government to provide regulatory systems for food safety and consumer protection.

14.1 FOOD LAWS AND REGULATIONS

Earlier, the regulatory frame work involved was of multiple agencies with overlapping functioning which prevented a smooth and co-ordinated execution. Various acts and orders for food safety in India are in vogue viz. Prevention of Food Adulteration Act 1954, Fruit Products Order, 1955, Meat Products Order, 1973, Milk and Milk Products Order. 1992, Edible Oil Packaging (regulation) Order, 1998. Standard of Weights and Measures Act and Rules 1956, Essential Commodities Act 1955, etc. These were governing food products regulations.

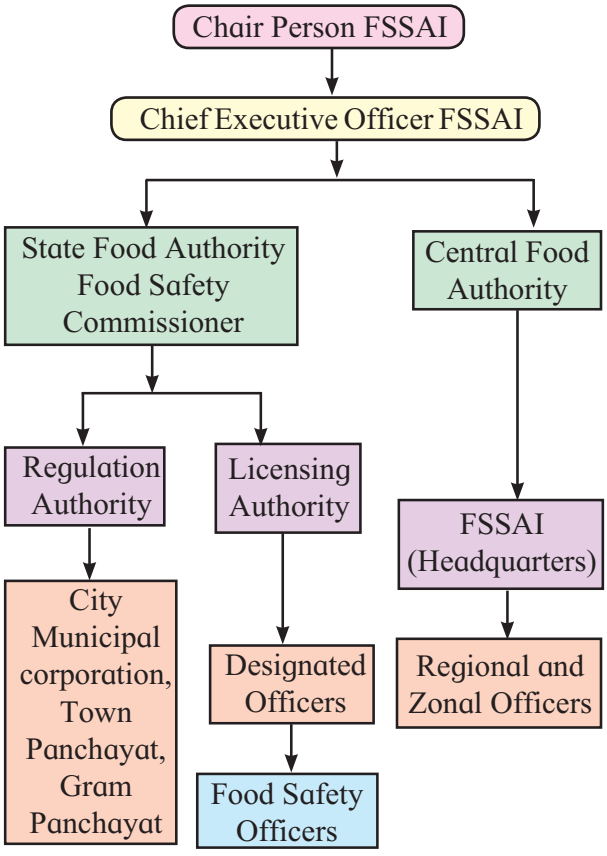
Considering the food adulterations, food borne illness, food handling hazards and World Trade Organization mandate it became imperative for the local food business operators to match up to the International Food Standards of food commodities.

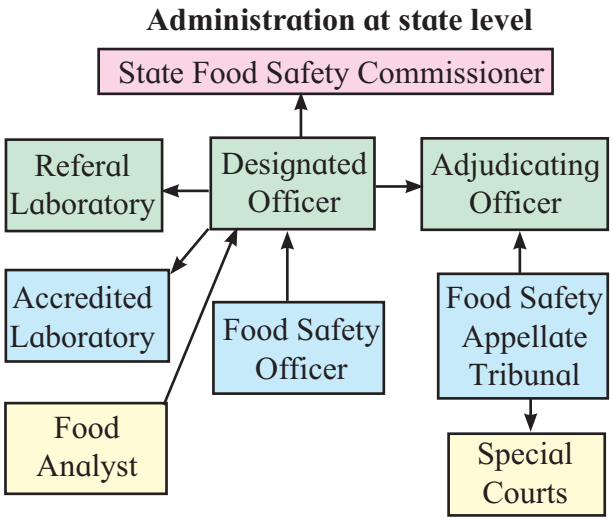
Therefore, the Government of India enacted a comprehensive Act, The Food Safety and Standards Act(FSSA) in August, 2006.

The food may be processed, partially processed, unprocessed, genetically modified or engineered. Primary food, the produce of agriculture, horticulture, animal husbandry, dairying, or aquaculture in its natural form, unless with a farmer or fisherman are also covered under this Act. Main focus of this Act is to ensure safety and quality across the food chain. Therefore, every food business operator handling food at any stage of manufacturing, processing, packaging, storage, transportation, distribution of food, import, food services, entering services, sale of food or food ingredients fall under the preview of this Act. The FSSAI is an independent statutory Authority with its headquarters in New Delhi, administered by Ministry of Health and Family Welfare, operates through four Regional offices in New Delhi, Kolkata, Mumbai, Chennai and four sub-Regional offices in Lucknow, Chandigarh, Guwahati and Cochin.

14.1.1 Regulatory Mechanism : FSSAI (Food Safety and Standards Authority of India) responsible for the enforcement of various provisions of the Act. They monitor and verify whether the relevant requirements are being fulfilled by food business operators. They maintain a system of control including public communication on food safety and risk, food safety surveillance and other monitoring activities covering all stages of food business.

Organization structure of FSSAI





14.1.2 Food Safety Standards Regulation : It encourages self-regulation by Food Business operators (FBO). FSSAI has to perform the following regulations (Act and Orders)

1. FSS – Licensing and registration of food Business, Regulations 2011
2. FSS – Food Products Standards and Food Additives, Regulation 2011
3. FSS – Production and Restriction on Sales Regulations 2011
4. FSS – Food Product Standards and Food Additives, Regulations 2011
5. FSS – Contaminants, Toxins, and Residue Regulations 2011
6. FSS – Laboratory and Sampling Analysis Regulations 2011

14.2 PRESERVED FRUIT PRODUCTS

Do you know ?

The present processing level of fruits and vegetables into value added products in our country is about 23%. However it was around 2 - 3% in the year 2002-03. The significant increase is due to the promotional schemes/projects launched by the Ministry of Food Processing Industries, Govt. of India. The level of processing of fruits and vegetables in other countries are at about 80% in Thailand, 78% in philippines, etc.

Fig. 14.1 Preserved fruit products

14.2.1 Principles of preservation :

In general fruits and vegetables deteriorate in quality or get spoiled mainly because of biochemical action of enzymes in the fruits and vegetables or of those that are affected by moulds, yeasts and bacteria; or purely chemical action or by physical means like bruising, moisture loss or gain, temperature extremes, absorption of foreign colours and attack of insects and rodents. Preventing all these should be the basis of food preservation.

William C. Frazier (1894-1991), a food microbiogist, outlines the principles underlying the various methods of food preservation as follows:

1. **Preservation or delay of microbial decomposition :**

a. By keeping out micro-organisms by sanitary handling (asepsis)
b. By removal of micro-organisms e.g. by filtration.
c. By hindering the growth and activity of micro-organisms by low temperature, drying, anaerobic conditions or chemicals.
d. By killing micro-organisms, e.g., by heat or radiations.

a. Asepsis : Avoiding micro-organisms is aimed at preventing initial spoilage. Natural protecting cover around the food is provided by shells of nuts, by skin or peels of fruits and vegetables, the husks of ear corn, the shells of eggs and the skin, membrane or fat on meat or fish. In advanced packaging technology, food material packed in loose cartons or wrapper to a hermetically sealed (aseptically) container for canned foods.

Do this

1. Study the different types of fruits and vegetables available in the local market.
2. Group them according ot their shape, type, fruits, vegetables, taste, colour, etc.

Sanitary methods of handling food from the source of production to the final point of use coupled with the control of environmental factors to inhibit microbial multiplication of the few contaminants will result in the preservation of the food.

b. Removal of micro organisms : It may not be very effective but helpful in reducing the contaminants. Rinsing raw food with potable water removes most of the soil organisms on the surface of fruits and vegetables. After this treatment, sanitary handling of the food is necessary to prevent re-contamination. The surface of the rinsed food should not be left moist as this encourages growth of whatever organisms may be left behind.

Trimming away the spoiled portions of a food may help in reducing the amount of contaminants that can proliferate and cause spoilage of fruits and vegetables.

c. Hindering the growth and activity of micro organisms: These methods are used to control the activity of microorganisms, in fact methods that alter environmental conditions like temperature, moisture, oxygen and pH of the food to a state unfavourable for microbial spoilage. Refrigeration and freezing slow down or stop microbial growth in chilled and frozen food. Drying reduces the level of moisture in food which is unfavorable for growth of micro organisms. Evacuation or vacuumization food pack will limit the oxygen and thus hinder the growth of micro-organisms.

d. Killing microorganisms by heat : It is the application of pasteurization or mild heating and sterilization with a more intense heating will reduce micro organisms by killing most of them. Coupled with improved packaging in hermetically sealed containers, microbial spoilage is significantly controlled. Canned and retortable pouch processed food are best examples.

2. Prevention or delay at self-decomposition of the food :

a. By destruction or inactivation of enzymes e.g. blanching

b. By destruction or delay of purely chemical reactions such as preventing oxidation by means of an antioxidant.

a. By destruction or inactivation of enzymes:

The method used to control the activity of microorganisms usually are effective against self-decomposition of the food which is brought about by enzymes. For example, the blanching of fruits and vegetables in boiling water inactivates the enzymes and is particularly an important pretreatment for freezing and dehydration.

b. By destruction or delay of purely chemical reactions :

Decomposition of refined oil (rancidity), non-enzymatic browning or amino-aldehyde reaction, oxidation of ascorbic acid (vit. C) are examples of purely chemical reactions. Temperature, moisture and oxygen favour these chemical reactions. The use of antioxidants (BHA) and oil containing antioxidant (vit. E) will prevent the problem.

3. Prevention of damage by insects, rodents and mechanical causes :

This requires the use of packaging and sanitary storage measures with moisture and temperature control to protect the food from damage caused by insects and rodents. Careful handling, proper packaging will check the mechanical damage of fruits and vegetables.

14.2.2 Preparation of value added products :

I. Jam : Jam is prepared by boiling the fruit pulp with a sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold fruit tissues in the mass. In its preparation about 20.4 kg of fruit pulp should be used for every 24.9 kg of sugar. It should contain not less than 68.5 percent soluble solids as determined

by refractometer (expressed as degree brix) when cold. As per the FSSAI (FPO,1955) specifications, jam may be prepared from one kind of fruit or from combination of two or more fruits.

The fruit used shall be mature, ripe, fresh, firm, sound, clean and free from fermentation and mould. Pectin derived from any fruit may be used when necessary. The other substances added are sugar, essence, permitted colours, citric acid and preservatives. No artificial sweeteners shall be added.

A jam is more or less concentrated fruit having a fairly thick consistency and firm body. It is also rich in flavour because of ripe fruit, which has developed full flavour, used in its preparation. Pectin present in the fruit gives it a good setting. High concentration of sugar facilitates preservation due to its osmotic pressure.

Fig. 14.2a Fruit Jam

Fig. 14.2b Fruit Jam

Recipe for fruit jam :

Ingredients	Weight (kg)			Final check points
	Mango	Pineapple	Apple	
Fruit pulp	1	1	1	• Pulp- 45%
Sugar	1.2	1.2	1.2	• Sugar- 55%
Citric Acid	6-8 gm	4-6 gm	5-6 gm	• Citric acid - 0.6 to 1.0% of pulp taken
Pectin Powder	10-12 gm	7-10 gm	10-12 gm	• Pectin- 0.5-1.0% of pulp taken
Essence	2 to 4 ml mango	5 ml pine apple	5 ml (ap-ple)	• Final pH-3.6
Colour	3-4 gm orange red	3-4 gm yellow	3-4 gm apple red	• Final TSS-68.5° brix
Preservative (Potassi-um meta-bi-sulphite)	100 mg	100 mg	100 mg	• Final acidity 0.4-0.6% (as citric acid)
Yield (approx)	**2 kg**	**2 kg**	**2kg**	

1. **Selection of fruits :** Select fully ripe, good colour, firm, rich aroma fruits. Rinse the fruits and blanch them before use.
2. **Preparation of fruit/extraction of pulp :** Remove peels, seeds, stone, unedible portion, stalk, and then cut fruits into small pieces. Put into fruit pulper/food processor and obtain fine, thick pulp, free of fibrous threads.
3. **Addition of sugar :** As per the recipe given above, weigh the fruit pulp, and take the sugar accordingly. Add sugar at the rate of 0.75 to 1.20 kg per kg of fruit plup

according to sweetness of the pulp. Weigh the other ingredients also.

4. **Cooking :** Take the pulp in a thick bottom vessel (having copper base), add sugar into it and start cooking on a medium flame. Stir it occasionally with long handled spatula or wooden scoop. Add citric acid, mix well, check the TSS, finally add the pectin powder in the mixture. After mixing it with little sugar, allow it to boil. Do not stirr it continuously. Check the TSS by using hand refractometer. It should be around 68.5° Brix. Stop cooking. Add the colour, essence and preservative separately in different containers. Then slowly add, one by one in the whole mixture, stirr well. Continue cooking for about 5 minutes.
5. **Judging end point (done stage) :**

a. **Sheet or flake test :** A small quantity of jam is taken from the mixture with the spoon. Cool slightly and allow it to fall down. It should flow in a sheet or flake not like a drop or thread.

b. **Total soluble solids (TSS) :** It is measured by using hand refractometer (range 58-92° Brix) by taking small quantity of the cooked mass, put it on the prism and observe the reading through eye piece, it should be around 68.5° Brix (%)

c. **Temperature test :** When the temperature of cooking mass reaches to 103-106° C, the jam is considered as ready.

d. **Ball formation test :** Place a drop of cooked jam in a glass of water. If a firm ball is formed at the bottom of glass, it will show that the jam is ready for setting.

e. **On the basis of weight :** the finished jam should be ½ of the initial volume/(wt).

Remember this

Analysis of Jam : Determination of invert sugar (glucose) : by titration method (using Lane and Enyon method) - 50 - 80% degree of inversion.

Estimation of acidity as citric acid : 0.5 to 0.7%.

Process flow chart for preparation of Fruit Jam

Selection of fruit
(ripe, deep coloured, high pectin, rich flavour, free from insects, pest, disease, damage and any blemishes)
↓
Clean, rins, grade
↓
Blanch
(Dip in boiling water whole fruit for 4-5 min. followed by cooling in cold water)
↓
Removal, cutting, removal of seeds, peels, stones, etc.
↓
Extraction of pulp using pulper/food processor
↓
Strain/sieve through sieve
↓
weigh the pulp, place it in an aluminium vessel
↓
Addition of sugar (pulp: sugar ratio 45:55)
↓
Cook using gas/steam
↓
Weigh of other ingredients as per the above recipe
↓
Addition of citric acid 0.6 to 1.0% of pulp taken, cook the mass up to ½ volume
↓
Addition of pectin powder 0.5 to 1.0% of the pulp taken.
↓
Cooking by intermitant stirring
↓
Check end point

1. Total soluble solids 68.5° Brix
2. Temperature 103-106°C
3. Sheet formation Test
4. Ball formation Test
5. Colour-deep orange red
6. Final stage shows excessive frothing in the vessel

↓

Addition of preservative
(Sodium meta-bi-sulphite 100 mg jam+colour 3-4 gm+essence 2-5 ml/kg jam)

↓

Fill the jam in sterilized hot jam type wide mouth glass bottles upto mouth leaving 1/4" space from the top

↓

While filling the hot thick mass in the bottle allow to flow slowly using long neck stainless steel funnel to avoid bubble formation

↓

Seal with plastic ring using hot air or pour on it melted wax, allow to cool over night

↓

Fix with screw type lid

↓

Label (as per FSSAI standards)

↓

Storage

↓

Quality evaluation (physical, chemical, microbial, sensory, etc)

6. **Filling and sealing :** Hot jam mass is filled in wide mouth sterilized hot glass bottles upto mouth. Place the hot bottles on a wooden plank while filling the hot jam. Allow them to cool to room temperature. Pour melted wax on the top of the jam at the mouth of the bottles. Cool it for over night or fix with plastic lid on the bottle mouth and seal it firmly using hot gun. Label it and store in a cool dry place.
7. **Quality testing :** Take out the samples periodically during storage period for observing the changes in quality parameters such as physical, chemical, microbial and sensory attributes.

II. Preparation of Tomato sauce :

Sauces are generally of two kinds and they are the thin and thick sauces. Thin souces mainly consist of vinegar extract of various flavouring materials like spices and herbs.

Thick tomato sauce is the sauce which does not flow freely and which is highly viscous. The thick sauces contain sugar, acid (acetic), and fruit or vegetable pulp. It should contain 1.2 to 3 percent acetic acid to ensure keeping quality. The acidity should not exceed 3.4%. The sugar content may usually vary from 15 to 30 percent according to the kind of sauce made. Usually malt vinegar is used.

In India, tomatoes are grown round the year. A large number of hybrid and selected varieties are grown every year. For processing purpose, the tomatoes should contain TSS>6° brix, thick pulp, less seed and peels, less poly-phenol oxydase enzymes and deepred tomato colouring pigments with characteristic flavour.

Amongst, the tomato sauce, thick, pungent hot, spicy is preferred by a large population. The FSSAI (PFA) has given the specifications for tomato sauce are as under:

Tomato sauce having acidity 1.2%, TSS > 15^0 brixfree from fungal attack or blemishes, added only fruit pulp, juice, sugar, spices, salt, vinegar, citric acid, acetic acid, malic acid, onion, garlic, permitted colours, etc.

Fig. 14.3 Tomato sauce

Process flow chart for tomato sauce

Selection of fruit (fully ripe, free of insect, pest, disease, damages/injuries).

↓

Blanch the fruits in boiling water for 5-7 min (we get cracks on tomato peels)

↓

Removal and extraction of hot tomato pulp using pulper

↓

Weigh the pulp and other ingredients as per recipe (1/3rd sugar and salt 1 to 4 ingredients)

↓

Place in aluminium-copper based vessel

↓

Cook at medium flame

↓

Continue stirring intermitantly to avoid charring at the bottom

↓

Grind the onion shreds, garlic, ginger in to fine paste, add all spices powder (*garam masala*) 6 to 11 ingredients

↓

Tie the mixture in a muslin cloth piece loosely.

↓

Dip it in the cooking vessel, to get spicy taste

↓

Add the remaining sugar, salt and mix well (continue cooking)

↓

Concentrate the mixture up to 1/2 of the volume

↓

Add guar gum @ 2-4 gms/kg, mix well

↓

Check the done stage

- Check TSS >15^0 - brix (minimum)
- Acidity - 1.2% (acetic acid)
- Taste - Spicy, pungent, little hot, sweet-sour
- Salt - 1.3-3.4%
- Colour - Tomato red with bright luster
- Consistency - Thick (thickening agent 0.1-0.2% by weight.)

↓

Add preservatives

i) Sodium benzoate @ (100mg/kg)

ii. Acetic acid 2 - 3 ml/kg

↓

Fill hot in sterlized hot glass bottles upto neck

↓

Capping/Sealing

↓

Dip in boiling water for about 25-30 min

↓

Removal, Cool under tap water

↓

Label and storage

Recipe : Tomato sauce

No	Ingredients	Qty
1	Tomato pulp	1.000 kg
2	Sugar	75-100 gm
3	Salt	10-12 gm
4	Chilli powder red	3-5 gm
5	Ginger cut pcs	2-3 gm
6	Onion chopped	5-10 gm
7	Cinnamon	1-3 gm
8	Cardamom (spicy)	3-5 gm
9	Cumin	3-5 gm
10	Black pepper	3-5 gm
11	Cloves	3-5 gm
12	Acetic acid/vinegar	2-3 ml/125 ml
13	Sodium benzoate (Preservative)	100 mg
14	Guar gum (thickening agent)	2-4 gm
Process - Follow the steps given in the above flow chart		

III. Pickles

The process of preservation of food in common salt or vinegar is called pickling. Spices and edible oil also may be added to the product. Pickles of various kinds are well known throughout India and many parts of the world. Some of the typical Indian pickles are made from mango, lime, turnip, cabbage, cauliflower, etc. and have become popular in several countries. Pickles have also good export market.

Pickles are good appetizers and add to the palatability of a meal. They aid digestion by stimulating the flow of gastric juice. The food value of cucumber pickle exceeds that of eggs, rice, onion and tomatoes.

The Indian pickles are prepared with oil. Mustard, rape seed and sesamum oils are generally used.

Preparation of Mango Pickle :

Raw Materials : Raw materials used in pickling should possess certain definite characterstics.

1. **Salt :** The common salt is most suitable, preferably use the crystal salt.
2. **Fruit pieces :** Firm, mature, raw mango fruit, light acidity, low in poly phenol oxydases enzymes causing browning, high starch, less sugar.
3. **Sugar :** Cane sugar or jaggery can be used a little to taste.
4. **Spices :** The spices used depend on the taste and liking of the people. However in general the mix spices used are clove, coriander seed, pepper, mustard seed, cardamom seed, mace, ginger, onion, garlic, cinamon, all spices, etc., in the form of powder-mixture, (commonly known as *garam masala*). Pickles are added with red chilli powder, turmeric powder, etc.
5. **Oil :** The oil is used to improve taste, keeping quality and appearance of pickles. Refined oil of any edible seed may be used. Mustard oil is used for red colour; refined cotton seed oil for checking rancidity in pickles; some portion of oil is used for sauting of the spices before mixing them in pickles.
6. **Vinegar/ acetic acid :** Vinegar contains acetic acid up to 3-5% and used in pickles to improve taste, check the growth of micro-organisms (spoilage), added just before filling the pickle in containers, it acts as preservative.
7. **Preservative :** Sodium benzoate is added in pickles for checking the growth of micro-organisms, after dissolving the powder, it forms benzoic acid which has more efficacy against the micro organisms, used @ 250 mg/kg pickle.

Recipe - Mango Pickle

Mango (raw) pieces	1 kg
Salt	226 g
Fenugreek ground powder	28 g
Turmeric powder	28 g
Red chilli powder	28 g
Black pepper	15 g
Fennel seed	28 g
Garam Masala	28 g
Acetic acid	1-2 ml
Sodium Benzoate	2-3 g
Mustard	50 g
Asafoetida	5 g

Remember this

Methods of Preservation :

1. Moisture Removal - Drying
2. Heat Treatment -Pasteurization
3. Low Temperature - Freezing
4. Chemical Preservatives -Class I & Class II
5. Asepsis - Advanced packaging
6. Irradiation - gamma rays
7. Removal of air - Vacuum
8. Fermentation - Acetic acid

Process flow chart :

Selection of raw mango

↓

wash, clean, grade

↓

Cut into desired size pieces, weigh

↓

Weigh all ingredients, clean and grind

↓

Take little oil in clean vessel/pan, heat it and add mustuerd seed, turmeric powder, all *garam masala* powder, fenugreek, mustard dal, stop heating

↓

Put the cut mango pieces, add salt, mix well

↓

Add sodium benzoate, acetic acid (vinegar), mix well lightly, add all oil, again mix

↓

Check the test for sourness, pungency, salt, oil, consistency, colour, etc.

↓

Fill in the sterilized glass/standy pouch/china containers upto neck, press it, store at clean dry place as such for about 25-30 days

↓

Mix lightly and take out sample for cut out test (colour, taste, flavour, consistency)

Fig. 14.4b Mixed pickle

Fig. 14.4a Mango pickle

Exercise

Q. 1 Answer the following questions.

A. Select the appropriate alternative and complete the following statements.

1. The Govt. of India enacted a comprehensive food act known as .....

   a. PFA b. ISO

   c. FPO d. FSSA

2. Preservation of food can be achieved by keeping out micro-organisms by sanitary handling known as .....

   a. pasteurization b. asepsis

   c. sterilization d. canning

3. The growth and activity of micro-organisms (spoilage) in tomato sauce is controlled by use of .....

   a. irradiation b. filtration

   c. sodium benzoate d. salt

4. In fruit jam making process the preservation action is carried out by using.....

   a. SO_2 gas b. high sugar

   c. pectin powder d. citric acid

5. In pickle making preservation is mainly achieved by addition of .....

   a. salt b. sugar

   c. colour d. water

B. Make the pairs.

Group 'A'		Group 'B'	
1.	Mango pickle	a.	Pectin rich fruit
2.	Tomato sauce	b.	Citric acid
3.	Fruit jam	c.	Sulphuric acid
		d.	Vinegar
		e.	Salt and oil

C. Find the odd one out.

1. Jam, Jelly, Pickle, Juice
2. Guava, Papaya, Mango, Tomato
3. Sodium benzoate, Acetic Acid, Citric acid, Guar gum
4. Cinnamon, Cumin, Clove, Sugar
5. Sheet test, Flake test, Ball test, Sweet taste

D. Write true or false.

1. The principle underlying in keeping out micro-organisms by sanitary handling is known as asepsis.
2. Preparation of value added products from agricultural commodities will reduce the post harvest losses.
3. Total soluble solids (TSS) in jam preparation is measured by thermometer.
4. Packaging of fruit juices by tetra pack technology helps in preservation.
5. The food products order, 1955 regulation is concerned to fruit and vegetable preserved products, now it is under FSSA, 2006.

Q. 2 Answer in brief.

1. Enlist the various principles of food preservation.
2. List the various methods of preservation of food.
3. What is the full form of FSSAI.
4. Write in brief about quality testing of fruit jam.

Q. 3 Answer the following questions.

1. Give the process flow chart for preparation of fruit jam.
2. What are the functions of FSSAI.
3. Enumerate the method of preparation of tomato sauce.
4. List the various ingredients required for mango pickle preparation.
5. What are the various methods of judging end point of fruit jam.

Q. 4 Answer the following questions.

1. What are the ingredients used for making fruit jam ?
2. What are the ingredients used for making tomato sauce ?
3. What are the steps in making pickles ?
4. List the various preservatives used in food.

Q. 5 Answer the following questions in detail.

1. Write the importance of preservation of food by checking/ killing the micro-organisms and enzymes.
2. Write flow sheet for preparation of mango jam.

Q.6 Answer the following questions in detail.

1. Explain the principles of preservation.
2. Write in detail complete procedure of jam preparation.

Activity

Prepare Pickles at your home.

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Agriculture Science and Technology
Practical Syllabus
Std - XII

List of Practicals

1. Calculation of plant population for given area.
2. Calculation of actual quantity of fertilizers for different crops and calculation of unit value (cost of fertilizer per kg)
3. Practicing different methods of fertilizer application for wheat, paddy and soybean.
4. Practicing layout of sugarcane planting and set treatment.
5. Practicing asexual methods of propagation viz: cutting, layering, budding and grafting.
6. Emasculation and pollination in cotton.
7. Prepartion of cropping scheme and calender of operations.
8. Practicing various nursery operations.
9. Evaluation of seedlings after germination and calculation of seed germination percentage.
10. Seed treatment with chemicals and biofertilizers.
11. Use of computer, internet and smart phones for collection and communication of agricultural infromation.
12. Preparation of mushroom pickle.
13. Practicing various green house operations.
14. Prepartion of jam, sauce and pickles.
15. Practicing post harvest operations in handling of agricultural produce.
16. Study of cost of cultivation of some crops.
17. Awareness in purchasing, storage and application of agricultural inputs.
18. Preparation of crop cafeteria and writing of reports in journal.

Visits

- At least four visits from the following list should be conducted.
- Separate section of visit report should be written in the journal.

1. Visit to tissue culture unit.
2. Visit to hightech nursery.
3. Visit to seed processing plant/seed testing laboratory.
4. Visit to polyhouse.
5. Visit to Agrotourism centre.
6. Visit to organic farming unit.
7. Visit to agriculture produce market committee (APMC).
8. Visit to allied agriculture enterprises (Sugar factory, Jaggery plant, *Dal* mill, Oil extraction plant, Processing industry).

Project work

Complete any one of the following projects.

1. Prepartion of seed album.
2. Collection of farm records.
3. Prepartion of seedling for transplanting.
4. Collection of mushroom samples.
5. Prepartion of album of diseased plant parts.

Agriculture Science and Technology

Specimen question paper (Practical) std - XII

Time - 3 hrs **Marks - 30**

Q. 1 Identification **6**

A. Identify

B. Subquestion

Note : In all 6 Specimens should be kept, each carrying 1 mark (1/2 mark for identification and 1/2 mark for correct answer of subquestion)

Q. 2 Solve any two of the following. **6**

A. Mathematical problem from practical syllabus
(viz. plant population/seed germination percentage)

B. Mathematical problem from practical syllabus
(viz. quantity of fertilizers/unit value of fertilizers)

C. Theoractical question from practical syllabus.

Q. 3 Practical exercise (any one) **6**

A. Layering/budding/grafting

B. Emasculation and pollination in cotton

C. Fertilizer application

D. Evaluation of seedlings after germination

E. Use of computer or smart phone and internet.

F. Layout of sugarcane planting or set treatment

G. Seed treatments with chemicals and bio-fertilizers

Q. 4 A. Viva-voce - 02 **6**

B. Journal - 04

Q. 5 A. Project report - 03 **6**

B. Visit report - 03

Any one report on project and the visit actually given by the student during the aca demic year.

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4. Principles of Agronomy - J. Yellamanda Reddy, G. H. Sankara Reddy - Kalyani Publishers.
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22. Commercial Production of Horticultural Crops - H. N. Samaddar, Naya Udyoy, Kolkata.
23. Basic Horticulture - Jitendra Singh, Kalyani Publishers, Ludhiyana.
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25. Introductory Ornamental Horticulture - J. S. Arora, Kalyani Publishers.
26. A Class Book of Botany - A. C. Datta, Oxford Publication.
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29. Hybrid seed production in cotton- CICR Techinal Bulletin No. 35 Nagpur By B. M. Khadi, V. Santhy.
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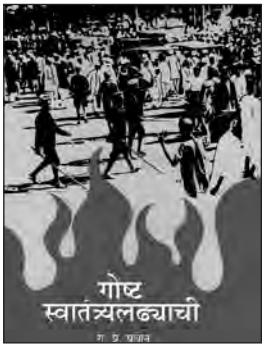

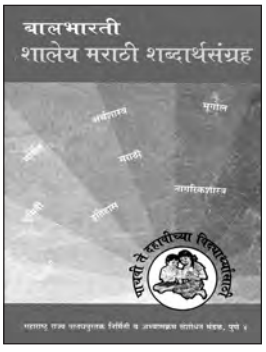

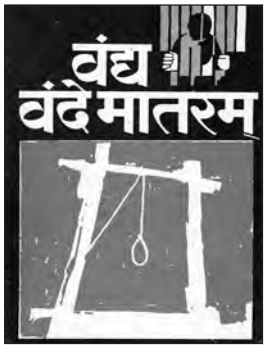

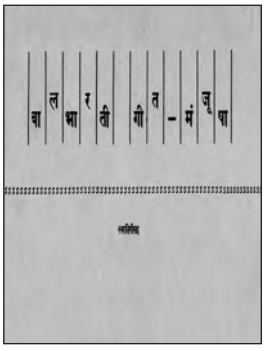

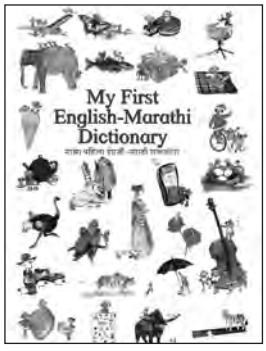

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