

**Vocational Higher Secondary  
Education (VHSE)**

**Second Year**

**AGRICULTURE SCIENCE AND  
PROCESSING TECHNOLOGY**

*Reference Book*



Government of Kerala  
Department of Education

State Council of Educational Research and Training (SCERT),  
KERALA  
2016

## LIST OF CONTRIBUTORS

### Participants

**Preeti S V**, Vocational Teacher (Agri), GVHSS (B), Kottarakkara

**Sidha P S**, Vocational Teacher (Agri), GVHSS (B), Kottarakkara

**Divya S**, Principal, GVHSS, Vithura

**Dr. Vijayasree V**, Vocational Teacher (Agri), GVHSS, Kulathur

**Smija P K**, Vocational Teacher (Agri), GVHSS, Thamarassery

**Sreejaya K C**, Principal, GVHSS, Thirumarady

**Reshmi R**, Vocational Instructor, GVHSS, Kulathur

### Experts

**Prof.C.K.Vani Devi**, HOD (Rtd.), PG and Research, Dept.of Botany,  
Sir.Syed College, Thaliparamba

**Dr. P R Geetha Lekshmi**, Asst Professor, KAU, Vellayani

**Dr.Chithra Vijayan**, Asst.Professor, S.N.College, Kollam

**Levakumar V**, Rtd Deputy Director, VHSE

### Academic Co-ordinator

**Manoj.K.V**, Research Officer, SCERT, Thiruvananthapuram

*Prepared by :*

**State Council of Educational Research and Training (SCERT)**

Poojappura, Thiruvananthapuram 695012, Kerala

Website : [www.scertkerala.gov.in](http://www.scertkerala.gov.in) e-mail : [scertkerala@gmail.com](mailto:scertkerala@gmail.com)

Phone : 0471 - 2341883, Fax : 0471 - 2341869

Typesetting and Layout : SCERT

© Department of Education, Government of Kerala

## **Foreword**

Dear Learners,

This book is intended to serve as a ready reference for learners of vocational higher secondary schools. It offers suggested guidelines for the transaction of the concepts highlighted in the course content. It is expected that the learners achieve significant learning outcomes at the end of the course as envisaged in the curriculum if it is followed properly.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of this reference book has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

**Dr. P. A. Fathima**  
**Director**  
**SCERT, Kerala**

Sl.No.	Content	Page No.
1	About the course -----	5
2	Major skills -----	7
3	Syllabus -----	8
<b>MODULE III APPLIED AGRICULTURAL TECHNOLOGY</b>		
4	Overview of the module III -----	10
5	Unit 1-Hi-Tech Agriculture -----	11
6	Unit 2-Organic farming and certification -----	35
7	Unit 3-Food safety measures and certification -----	50
8	Unit 4-Agri- Enterprises -----	59
9	Unit 5-Farmer Support Services -----	76
10	Extended activities -----	111
11	List of Practicals -----	112
<b>MODULE IV POST HARVEST AND PROCESSING TECHNOLOGY</b>		
12	Overview of the module IV -----	113
13	Unit 1 - Post harvest technology -----	114
14	Unit 2 - Post harvest Handling -----	118
15	Unit 3 - Post harvest technology of major crops -----	136
16	Unit 4 - Agro-Processing Technology -----	152
17	Unit 5 - Entrepreneurship Development in Agri-based processing industries -----	167
18	Extended activities -----	180
19	List of Practicals -----	181
20	References -----	182
21	<b>Appendix I</b>	
	<b>Appendix II</b>	

## **ABOUT THE COURSE**

In recent times agricultural sector in Kerala confronts an array of issues which is undeniably a matter of contemplation, especially in view of livelihood and sustainability of the sector in the state. The youth moving away from agriculture to comparatively more remunerative fields poses serious threats to the agrarian future of the state. An asymmetric socio-economic regime with excessive stress on consumerism will also prove to be detrimental in the long run. Viewed from this context, a paradigm shift in this regard, especially placing the agricultural sector in the upfront of the present socio-economic structure of the society, requires concerted effort.

Huge post-harvest losses and lack of secondary agriculture are major threats to our economic, social and nutritional security. Even though we have made tremendous improvement in production and productivity of agricultural crops, about 30 to 40% of fruits and vegetables are still lost due to poor post-harvest handling.

‘Secondary agriculture’ is adding value to the basic agro commodities to allow farmers to get better returns from their harvest, create new jobs in rural sector to grow rural economy which is entirely based on agriculture. Thus secondary agriculture provides ample scope for new job opportunities in all steps of value addition throughout the supply chain right from production, harvesting, Post-harvest handling practices, packaging, labelling, marketing, storage, primary processing and product development through secondary processing. This will provide better returns to farmers and creation of employment with off spin benefits of reduction of Post harvest losses and food and nutritional security.

For the prosperity of our nation, a successful transition from primary agriculture to secondary agriculture, creating new jobs and building wealth, is inevitable, and all developed countries have succeeded in this regard. Agro processing industries have the potential to generate directly significant employment in production activities and also indirect employment through its forward and backward linkages.

Kerala’s revised educational curriculum in Agriculture Science and Processing Technology, in its essence, holds this perception. It comprehensively covers the basic agricultural aspects by giving emphasis to Agri-Field Techniques, Crop Production Technology, Applied Agricultural Technology and Post-harvest and processing Technology. The renewed curriculum touches upon all the important aspects of agricultural technologies in a structured and phased manner while giving sharp focus towards the need for organic farming and give emphasis to Post-harvest and Processing Technology. The course is designed in such a way to train the students

in the above aspects to satisfy the new employment opportunities associated with secondary agriculture and also to create successful entrepreneurs.

The current course structure also gives paramount importance to inculcating the entrepreneurship skill in students pursuing vocational education in agriculture. The scope and potential of the agricultural sector in this state lies beyond any quantifiable magnitude. Nevertheless, for the realistic manifestation of the existing potential, we need to revamp the conventional thoughts and practices in accordance with the advances made in agricultural sector. The system envisages a vibrant and sustainable agrarian sector in the state through equipping the youth with advanced technological and entrepreneurial skills.

### **Objectives**

The course has the following objectives:

- To equip the students in starting commercial enterprises in the field of Agriculture.
- To create awareness about environmental hazards due to indiscriminate use of pesticides and the need for organic farming.
- To practice organic farming and to familiarise the learners with organic certification procedures.
- To practise mass production of bio control agents and preparation of bio pesticides
- To develop skills in field level identification of pests and diseases of major crops and to practise their eco-friendly management.
- To develop skilled technicians in the area of post-harvest handling (sorting, grading, pre-treatments, packaging and storage of crop produces).
- To develop skills in preservation of food products and preparation of various value added products.
- To develop the required skills and competencies among the students to be successful entrepreneurs.

### **Major Skills (with Sub Skills)**

#### **I. Skill in High-tech Agriculture**

- Construction of Rain shelter.
- Cultivation of crops in rain shelter and poly houses.
- Seed bed preparation.

#### **II. Skill in organic farming**

- Setting up of organic vegetable garden
- Preparation of botanicals and organic nutrient solutions
- Mass multiplication and application of biocontrol agents
- Method of application of biofertilizers (Rhizobium)

#### **III. Skill in pesticide residue elimination through domestic practices**

#### **IV. Skill in running successful agri-enterprises**

- Mushroom and spawn production.
- Preparation of value added products from mushroom
- Vegetable seed production.
- Apiculture unit.
- Identification of ornamentals
- Landscaping and its maintenance
- Lawn making and its aftercare
- Flower arrangement- Fresh and dry flower.
- Preservation of plant materials

#### **V Skill in identification of pest and diseases of major crops**

#### **VI Skill in suggesting ecofriendly management practices for controlling major pest and diseases.**

#### **VII. Skill in post harvest handling (Sorting, Grading, Pretreatments, Packaging and storage of crop produces) to enhance shelf life.**

#### **VII. Skill in preservation of food products and preparation of various value added products.**

**SYLLABUS****MODULE III****APPLIED AGRICULTURAL TECHNOLOGY****Unit 1 Hi-Tech Agriculture (69 periods)**

Protected cultivation - definition - advantages – scope and constraints in Kerala – Green House/ poly house– definition – classification based on shape, structure and cladding material – components of green house - Growing media and bed preparation- list of crops cultivated commonly in protected cultivation- drip irrigation, fertigation- automated climate regulation in protected cultivation - Mistifiers, foggers- cultivation practices of yard long beans, cucumber and rose- rain shelter cultivation- New trends in high-tech agriculture techniques like aquaponics, aeroponics and other soil less cultivation practices.

**Unit 2 Organic farming and certification (55 periods)**

Concept - importance with reference to global scenario – scope in Kerala – organic farming principles and practices - Organic plant nutrient management ,compost, biofertilizers ,Organic plant protection, Biocontrol agents, Botanicals- plant growth promoting preparations- Organic certification procedure – agencies involved.

**Unit 3 Food safety measures and Certification (72 periods)**

International scenario on food safety -FSSAI – Good Agricultural Practices -GAP definition, objectives, principles and certification- GLOBALGAP -HACCP—GMP -GHP- Hazards associated with production flow-biological, physical and chemical -residual toxicity - Maximum residue limit – waiting period concepts – Biomagnification hazards. Pesticide residue elimination methods of common food materials with special emphasis to fruits and vegetables.

**Unit 4 Agri- Enterprises (84 periods)**

Mushroom cultivation –Spawn production and Cultivation of oyster mushroom- Value addition in mushroom-Apiculture – Importance and Scope- Honey bee species- Honey bee castes, General Apiary management Practices- collection of Honey - value added products from Bee keeping- pest and disease.-Sericulture Technology-Vegetable seed Production-Landscaping- Basic principles of landscape design- Lawn making– After care and management-Flower arrangement

**Unit 5 Farmer Support Services**

**(60 periods)**

Services from Krishibhavan - agriclincs - Concept of IPDM-Identification of pest – Nature of damage and diseases–symptoms and management – Rice, Coconut, Rubber, Banana, Mango, Cashew, Pepper, Solanaceous vegetables – cucurbits, cowpea, Amaranthus, Bhindi - Agri-input centers – biopharmacy – Various Schemes under Dept of Agri-ICT enabled extension services in Agriculture – Practicing e – crop doctor and other related software for Pest and disease diagnosis – Familiarization of popular agri extension related softwares- crop decision support system – pest, disease and nutrient deficiency diagnosis softwares – Kisan Call Centres – Krishi Vigyan Kendras - NGOs

**MODULE IV**

**POST HARVEST AND PROCESSING TECHNOLOGY**

**Unit 1 Post harvest Technology**

**(30periods)**

Post harvest Technology-Concept - Importance with reference to agricultural products - Present scenario with reference to World, India and Kerala- Scope- extent of Post harvest losses – causes of Post harvest losses – salient features of Post harvest management

**Unit 2 Post harvest Handling**

**(50 periods)**

Steps in Post harvest Handling – Harvesting stages – maturity indices of fruits and vegetables - sorting and Grading- Precooling – Pretreatments- Importance of packing – Types of Package used for packing of commercial products - Methods of storage — transportation

**Unit 3 Post harvest technology of major crops**

**(114 periods)**

Post harvest technology and product diversification aspect of important crops like Cereals – Rice; Fruits – Jack fruit, mango, banana; Spices – Ginger, Pepper, Turmeric; Plantation crops - Coconut, Cashew; Commercial Flowers

**Unit 4 Agro-Processing Technology**

**(116 periods)**

Concept– steps and Principles - methods of preservation - important commercial methods like - Canning, preparation of Jam, Jelly, Pickles, Squash, Marmalade, etc.

**Unit 5 Entrepreneurship Development in Agri-based processing industries**

**(30 periods)**

Scope of self-employability – Present scenario - licensing and FSSAI registration aspects -list of machineries used in processing industry- marketing strategies.

### **MODULE III**

## **APPLIED AGRICULTURAL TECHNOLOGY**

Technology has played a big role in developing agriculture as industry. This module presents promising technologies that are going to give a new momentum to agriculture and farmer welfare. Among the promising technologies high tech agriculture and organic farming are detailed in the module.

The technology development has necessitated introduction of specific standards and certification to build up consumer confidence in farmer produce and products of agro based industries. Topics on organic certification, food safety measures and food certification are intended to give awareness and knowledge on international and national protocols that assures conformation to the prescribed standards.

The module also attempts to strike a proper balance between the technological needs of farmers and the job opportunities for students in agrobased industries. The unit on Agri enterprises emphasizes the skill development of learners in selected micro enterprises that support farm income in a sustainable way and equip them to give inputs on farm planning.

In the changing era of agriculture, farmers look for more environment-friendly and cost-efficient crop inputs and decision support systems. The module exposes learners to Agri input centers and ICT- enabled farmer support services and equips them how to act as an interface between technology and farmers.

## UNIT 1

### High Tech Agriculture

#### Introduction

The unit focuses on technology intensive agriculture, with special emphasis on Kerala. Structures in protected cultivation, greenhouse, polyhouse and rain shelters and the crop management aspects like drip irrigation, fertigation, temperature and humidity management in protected cultivation are included in this unit. Learners also get practical exposure in high tech agriculture in cultivating Yard long bean, Cucumber and Rose. Emerging fields in high tech agriculture like soilless cultivation techniques are also mentioned.

#### Learning outcome

The learner :

- defines the concepts of protected cultivation and its advantages in the present scenario of Kerala and list out the major problems.
- defines green house and classify them based on shape, structure and cladding material and list the components.
- lists the crops grown under protected cultivation and acquire skill in preparation of media.
- understands the methods of irrigation in Protected cultivation; drip irrigation and fertigation
- understands the climate control system of a green house unit and familiarize with foggers, filters and mistifiers in greenhouse.
- familiarizes with the cultivation practices of yard long beans, cucumber and rose.
- practices rain shelter cultivation.
- understands the concept of aeroponics, hydroponics and other soil less cultivation.

### 3.1.1 Protected cultivation - definition, advantages, scope and constraints in Kerala

Protected cultivation refers to the cultivation of crops in a climatologically isolated structure. Here five climatic factors must be controlled ie solar radiation, temperature, CO<sub>2</sub> concentration, humidity, air movements

#### Advantages

- protection of plants from wind, rainfall, excess solar radiation, temperature etc
- yield 10-12 times higher than that of open field
- modern techniques of hydroponics, aeroponics etc are possible
- reduce pesticide use
- water and fertilizer requirements are limited and easy to control
- Crops can be cultivated during off-seasons too
- Better quality of produce
- Efficient use of resources
- Nursery raising and hardening of plants

#### Constraints of Protected cultivation in Kerala

- High initial investment coupled with high operational cost
- Unavailability of up-to-date knowledge among the green house cultivators
- Insufficient knowledge and research on cultural techniques
- Non availability of good quality planting materials from genuine sources
- Shortage of trained workers for performing cultural operations
- Failure of the crop leads to complete failure of the entire system due to non availability of efficient insurance coverage
- Problems in marketing of the produce- Rapid fall in prices during market surplus ,lack of organization for marketing and inadequate export standards

#### Scope of hitech cultivation in Kerala

- As protected cultivation is more remunerative, not much laborious and following advanced technology , it attracts educated unemployed youth of Kerala
- Labour wages in Kerala is 3-4 times higher than neighbouring states. Labour saving due to adoption of micro irrigation and fertigation (66-77%).

- Open well based home stead farms in Kerala. Hence quality of water is excellent
- Average land holding size varies from 0.01 to 0.025 ha. Most of the farmers are wage seekers. Hitech horticulture with less labour involvement is easily adaptable to literate farmers in the State.
- Adoption of micro irrigation in coastal areas facilitates the chance of using saline water for irrigation without much loss in production.
- Fertigation and Microirrigation facilitates effective utilization of water and nutrients and avoid contamination of ground water

#### **Assessment activity**

Student response—Collect student response to a set of questions based on Animated CD show and PowerPoint presentation on protected cultivation.

### **3.1.2 Green House/poly house-definition and classification**

#### **What is green house?**

A polyhouse and green house refers to the same. Traditionally the green houses were constructed using wooden frames where glass was used as the cladding material. Polyethene, being the most popular greenhouse material the green houses were renamed as polyhouses. The modern green houses are built on a steel frame and covered with plastic. In general flowers, vegetables and fruits are produced in a green house. It is a frame work structure covered by transparent material inorder to protect the crops from adverse climate conditions such as wind, rain, radiation, rainfall etc. It provides a micro climate surrounding the crops that helps for maximum production. It also provides higher CO<sub>2</sub> concentration to increase the production. A poly house consists of its structure, cladding material, gutters, ventilation and climate control systems

#### **❖ Site selection**

1. Soil with PH of 5.5-6.5 and EC of 0.5-0.7ms/cm
2. Availability of continuous source of quality water
3. Selected site should be pollution free and elevated
4. Transportation facility to the near by markets should be there

#### **❖ Orientation of Green houses**

Correct orientation can provide good environmental condition inside the Green house. The criteria relevant to green house orientation are;

1. The light levels in green house should be adequate and uniform for crop growth.
2. The prevailing winds should not adversely affect with structure or operation of the unit.

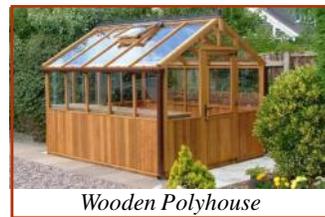
Single span green houses are to be constructed in the E –W orientation.

Multispan Green houses are to be constructed in the N –S orientation.

❖ **Classification of green house**

■ **Based on shape**

1. Multispan
2. Sawtooth multispan
3. Wide span
4. Uneven widespan
5. Pitched saw tooth



*Wooden Polyhouse*

■ **Based on material of structure**

1. Galvanized Iron structure (GI structure)
2. Mild Steel structure (MS structure)
3. Wooden polyhouse



*Glass House*

■ **Based on cladding material(covering material)**

1. Flexible cladding material eg polythene (UV Stabilized sheet)
2. Rigid cladding material eg. Glass House
3. Shade net as cladding materials eg; shade house



*Shade net*

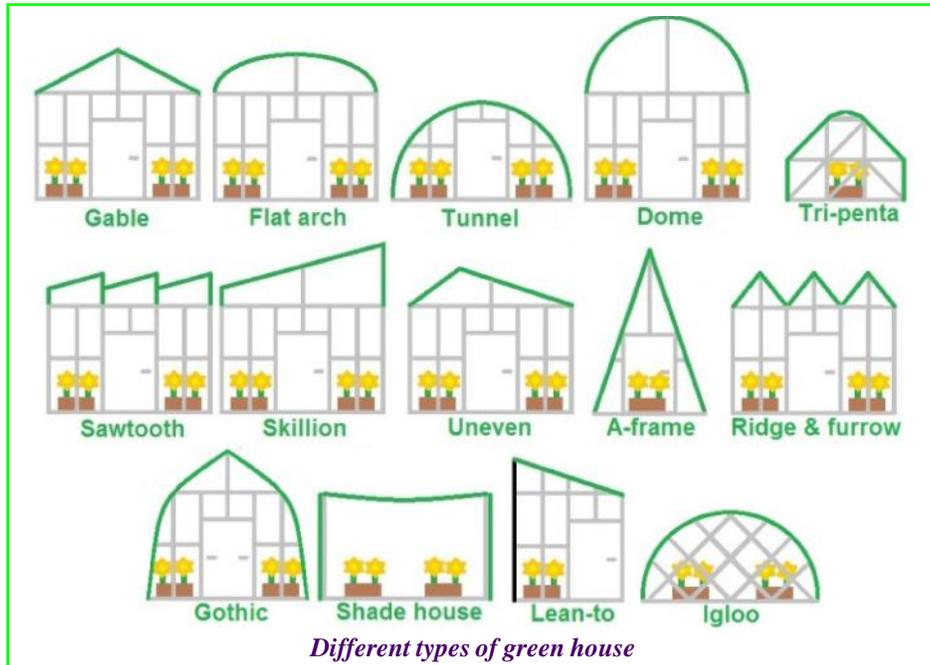
■ **Based on number of spans**

1. Free standing or single span
2. Multispan or ridges and furrow



*Multispan*

## Different types of Green house



### Components of greenhouse

- Roof** : transparent cover of a green house.
- Gable** : transparent wall of a green house
- Cladding material** : transparent material mounted on the walls and roof of a greenhouse
- Rigid cladding material** : cladding material with such a degree of rigidity that any material deformation of the structure may result in damage to it. eg. Glass
- Flexible cladding material** : cladding material with such a degree of flexibility that any material deformation of the structure will not result in damage to it. eg. Plastic film
- Gutter** : collects and drains rain water and snow which is placed at an elevated level between two spans.
- Column** : vertical structure component carrying the green house structure
- Bracings** : To support the structure against wind
- Arches** : Component supporting covering materials
- Span width** : Center to center distance of the gutters in multispans houses

## Properties of cladding material

The cladding material used in Poly houses are usually made up of Low Density Poly Ethylene(LDPE) sheets. It should have the following properties.

### 1. UV Stabilization

The sheet stabilizes the harmful UV radiation from entering into the Green house and allow more transmission of light. It also helps against degradation of the sheet due to solar radiation.

### 2. Diffused film

The sheet allows diffused light to enter inside, which does not allow the shadow formation of the top layers of leaves on to the lower layers of leaves. A diffused light is like a light from tube light wherein you can see everything but no shadow is formed.

### 3. UV Blocker/Antivirus film

A UV blocker does not allow the UV radiation (up to 381 nm ) to enter the green house. Insects have compound eyes and they can see in the UV range as well as in the visible range. Since insects cannot see many of the signals (due to blockage of UV rays) under UV blocker film,a considerable decrease in insects have been observed.Insects are carriers and transmitters of many viruses and since this film reduces insect activity, it is also called Antivirus film.

### 4. Anti drip

Antidrip reduces surface tension of condensing water vapour.Instead of dripping on top of plants, this helps in trickling of water down the plastic walls of green house.

### 5. Anti dust

It is created by giving an extremely smooth outer surface. Low dust accumulation will result in more light transmission and thus increase production.

## Assessment activities

1. Prepare a chart on classification of protected cultivation structures.
2. Prepare a photo album of structures used in protected cultivation.

### 3.1.3 Growing media and bed preparation and list of crops cultivated commonly in protected cultivation

#### Growing media and bed preparation

##### Media preparation

For cultivating crops in green house proper media need to be prepared. Mix red soil (70%), FYM (20%), Rice husk / sand (10%) and irrigate for 3 days. Also other organic manures such as neemcake, bonemeal, basal dose of fertilizer according to crops is to be added before bed preparation.

##### Soil sterilization

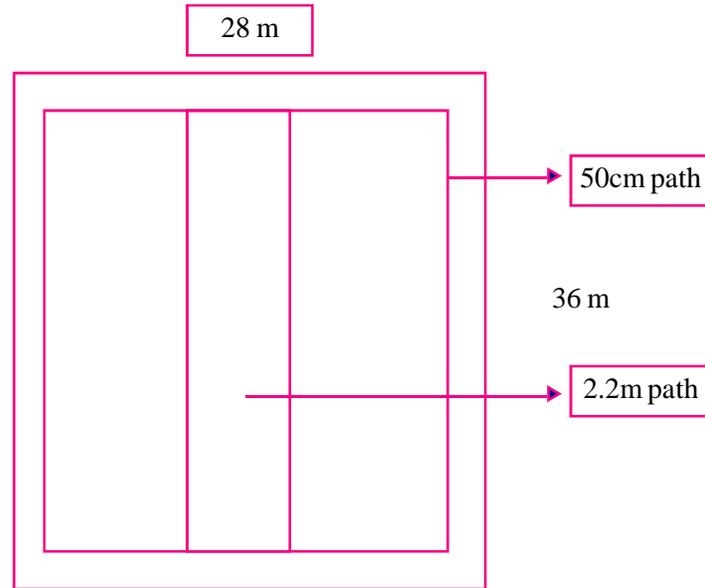
It is a process of destroying pests, diseases and weeds. Microorganisms can be killed, inhibited or removed by physical (steam sterilization/sun radiation) or chemical methods (Formaldehyde @ 8lit/100m<sup>2</sup> or methyl bromide @ 20g/m<sup>2</sup>)

Requirement for 1008m<sup>2</sup> green house

- Formalin- 80 L
- Water- 800 L
- Plastic barrel – 200 L capacity
- 100 micron black plastic sheet

##### Procedure

- Loosening the soil
- Wet the soil inside the green house upto the field capacity
- Close the green house completely
- Cut the plastic into 4m size
- Drench the soil media with formalin and cover it immediately with black polythene sheet and leave it for 5 days
- On the 6<sup>th</sup> day open the side ventilation and remove the plastic
- Irrigate the soil with water 100 L/m<sup>2</sup> and leave it for 3days
- Planting is done 2 weeks after drenching



Note: Not used in a standing crop

Bed size varies according to the crops grown.

Procedure of media and bed preparation (Flow chart)

Mixing red soil and FYM → Adding rice husk → wetting of media  
 Soil Sterilization → Washing the media → Bed preparation

### Plastic mulches

Mulching is the process or practice of covering the soil/ground with plastic sheet to make more favourable conditions for plant growth. It prevents the direct evaporation of moisture from the soil and thus limits the water losses and conserves moisture. Mulches develop a microclimatic underside of the sheet, which is higher in carbon dioxide due to the higher level of microbial activity

### List of crops cultivated in Poly house

Flowers : Rose, Orchid, Gerbera, Aster, Lilies, Marigold, Chrysanthemum, Carnation, Anthurium

Vegetables : Cucumber, Yardlong Bean, Tomato, Chillies, Brinjal, Cabbage, Cauliflower, Broccoli, Brussels, Celery, Onion, Bellpepper, Okra, Radish, Melon, Amaranthus, French bean, Palak, Lettuce, etc.

Fruits : ..... Banana, Watermelon

Foliage Plants and Ornamentals

### Practical activity

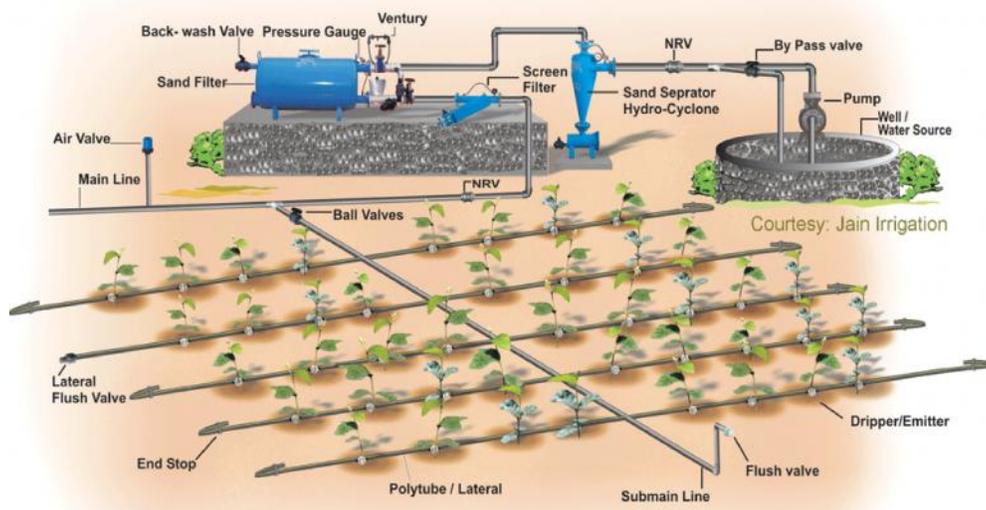
1. Media and bed preparation- Method demonstration

### Assessment activities

1. Prepare a flow chart of media and bed preparation in poly house.

## 3.1.4 Irrigation in Protected Cultivation - Drip Irrigation and Fertigation

Drip Irrigation is the common method of irrigation used in protected cultivation.



### Components of Drip Irrigation

#### 1. Water Source

The source of water should be open wells, borewells, canals, rivers, reservoirs etc

#### 2. Pump

The water from the source has to be supplied under appropriate pressure and discharge using Pumps.

#### 3. Filters

The filters are heart of the drip irrigation system. The filters remove sand, soil particles, algae, fertilizer chemical residues etc in order to avoid clogging of the drippers. Filters are mainly of two types

- Primary Filters- Sand filters and Hydrocyclon filters
- Secondary filters- Screen filters and Disc filters

**a. Primary Filters**

- a. Sand Filter- Sand filter contain sand made up of silica and is used to remove all types of suspended impurities and organic matter in the irrigation water.
- b. Hydrocyclon filters- This filter is rarely used in India It is used only for bore well water that contains high quantity of sand.

**b. Secondary filters**

- a. Screen filters- A screen mesh filter is useful primarily for removing inorganic particles. A screen filter does not have the capacity to remove large amount of suspended particles and organic particles.
- b. Disc filters – Disc filters are used to clean the impurities in water. The cleaning efficiency of disc filters is more than screen filters. So now a days most of the green house prefer disc filters.

**Selection of Filters**

Water does not contains much impurity like sand, gravel, algae and suspended matter.	Disc Filter
Water contain large amount of suspended impurities and organic matter.	Sand filter as primary filter and Disc filter as secondary filter.
Water is pumping from a tube well/pond /river where there is a chance of large amount of sandy particles	Hydrocyclone Filter as primary filter and Disc filter as secondary filter

**4. Main Line**

Main line in Drip system is made up of either PVC (Poly Vinyl Chloride) or HDPE (High Density Poly Ethylene). The size of the pipe depends on the water required for the crop and the distance between the plot and the water source.

**5. Sub main line**

Sub main line in Drip system is made up of either PVC (Poly Vinyl Chloride) or HDPE (High Density Poly Ethylene). The size of the pipe depends on the the number of drippers on the laterals

## 6. Laterals

The laterals are made up of LDPE (Linear Density Polyethylene). The laterals are available in 12mm, 16 mm and 20 mm size. In green houses 16 mm size is ideal.

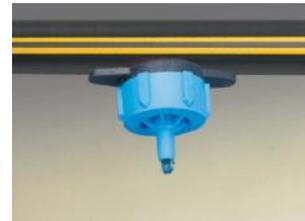
## 7. Drippers

Dripper or emitter is a component from where the water comes out of the system. The drippers are of two types

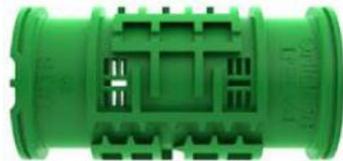
- a. Online dripper
- b. Inline Dripper

### a. Online dripper

Online drippers are attached to the laterals from outside. These drippers are commonly used for long spaced crops, seasonal crops and for unevenly spaced crops.



### b. Inline dripper



In this method, the drippers are attached to the lateral from inside at fixed distance at the time of manufacturing of lateral. For each dripper a separate filter is attached to avoid clogging. For green house cultivation it is suggested to use inline drippers.

## 8. Pressure Gauge

Pressure has an important role in operating the drip irrigation system. Pressure is measured by using Pressure Gauge. It is fixed at the inlet and outlet of filter and also at the starting point of the main line.

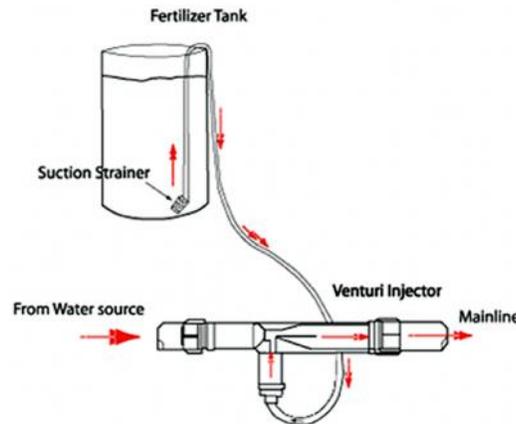
### Maintenance of Drip Irrigation System

- Flush the laterals everyday.
- Flush the mains and submains once in a week.
- Clean the Screen / Disc Filter everyday after irrigation is over.
- Backwash the sand filters once in a week.
- Clean the water tank once in 6 months.

## Fertigation

Application of fertilizers through irrigation water is called fertigation. Fertilizers are injected to the drip irrigation system by selecting appropriate equipment like

- Fertilizer tank
- Fertilizer injector
- Venturi



## Qualities of fertilizers suitable for fertigation

- High nutrient content readily available to plants
- Fully water soluble at field condition
- No clogging of filters and emitters
- Compatible with other fertilizers

## Commonly used fertilizers in greenhouse

19:19:19, 12:6:18, Urea, Magnesium nitrate, Ferrous sulphate, Zinc sulphate, Borax

## Practical activities

1. Practise drip irrigation and identify the different components.
2. Prepare nutrient solution and practise fertigation.

## Assessment activities

1. Prepare a double entry chart that gives the names of individual units of irrigation system and their function.
2. Prepare an assignment on drip irrigation and fertigation in protected cultivation.

## 3.1.5- Automated Climate regulation in protected cultivation

The main climatic factors which are controlled under protected cultivation are Light, Temperature, Relative Humidity and CO<sub>2</sub> concentration.

### Climate control methods

Parameters	To Control	Equipment
Light/Radiation	To increase light intensity and day length- Artificial lighting.	Incandescent Lamp, Fluorescent Lamps, High intensity Discharge lamps.
	To decrease light intensity and day length- Shading/ Screening, White washing.	Shade nets, Blackout-screens, Aluminets, White wash.
Temperature	Increase Temperature- Heating	Heaters, Hotwatering, Steam heating
	Decrease Temperature- Cooling	Misters, Foggers, Roof Sprinklers.
	Shading Ventilation.	Shade nets/Screens/Vents, Exhaust fans
Relative humidity	To increase	Humidifiers, Foggers, Misters.
	To decrease	Heaters, Vents, Dehumidifiers
CO <sub>2</sub> concentration	CO <sub>2</sub> enrichment	CO <sub>2</sub> burner, Pure CO <sub>2</sub>

### Mistifiers / Foggers

Misting/Fogging in greenhouses helps in reducing temperature and increasing the humidity. Mistifiers/ Foggers produce very small droplets of water in the air and get evaporated before falling into the crop canopy. The operating pressure of mister/ fogger varies between 2.5 to 5.5 kg/cm<sup>2</sup>. The pressure operated for fogger is more than that of mister. The foggers/misters can be operated between 10.30am and 3.30 pm. It can be operated upto 3 to 4 times in an hour. Operating foggers after 4 pm is to be strictly avoided. If the fogger is operated more times after 4 pm, plants may be affected by fungal attack. The foggers are placed over the head or in the paths while the misters are placed in the paths only.

#### Instruments required for protected cultivation

- EC and pH meter
- Tensiometer (Soil moisture)
- Dry and wet bulb thermometer

- d. Lux meter
- e. CO<sub>2</sub> analyser
- f. Hygrometer
- g. Anemometer
- h. Wind vane
- i. Rain gauge

### **Assessment activity**

1. Prepare a booklet containing pictures along with a small write up of equipments used for climatic control in poly houses.

## **3.1.6 Cultivation practices of Yard long bean, Cucumber and Rose in Poly house**

### **Yardlong bean (Vegetable cowpea)**

#### ***Climate and soil***

Ideal temperature: 25 -35°C

Soil: well drained loamy soil with pH 5.5 – 6.5

#### **Planting**

Seed inoculation with Rhizobium.

Before sowing apply Rhizobium inoculants to cowpea seeds particularly if the soil is being used for the first time. 25-35g of inoculant is needed for 1000sqm. Mix the inoculant uniformly with the seeds by using minimum quantity of water or starch solution. Dry the seeds under shade and sow immediately.

#### **Lime pelleting**

Lime pelleting is required only for seeds that are to be sown in acid soils. Add finely powdered calcium carbonate @ 0.6 kg/10kg of moist fresh rhizobium treated seed and mix for 1-3 minutes until each seed is uniformly pelleted. Good quality high grade lime should be used for pelleting.

#### **Bed preparation**

Raised beds of 60 x 50 cm dimension with 40cm height is prepared.

#### **Varieties**

Super green, Super light, NS621, NS620, Reenu.

### Sowing

- Sow the seeds 2-3 cm deep. Temperature for germination is 16 -26°C.
- Protray seedling of high yielding hybrid varieties are also preferred in protected cultivation.

### Fertilizer Application (400m<sup>2</sup>)

#### ❖ Basal Dose

Well decomposed FYM- 800 kg

Neem Cake- 1 kg

Mycorrhiza-1 kg

Pseudomonas-1kg

#### ❖ Fertigation schedule (200 m<sup>2</sup>)

Application of 19:19:19 complex fertilizers

3rd to 18th DAS – 140g (3 days interval)

21st to Harvest – 10 g (3 days interval)

Sl. No.	Name of pest/ Disease	Major symptoms	Management
<b>Pests</b>			
1.	Aphids	Distorted leaves with chlorotic spots, honeydew excretion.	Botanicals – 2% neem oil emulsion <i>Fusarium pallidoroseum</i> - biocontrol agent.
<b>Diseases</b>			
2	Powdery mildew	White Powdery coating on the leaf surface, malformation of young leaves.	Sulphur dusting. Soil drenching with
3	Wilt	Yellowing of leaves, wilting of plants, Discoloration in the collar region.	Pseudomonas, Need based application of Fytolan.

**Harvesting**

Cowpea requires about 7 weeks from seeding until the start of harvest. Harvesting periods continues for about 6-8 weeks.

Yield - 25 – 30 t/ha.


**Bed preparation**

After sterilization, raised beds of 60 cm width, 40cm height and of convenient length is prepared.

**Planting** distance- 60cm between two plants and 50 cm between two rows.

**Sowing**

- Seeds can be directly sown in the bed with two seeds per hole.
- Protray seedling of high yielding hybrid varieties are also preferred in protected cultivation.

**Fertigation schedule** (200 m<sup>2</sup>)

Application of 19:19:19 complex fertilizers

3rd to 18th DAS – 220g (3 days interval)

21st to Harvest – 110 g (3 days interval)

**Training and pruning**

Plants can be trained on plastic twine supported from horizontal support wires running along the length of the bed (3m above the top of the bed). The base of the string can be anchored loosely to the base of the plant.

The commonly adopted pruning system is the umbrella. Here the growing point of the main stem is removed when one or two leaves have developed above the wire. Two lateral branches near the top of the plant are allowed to grow and are trained over the overhead wire in downward direction. The growing point of each lateral is removed when they are approaching the ground.

**Fruit pruning**

If too many fruits are set at once fruit thinning is necessary to avoid malformed and small fruits.

### **Mulching**

Straw, hay and other locally available mulching materials are used. Plastic mulches are now becoming more popular than organic mulching materials.

### **Harvesting**

Harvesting may begin 50-65 days after planting. Harvesting is done 3-4 times per week. In a well-managed crop, harvesting period extends up to 12 weeks.

### **Yield**

8-10 kg per plant.



### **Bed Preparation**

A raised bed is always preferred for planting of Rose. After fumigation, the beds of following dimensions are prepared.

1. Bottom width – 100 cm
2. Top width – 90 cm
3. Path width – 50 cm
- Height – 40 cm

### **Planting Distance**

- Plant to Plant – 15-17 cm  
Planting density – 8 plants /sqm  
Planting Season – June to July

### **Types of Roses**

1. Standard Roses - Large size single flowers with long flower stalk
2. Sweet heart Roses - small size single flowers with short flower stalk
3. Spray Roses - 5-6 flowers per stem

### **Selection of variety**

Based on –

**Market Demand-**The farmer should go for market survey and select the varieties which are of great demand in the market.

**Colour Percentage-**A farmer should always plant varieties of different colours. In general, the red colored flowers are more preferred in markets.

## **Planting**

Planting should be done in the early morning or late evening.

Two small trenches should be made on the bed for planting and the bed should be irrigated before planting.

While planting care should be taken that the budding point should be 2 cm above the ground level.

After planting, drench Bavistin 0.2% once in a week.

## **Special Cultural Practices**

1. Initial plant development
2. Bending
3. Pinching
4. topping

### **1. Initial plant development**

After planting 2-3 eye buds will sprout on main branch and these branches grow and form buds. At this stage the mother shoots are to be bent to initiate the bottom breaks.

### **2. Bending**

Bending is necessary for keeping enough leaves on the plants. For bending only weak stems are selected.

### **3. Pinching**

Removal of unwanted vegetative or floral growth. This is to improve the quality of flower and stem.

### **4. Topping**

Clipping of main bud on stem is called Topping. This is to keep the stems in standing positions.

## **Harvesting**

For harvesting cut and hold secateurs should be used They should be dipped in containers containing disinfectants. The harvesting should be done from one side of the green house.

## **Practical activity**

Visit to a protected cultivation Unit.

### Assessment activities

1. Prepare a leaflet on the cultivation practices of Yard long Beans/Cucumber/Rose in poly house.
2. Collection of news articles on cultivation practices of crops other than the crops detailed in the unit.

### 3.1.7 Rain shelter cultivation

Rain shelters are designed to protect a certain area of land against receiving precipitations. There are two main designs: (1) static and (2) movable. Within the movable design there are automatic/motorized and manual versions. The manual version is moved from its parking spot onto the protected plot whenever rain is expected and not when the rain begins. It is moved into the parking space whenever rain is expected to cease completely.



#### Salient features

- Increased productivity
- Superior quality of the produce
- Sustained year round production

#### What kind of Protection?

- Protection from heavy rain
- Protection from strong wind
- Protection from low or high temperature
- Protection from intense sunshine

#### Advantages

- Protection from heavy rain and sun light
- Low cost compared to polyhouse
- Year round production of high value crops possible
- Sides are open :-
  - ❖ More ventilation
  - ❖ Open and cross pollinated crops can be grown easily

- Can be built on sloping grounds
- Easily manageable

### **Practical activity**

Practising Rain Shelter Cultivation.

### **Assessment activity**

Collect the success stories of rain shelter cultivation from popular articles and daily newspaper.

## **3.1.8- Hydroponics, Aquaponics and Aeroponics**

Now a days, conventional crop growing in soil is difficult as it involves large space, lot of labour and large volume of water. In some places like metropolitan areas, soil is not available for crop growing. Furthermore, continuous cultivation of crops has resulted in poor soil fertility, which in turn has reduced the opportunities for natural soil fertility build up by microbes. This situation has lead to poor yield and quality. Hydroponics , Aquaponics and Aeroponics systems of soil less cultivation helps to overcome the above said constraints to a certain extent.

### **HYDROPONICS**

Hydroponics or soil-less culture is a system of growing plants in nutrient solutions that supply all nutrient elements needed for optimum plant growth with or without the use of an inert medium such as gravel, vermiculite, rockwool, peat moss,



saw dust, coir dust, coconut fiber, etc. to provide mechanical support, which helps reduce some of the above mentioned problems experienced in conventional crop cultivation.

The word hydroponics technically means working water, stemming from the Latin words “hydro” means water, and “ponos” means labor. Many different civilizations from the beginning of time have relied on hydroponics for growing plants, such as the early Mexican and Egyptian civilizations. There are mainly 6 basic types of hydroponic systems:

1. Wick System
2. Water Culture
3. Ebb and Flow (Flood and Drain)
4. Drip System (recovery or nonrecovery)
5. N.F.T (Nutrient Film Technique)
6. Aeroponic System

### **Wick system**

The Wick system is one of the simplest type of passive hydroponic system, which means there are no moving parts. The nutrient solution is drawn into the growing medium from the reservoir with a wick. This system can use a variety of growing medium like perlite, vermiculite or coconut fiber. The biggest drawback of this system is that large plants needs large amounts of nutrient solution than the wick can supply it.

### **Water culture system**

The water culture system is the simplest of all active hydroponic systems. The platform that holds the plants is usually made of Styrofoam and floats directly on the nutrient solution. An air pump supplies air in the form of bubbles to the nutrient solution and supplies oxygen to the roots of the plants. Water culture is the system of choice for growing leaf plants like lettuce, which are one of the fast growing water loving plants.

### **Advantages of Hydroponics**

- Land is not necessary : It can be practiced even in upstairs, open spaces and in protected structures.
- Clean working environment : The grower will not have any direct contact with soil.
- Low drudgery : No need of making beds, weeding, watering, etc.
- Continuous cultivation is possible.
- No soil borne diseases or nematode damage.
- Off-season production is possible.
- Many plants were found to give yield early in hydroponics system.
- Water wastage is reduced to minimum.

### **Limitations**

- Higher initial capital expenditure.

- High degree of management skills is necessary for solution preparation, maintenance of pH, nutrient deficiency judgment and correction, ensuring aeration, maintenance of favorable condition inside protected structures, etc.
- Considering the significantly high cost, the soil-less culture is limited to high value crops.
- A large-scale cultivator may have to purchase instruments to measure pH of the nutrient solution.
- Energy inputs are necessary to run the system.
- Yields were found to decrease when temperature of the solution rises during warm periods.
- A constant supply of water is required.

### General Requirements for basic Hydroponic System

The basic requirements needed for growing plants are the same as in conventional system.

- Hydroponic systems will not compensate for poor growing conditions such as improper temperature, inadequate light, or pest problems. Plants need 12-18 hours of light per day this is essential for photosynthesis for strong healthy growth.
- An outdoor hydroponic system needs to be placed in a good sunny position for the plants to receive enough light from sun for an optimal growth.
- Indoor hydroponic system will need artificial light to replace the loss of natural light.
- Another factor to take into consideration is that adequate spacing is to be ensured between plants so that each plant receives sufficient light. Generally, a 1% decrease in light reduces yield by 1%.
- Plants require oxygen for respiration to carry out their functions of water and nutrient uptake. In soil, adequate oxygen is usually available, but plant roots growing in water will quickly exhaust the supply of dissolved oxygen and can be damaged or killed unless additional air is provided. A common method of supplying oxygen is to bubble air through the solution.
- Hydroponic grower must have a good knowledge of the plant nutrients, as management of plant nutrition of nutrient solution is the key to success in hydroponic gardening.
- A variety of crops can be grown using hydroponics/soil-less culture.

## AQUAPONICS

Integrated farming of fish and farm crops mainly rice, vegetables and flowers is called aquaponic farming. Fish farming coupled with soil less hydroponics is done here. This is because fish waste enriches water with plant nutrients and plants provide natural filter for the water in which the fish lives. Microbes present in the media convert ammonia from fish waste into nitrates which plants can easily absorb. Plants are grown organically. In Kerala the vegetables that are successfully grown are vegetables like lettuce, broccoli, spinach, mint, tomato, ladies finger and brinjal. Two or three vegetables can be taken in a year. Tilapia and Carp fish are best suitable for aquaponics. Prawns, catfish, fresh water mussels can also be grown under this system.

### THE AQUAPONICS CYCLE

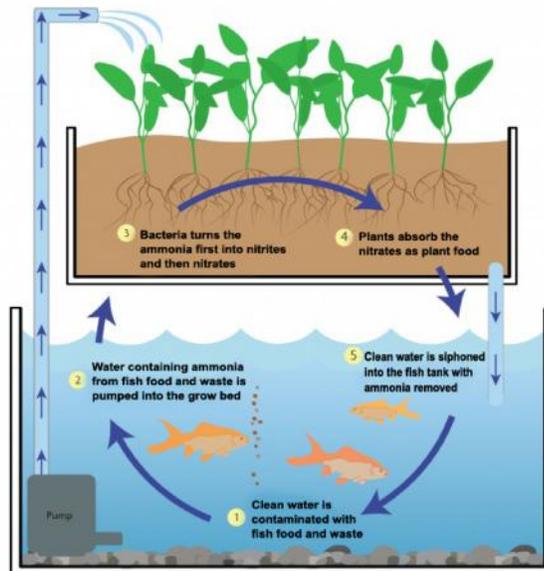
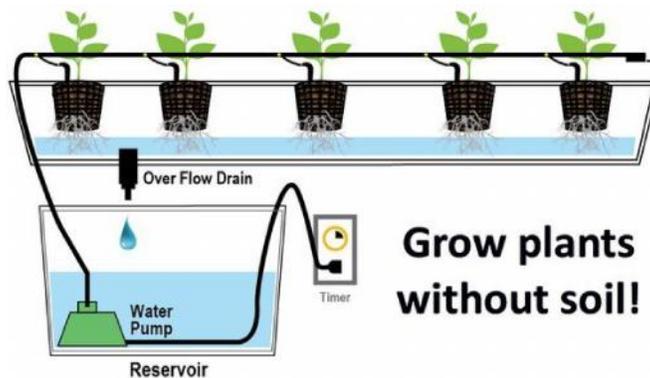


Illustration by Jillian Heivey  
Source: aquapenichowto.com

## AEROPONICS

The aeroponic system is probably the most high-tech type of hydroponic gardening. The roots hang in the air and are misted with nutrient solution. The misting are usually done every few minutes. Because the roots are exposed to air, the roots will dry out rapidly if the misting cycles are interrupted. A timer controls the nutrient pump much like other types of hydroponic systems, except that the aeroponic system needs a short cycle timer that runs the pump for a few seconds in every minute.



### Assessment activities

Conduct seminar on Aquaponics, hydroponics and other soilless cultivation practices. (Group activities) [*Hint*-Concept, Scope, Advantages, Limitations].

### TE Questions

1. Prepare a news article on “Role of Protected Cultivation (advantages and disadvantages) in Modern Agriculture” for a leading Agricultural monthly magazine.
2. As an agriculture expert, you are invited to conduct training on “Establishment of Green house”. Prepare a study material based on site selection, classification of green house and materials used
3. The Krishi Bhavan of your area has entrusted the VHSE student with the task of preparing a leaflet on Irrigation and fertigation in protected cultivation and its maintenance. Prepare a draft of the leaflet.
4. Arjun wants to prepare a chart on the advantages and disadvantages of Hydroponics. How will you help him?

## UNIT 2

### Organic farming and certification

#### Introduction

The Unit encompasses the concept, scope and the essentialities of organic farming like organic plant nutrient management, soil and water conservation and biodiversity of farm land. The organic certification procedure and agencies involved are also elaborated. The unit also lists resources for organic nutrient management and organic plant protection, their preparation and method of application.

#### Learning outcome

The learner :

- understands the concept of organic farming and its importance in global and Kerala condition.
- understands the principles and practices of organic farming.
- demonstrates the use of biocontrol agents, botanicals and other plant growth promoting preparations.
- gets familiarized with the procedure of organic certification and the agencies involved.

#### 3.2.1 Concept of organic farming, importance with reference to global scenario – scope in Kerala

##### Introduction

In modern scenario organic farming is a technique, which is used for achieving good crop yield without harming the natural environment or the people who live and work in it. The main theme of food security is to provide sufficient, safe and nutritious food to every one or individual. To achieve this level of food security various modern agricultural practices have been used in past few decades wherein the chemical pesticides and fertilizers are used injudiciously. Organic farming methods are very much important in the present scenario for improving the soil health and fertility status, for controlling the pests and diseases without harming the environment, producing safe, nutritious and high quality of food. This also indicates the importance of organic farming that not only the total area as well as the number of organic producers also increasing all over the world.

### Definition of organic farming

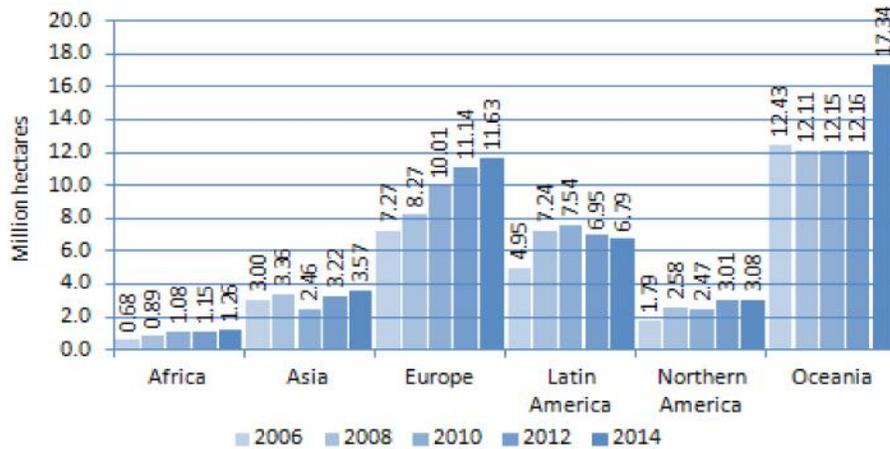
- It is a method of farming in which only organic substances are used for crop production. Inorganic substances like fertilizers, pesticides and hormones largely excluded.
- It is a method of farming system primarily aimed at cultivating the land and raising crops in such a way as to keep the soil alive and in good health by the use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

As per the definition of the United States Department of Agriculture (USDA) study Team on Organic farming “organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection”.

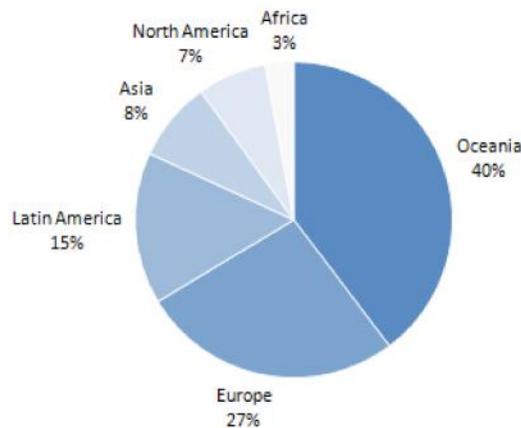
### Importance with reference to global scenario

Current statistics related to the share of Organic Agricultural Land in the world.

International Federation of Organic Agriculture Movements (IFOAM) is the monitoring body of organic farming organizations all over the world. According to the latest FiBL-IFOAM survey organic agriculture is practiced in 172 countries and 43.7 million hectares of agricultural land are managed organically by approximately 2.3 million farmers. The regions with the largest areas of organic agricultural land are Oceania (17.3 million ha or 40% of global organic land area) and Europe (11.6 million ha or 27% of global organic land area). Latin America has 6.8million ha or 15 %) followed by Asia (3.5 million ha or 8%), North America (3.0 million ha or 7%) and Africa (1.2 million ha or 3%). The global sale of organic food and drink reached 80 billion US dollars in 2014 (Source: fibl.org: Media release of FiBL and IFOAM - Organics International of February 2016, Organic-World.net: Information and background material on “The World of Organic Agriculture”, edition 2016).



*Growth of the organic agricultural land by continent 2006-2014*



*Distribution of organic agricultural land by region 2014*

### Important features of Indian organic sector

With the phenomenal growth in area under organic management and growing demand for wild harvest products, India has emerged as the single largest country with highest arable cultivated land under organic management. India has also achieved the status of single largest country in terms of total area under certified organic wild harvest collection. With the production of more than 77,000 MT of organic cotton lint India had achieved the status of largest organic cotton grower in the world a year ago, with more than 50% of total world's organic cotton. In India, organic farming shows a growing trend. As on March 2014, India has brought 4.72 million ha area under organic certification process.

## Organic farming in Kerala

Sustainability was the hallmark of our farming system from time immemorial. The once flourished Pokkali cultivation in coastal districts and the Kaipad farming system in Kannur district are testimonials to man's ability to harness natural events without affecting the natural ecological processes.

State department of Agriculture set up a cell for Promotion of sustainable Agriculture and Organic farming in 2003 with two brands 'Kerala organic' and 'Kerala naturals' to market organic farm produces.

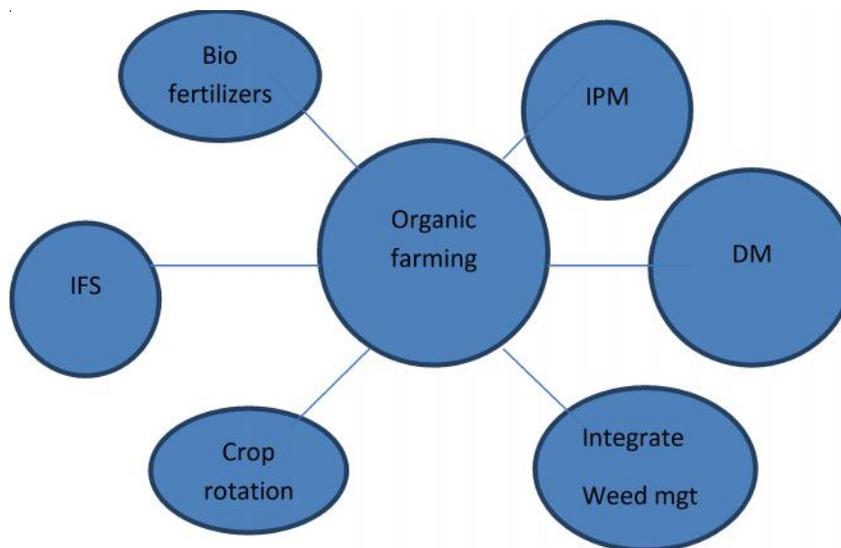
### Assessment activities

1. Literature collection of success stories on organic farming.
2. Basic data collection of farmer practicing organic farming in your Panchayat.

### 3.2.2 Organic farming principles and practices

Objectives of organic farming :

- To provide safe food of high quality.
- To maintain and increase soil fertility for long term.
- To encourage and enhance the activities of micro organisms, soil flora and fauna.
- To work within the natural system and cycles.
- To promote sustainable use of natural resources.



*Components of organic farming*

Comparative advantage	
Organic farming	Chemical farming
Discard chemicals	Use of chemicals
Ecofriendly	Eco unfriendly
Non hazardous	Hazardous
Makes the soil “Live”	Makes the soil “Dead”

**Organic farming approach involves following five principles:**

- Conversion of land from conventional management to organic management.
- Management of the entire surrounding system to ensure biodiversity and sustainability of the system.
- Crop production with the use of alternative sources of nutrients such as crop rotation, residue management, organic manures and biological inputs.
- Management of weeds and pests by better management practices, physical and cultural means and by biological control system.
- Maintenance of livestock in tandem with organic concept and make them an integral part of the entire system.

**Steps to a Successful Organic Transition**

- Understand the basics of organic agriculture and the organic farming standards
- Identify resources that will help you
- Plan your transition carefully
- Understand your soils and ways to improve them
- Identify the crops or livestock suited for your situation
- Design good crop rotations
- Identify pest challenges and methods of control
- Be ready to conduct your own on-farm trials
- Be ready to keep good records

**Practical activity**

Setting up of an organic vegetable garden in the school.

### Assessment activities

Chart preparation on the principles of organic farming.

### 3.2.3-Organic plants nutrient management and protection

#### Resources for soil Nutrient Management in Organic farming (Refer Module I)

1. Bio fertilisers
2. Green manure and green leaf manure
3. Compost
4. Farm Yard Manure

#### Resources for Pest management in organic farming

1. Botanicals
2. Bio control agents
3. Permitted fungicides
4. Other organic nutrient solutions

### 1. BOTANICALS

Botanical pesticides are agricultural pest management agents which are based on plant extracts. These are naturally occurring chemicals extracted or derived from plants. In general they act quickly, degrade rapidly and have low mammalian toxicity. In modern times these have been used as alternatives to synthetic chemicals in organic pest management.

#### Preparation of important botanicals

##### I. Neem based botanicals

The active principle of these botanicals is azadiractine which is capable of controlling a large group of insects.

##### 1. Neem oil emulsion

Dissolve 60g barsoap in 500ml water. This should be thoroughly mixed with 1 litre neem oil. Dilute with 15 litres of water and apply. For pulse crops 16 litres of water should be added. This is effective against sucking pests and mites.

##### 2. Neem oil garlic emulsion (2%)

To prepare 10 litres of 2% neem oil- garlic emulsion, 200 ml neem oil, 200 g garlic and 50 g ordinary bar soap are required. Slice the bar soap and dissolve in 500 ml lukewarm water. Grind 200 g of garlic and take the extract in 300 ml water. Pour the 500 ml soap solution in 200 ml neem oil slowly and stir vigorously to get a good emulsion. Mix the garlic extract in the neem oil + soap emulsion. Dilute this one litre stock solution by adding 9 litres of water to get 10 litres of 2% neem oil + garlic emulsion.

### 3. Neem kernel suspension

This is very effective as a repellent/deterrent against locusts, grasshoppers and other chewing insects particularly lepidopterans. The kernel should be ground into a coarse powder. The effective concentration of NKS ranges from 0.1 to 0.3%. For obtaining 0.1% concentration, 1g of powdered neem seed is required per litre of water. The required quantity of the coarse powder should be put in a small muslin cloth bag and dipped in water for about 12 hours. Thereafter, squeeze the cloth bag repeatedly so that the out-flowing fluid turns light brownish. The NKS is now ready to be sprayed as such on crops.

### II. Tobacco decoction

Nicotine, the alkaloid present in the leaves of tobacco has insecticidal property. This is very effective for controlling aphids and other soft-bodied insects infesting vegetable crops. Tobacco decoction can be prepared by steeping 500 g of tobacco waste in 4.5 litres of water for 24 hours. Dissolve 120 g of ordinary bar soap separately in another vessel. The soap solution is added to tobacco decoction under violent agitation. Dilute this stock solution 6-7 times before spraying.

### Botanical preparations for pest control

PREPARATION	DOSE	PEST
<b>NEEM (<i>Azadirachta indica</i>)</b>		
Neem leaf	250 g/plant	Nematodes of bhindi, brinjal.
Leaf Extract	2 – 5%	Leaf feeders of amaranthus like <i>Spodoptera litura</i> and leaf webber, aphids of vegetables.
Neem Twig	Plant neem twigs in coconut gardens after receipt of monsoon rains during April-May.	for controlling root grubs.
NSKE	3-5%	Aphid of brinjal, Shoot and Fruit borer of okra, brinjal <i>Helicoverpa armigera</i> of tomato and cowpea, Pod fly of cowpea, American Serpentine Leaf miner of vegetables (ASLM) (Cucurbits, brinjal, cowpea), Ornamentals (Marigold).
Neem oil	2.5-10%	Pea Aphid, ASLM, Epilachna Beetle, Mites of vegetables
Neem Cake	250 Kg/ha	Shoot and fruit borer of bhindi, brinjal
Neem Cake extract	10%	Root knot nematode of vegetables

## 2. BIOCONTROL AGENTS

Biological control is a component of an integrated pest management strategy. When a particular species of pest is controlled by a living organism which is introduced, encouraged and disseminated by man, it is called biological control. The organism used in biological control to depress the pest population are called biocontrol agent

### Major advantages

- No harmful residues.
- Target specific and safe to beneficial organisms like pollinators, predators, parasites etc.
- Growth of natural enemies of pests is not affected, thus reducing the pesticide application;
- Environmental friendly.
- Cost effective
- Important component of IPM as 1st line and 2nd line of defense, chemicals being the last resort.

### I. Fungal and bacterial pathogens (mycoparasitic and antagonists)

The microorganisms used in the control of plant pathogens are called as antagonists.

#### 1. Arbuscular Mycorrhizal Fungi (AMF)

Inoculation with AMF at the time of planting in the nursery or main field improves the growth and tolerance of crop against root pathogens, particularly *Phytophthora*, *Pythium*, *Rhizoctonia* and root nematodes of black pepper, cardamom, ginger, turmeric, cowpea, rice and transplanted vegetables. It also helps to improve the uptake of available Phosphorus. It is commercially available as granular inoculums consisting of infected roots and soil with mycorrhizal spores. It is given as soil application.

#### 2. Trichoderma

Biocontrol of soil borne plant pathogens involves mass introduction of antagonistic microorganisms in the soil. *Trichoderma* spp. is a group of broad-spectrum antagonists subjected to detailed studies for their potential as biocontrol agents. They are effective against the foot rot of pepper, rhizome rot of cardamom and ginger. Neemcake-cow dung mixture is used as food base/ media for *Trichoderma* spp.

On Farm multiplication of Trichoderma.

- Dry neem cake and cowdung are to be powdered and mixed to get a coarse texture and then moistened by sprinkling water.
- Add the commercial preparation of Trichoderma spp. (available in polythene packets) @ 1-2 kg per 100 kg of neemcake - cow dung mixture.
- After thoroughly mixing, cover it with a perforated polythene sheet or ordinary newspaper and keep it in shade for 4-5 days for multiplication.
- Again mix well and keep for three more days for further multiplication. This preparation is ready for incorporation in the soil.

Cow dung alone can also be used as the food base; but, since neem cake is found to be a better substrate, the incorporation of neem cake to cow dung at the ratio of 1:10 (w/w) is better than using cow dung alone. If cow dung alone is used, mixing has to be done at 5 days interval and it will be ready for use only on the 15th day. This Trichoderma incorporated neemcake-cow dung mixture can be used in the potting mixture in nursery beds and in the field; i.e. wherever cow dung is used as a manure.

### 3. Fluorescent pseudomonads

Fluorescent pseudomonads are a group of bacteria very effective in disease management of plants in the nursery as well as in the main field. Among this, *Pseudomonas fluorescence* is a potential biocontrol agent commercially used. This is found highly effective for the management of foot rot and fungal pollu of black pepper, sheath blight and bacterial leaf blight of paddy, bacterial leaf spot and Phytophthora infestation in betel vine, bacterial wilt of solanaceous vegetables, bacterial leaf blight of anthurium and Colletotrichum and Phytophthora infestation in vanilla and rhizome rot of ginger. The organism significantly improves the growth and biomass production of crop plants.

Method of application of Pseudomonas

- The talc-based formulation at 1-2% level may be used for soil drenching and spraying.
- Seedlings / cuttings are treated with Pseudomonas culture by dipping the root/ tip of cuttings in slurry of Pseudomonas (250g in 750ml for 20 minutes).
- For seed treatment in paddy use 10g talc-based Pseudomonas culture for 1 kg of seed; suspend Pseudomonas in water used for sprouting. This helps in the control of fungal and bacterial diseases.

For transplanted crop, dip the roots at the time of transplanting, and one spray may be given at 30th day after transplanting. For black pepper, drenching the nursery plants immediately after planting followed by one or two sprays depending on the extent of disease. For all the crops, the time of application and the frequency of application may vary depending on the incidence and intensity of the infection.

## II. Entomopathogens

The various micro organisms that cause diseases in insects are called entomopathogens. They are used as bio control agents. These include bacteria, fungus, virus, protozoans and nematodes. Biocontrol using entomopathogens is known as microbial control. The use of microbial pesticides as one of the major components of IPM is gaining acceptance as they are generally specific, apparently harmless to the beneficial insects, animals and human beings with no residue problems and environmental hazards.

### A. Entomopathogenic fungi

Entomopathogenic fungi are fungal species that can act as parasites of insects and kill or seriously disable them. The important fungi include *Beuvaria bassiana*, *Metarrhizium anisopliae*, *Verticillium lecanii*. They directly infects the insects, softens their chitin by releasing some enzymes. The pathogen fills up the body cavity with hyphae due to which the insect become hard and mummified. They become phototropic, climb to the tips of the branches and dies in that position.

#### 1. *Beuvaria bassiana*

It is commonly known as white muscardine fungus and occurs naturally in soils throughout the world. It can be mass multiplied on locally available grains and other solid substances. It is effective against thrips, whiteflies, aphids, grasshoppers, diamond back moth of cabbage etc

#### 2. *Metarrhizium anisopliae*

It is commonly known as white muscardine fungus. It is widely distributed soil inhabiting fungus. It is effective against rhinoceros beetle of coconut, termites, leafeating caterpillars, beetles etc.

### B. Entomopathogenic bacteria

#### 1. *Bacillus thuringiensis* (B t)

This is a gram positive bacteria and is a very important pathogen extensively studied and tested. When ingested by the insect larvae, the insect body becomes softer and darker in colour. The paralysis of gut takes place because of infection leading to

mortality of the larvae in 3 to 4 days. It is widely used to control lepidopteran, dipteran and some coleopteran insect pests.

### C. Entomopathogenic virus

Nuclear Polyhedrosis Virus (NPV) is the most important one. The virus are highly specific and hence do not affect beneficial insects, and are safe to fish and mammals. When virus is ingested, the insect larvae become diseased, stop feeding and are found hanging in an inverted position. It dies in 5-7 days. Others include Cytoplasmic Polyhedrosis Virus (CPV), Baculovirus (OBV). NPV and CPV are used against lepidopteran larva while OBV is used against rhinoceros beetle.

For getting effective control, the microbial insecticide needs to be applied in the early instar stages, preferably in the evening hours and repeated 2-3 times based on the pest incidence.

Biopesticides available in the market.

Generic names and formulations	Trade name
Bacillus thuringiensis	Dipel-8L Kurstaki Halt Biobit Biolep Delfin (Serotype 3a x b)
<i>Trichoderma viride</i>	Ecoderma
<i>Trichoderma harzianum</i> 0.5WS	NIPROT
NPV of <i>Helicoverpa armigera</i>	HELICIDE
NPV of <i>Spodoptera litura</i>	SPODOCIDE
<i>Pseudomonas fluorescens</i>	Biocure B
<i>Verticillium lecani</i>	Biocatch
<i>Beauveria basiana</i>	Biopower

### 3. PREPARATION OF PERMITTED FUNGICIDES FOR ORGANIC FARMING

#### Bordeaux mixture (1%)

Dissolve 1 kg of powdered copper sulphate crystals in 50 litres of water. In another 50 litres of water, prepare milk of lime with 1 kg of quick lime. Pour the copper

sulphates solution into the milk of lime slowly stirring the mixture all the while. Test the mixture before use for the presence of free copper, which is harmful to the plants, by dipping a polished knife in it. If the blade shows a reddish colour due to the deposits of copper, add more lime till the blade is not stained on dipping. Always use wooden, earthen or copper vessels for the preparation of Bordeaux mixture. Use the fungicide in the same day of preparation.

In order to confer sticking qualities to Bordeaux mixture, rosin washing soda mixture, may be added. The addition of the sticker is particularly recommended for sprayings conducted during rainy season. For preparing the mixture, 10 litres of water out of 100 litres required for preparing Bordeaux mixture may be kept apart. Boil 10 litres of water, preferably in an earthen pot and add 500 g of good quality washing soda (sodium carbonate). Boil again until the solution becomes slightly dark in color. Add one kg of powdered rosin (arpoons) in the boiling washing soda solution. Reduce the flame for avoiding frothing, foaming and spilling over. Boil the solution for 5-10 minutes till the black bubbles appear. Cool the solution until the temperature reaches below 45 degree Celsius. The cooled mixture (10 litres) is then added slowly to the prepared Bordeaux mixture (90 litres) under vigorous stirring.

### **Bordeaux paste**

Dissolve 100 g of copper sulphate and 100 g of quick lime each in 500 ml of water. The procedure is same as that of Bordeaux mixture.

## **4. PREPARATION OF ORGANIC NUTRIENT SOLUTIONS- 'PANCHAGAVYA'**

This is a nutrient solution which is widely used by farmers as an organic fungicide. Cow dung -7 kg and cow ghee-1 kg are mixed in a clean container thoroughly both in morning and evening hours and kept aside for 3 days. After 3 days, cow Urine - 10 litres and water - 10 litres are added. The mixture is kept for 15 days with regular mixing both in morning and evening hours. After 15 days, add cow milk – 3 litres, cow curd - 2 litres, tender coconut water - 3 litres, jaggery - 3 kg and well ripened poovan banana - 12 nos. Panchagavya can be prepared in a wide mouthed mud pot or concrete tank or plastic can.

### **Precautions**

- a) Keep the container open under shade
- b) Stir the contents twice a day both in morning and evening
- c) The Panchagavya stock solution will be ready after 30 days
- d) Do not mix buffalo products.

It is stored in shade covered with a wire mesh or plastic mosquito net to prevent houseflies from laying eggs and the formation of maggots in the solution.

### **Practical activities**

1. Preparation of botanicals- Neem oil garlic emulsion, Tobacco decoction – Demonstration and field application.
2. Seed treatment with Rhizobium – Demonstration.
3. Field level multiplication and application of Trichoderma.

### **Assessment Activities**

1. Assignment on various biofertilizers and Biopesticides practicing in the fields of the locality.
2. Preparation of leaflet showing steps involved in the preparation of botanicals and fields level multiplication of Biocontrol agents.

### **3.2.4 Organic certification procedure – agencies involved**

Organic certification means having the farm and the farmer's methods inspected by an organic certifying group to ensure that they comply with the guidelines on organic farming.

For gaining consumers confidence valid organic certification is an essential prerequisite for marketing especially in the export market.

#### **Stages of organic certification**

- a) Conversion period
- b) Transition period
- c) Complete conversion to organic farming

#### **The steps to be followed to obtain organic farming certification**

Register at any one of the certification agencies

- Follow steps of certification
- Follow stages of organic certification
- Obtain certificate

#### **Steps for INDOCERT Certification**

INDOCERT is a nationally and internationally operating, certification body established in India. It is accredited by National Accreditation Body (NAB), Government of India, as per National Programme for Organic Production (NPOP).

**Initial Application**

As the initial step for getting INDOCERT certification, the operator (the person responsible for the unit to be certified) has to contact the INDOCERT office. Upon request INDOCERT sends a detailed application package including the application form and procedure for INDOCERT certification.

**Pre-inspection procedure**

After receiving the filled in application form, INDOCERT sends an offer for inspection and certification along with the scale of fees. On accepting the offer, the operator needs to send 75 % of the offer fees as advance in the form of DD in favour of M/s. INDOCERT payable at Alwaye.

**Inspection**

Prior to the inspection the operator must sign the inspection and certification contract. During the inspection, the INDOCERT inspector will inspect your operational activities with regard to your compliance with the chosen organic standards. The original inspection report will be forwarded to INDOCERT office for further certification process.

**Balance Payment**

After inspection, the total inspection and certification costs are finalised and an invoice is sent to the operator. The operator must send the remaining amount of the final invoice to INDOCERT.

**Certification**

Upon receipt of the full payment, INDOCERT will review the inspection report. The certification committee will take the certification decision based on the available documentation. After obtaining the certificate, market the product using a logo, product statement or certificate that identifies it as 'ORGANIC'.

**ORGANIC CERTIFICATION AGENCIES**

IMO Control Pvt. Ltd, Bangalore

Indian Organic Certification Agency, (INDOCERT), Aluva

Lacon Quality Certification, Pvt Ltd, Thiruvalla

Natural Organic Certification Agency, Pune

OneCert Asia Agri Certification Pvt Ltd, Jaipur

Bureau Veritas Certification India Pvt Ltd, Mumbai

ECOCERT India Pvt. Ltd, Aurangabad.

Food Cert India Pvt. Ltd, Secunderabad.

### **Practical activity**

Visit to a certified organic farm.

### **Assessment activities**

Reading assignment.

### **TE Questions**

1. Your friend is participating in a debate competition in favour of the need of organic farming. Help him to prepare some points on the importance of organic farming (principles and practices).
2. A farmer approaches you with doubts regarding preparation of Panchagavyam. How will you help him?
3. Your friend has approached you to clear doubts regarding Organic certification procedure, steps involved and the agencies involved. How will you help him?
4. Your School PTC has decided to start a Plant protection unit which involves preparation of botanicals. Can you list out the important ones to be prepared for the unit?

## UNIT 3

# FOOD SAFETY MEASURES AND CERTIFICATION

### Introduction

Food safety is an important component of food quality. Maintaining food quality without compromising economic, social and environmental sustainability is one of the major challenges in world agriculture scenario. This unit also introduces voluntary programmes that a farmer or seller may wish to pursue to ensure quality of his/ her food products like FSSAI, GAP and HACCP.

The potential hazards from food that cause adverse health effects and the indicators for defining chemical hazards and pesticide residue elimination methods of fresh agricultural produce are also annexed.

### Learning outcome

The learner:

- analyses the international scenario of food safety and certification with Indian context and understand functions of FSSAI.
- defines GAP and enumerate the objectives and principles.
- gets an awareness about Global GAP, HACCP, GMP and GHP.
- enlist the hazards associated with production flow.
- understands the importance of residual toxicit, MRL,waiting period, biomagnification etc.
- performs pesticide residue elimination methods in food materials with emphasis to fruits and vegetables.

### 3.3.1 International Scenario on Food Safety

The International Standard ISO 22003 defines food safety management system (FSMS) as the set of interacting elements to establish policy and objectives with regard to food safety.

Internationally and even in India, there are many Food Safety Certifications which meets these requirements. These are HACCP, ISO 22000, FSSC 22000 etc. These are voluntary certifications to strengthen the food safety system. However, under current Indian regulation defined by the Food safety and standards act (FSS Act) 2006, Food Safety Management System (FSMS) means the adoption of Good

Manufacturing Practices, Good Hygienic Practices, Hazard Analysis and Critical Control Point and such other practices for ensuring quality produce.

### **FOOD SAFETY AND STANDARDS ACT, 2006**

An Act to consolidate the laws relating to food and to establish the Food Safety and Standards Authority of India (FSSAI) for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe food for human consumption. The Act establishes an independent statutory Authority – the Food Safety and Standards Authority of India with head office at Delhi. Food Safety and Standards Authority of India (FSSAI) and the State Food Safety Authorities shall enforce various provisions of the Act.

The office of the Commissioner of Food Safety, Kerala situated at Thycaud, Thiruvananthapuram has been created for the implementation of the Food Safety and Standards Act, 2006. There are three food testing laboratories in the state at Thiruvananthapuram, Ernakulam and Kozhikkode. Public can analyse food samples in these laboratories by paying the fee fixed by Government.

**FSSAI has been mandated by the FSS Act, 2006 for performing the following functions:**

- Framing of Regulations to lay down the Standards and guidelines regarding food safety measures.
- Laying down mechanisms and guidelines for accreditation of certification bodies engaged in certification of food safety measures.
- Laying down procedure and guidelines for accreditation of laboratories and notification of the accredited laboratories.
- To provide scientific advice and technical support to Central and State Governments in the matters of framing the policy and rules in areas which have a direct or indirect role in food safety and nutrition.
- Collect data regarding food consumption, food adulteration, identification of emerging risks etc.
- Creating an information network across the country so that the public, consumers, Panchayats etc receive rapid, reliable and objective information about food safety and issues of concern.
- Provide training programmes for persons who are involved or intend to get involved in food business.

- Contribute to the development of international technical standards for food, sanitary and phyto-sanitary standards.
- Promote general awareness about food safety and food standards.

### **Assessment activities**

Brainstorm after providing the background information on international scenario of food safety and record the outputs on common chart.

### **3.3.2 Good Agricultural Practices (GAP) definition, Objectives and Principles**

There are numerous systems that growers can adopt to ensure safe food production, which include Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Points (HACCP) and Good Hygiene practices (GHP).

#### **Good Agricultural Practices (GAP)**

##### **Definition**

Good Agricultural Practices is a collection of principles to apply for on-farm production and post-production processes which results in safe and healthy food and non-food agricultural products. GAP are specific methods which, when applied to agriculture, create food for consumers or further processing that is safe and wholesome.

##### **Objectives**

1. Ensuring safety and quality of produce in the food chain
2. Improving natural resources use, workers health and working conditions
3. Creating new market opportunities for farmers and exporters in developing countries.

##### **Principles of Good Agricultural Practices for Selected Agricultural Components**

###### **1. Soil**

Good practices related to soil include maintaining or improving soil organic matter through crop rotations, manure application, pasture management and other land use practices and conservation of tillage practices.

## 2. Crop Protection

Use resistant cultivars and varieties, adopt organic control practices, apply pest and disease forecasting techniques and promote integrated pest management (IPM).

## 3. Water

Good practices related to water will include those that maximize water infiltration and practices that avoid contamination of water resources.

## 4. Crop and Fodder Production

Good practices related to crop and fodder production will include selection of cultivars and varieties with high productivity, quality, market acceptability and nutritional value, disease and stress resistance etc.

## 5. Harvest and On-farm Processing and Storage

Good practices related to harvest and on-farm processing and storage will include

- clean and safe handling for on-farm processing of products.
- use recommended detergents and clean water for washing.
- store food products under hygienic environmental conditions.
- pack food produce for transport in clean and appropriate containers.
- training of staff for giving awareness on personal health and hygiene.
- proper maintenance of equipment.

### Assessment activity

1. Jigsaw grouping and discussion on the principles of GAP.

Jigsaw grouping -Learners are divided into groups of 5 each and. each member will be asked to study one component in GAP principle. Learners getting the same component discuss together and finally go back to their original group and contribute their ideas to the original group.

### 3.3.3 Global GAP, GMP, GHP, HACCP - Definition

**GLOBALGAP** started as a retailer initiative in 1997 with major inputs and support from the chemical companies. GLOBALGAP was established by the Euro-Retailer Produce Working Group (EUREP) with the aim of setting standard and procedures for the development of GAP. The GLOBALGAP standard is primarily designed to reassure consumers about how food is produced on the farm by minimizing environmental impacts of farming operations, reducing the use of chemical inputs such as chemical fertilizers, pesticides etc and ensuring a responsible approach to workers health and safety.

Currently, there are numerous systems that growers can adopt to ensure safe food production other than GAP, which include Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Points (HACCP), Good Hygiene Practices (GHP) etc.

**Good Manufacturing Practices (GMP)** guidelines provide guidance for manufacturing, testing, and quality assurance in order to ensure that a food is safe for human consumption. It includes specifications and calibration of equipment and its designs where conditions for food safety can be achieved, maintain and monitor lighting and ventilation systems, storage conditions etc.

**Good Hygiene Practices (GHP)** states the safety and suitability of food at all stages of the food chain for maintaining hygiene and sanitation. Sanitation include personal hygiene and employee health conditions. Maintenance of plant and equipment hygiene includes hygiene of food contact surfaces, pest control, waste disposal, water quality, toilet and hand wash facilities.

### **Principles of good hygiene**

Assurance that food will not cause harm to the consumer when it is prepared and/ or eaten, Assurance that food is acceptable for human consumption.

**HACCP (Hazard Analysis Critical Control Point)** is an internationally accepted technique for preventing microbiological, chemical and physical contamination along the food supply chain. The effective implementation of HACCP will enhance the ability of companies to protect and enhance brands and private labels, promote consumer confidence and conform to regulatory and market requirements.

- GMP (Good Manufacturing Practices), Good Hygiene Practices (GHP) are prerequisite programs for HACCP.
- It is a system for ensuring that products are consistently produced and controlled according to quality standards in each steps.
- Establish Procedures for Verification to confirm that the HACCP System is working effectively.
- Establish documentation concerning all procedures and records appropriate to these Principles and their application.
- GLOBALGAP only covers produce up to the farm gate and thereafter other systems such as GMP, HACCP etc will become essential.

Who can use HACCP?

All businesses involved in the food supply chain from producers to retailers can use HACCP.

### Principles of HACCP

- *Conduct a hazard analysis*
- *Determine the CCPs*
- *Establish Critical Limits*
- *Establish a system to monitor Control of the CCPs*
- *Establish the Corrective Actions to be taken when monitoring indicates that a particular CCP is not in control*

### Practical activity

Visit an accredited institution that follows FSSAI/ GAP/ HACCP and map the flow diagram of production process and steps followed in the certification process.

### Assessment activity

Class test on definition of Global GAP, HACCP, GMP, GHP

### 3.3.4 Potential Hazards that cause adverse health effects

1. Biological hazards (caused by food borne microorganisms)
2. Chemical hazards (Pesticides, fertilizers, antibiotics, heavy metals, oils)
3. Physical hazards (foreign bodies like residual soil and stone, remains of packaging, glass and sharp objects )

### Assessment activities

General Discussions

### 3.3.5 Key terms associated with chemical hazards

#### Residual toxicity

Residual toxicity is the presence of pesticide residue in food, agricultural commodities, or animal feed resulting from the use of a pesticide. The term includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance. The concentration is generally expressed in parts per million (ppm) or parts per billion (ppb).

The toxicity of a pesticide is its capacity to cause injury to a living system, may be a human body, or parts of the body (such as the lungs or the respiratory system); a pond, a forest and those creatures that live there.

The toxicity of a pesticide is dependent on a number of factors.

1. Dose : It is the quantity of a pesticide that a surface, plant or animal is exposed to.
2. Time : How often the exposure occurs.

Thus, the how much of the substance is involved and how often the exposure to the substance occurs gives rise to two different types of toxicity - acute and chronic toxicity.

### **Maximum residue limits (MRL)**

Maximum residue limit may be defined as the maximum levels of pesticide residue that can be present in or on a produce when pesticide is used under supervision following good agricultural practices (GAP). The concentration is expressed in milligrams of pesticide residue per kilogram of the commodity.

Under the Prevention of food adulteration Act, MRL or Tolerance Limits (TLs) are fixed based on supervised trials conducted in India as well as the dietary habits of our population. Pesticide residues on crops are monitored through the use of Maximum Residue Limits (MRL), which are done based on the analysis of the quantity of a given chemical remaining on food product samples.

### **Biomagnification**

Biomagnification is the bioaccumulation of a substance up the food chain by transfer of residues of the substance in smaller organisms that are food for larger organisms in the chain. It occurs when a chemical becomes more and more concentrated as it moves up through a food chain.

Eg. DDT, cyclodienes like aldrin, endrin, chlordane, heptachlor

For the biomagnification to occur, the pollutant must be

- long-lived
- mobile
- soluble in fats and
- Biologically active

### **Bio magnification Hazards**

- Insect resistance to pesticides
- Shell-thinning in birds, particularly carnivorous birds
- Life threatening diseases

### Waiting period

Pesticides once applied will remain in the plant parts without degradation for varying lengths of time depending on the type of the pesticide. Hence those pesticide treated produces shall be eaten only after a certain period. Hence interval between pesticide application and harvest has been fixed for each pesticides and for the same pesticide for different crops. In the case of crops like vegetables (Chillies, Bhindi, Cowpea etc.) where harvesting takes place in short intervals, pesticide having waiting periods matching with the normal harvest interval may be chosen.

Pesticide	Crops	Waiting period
Quinalphos	Bhindi	3 days
	Bittergourd	5 days
	Black Pepper	12days

### Assessment activities

Prepare an assignment on the key terms associated with chemical hazards.

### 3.3.6 Domestic practices for insecticide residue removal

The following practices/ treatments have been evaluated for their efficacy in removing residues of the insecticides detected in fruits and vegetables.

- Common salt 2% (20 g of common salt dissolved in one litre of water)
- Tamarind 2% (20 g of preserved tamarind pulp extracted in one litre of water)
- Vinegar 2% (20 ml of vinegar diluted in one litre of water)
- Slaked lime 2% (20 g of hydrated lime dissolved in one litre of water)
- Baking soda 2% (20 g of baking soda ( $\text{NaHCO}_3$ ) dissolved in one litre of water)
- Turmeric 1% (10 g of turmeric powder dissolved in one litre of water)
- Scrubbing for 2 minutes
- Washing in running water and steaming for 10 minutes
- Washing in running water for 10 minutes.
- Peeling/Removal of skin of fruits and vegetables
- Use of UV radiation

Fruits of the crops harvested can be dipped in the decontaminating solutions for 20 minutes and then washed in running water.

### **Practical activity**

Practice in the lab domestic practices for removal of pesticide residues.

### **Assessment activities**

Preparation of point card showing the domestic practices for the removal of insecticide residues from fruits and vegetables.

### **TE Questions**

1. You are invited by your residents association to take a class on “Domestic practices for insecticidal removal residue”. List out the important points.
2. What is Good Agricultural Practice?. Explain the principles of GAP for selected agriculture component.
3. What are the key terms associated with chemical hazards?

## Unit 4

### Agri- Enterprises

#### Introduction

Agriculture Technology can be used to generate farm income through different agri –enterprises. This Unit explores the enterprises viz. Mushroom technology, Landscaping, Lawn making, Flower arrangement, Apiculture and Sericulture Technology.

#### Learning outcome

The learner :

- acquires skill on starting mushroom and spawn production unit and its processing.
- gets familiarised with apiculture.
- gets familiarized with sericulture.
- acquires skills in Vegetable seed production.
- acquires skill in landscaping and lawn making.
- understands the scope of flower arrangement as an enterprise.

#### 3.4.1 Mushroom and spawn production unit and its processing

Mushroom is the fruiting body of the fungus. Vegetative part is mycelium, consists of fine threads running all over through the material upon which it is growing. Mushroom protein is comparable with muscle protein. Mushroom is rich source of protein, vitamins, folic acid etc.

#### Edible mushrooms

- Oyster mushroom – *Pleurotus* sp
- Paddy straw mushroom – *Volvariella* sp

#### Spawn production

Spawn, i.e. seed required for growing mushroom, is the vegetative mycelium from a selected mushroom cultured on a convenient medium like wheat, pearl millet, sorghum grains, etc. In simple words spawn is grains covered with mushroom mycelium. It essentially involves preparation of pure culture of mushroom from tissue/spores, followed by culturing on sterilized grains and further multiplication on grains. Mushroom spawn can be prepared on any kind of cereal grains like wheat, jowar,

bajra or rye and on agricultural wastes like corn cobs, wooden sticks, rice straw, saw dust and used tea leaves, etc. The grains are thoroughly washed in sufficient water and then soaked in sufficient water for 20-30 minutes and boiled in a container for 15-20 minutes. It should be ensured that grains get boiled but do not burst and same can be tested by pressing the grains. Excess water from the boiled grains is strained off. Now the grains are mixed with gypsum (Calcium sulphate) and chalk powder (Calcium carbonate) so that the pH of the grains is around 7 to 7.8 ( 200 g gypsum and 50 g chalk powder for 10 kg grains).

About 300 g prepared substrate (boiled grains mixed with gypsum and chalk) is filled in glucose/milk/glass bottles upto 2/3 volume and plugged with non-absorbent cotton. The plugs are covered with aluminum foil. These bottles are sterilized in autoclave or Pressure cooker. Autoclaved bottles are left in the room for 24 hours for cooling. Pure culture of fungus is transferred to these bottles under UV Laminar Air flow chamber and inoculated bottles are incubated. The fungus grows on the substrate within 20-25 days and covers the entire bottle. Now the mother spawn is ready. These can be used for further production of spawn bags. One mother spawn is sufficient for production of 25-30 spawn bags. Commercial spawn can be prepared in polypropylene bags (heat resistant). The bags are filled with substrate, plugged and autoclaved. The bags are then inoculated from mother spawn (10-15g) and incubated under aseptic condition. It takes 15-20 days for complete mycelial growth, which can be used for mushroom production.

### **Method of cultivation of Oyster mushroom**

A short duration variety 'Ananthan' introduced by KAU is widely used for cultivation. 1 Kg of one year old paddy straw is cut into small bits of 5-8 cm length and kept in water for 18 hrs. Soaked straw is taken out of water and kept inside a basket for 1-2 hrs to drain away excess water. The soaked straw kept under boiling water for 30-40 minutes for surface sterilization. Keep this in basket. Allow to drain excess water and cool down. Then fill this straw up to 5cm height in polythene bags of 30X60cm size and 150-200 gauge thickness. Instead of chopped straw, bundles of straw can be used. Press well with hand. Then sprinkle one table spoon full of spawn over the filled straw around the peripheral region. Again second layer of straw is filled, press well and sprinkle spawn. This process is repeated till it reaches the mouth of the cover. Then bag is tied tightly with twine. Keep undisturbed for about 15-20 days, under thatched rooms, well ventilated with rat proof coverings. Ideal temperature is 28-30°C and humidity 80-85%. Good spawn run can be judged from the whitish growth covering the straw completely. After 15 days, remove the

polythene bag by cutting with blade. Pinhead formation starts on 20<sup>th</sup> day onwards. It will take 2-3 days for full development of mushroom. Harvesting can be continued up to 2-3 weeks with occasional sprinkling of water.

### Value added products

Dehydrated mushroom, canned mushroom, mushroom ketchup, mushroom pickles etc.

### Practical activities

1. Method demonstration of mushroom bed preparation
2. Visit to a spawn production unit
3. Marketing and sale of mushroom products
4. Practice preparation and marketing of value added product of mushroom (dried mushroom, mushroom cutlet, mushroom pickle etc)

### Assessment activities

1. Prepare a project on establishing a small scale mushroom unit (No.of beds-30-50beds) .
2. Article collection on new trends in mushroom cultivation.

## 3.4.2 Apiculture

### Importance and Scope

Honey bee is one of the very few domesticated beneficial insects. Rearing of honey bees on a commercial scale is called apiculture. Apiculture (bee - keeping) is becoming popular in India not only because of the production of honey and beeswax but also because honey bees are valuable pollinators of cultivated plants.

### Honey bee species

Honey bees belong to the genus *Apis*. The well known indigenous species of *Apis* in India are:

1. **Rock Bee (*Apis dorsata*)**-They are giant bees found all over India. They are very good honey gatherers with an average yield of 50-80 Kg of honey per colony per year.
2. **Indian Bee (*Apis ceranaindica*)** –They are domesticated species which construct multiple parallel combs with an average honey yield of 6-8 Kg per colony per year.

3. **Little bee (*Apis florea*)**–They are the smallest of the true honey bees. They build single vertical combs. They are poor honey yielders and yield about 200-900g of honey per colony per year
4. **European bee (Italian bee – *Apis mellifera*)** – similar in habits to Indian bee. Build parallel combs, suited for rearing in artificial bee boxes. Average production comes up to 25-40 kg/colony/year.
5. **Sting less bee (*Trigonella iridipennis*)** – They are not truly stingless but the sting is poorly developed. They make nest in ground, holes on trees, cracks of wall. They are efficient pollinators. Yield 300 – 400 g/year. Honey fetch high price due to its medicinal properties.

### Honey bee castes

The bee colony is polymorphic, comprising three varieties or castes:

- Queen (fertile female) is unable to produce wax or to gather pollen or nectar, and her sole duty is to lay eggs. She has a very large body but less powerful wings than workers. Lays 1000 – 2000 eggs per day.
- Workers (imperfectly developed females) undertake all the work of the colony. These are small bees but have very well developed and powerful wings. A worker has wax glands, a pollen basket on her hind legs, well developed mandibles for work in the hive and a full fledged sting.
- Drones (fertile males) are considerably larger and stouter than the workers and have greatly enlarged eyes. Their main function is to mate with the queen after which the workers drive them out.

### General Apiary management Practices

To start a new colony

1. Natural swarms are trapped during swarming season and transferred to artificial hives.
2. Collect or buy the unit from apiaries or divide the existing units. Ensure that all units include queen, workers and drones.

### Periods in rearing

Three distinct periods are identified in artificial bee keeping

- a) Growth period- New unit can be established during this period.

The reproductive rate is quite high during this period. New colonies will be formed and this usually happens in Sept-Dec period.

- b) Yielding period – (Jan – April) During this period wild plants flower profusely and more nectar will be available to bees.
- c) Lean period – (May – Sept) During this period food availability is minimized hence we have to provide sugar solution (1:1 sugar+water)

### Instruments used in apiculture

1. Bee box – it consists of a rectangular wooden box, open both at the top and at the bottom. ISI type A box is recommended for Kerala.
2. Smoker – to generate smoke to subdue bees during handling.
3. Bee knife – to open the comb before extraction of honey.
4. Honey extractor – instrument used to extract honey from combs by centrifugation.

### Collection of honey

Worker bees fill the cells of the super with honey and remove excess moisture by a process of natural ripening. Cells filled with ripened honey are sealed with wax. Combs can be taken off for extraction when about 75 percent of cells are found sealed. After driving off the bees, the cells are uncapped by cutting with a hot knife and honey is separated using the honey extractor.

### Important products of Apiculture

- (a) Honey – honey has high calorie content. Antibacterial properties, increase haemoglobin content in blood. Widely used in Ayurvedic, Unani and Naturopathic medicines.
- (b) Bee wax – used in cosmetics, candle industry, medicines, polish, crayons, gums etc.
- (c) Bee venom – remedy for rheumatism

### Pests and diseases

Important pests are,

Wax moth, Yellow banded wasp, brood mite, bee eating birds, Black ants, lizard, spiders etc

### Diseases

- Thai sac brood disease caused by virus - larvae affected and colony become weak.
- Nosema disease caused by protozoa - affects larvae.

**Supporting agencies** - A number of institution under government and private sector support bee keeping like Kerala Khadi and Village Industries Board, HortiCorp, Rubber Board, KAU – ICAR supported All India Co-ordinated Bee keeping project, Malanadu development Society (MDS), Kottayam

### **Practical activity**

Preparation of an interview schedule and visit to an apiary unit.

### **Assessment activities**

1. Seminar on Apiary management practices
2. Preparation of chart on honey bee species and castes

## **3.4.3 Sericulture Technology**

Rearing of silk worms on a commercial basis is known as sericulture. Silk is a fibrous protein produced by the silkworm for spinning a cocoon. Silk may be defined as yarn reeled from the cocoons spun by the caterpillars of silk producing insects. There are four kinds of silk of commercial importance in the world ie mulberry, tasar, eri and muga silk. Common silk is the mulberry silk. It is produced by the silkworm called *Bombyx mori*. Nearly 95% commercial silk comes from *Bombyx mori*. The silkworms of this type are fed on mulberry leaves. Mulberry culture in other words called moriculture. The other kinds of silks are called non-mulberry silks since mulberry is not the food plant.

### **Steps involved in Sericulture**

- (1) Mulberry cultivation (Moriculture)
- (2) Silkworm egg production
- (3) Silkworm rearing
- (4) Disposal of cocoons

### **Rearing equipments**

1. Chawki stand
2. Wooden trays
3. Rearing racks
4. Chopping knives
5. Chopping board
6. Wooden or bamboo rearing trays
7. Chandrika / Nethrika / Mountage

8. Leaf chamber
9. Feeding stands
10. Ant well

A number of diseases and pests are found to infect silkworm during rearing. The most important diseases with their causal organism are given below.

SI No	Disease	Causal Organism
1	Pebrine	Protozoa
2	Flacherie	Bacteria
3	Grasserie	Virus
4	Muscardine	Fungus

**Yield :** For every 100 DFLS the yield ranges from 25 Kg to 50 Kg.

**Supporting agencies** - Central Silk Board, Kerala Khadi and Village Industries Board, SERIFED – Sericulture Co-operative Federation Ltd. (assist in marketing, training and monitoring), Kerala Agricultural University.

### Practical activity

Visit a silkworm production unit.

### Assessment activities

- Preparation of brochures on sericulture.
- Preparation of chart showing rearing equipments.

### 3.4.4 Vegetable Seed production

Production and supply of genetically pure seed of high yielding varieties would ensure high productivity of quality produce vegetables. The handling of seed crop, curing, threshing, cleaning, grading, packing, and storage need specialised knowledge.

#### Procedure

1. **Harvest:** - Collect fruit at correct stage of maturity for seed extraction in common vegetables available in the farm viz. Tomato, Brinjal, Chilly, Bitter Gourd, Snake Gourd, Cucumber, Pumpkin, Amaranthus, Cowpea, and Okra.
2. **Extraction and Drying:-** Seeds will be extracted from 1kg fruit by the following methods.

**Tomato**

Keep the fruits for one day, Crush it by hand and keep for 1 to 3 days. Collect the settled seed and wash 8 to 10 times, dry under shade. For faster extraction, acid and alkali treatments can be resorted to.

**Brinjal**

Peel of the outer covering and the flesh with seed are cut into slices. The sliced material is kept overnight and washed thoroughly in water. The extracted seed are dried under shade.

**Chilli**

Fully ripe pods are dried in sun and seeds are extracted mechanically. Seeds can be extracted from fresh fruits also.

**Cucurbits**

In fleshy fruits like bitter gourd, snake gourd, pumpkin, cucumber, water melon and musk melon, the seeds are scooped out with a little pulp and collected in a dish. Rub it with sand/ash to remove pulp. Wash in water and dry in shade. In dry fruits like bottle guard and smooth guard, extract the seeds by breaking the shells and clean it.

**Okra**

Collect fruit which have turned brown and hard before seed shattering leaving 2-3 pods at the top. Keep for few days for drying. Then thresh by beating with sticks. Clean the seeds and dry to a moisture content of 10%.

**Amaranthus**

When grains attain maturity ie; when the glumes turn brown and seeds to black, it can be harvested along with stem. Sundry the inflorescence harvested up to 15% moisture content. Thresh it with sticks, sieve dry up to 7% of moisture content and store.

**Cowpea**

Dry pods are collected dried and threshed by beating with a stick to extract the seeds. It is cleaned and dried under shade to a moisture content of 9%.

**Vegetable seed processing equipments**

1. Axial flow seed extracting machine.
2. Seed drier TAU model
3. Air screen cleaner
4. Gravity separator
5. Slurry seed treater



*Seed extracting machine*

### **Practical activity**

Practice seed extraction from vegetables like cucumber, tomato and okra.

### **Assessment activities**

Preparation of chart explaining the extraction and drying of vegetable seeds in a tabular form.

## **3.4.5 Landscaping and lawn making**

Landscaping or landscape gardening is the aesthetic improvement of any area using plants and other components.

### **Basic Principles of Landscaping**

There are certain basic principles, which enable a designer to design a garden that is aesthetically pleasing.

#### **■ Initial approach**

This principle specifies how the designer should approach the activity of designing and the factors, which are to be taken into account.

#### **■ Axis**

This is an imaginary reference line which can be used to divide the garden area into 2 equal halves. Such a reference line greatly simplifies the process of designing.

#### **■ Focal point**

The feature focused as a point of interest in the garden, usually at the central position is called the focal point of the garden. Depending upon the size of the garden this feature may be small or large.

#### **■ Divisional lines**

These are demarcations between features, which help to outline their position. The divisional lines used may be edge plants, other edging materials, narrow paths or paving.

#### **■ Proportion and scale**

The size of garden components should be proportionate to each other and with the size of the garden.

#### **■ Space**

A garden should appear larger than it actually is. The unbroken green cover of a lawn gives an impression of greater space than when it is interspersed by other plantings. Placing taller plants towards the periphery of the garden and leaving more open areas inwards also gives an impression of greater space.

### ■ **Unity**

There should be perfect unity in style and function between the garden components.

### ■ **Mass effect**

The enhanced visual effect got from grouping plants in large numbers is referred to as mass effect. Foliage and flowering plants can be mass planted or grouped in containers to display them effectively.

### ■ **Colour and tone**

Colour and tone effects can be used in gardens to obtain spectacular visual display. For flowerbeds, carpet beds, shrub groupings and flowering hedges, combining plants with different flower colours and colour tones is done to provide varying visual effects.

### ■ **Texture**

Surface characteristics of all garden components for example a lawn, a path, a pool, a hedge or a tree canopy can be used effectively to obtain textural contrasts or unity. The appearance of the surface of a component may contrast with or complement with that of another component nearby.

### ■ **Time and light effects**

The principle of time and light specifies that garden components should be established or planted taking into account the light and shade received in different parts of the garden at different times of the day over different seasons of the year.

### ■ **Mobility**

Though plants are not mobile, the changes undergone by them during their growth and development and over the seasons provide visual mobility. Movement of birds and small animals can be ensured in a garden by growing trees that provide means of subsistence to them. Water flowing along channels and falling in cascades also provide mobility in gardens.

### ■ **Style**

The style of the background architecture whether it is a building or a residence decides the style to be followed in designing.

## Lawn

A grass cover that is maintained at a uniform height is called a Lawn which is known as the “heart of the garden” Quick growing hardy perennial varieties of Hariyali or bermuda grass (*Cynadon dactylon*), Kentucky blue grass or Meadow grass (*Poa spp*) and the Japanese coarse grass (*Zoysia japonica*) are used for lawn making throughout the world. The Indian buffalo grass (*Axonopus affinis*) is a relatively broad-leaved grass used for lawn making.

### Lawn making and maintenance

#### 1. Lawn grasses

- i. **Hariyali grass/ doob grass/Bermuda grass**-*Cynodon dactylon*
- ii. **Blue grass/ Kikiyu grass**- *Pennisetum clandestinum*. –for high ranges or hilly areas with low temperature.
- iii. **Carpet grass** - *Axonopus compressus*-for shady areas.
- iv. **Korean grass/Japanese Mexican grass** -*Zoysia japonica*.
- v. **Buffalo grass** - *Stenotaprum secundatum*.

#### 2. Planting

Planting can be done by means of seeds, turfing, turf plastering, dibbling shoots or by planting cut grasses.

##### a. Using seeds

The soil has to be forked to a depth of about 2-3 cm before sowing the seeds. The seed rate is 250g/100m<sup>2</sup>. Seed is mixed with some inert material like sand, and sown above the prepared land. Cover the seeds with a thin layer of soil and press well with a roller. Then irrigate with a rose can. Seeds germinate within 3-5 weeks.

##### b. Turfing/ sodding

Turf or sod is a piece of earth with a grass cover. Turfs of about 20cm x 20cm size and 6-8cm thickness are taken from places where the grass is growing without weeds. Such turfs are paved closely on the prepared land after forking the surface and the gaps are filled with soil. Then, the sods are pressed with a roller and irrigated with a rose can. This is the quickest method of establishing a lawn.



**c. Turf plastering**

After the preparation of land, the grass is collected from a well established place. They are cut into small pieces, each with 2-3 nodes. The cut pieces are mixed with slurry of cow dung and sand and is placed or applied on the prepared land. Then the land is covered with a layer of straw to prevent the evaporation for 2-3 days and irrigated daily. Successful in rainy seasons.

**d. Dibbling shoots**

The off-shoots of grass collected are cut into small pieces and scattered evenly over the prepared land. Then a mixture of sand and soil is evenly spread on it to a thickness of about 1 cm and a light rolling is given followed by watering. Successful in rainy seasons.

**e. Planting cut grasses**

The slips of lawn grass are collected and they are planted very closely on the prepared land. Then it is lightly rolled and irrigated daily.

**3. Aftercare**

Once the lawn is established, it requires great care and maintenance. Otherwise the lawn becomes ugly and it spoils the beauty of the whole garden. The important operations in the maintenance of a lawn are mowing, rolling, irrigation, weeding, manuring and plant protection.

**a. Mowing**

The cutting and levelling of the grass periodically is known as mowing. To have good appearance, the lawn is to be mowed regularly at an interval of 2-3 weeks. In the early stages, grass cutting swords can be used. When the grass has grown well, a mower is best suited. The height of the grass should not be more than 5 or 6 cm.

**b. Rolling**

During the time of land preparation, the soil is rolled to make it level and compact. When the lawn is established, rolling is done in order to bring the grass in contact with soil and also to keep the ground level. It also helps to prevent the attack of white ants (termite) and to kill the air pockets created by earthworms. Rolling can be done twice or thrice in a month. In rainy season, or when the soil is too wet, it is not advisable to roll the lawn.

### **c. Irrigation**

The lawn needs watering in summer season. Frequent and light irrigation is preferable than heavy watering at long intervals.

### **d. Weeding**

All plants other than the lawn grass are to be uprooted and removed frequently. Never allow weeds to produce seeds.

### **e. Manuring**

Yellowing of grass indicates N deficiency. Drenching the soil with 1-2% urea in water can cure the yellowing. This can be done every month.

It is advisable to fork the lawn once in a year. Then top dressing may be done with a mixture of powdered cow dung and sand in 1:1 ratio. Also add a fertilizer mixture of ammonium sulphate, super phosphate and MOP in the ratio of 2:1:1 at the rate of 50-75g/m<sup>2</sup> area. Then roll the lawn.

### **f. Plant protection**

Termite and earthworms may damage the lawn. Rolling can control them to some extent.

### **Replanting**

The beauty of the lawn is lost about 4-5 years after its establishment. Then replanting will be necessary after about 5 years.

### **Practical activities**

- 1 Setting up of lawn through different planting methods.
- 2 Identify the ornamentals in school garden.
- 3 Identifying and reporting major problems in lawn or garden maintained in the school.
- 4 Landscaping in school premises.

### **Assessment activities**

Chart preparation of basic principles of landscaping.

### 3.4.6 Flower arrangements

Flower arrangements are an important part of the ambience on any occasion, such as weddings, birthdays, parties or any other events in life. Flower arrangement is an organization of design and color towards creating an ambience using flowers, foliage and other floral accessories. Flower arrangement can be classified into two:

1. Fresh flower arrangement
2. Dry flower arrangement

#### 1. Fresh flower arrangement

Two different approaches to floral designs: western styles, employing a 'mass' concept of arranging flowers in an even symmetry, and the eastern or Japanese or Ikebana styles, which are based on specific rules and angles, using less material.

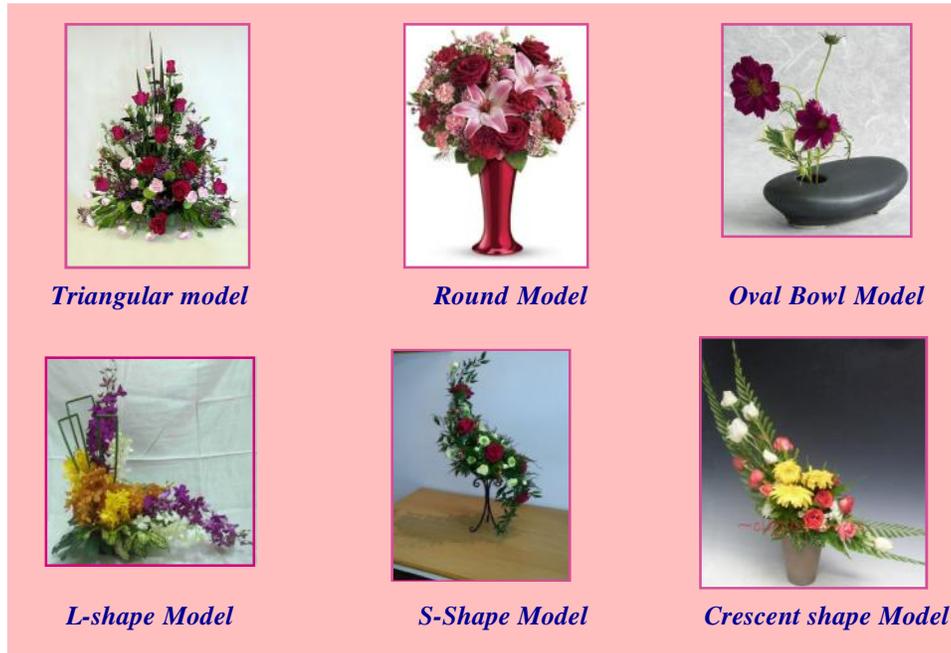
Some of the basic differences between eastern and western arrangements are

- Primarily western style is symmetrical arrangement, but eastern style is asymmetrical one.
- Western arrangements employ more flowers to create mass effect, but eastern styles impress more by the beauty of individual material.
- Contrary to western arrangements the materials in Japanese never touch the rim of the vase.
- Accessories are never used in western arrangements. But in Ikebana interesting branches, drift wood, pieces of bark, shells etc., are used to imitate the nature. Here the more emphasis is given on western arrangements.

#### Western styles of flower arrangement

Different models

- The triangular model
- The Round model
- The Oval bowl model
- The L-Shape model
- The S-Shape model
- The Crescent shape model



**Eastern or Japanese or Ikebana styles**

Ikebana arrangement-

There are two types of Ikebana arrangement – Moribana and Nageire In Moribana, flowers are arranged in wide mouthed containers while in nageire style flowers are arranged in narrow mouthed tall containers

- Moribana upright style
- Moribana slanting style
- Nageire upright style
- Nageire slanted style
- Nageire cascading style



*Moribana upright style*    *Moribana Slanting style*



*Nageire upright style*



*Nageire slanted style*



*Nageire cascade style*

## 2. Dry flower arrangement/ potpourri

Dried flower products are in very high demand and add an enriched value to the flourishing industry. The flower arrangements using dried samples of cone, foliage, flowers like rose buds, lilies and other such plant material enhances the beauty of dry flowers, adding more export value to this industry. In recent years, there has developed a trend to fragrance a mixture of flowers for keeping in rooms, kitchens, toilets etc. This is known as ‘Potpourri’.



*Dry Flower Arrangements*

*Potpourri*

### Materials for dried arrangement

- Cultivated flowers and vegetable including seed, pods, vines and grains.
- Naturally available materials like flowers, seed pods, fern leaves, certain weeds and grasses.
- Pods, cones, capsules, fruits, branches, leaves, berries and flowers of broadleaved evergreen trees and shrubs.

### Preservation of plant materials

There are a few methods of preserving flowers and foliage.

- Hanging upside-down: Here the materials intended for drying are tied and allowed to hang upside down from string without touching each other.
- Burying in sand or borax: Fine and dry sand are poured to a depth of 10 cm into a box or pan. The foliage of the flower stalk are to be stripped off and kept upside down on the sand and then covered with a layer of sand over them. After two weeks of time, the sand may be poured off carefully and the flowers may be taken out after gently wiping them free of sand with a soft brush. Marigold, Chrysanthemum, Sunflowers, all types of Roses are preserved by this method.

- Drying flowers using Silica Gel.
- Glycerin method: This method is used for foliage only. The clean foliage materials are kept inside a jar containing a solution made up of 2/3 of water and 1/3 glycerin.
- Drying flowers using a book
- Pressing between papers

### **Practical activities**

1. Practising different styles of Flower arrangement.
2. Prepare a flower arrangement method and submit a report.

### **Assessment activities**

Collect pictures of different types of flower arrangement.

### **TE Questions**

1. As a part of your work on “Beautification of school garden” You are assigned with a task to prepare a lawn .Can you suggest two method for its establishment and maintainance.
2. If you get a chance in AIR for conducting a radio talk about the “Oyster Mushroom cultivation”. How will you give a detailed write up on the topic.
3. You are a landscape professional and you are invited to take a class on principles of landscaping. Prepare a brief writeup.
4. A Kudumbasree unit has approached you to take a class on the importance of apiculture in Kerala. How will you prepare a script for the presentation.

## Unit 5

# FARMER SUPPORT SERVICES

### Introduction

The unit deals with the various services implemented by the government as well as semi government and private agencies given to farmers to increase the farm production and productivity. Emphasis is given to agri clinics and input centers in this unit. A guide on pest and disease diagnosis is also detailed. Unit also gives an overview on ICT enabled extension services related to agriculture such as popular agri extension related softwares, decision support systems , pest, disease and nutrient deficiency diagnose softwares, ICT enabled crop health clinics and farmer support schemes.

### Learning outcome

The learner:

- gets an awareness on the services rendered by Krishi Bhavan especially on the functioning of Agri clinics.
- identifies the pests and disease symptoms and practice IPDM practices for Rice, Coconut, Rubber, Banana, Mango, Cashew, Pepper, Solanaceous vegetables, Cucurbits, Cowpea, Amaranthus, Bhindi.
- explores the services rendered by Agri input centres and Bio pharmacy.
- explores the scope of ICT enabled extension services in Agriculture and the related softwares and various schemes in Dept of Agriculture.

### 3.5.1. Services from Krishi Bhavan

Krishi Bhavans in every panchayat is the grass-root level office headed by the Agricultural Officer. There are 1046 Krishi Bhavans in the State. 2-3 Agricultural Assistants assist the Agricultural Officer. The activities of the Department are spearheaded and co-ordinated by the Agricultural Officer in his jurisdiction. Krishi Bhavans have a lead role in planning, formulation and implementation of agriculture projects of local self-government.

- Agri Clinics
- Agro Service Centres

- Biopharmacy
- Various Schemes

### **AgriClinics**

The Ministry of Agriculture and farmers welfare, Government of India, in association with NABARD has launched a unique programme to take better methods of farming to each and every farmer across the country called Agriclincs and Agri Business Centers (AC and ABC) scheme.

Agri-Clinics are envisaged to provide expert advice and services to farmers on various technologies including soil health, cropping practices, plant protection, crop insurance, post-harvest technology and clinical services for animals, feed and fodder management, prices of various crops in the market etc. which would enhance productivity of crops/animals and ensure increased income to farmers.

One of the major agri ventures under this scheme is Crop protection services, including pest surveillance, diagnostic and control services (with culture rooms, autoclaves, microscopes, ELISA Kits etc. for detection of plant pathogens including viruses, fungi, bacteria, nematodes and insects).

#### **Functioning of Agri clinics**

1. Baseline data on plant health in the panchayat is to be collected.
2. Plant health record should be maintained.
3. Feedback register should be kept.
4. Pest surveillance group should be formed.
5. Training and awareness programme should be given in regular intervals.
6. Computerised data base for all the pest and diseases reported in the panchayat should be developed and e -mail support should be used for consultation for diagnosis and advisories.
7. Panchayat should be involved in all the activities of the clinic.

#### **Assessment activity**

Visit to Krishi Bhavan and participate in agriclincs .

### **3.5.2 Concept of IPDM**

“Pest has been defined as any organism detrimental to man and his property in causing damages significant of economic importance.

## Integrated Pest and Disease Management (IPDM)

IPDM is comprehensive approach to pest control that uses a combined means to reduce the status of pests to tolerable levels while maintaining a quality environment.

### What does IPDM integrate?

1. Integrates multiple pest management tactics (chemical, biological, cultural, mechanical).
2. Integrates management of multiple pests (insects, weeds, disease pathogens, nematodes, vertebrates, etc.).
3. Integrates pest management tactics on an area wide basis (many pest control situations are better handled on a large-scale or regional basis).
4. Reduces pests to tolerable levels and social concerns.

**Economic injury Level (EIL):** *The smallest number of insects (amount of injury) that will cause yield losses equal to the insect management costs. The EIL has been described as the break-even point, the level of pest a plant can tolerate, among other things.*

**ETL:** *The economic threshold is the pest density at which control measures should be determined to prevent an increasing pest population from reaching economic injury level.*

*For example, sometimes the ETL is simply set at 80% of the EIL, as it is with bean leaf eating caterpillars. In this case the ET is relatively close to the EIL. On the other hand, for an insect such as the aphid that has an exponential population growth rate, the ET is well below the EIL and at a level where no damage occurs.*

### Pest resurgence

*Pest resurgence is the rapid reappearance of a pest population in injurious numbers, usually brought about after the application of a broad-spectrum pesticide has killed the natural enemies which normally keep a pest in check. A well-known example in rice cultivation is the resurgence of brown plant hopper (BPH).*

### IPDM of Rice

1. Select High Yielding Varieties of rice suitable to the locality having resistance/ tolerance to major pests /diseases of the locality.
2. Use only healthy certified seeds.
3. Resort to seed treatment .
4. Raise varieties having the same duration at the same time in a padasekharam to avoid overlapping of cultivation.
5. Maintain bunds and fields free of weeds.
6. Assure nursery protection by periodic draining and flooding .
7. Assure protection and multiplication of natural enemies of pests and diseases in the field.
8. Collect egg masses of rice stem borers in perforated poly bags and keep them in the field so that the parasites that emerge from parasitized egg masses can establish in the field effectively.
9. *Trichogramma chilonis* and *T. japonicum* effectively control eggs of leaf roller, stem borer etc. These parasitoids are to be released in the form of Tricho cards 15 -30 days after transplantation or 25 – 30 days after sowing or immediately after noticing leaf roller or stem borer or moth activity in the field. Release 1 lakh parasitoids of both *T.chilonis* and *T. japonicum* @ 5 cc each per ha). The release has to be carried out at weekly intervals. 6- 8 releases are necessary to manage the pests. Tricho cards are to be placed either in the early morning or late in the evening.
10. Spray supernatant liquid of cow dung prepared from 200g of fresh cowdung in 10l water preferably from local breeds to manage bacterial diseases.
11. Try to avoid insecticides during the early stages of crop, to protect the natural enemies, especially predators.
12. Manage pests and diseases by spot application during initial stages rather than blanket spraying.
13. Select safe pesticides that cause least damage to natural enemies and environment.
14. Destroy stubbles by burying in soil by ploughing.
15. Select appropriate plant protection equipment in good working condition for application of pesticides.
16. Provide perches in the field to attract birds.

(Surveillance based pest and disease management in crop plants by C.K Peethambharan, P. Regunath, Department of Agriculture, June 2014).

## A Guide for Pest and Disease Diagnosis in Agriclincs

RICE – Pest			
Pest	Symptom	Stage of attack of pest	Management
Rice stem borer	In vegetative phase : dead heart symptom In reproductive phase: white ear head.	Caterpillar	<ul style="list-style-type: none"> <li>• Use Trichogramma egg cards</li> <li>• Clip the seedling tips before transplanting to eliminate egg masses</li> <li>• Application of flubendiamide or indoxacarb 15-20DAT</li> </ul>
Brown plant hopper (BPH)	Hopper burn	Nymph and adults	<ul style="list-style-type: none"> <li>• Use resistance varieties</li> <li>• Drain away water from the field</li> <li>• Application of Imidachloprid or Quinalphos</li> </ul>
Gall midge	Silver shoot	Maggot	<ul style="list-style-type: none"> <li>• Use tolerant varieties like uma</li> <li>• Release <i>Platygaster oryzae</i> parasitized galls</li> <li>• Apply granules of Quinalphos 250gai/ha or Chlorpyrifos 10G @0.5kg ai/ha within 10DAS</li> </ul>
Rice bug	Brownish discoloured patches on the husk	Nymph and adult	<ul style="list-style-type: none"> <li>• Strict monitoring at milky stage</li> <li>• Application of malathion or carbaryl</li> </ul>
Case worm	Small cylindrical cases made from leaves	Caterpillar	<ul style="list-style-type: none"> <li>• Drain away water from the field</li> <li>• Apply carbaryl dust</li> </ul>

RICE – Disease			
Disease	Pathogen	Symptoms	Management
Blast	Fungus	<ul style="list-style-type: none"> <li>Spindle shaped water soaked grayish green spots which enlarge in size and develop to spots with grey centre and brown margin</li> <li>Nodal blast, neck blast.</li> </ul>	<ul style="list-style-type: none"> <li>Avoid excess nitrogenous fertilizers</li> <li>Destroy collateral weed hosts</li> <li>Biocontrol with pseudomonas@ 10g/kg seed</li> <li>Seed treatment with Carbendazim @ 2g/kg seed</li> </ul>
Brown spot	Fungus	<ul style="list-style-type: none"> <li>Small definite oval / oblong spots with brown colour are formed on leaves and glumes.</li> </ul>	<ul style="list-style-type: none"> <li>Use resistant varieties</li> <li>Hot water treatment of seeds</li> <li>Seed treatment with Carbendazim, COC or Mancozeb.</li> <li>Foliar spray with Pseudomonas/ PGPR @ 20g/l.</li> <li>Foliar spray of zineb or Mancozeb (2kg/ha)</li> </ul>
Sheath blight	Fungus	<ul style="list-style-type: none"> <li>Symptoms first appear on lower leaf sheath near the water level as oval, oblong or irregular greenish grey spots, which enlarge and become grayish white with brown margin</li> </ul>	<ul style="list-style-type: none"> <li>As prophylactic measure, apply neem cake - coated urea. apply 50% more potash</li> <li>Control weeds</li> <li>Spray Pseudomonas/PGPR @ 20 g/l just before panicle initiation.</li> <li>Spray neem formulations Azadirachtin 0.15% w/w @ 2.5l/ha or Azadirachtin 0.03% EC @ 2.5l/ha at the time of sheath blight disease occurrence.</li> </ul>
Bacterial leaf blight	Bacteria	<ul style="list-style-type: none"> <li>Water soaked lesions on the tip of leaves which later increase in length downwards along the margins resulting in yellow to straw coloured stripes with wavy margins</li> <li>Systemic infection in seedlings – KRESEK</li> </ul>	<ul style="list-style-type: none"> <li>Spray fresh cowdung extract (dissolve 20g cowdung in one litre of water)</li> <li>Application of bleaching powder @ 5kg/ha in the irrigation water</li> <li>Apply Streptocycline 15g/300l/ha</li> </ul>
Tungro	Virus Vector - Leaf hoppers	<ul style="list-style-type: none"> <li>Stunting, change in colour of leaves to different shades of yellow or orange</li> </ul>	<ul style="list-style-type: none"> <li>Use resistant varieties.</li> <li>Spray Carbaryl to manage vectors</li> </ul>

COCONUT- Pest			
Pest	Symptoms	Stage of attack of pest	Management
Rhinoceros beetle	<ul style="list-style-type: none"> <li>attacked frond when fully opened shows characteristic triangular cuts.</li> </ul>	Adult	<ul style="list-style-type: none"> <li>Treat manure pits and other possible breeding sites with Carbaryl 0.01%.</li> <li>Control using the virus, Oryctes Baculo Virus (OBV) and fungus <i>Metarrhizium anisopliae</i></li> <li>Using pheromone traps @ 1 trap per 4 ha.</li> </ul>
Red palm weevil	<ul style="list-style-type: none"> <li>Presence of holes on the stem, oozing out of a viscous brown fluid through the holes, longitudinal splitting of leaf base and wilting of central shoot.</li> </ul>	Grub and adult	<ul style="list-style-type: none"> <li>Leaf axil filling with neem cake 250g or marotti cake</li> <li>Coconut log traps with fermenting toddy and pine apple or sugarcane activated with yeast or molasses.</li> </ul>
Leaf eating Caterpillar	<ul style="list-style-type: none"> <li>The caterpillar feeds on green matter from the lower leaf surface, remaining within galleries of silk and frass.</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>liberation of Braconid or Bethilidor elasmid parasite</li> <li>Under severe infestation spray the under surface of leaves with Quinalphos 0.05%.</li> </ul>
Coconut eriophyid mite	<ul style="list-style-type: none"> <li>Pale yellow triangular patches below the perianth which later becomes brown.</li> <li>Later these develop into brown to black necrotic lesions with longitudinal fissures on husk</li> </ul>	Nymphs and adults	<ul style="list-style-type: none"> <li>Spray neem oil garlic emulsion</li> <li>Wettable Sulphur 80% WP 4gm in 1 ltr. water.</li> </ul>

**COCONUT- Disease**

Disease	Pathogen	Symptoms	Management
Bud rot	Fungus	<ul style="list-style-type: none"> <li>• Yellowing of spindle leaves and droop down later.</li> <li>• The tender leaf base and soft tissues of the crown rot into a slimy mass of decayed material emitting a foul smell finally rotting progresses and kills the entire palm.</li> </ul>	<ul style="list-style-type: none"> <li>• Spray 1% Bordeaux mixture on spindle leaves and crown of the diseases affected</li> </ul>
Leaf rot	Fungus	<ul style="list-style-type: none"> <li>• Water soaked lesions in the spear leaves of Root (wilt) affected palms.</li> <li>• As the leaf unfolds the rotten portions of the lamina dry and get blown off in wind giving a "fan shape" to leaves.</li> </ul>	<ul style="list-style-type: none"> <li>• Spray crown and leaves with 1% Bordeaux mixture or 0.4% Mancozeb.</li> </ul>
Stem bleeding	Fungus	<ul style="list-style-type: none"> <li>• Exudation of reddish brown liquid through the growth cracks at the basal part of trunk.</li> <li>• Trunk gradually tapers towards the apex</li> </ul>	<ul style="list-style-type: none"> <li>• Chisel out and apply Bordeaux paste</li> <li>• Application of Calyxin 25ml/ 25 litres of water as soil drenching once in four months.</li> </ul>
Root (Wilt)	Etiology unknown	<ul style="list-style-type: none"> <li>• Leaves show flaccidity, ribbing, yellowing and marginal necrosis.</li> <li>• Yield gradually decreases</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt integrated management practices</li> </ul>

## BANANA - Pest

Pest	Symptoms	Stage of attack Pest	Management
Pseudostem weevil	<ul style="list-style-type: none"> <li>Bore holes on the pseudostem, fibrous extrusion from the base of the leaf petioles</li> <li>Yellowing and withering of leaves and decaying of peduncles</li> <li>In advanced stages pseudostem turns pale and bend down.</li> </ul>	Grub and Adult	<ul style="list-style-type: none"> <li>Field sanitation.</li> <li>Remove the affected plants and destroy them.</li> <li>Fill leaf axils with Neem seed kernel powder@ 50g/plant.</li> <li>Cowdung ash slurry can be brushed on pseudostem.</li> <li>Set up pseudostem traps</li> <li>Spray Namma 5% covering leaf axil and pseudostem 4-5 months after planting.</li> <li>Inject undiluted Menma just below the bore holes made by the weevil.</li> <li>In endemic areas, spray insecticides such as Chlorpyrifos.</li> </ul>
Rhizome weevil	<ul style="list-style-type: none"> <li>Premature yellowing, withering of outer leaves and death of heart leaves</li> <li>Young plants wilt and die.</li> <li>Older plants show growth retardation.</li> </ul>	Grub and Adult	<ul style="list-style-type: none"> <li>Field sanitation.</li> <li>Select only healthy planting material.</li> <li>Cut and remove outer layers of rhizome and sundry for 3-4 days after smearing with cow dung slurry and ash.</li> <li>Set up pseudostem traps</li> <li>Apply 1 kg neem cake in two split doses.</li> <li>Cosmolure can be set up 2-4 traps/ha.</li> </ul>
Banana aphid	<ul style="list-style-type: none"> <li>Indirect damage as it is a vector of Bunchy top.</li> </ul>	Nymphs and adults	<ul style="list-style-type: none"> <li>Spread lemon grass in the pit before planting.</li> <li>Apply cartap hydrochloride 4 G @25 g/plant, 20 DAP. A second and third dose is applied to the leaf axil @ 12.5 g at 65 and 165 DAP.</li> <li>Spray <i>Verticillium lecanii</i> to control vectors.</li> </ul>
Nematode - Root knot nematode, burrowing nematode, etc.	<ul style="list-style-type: none"> <li>Lanky pseudostem and foliar necrosis due to poor root growth.</li> <li>Heavily infested plants topple over easily.</li> <li>Very small bunches are produced.</li> </ul>	All stages	<ul style="list-style-type: none"> <li>Marigold grown as intercrop.</li> <li>Crop rotation with paddy/sugarcane/ tapioca.</li> <li>Apply neem cake @ 1 Kg/plant at the time of planting.</li> <li>Apply bioagents (<i>Paecilomyces lilacinus</i>, <i>Pseudomonas</i>, <i>Verticillium</i> and AMF)</li> </ul>

**BANANA - Disease**

Disease	Pathogen	Symptoms	Management
Bunchytop	Virus	<ul style="list-style-type: none"> <li>Severe stunting, narrowing of leaves with chlorotic margins.</li> <li>Crowding of leaves/ rosette, brittle leaves.</li> </ul>	<ul style="list-style-type: none"> <li>(Same as Banana Aphid)</li> </ul>
Kokkan / banana bract mosaic	Virus	<ul style="list-style-type: none"> <li>Characteristic dark reddish brown mosaic pattern in the bracts of inflorescence.</li> <li>Distinctive pinkish streaks on pseudostem which later turn dark.</li> <li>Travellers palm like aestivation.</li> </ul>	<ul style="list-style-type: none"> <li>Infected plants should be uprooted and destroyed.</li> <li>Use healthy planting material.</li> </ul>
Sigatoka	Fungus	<ul style="list-style-type: none"> <li>Yellow streaks appear on older leaves which later turn brown with yellow halo.</li> </ul>	<ul style="list-style-type: none"> <li>Cut and burn severely infected leaves.</li> <li>Grow resistant varieties such as BRS 1, BRS 2 and Manjeri nendran 2</li> <li>Spray 1% BM or 0.4% Mancozeb .</li> <li>Spray bioagents such as Pseudomonas 20 g/l or Bacillus subtilis 5 g/l.</li> </ul>

**CASHEW - Pest**

Pest	Symptom	Stage of attack	Management
Tea Mosquito Bug	Drying of inflorescence and die back of shoot.	Nymphs and Adults	<ul style="list-style-type: none"> <li>0.1 % carbaryl or 0.05 % quinolphos</li> <li>First Spray- Oct-Nov (Vegetative stage)</li> <li>Second Spray- Dec- Jan(panicle emergence)</li> <li>Third spray - Jan- Feb (fruit set)</li> </ul>

**CASHEW - Disease**

Disease	Pathogen	Symptom	Management
Dieback or Pink Disease	Fungus	Appearance of white patches on branches, drying of twigs from the tip.	<ul style="list-style-type: none"> <li>Apply bordeaux paste</li> <li>Prophylactic spray of 1% BM.</li> </ul>

**PEPPER - Pest**

Pest	Symptom	Stage of attack of Pest	Management
Pollu beetle	<ul style="list-style-type: none"> <li>Attacked berries become hollow (pollu) and crumble when pressed</li> <li>Attack on spike results in murithiri (broken spike)</li> <li>Holes on leaves</li> </ul>	Grub and adult	<ul style="list-style-type: none"> <li>Regulation of shade in the plantation</li> <li>Neem oil + Garlic 2% or Neem oil garlic 2% + Karanj oil 1%, as 3 sprays at spike emergence, berry formation and berry maturation stage.</li> <li>Spray neem 0.6%</li> <li>Spraying quinalphos (0.05 per cent) during June-July and September-October or quinalphos (0.05 per cent) during July</li> </ul>
Marginal gall thrips	<ul style="list-style-type: none"> <li>Marginal galls on leaves</li> <li>Galled leaves are malformed, thickened and crinkled</li> </ul>	Nymph and adult	<ul style="list-style-type: none"> <li>Spray Dimethoate 30 EC 1.5 ml/L (0.05%) on tender flushes. Repeat the spraying if necessary</li> </ul>

PEPPER - Disease			
Disease	Pathogen	Symptoms	Management
Quick wilt/ foot rot	Fungus	<ul style="list-style-type: none"> <li>• Occur during rainy season. Disease spread to entire vine through rain splash.</li> <li>• Tender leaves, succulent shoot tips of freshly emerging runner shoots on the soil turn black.</li> <li>• Water soaked lesions.</li> <li>• Breaking up of branches at nodes and the entire vine collapse within a month.</li> </ul>	<ul style="list-style-type: none"> <li>• Select disease free healthy planting material.</li> <li>• Remove and destroy dead vines along with root system</li> <li>• Adequate drainage should be provided.</li> <li>• mulching to avoid soil splash.</li> <li>• The runner shoots should be tied back to the standards.</li> <li>• Apply 1 Kg lime and 2 Kg neem cake /standard/year as premonsoon dose.</li> <li>• Inoculate with AMF, Trichoderma and Pseudomonas at the time of planting. Trichoderma is applied at the rate of 5-10 Kg/vine/year.</li> <li>• Spray nursery and main field with 2% Pseudomonas.</li> <li>• A foliar spray with 1 % BM.</li> <li>• Apply Bordeaux paste upto a height of 50 cm from collar region.</li> <li>• Drenching and spraying with potassium phosphonate (Akomin) 0.3%.</li> <li>• Drenching and spraying with 0.125% metalaxyl-mancozeb (Ridomil MZ) @ 5-10 l/vine.</li> </ul>
Anthracnose/ fungal pollu	Fungus	<ul style="list-style-type: none"> <li>• Chlorotic angular leafspots surrounded by yellow halo</li> <li>• Later leaf spots may join together resulting leaf blight followed by defoliation</li> <li>• Necrosis on the stock of the spike lead to spike shedding</li> <li>• Affected berries dry up gradually (fungal pollu)</li> </ul>	<ul style="list-style-type: none"> <li>• Remove and destroy fallen leaves and spikes</li> <li>• Minimize shade in the garden.</li> <li>• Spray with 2% Pseudomonas / PGPR mix II.</li> <li>• Spray 1% Bordeaux mixture, once before flowering starts (late June and early July) and then at berry formation stage (late August).</li> </ul>

## VEGETABLES

### BRINJAL- Pest

Pest	Symptom	Stage of attack	Management
Shoot and fruit borer	<ul style="list-style-type: none"> <li>• Infested shoots droop, wither and dry up</li> <li>• Affected fruits show holes on the surface plugged with excreta</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>• Collect and destroy affected plant parts</li> <li>• Spray Neem seed kernel extract 5% or Neem oil garlic emulsion 2%</li> <li>• Spray <i>Bacillus thuringiensis</i> (Dipel/Halt/Bioaps/Bioloe) 0.7ml/L</li> <li>• Spray Quinalphos 25EC 2ml/L</li> </ul>
Epilachna beetle	<ul style="list-style-type: none"> <li>• Skeletonisation of leaves and drying</li> </ul>	Adults and grubs	<ul style="list-style-type: none"> <li>• Collection and destruction of egg mass, grub and adults</li> <li>• 2% Neemoil/Castor oil garlic emulsion Or 10% Peruvalam (<i>Clerodendron infortunatum</i>) extract</li> </ul>

### BRINJAL- Disease

Disease	Pathogen	Symptom	Management
Damping off	Fungus	<ul style="list-style-type: none"> <li>• Pre emergence-Seedlings are killed before they emerge from the soil</li> <li>• Post emergence-Toppling over of the infected seedlings at any time after they emerge from the soil until hardening of the stem.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure drainage in nurseries</li> <li>• Drench 1% Bordeaux mixture or spray 1% Bordeaux mixture on leaves</li> <li>• Drench with Pseudomonas 20ml/l once in a week</li> <li>• as prophylactic measure apply Trichoderma enriched FYM as basal dose</li> <li>• Spray <i>Beauveria bassiana</i></li> <li>• Natural enemy <i>Chrysocharis johnsoni</i>.</li> </ul>
Little leaf	Phytoplasma Vector- Leaf hopper	<ul style="list-style-type: none"> <li>• Reduction in the size of the leaves. With arrowing, softening, smoothening and yellowing.</li> <li>• Internodes shortened, axillary buds enlarged</li> </ul>	<ul style="list-style-type: none"> <li>• Destroy the affected plants</li> <li>• Control Jassids using Neem oil garlic emulsion/Dimethoate 30EC 1.5ml/L</li> </ul>

		which give the crop a bushy appearance, floral part deformed leading to sterility.	
Phomopsis blight and fruit rot	Fungus	<ul style="list-style-type: none"> <li>• Circular grey to brown spots on the leaves nearer to the soil. Lesions also formed on the stem</li> <li>• Fruits are attacked while still attached on the plant covering the entire fruit.</li> </ul>	<ul style="list-style-type: none"> <li>• Use of disease free seeds..</li> <li>• Nursery application with mancozeb 0.2%.</li> <li>• Difolatan 0.2% or captan 0.2% in the main field at intervals of 10 to 15 days.</li> </ul>
Bacterial Wilt	bacteria	<ul style="list-style-type: none"> <li>• Wilting, stunting, yellowing of the foliage and collapse of the whole plant</li> <li>• Entire vascular system undergoes blackening and bacterial slime oozes out from it if cut open.</li> </ul>	<ul style="list-style-type: none"> <li>• Destroy affected plants.</li> <li>• Drench Bleaching powder 10g/L</li> <li>• Spray on leaf and drench Pseudomonas 20g/L once in a week.</li> <li>• Use resistant varieties like Soorya, Swetha, Haritha, Neelima.</li> </ul>

#### TOMATO - Pest

Pest	Symptom	Stage of attack	Management
Fruit borer	<ul style="list-style-type: none"> <li>• Emerging caterpillars feed on leaves, bore into the fruits</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>• 5% Neem seed Kernal extract</li> <li>• 1Kg/cent Neem cake as basal dose and one month after planting.</li> <li>• In severe cases spray 2ml/L Ekalux.</li> </ul>
American Serpentine Leaf Miner(ASLM)-polyphagous pest	<ul style="list-style-type: none"> <li>• Mining of the leaves in a serpentine manner appar as white lines on the surface</li> <li>Drying of leaves</li> </ul>	Maggots	<ul style="list-style-type: none"> <li>• Collect and destroy affected lower leaves.</li> <li>• Apply neem cake 20g/ plant around the base 1 week after planting.</li> <li>• Spray 2% neemoil emulsion.</li> </ul>

### TOMATO - Disease

Disease	Pathogen	Symptom	Management
Damping off Same as brinjal			
Tomato Spotted Wilt Virus (TSWV)	Virus Vector- Thrips	<ul style="list-style-type: none"> <li>Slight thickening of the veins of younger leaves. Simultaneously concentric rings appear in the foliage, curling of younger leaves.</li> <li>Green fruits show concentric rings of yellow or brown.</li> </ul>	<ul style="list-style-type: none"> <li>Spray any systemic insecticides till flowering to control insect vectors, Closer spacing, Timely weeding especially in early stages.</li> <li>Removal of all collateral hosts.</li> </ul>
Bacterial wilt Same as brinjal			

### CHILLI - Pest

Pest	Symptom	Stage of attack	Management
Thrips Vector of chilli virus	<ul style="list-style-type: none"> <li>Infested leaves crinkle and attain boat shape</li> <li>Affected plants become stunted and fruits deformed.</li> </ul>	Adults and nymphs	<ul style="list-style-type: none"> <li>Spray 10% Kiriya (<i>Andrographis paniculata</i>)</li> </ul>
Aphid Vector of virus disease of chilli	<ul style="list-style-type: none"> <li>Leaves become yellow and later shed</li> </ul>	Adults and nymphs	<ul style="list-style-type: none"> <li>Spray tobacco decoction or neem oil -garlic emulsion (2%) or Nattapoochedi (<i>Hyptis suaveolens</i>) emulsion (10%).</li> <li>Spray <i>Verticillium lecaniae</i> or <i>Fusarium pallidoroseum</i>.</li> <li>Release green lacewing bugs @ 50,000 eggs/ha.</li> </ul>
White fly Vector of leaf curl virus	<ul style="list-style-type: none"> <li>Leaves become yellow and later shed</li> </ul>	Adults and nymphs	<ul style="list-style-type: none"> <li>Spray <i>Verticillium lecaniae</i> or garlic emulsion (2%). Place Sticky yellow traps.</li> </ul>
Mites	<ul style="list-style-type: none"> <li>Leaves become thick, brittle and tubular</li> </ul>	All stages	<ul style="list-style-type: none"> <li>Apply neem oil 5% or neem oil + garlic emulsion 2%. Spray diluted rice water once in 10 days against mite.</li> </ul>

**CHILLI - Disease**

Disease	Pathogen	Symptom	Management
Damping off Same as brinjal			
Anthraxnose and fruit rot of chilli	Fungus	<ul style="list-style-type: none"> <li>Seedling blight</li> <li>Dark sunken lesions on leaf and fruit.</li> <li>Die back</li> <li>Fruit rot</li> </ul>	<ul style="list-style-type: none"> <li>Collect seeds only from fruits without infection.</li> <li>Crop debris should be collected and destroyed.</li> <li>Dry seed treatment with carbendazim @ 2.5g/kg seed.</li> <li>Apply Trichoderma, cowdung neem cake mixture ten days before transplanting.</li> <li>Spray COC, or Captan 70WP+ Hexaconazole 5WP alternatively at biweekly interval.</li> </ul>
Leaf curl	Virus	<ul style="list-style-type: none"> <li>Curling of leaves, thickening and swelling of veins followed by puckering and blistering of interveinal areas.</li> </ul>	<ul style="list-style-type: none"> <li>Spray neem based insecticides (2ml/litre) to control the vectors.</li> <li>Grow resistant varieties like Punjab Lal and PusaSadabahar.</li> </ul>
Bacterial wilt	Bacteria	<ul style="list-style-type: none"> <li>Wilting, stunting, yellowing of the foliage and collapse of the whole plant.</li> <li>Entire vascular system undergoes blackening and bacterial slime oozes out from it if cut open.</li> </ul>	<ul style="list-style-type: none"> <li>Use disease free seeds and transplants.</li> <li>Remove and destroy infected plants.</li> <li>Apply lime @ 500kg/ha 15 days before planting.</li> <li>Drenching the pits with copper oxy chloride 0.3% two weeks before transplanting.</li> <li>Incorporate bleaching powder in irrigation water @ 5kg/ha.</li> <li>Apply neem cake @ 25g/plant.</li> <li>Soil application of pseudomonas or PGPR mix2 @ 25g/l at 15days interval.</li> <li>Seedling root dip and foliar spray of Pseudomonas 2%.</li> </ul>

**BHINDI - Pest**

Pest	Symptom	Stage of attack	Management
Fruit and Shoot borer	<ul style="list-style-type: none"> <li>Larvae bore into terminal shoot or fruit and feed on internal content leading drooping withering and drying of shoot.</li> <li>Deformed appearance of infested fruits with holes plugged with excreta.</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>Collect and destroy leaf rolls, bored fruits and shoots with different stages of pest.</li> <li>Spray Carbaryl 0.15% at intervals of 15-20 days.</li> </ul>

**BHINDI - Disease**

Disease	Pathogen	Symptom	Management
Yellow vein mosaic	Virus Vector-White fly	<ul style="list-style-type: none"> <li>Yellowing of vein followed by venial colorists.</li> <li>Thickening of veins and veinlets. Fruits are dwarf, malformed and yellowish green.</li> </ul>	<ul style="list-style-type: none"> <li>Use YVM resistant varieties, like Arka Anamika, Arka Abhay and Susthira.</li> <li>Rogue out virus infected plants and collateral host like ageratum, croton.</li> <li>Vector control using insecticides.</li> </ul>

**AMARANTHUS - Pest**

Pest	Symptom	Stage of attack	Management
Leaf webber	<ul style="list-style-type: none"> <li>Larva web together the leaves and skeletonise them</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>Use Birds eye chilli- cows urine extract (Grind 20 g birds eye chilli and mix with one litre of cows urine. Dilute this mixture with ten litres of water.)</li> </ul>

**AMARANTHUS - Disease**

Disease	Pathogen	Symptom	Management
Amaranthus leaf blight	Fungus	<ul style="list-style-type: none"> <li>• Straw colored lesions in leaf which later coalesce and show shot hole symptoms.</li> </ul>	<ul style="list-style-type: none"> <li>• Use Baking soda- turmeric- asafoetida mixture (40 g asafoetida gum is dissolved in 10 l of water. Add 8 g soda powder and 32g turmeric powder to this solution and mix well. ).</li> <li>• Growing red and green varieties together</li> </ul>

**CUCURBITACEOUS VEGETABLES- Pest**

Pest	Symptom	Stage of attack	Management
Fruit fly	<ul style="list-style-type: none"> <li>• Microorganisms gain entry through the injury formed by the ovipositor on the fruits</li> <li>• Emerging larvae feed within the fruit which as a result rot and drop.</li> </ul>	Maggot	<ol style="list-style-type: none"> <li>1. Cover the fruits.</li> <li>2. Remove and destroy infested fruits.</li> <li>3. Apply neem cake 250 kg / ha (100g / pit) at planting and one month later.</li> <li>4. Use any of the following fruit fly traps               <ol style="list-style-type: none"> <li><b>i) Fish meal trap</b> - Place 5 g dry fish in coconut shell, moisten and add 0.5 g carbosulfan. Put coconut shell inside a polythene cover. Make holes on the cover above shell and hang the cover from 'pandal' (trellis).</li> <li><b>ii) Fruit fly trap</b> can also be made by taking 20 g banana pulp in a coconut shell and beer 3 ml and palm oil 3 drops.</li> </ol> </li> </ol>

			<p>iii) Trap adult fruit flies using cue lure plywood blocks containing 6:4:1 mixture of ethyl alcohol : cue lure : Malathion. Re set traps at four months interval. Hang plywood blocks with pheromone @ 10nos./ha</p> <p>iv) Trap adult fruit flies using food baits. Make a pulp of 20 g banana, 10 g jaggery and 5 g carbosulfan in 100 ml water (jaggery heated to 80 degree Celsius) at 2.5m spacing.</p> <ul style="list-style-type: none"> <li>• Change traps after 3 weeks. Red banana, Robusta, Njalipooan and Palayankodan fruits can be used.</li> </ul>
Epilachna beetle	<ul style="list-style-type: none"> <li>• Scraping and skeletonising the leaves.</li> </ul>	Grubs and adults	<ul style="list-style-type: none"> <li>• Remove and destroy egg masses, grubs and adults occurring on leaves.</li> <li>• Use predator (<i>Chrysocaries johnsoni</i>) of larvae and pupae.</li> <li>• Apply <i>Beauveria bassiana</i> 10% WP and <i>Paecilomyces lilacinus</i> 5% WP</li> <li>• Neem oil + garlic emulsion spray (2%).</li> </ul>
Pumpkin beetle	<ul style="list-style-type: none"> <li>• Grubs bore into the base of the plant resulting in wilting and drying of plants</li> <li>• Adult beetles damage by making feeding holes on leaves</li> </ul>	Grubs and adults	<ul style="list-style-type: none"> <li>• Plough the fields just after harvesting destroy the hibernating adults</li> <li>• Collect and destroy adult beetles</li> <li>• Spray malathion 50 EC @ 500 ml or dimethoate 30 EC 500 ml /ha</li> </ul>

Snake gourd caterpillar	<ul style="list-style-type: none"> <li>• Damage on leaves leads to defoliation</li> <li>• Flowers and young fruits also eaten up by the caterpillars</li> </ul>	caterpillar	<ul style="list-style-type: none"> <li>• Collect and destroy the caterpillars</li> <li>• Spray any following insecticides</li> <li>• Malathion 50 EC @500 ml/ha</li> <li>• Dimethoate 30 EC @500 ml/ha or Methyl demeton 25 EC @500 ml/ha</li> </ul>
-------------------------	---	-------------	--

#### CUCURBITACEOUS VEGETABLES- Disease

Disease	Pathogen	Symptom	Management
Fruit rot	Fungus	<ul style="list-style-type: none"> <li>• Soft dark green water soaked lesions that gradually develop to form water soft rot</li> </ul>	<ul style="list-style-type: none"> <li>• Keep fruits not in touch with soil</li> <li>• Heavy mulching reduces infection</li> <li>• Spray pseudomonas 2% with commencement of flowering.</li> <li>• Remove badly infected fruits and spray mancozeb 0.2%</li> </ul>
Powdery mildew	Fungus	<ul style="list-style-type: none"> <li>• Whitish grey superficial spots on upper surface of leaves.</li> <li>• Later defoliation</li> </ul>	<ul style="list-style-type: none"> <li>• Destroy affected plant parts</li> <li>• Spraying Tridemorph at 0.05% (or) Thiophanate methyl 0.05%</li> </ul>
Mosaic	Virus	<ul style="list-style-type: none"> <li>• Leaves become mottled, deformed and reduced in size and are curled</li> </ul>	<ul style="list-style-type: none"> <li>• Uprooting and destruction of affected plants and collateral hosts should be done.</li> <li>• Periodical spraying neem based insecticide (2%) to control the vector</li> <li>• Use seeds from disease free plants</li> </ul>

## COWPEA - Pest

Pest	Symptom	Stage of attack	Management
Pea aphid	<ul style="list-style-type: none"> <li>Yellowish hue on infested leaves</li> <li>Growth of the plant retarded</li> <li>Pods become malformed</li> </ul>	Nymphs and adults	<ul style="list-style-type: none"> <li><i>Hyptis suaveolens</i> (Nattapoochedi) extract (one litre leaf extract + 60g ordinary bar soap diluted in half litre of water.) and is diluted with 10-15 litres of water</li> <li>Spray tobacco decoction or Neem seed kernel extract 5% or 2% neem oil garlic emulsion .</li> <li>Spray Neemzal 1% @ 2ml/lit at fortnightly intervals</li> <li>Apply <i>Fusarium pallidroseum</i> @ 3kg/400m<sup>2</sup>.</li> <li>Spray 0.15% malathion or 0.05% quinalphos</li> </ul>
Pod bug	<ul style="list-style-type: none"> <li>Seeds shrink and shrivel within the pods</li> <li>Attacked seeds become discoloured</li> </ul>	Adults and nymphs	<ul style="list-style-type: none"> <li>Use hand net to trap the bug.</li> <li>Prepare a spray solution containing one litre cows urine extract + 250g garlic + 30g well crushed hot chilli and give a drenching spray.</li> <li>spray <i>Beauveria bassiana</i> (20g or 5ml per litre of water.) to control residual population</li> <li>Spray Nimbizidine / Neemazal 2ml/lit</li> </ul>
Pod borer	<ul style="list-style-type: none"> <li>Seeds and buds destroyed by larva</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>Remove and destroy crop residues by burning.</li> <li>Spray 5% NSKE.</li> <li>Spray <i>Bacillus thuringiensis</i> formulations @ 0.7-1ml/lit(Biolep, Biobit,Halt, Dipel etc</li> </ul>
American serpentine leaf miner	<ul style="list-style-type: none"> <li>Leaves with serpentine mines</li> <li>Drying and dropping of leaves</li> </ul>	Maggot	<ul style="list-style-type: none"> <li>Destruction of the weed host plants</li> <li>Need based application of neem oil, marotti oil @ 2.5%</li> </ul>

**COWPEA - Disease**

Disease	Pathogen	Symptom	Management
Collar rot and web blight	Fungus	<ul style="list-style-type: none"> <li>• Reddish brown lesions at the collar region</li> <li>• Girdling of stem</li> <li>• Collar region becomes sunken and rotten with thick mycelium at later stages</li> <li>• Yellowing and defoliation and web blight on foliage with mycelia growth</li> </ul>	<ul style="list-style-type: none"> <li>• Cultural practices like shallow sowing, use of raised beds, deep ploughing, rotation with cereal crops and mulching.</li> <li>• Apply neem cake @ 250 kg/ha</li> <li>• Reduce soil moisture</li> <li>• Use organic manure enriched with <i>Trichoderma viride</i> and drench with 2% Pseudomonas.</li> </ul>
Fusarium wilt	Fungus	<ul style="list-style-type: none"> <li>• Plant show yellowing, withering and drooping of leaves</li> <li>• Vines show blackening and drying</li> <li>• Roots show rotting and blackening</li> <li>• Basal swelling</li> </ul>	<ul style="list-style-type: none"> <li>• Burn trashes in the pit before sowing.</li> <li>• Remove and burn the affected plants along with the root system.</li> <li>• Seed treatment with <i>Trichoderma viride</i> @ 2 g/ kg seed + soil application 2.5 kg/ha at 30 DAS coupled with soil application of neem cake @ 150 kg/ ha at the time of land preparation</li> <li>• Drenching with 2 % Pseudomonas</li> </ul>
Anthraco nose	Fungus	<ul style="list-style-type: none"> <li>• All parts are affected</li> <li>• Severely affected pods are curled and do not contain normal size seeds</li> </ul>	<ul style="list-style-type: none"> <li>• Use certified disease-free seed for planting and removing all plant debris after harvest.</li> <li>• Avoid overhead watering and avoid splashing soil onto the plants when watering.</li> </ul>
Cowpea mosaic	Virus Vector : aphid	<ul style="list-style-type: none"> <li>• Irregular chlorosis of young leaves</li> <li>• Mosaic mottling</li> <li>• Vein banding</li> <li>• Puckering and distortion</li> <li>• Pods twisted, curved and reduced in size and seeds shrivelled</li> </ul>	<ul style="list-style-type: none"> <li>• Destroy infected plants</li> <li>• Spray neem oil garlic emulsion or tobacco decoction to control aphids</li> <li>• In severe cases spray Dimethoate 2ml/l</li> </ul>

## MANGO - Pest

Pest	Symptoms	Stage of attack	Management
Mango hopper	<ul style="list-style-type: none"> <li>• Infested flowers shrivel, turn brown, dry and ultimately fall off</li> <li>• Sooty mould forms on leaves and inflorescence due to the excretion of honey dew by hoppers</li> <li>• Reduces fruit set considerably</li> </ul>	Nymphs and adults	<ul style="list-style-type: none"> <li>• Avoid close planting.</li> <li>• Orchards must be kept clean by ploughing and removal of weeds.</li> <li>• Spray two rounds of acephate 75 SP@ 1g/l or phosalone 35 EC@ 1.5 ml/l</li> </ul> <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> <li>• First spray at the time of panicle emergence, second spray two weeks after first spray.</li> <li>• Wettable sulphur @ 2 g/lit may be sprayed after spraying carbaryl to avoid mite resurgence.</li> <li>• The mixture toxaphene with sulphur (1:1) have been reported to be effective against pest.</li> <li>• Neem oil 5 ml/l of water can be mixed with any insecticides</li> <li>• Spray 3 per cent neem oil or neem seed kernel powder extract 5 per cent</li> </ul>
Mango Fruit Fly	<ul style="list-style-type: none"> <li>• Rotting of fruits rendering them unfit for human consumption</li> </ul>	Maggots	<ul style="list-style-type: none"> <li>• Collect fallen infested fruits and dispose them by dumping in a pit</li> <li>• Provide summer ploughing to expose the pupa</li> <li>• Monitor the activity of flies with methyl eugenol sex lure traps.</li> <li>• Bait spray - combining any one of the following insecticides and molasses or jaggery 10 g/l - <ul style="list-style-type: none"> <li>- fenthion 100EC 1ml/l,</li> <li>- malathion 50EC 2 ml/l,</li> <li>- dimethoate 30 EC 1 ml/l,</li> <li>- carbaryl 50 WP 4 g/l.</li> </ul> </li> </ul> <p>Two rounds at 2 weeks interval before ripening of fruits.</p>

Mango Stem Borer	<ul style="list-style-type: none"> <li>• Branches and stem dries and dies</li> <li>• Bore holes in stem with sap and frass coming out</li> <li>• Shedding of leaves and drying of branches</li> </ul>	Grub	<ul style="list-style-type: none"> <li>• Remove and destroy dead and severely affected branches of the tree</li> <li>• Grow tolerant mango varieties viz., Neelam, Humayudin.</li> <li>• Swab Coal tar + Kerosene @ 1:2 or Carbaryl 50 WP 20 g / l (basal portion of the trunk - 3 feet height) after scraping the loose bark to prevent oviposition by adult beetles.</li> <li>• If infestations are severe then apply the copper oxychloride paste on the trunk of the tree.</li> <li>• One celphos tablet (3 g aluminum phosphide) per hole</li> <li>• Apply carbofuran 3G 5 g per hole and plug with mud.</li> </ul>
Shoot midge	<ul style="list-style-type: none"> <li>• Drying of terminal shoots</li> <li>• Infested flower buds and fruits show minute exit holes and drop</li> <li>• If young plants are attacked they are often prevented from growing due to continuous killing of new shoots</li> </ul>	Maggot	<ul style="list-style-type: none"> <li>• Remove and destroy affected flowers and tender shoots</li> <li>• Spray dimethoate 30 EC @ 0.06%, methyl demeton 25 EC @ 0.05%</li> </ul>
Shoot webber	<ul style="list-style-type: none"> <li>• Webbing together of clusters of leaves and feeding on them leaving only the midribs</li> <li>• webbed leaves dry up</li> </ul>	Caterpillar	<ul style="list-style-type: none"> <li>• Remove and destroy the webbed leaves along with larva and pupa</li> <li>• Spray carbaryl at 50 WP @ 0.1%</li> </ul>

### MANGO - Disease

Disease	Pathogen	Symptom	Management
Anthracnose	Fungus	<ul style="list-style-type: none"> <li>Leaves show oval/irregular grayish brown spots which later coalesce, dry and shred</li> <li>Girdling and drying of affected stem</li> <li>Die back of twigs</li> <li>Infected flower parts ultimately sheds resulting in complete or partial de blossoming</li> <li>Ripening fruits show typical anthracnose- black sunken spots on fruits which coalesce.</li> </ul>	<ul style="list-style-type: none"> <li>Spray carbendazim or Topsin M. (0.1%) or Chlorothalonil (0.2%), Micop, Blitox and Dithiocarbamate at 14 days intervals until harvest.</li> <li>Before storage, treat with hot water, (50-55°C) for 15 minutes or dip in Benomyl solution (500ppm a.i.)</li> </ul>
Powdery mildew	Fungus	<ul style="list-style-type: none"> <li>Whitish/grayish powder area on tender foliage and inflorescence</li> <li>Infection covers the floral axis, young leaves and stem</li> <li>The affected fruits drop off prematurely or show malformation and discolouration.</li> </ul>	<ul style="list-style-type: none"> <li>Dusting the plants with fine sulphur (250-300 mesh) at the rate of 0.5 kg/tree. The first application may be soon after flowering, second 15 days later followed by a third one.</li> <li>spray wettable sulphur (0.2%) or Carbendazim (0.1%).</li> </ul>
Die back	Fungus	<ul style="list-style-type: none"> <li>Discolouration and darkening of bark some distance from tip.</li> <li>Twig or branch dies, shrivels and falls</li> </ul>	<ul style="list-style-type: none"> <li>Prune and destroy infected twigs and spray Bordeaux mixture 1% or Carbendazim or Thiophanate Methyl (0.1%) or Chlorothalonil (0.2%) as fortnightly interval during rainy season.</li> </ul>

**RUBBER - Pest**

Pest	Symptom	Stage of attack	Management
Stem borer	<ul style="list-style-type: none"> <li>• Branches and stem dries and die.</li> <li>• Shedding of leaves</li> <li>• Bore holes with sap and frass coming out from them</li> </ul>	Grubs and adults	<ul style="list-style-type: none"> <li>• Remove and destroy dead and severely affected branches of the tree</li> <li>• Swab Coal tar + Kerosene @ 1:2 or Carbaryl 50 WP 20 g/l (basal portion of the trunk - 3 feet height) after scraping the loose bark to prevent oviposition by adult beetles.</li> <li>• If infestations are severe then apply the copper oxychloride paste on the trunk of the tree.</li> <li>• One celphos tablet (3 g aluminum phosphide) per hole</li> <li>• Apply carbofuran 3G 5 g per hole and plug with mud.</li> </ul>

**RUBBER - Disease**

Disease	Pathogen	Symptom	Control
Abnormal leaf fall (During SW Monsoon)	fungus	<ul style="list-style-type: none"> <li>• First the fruits rot, later infected leaves fall in large numbers prematurely either green or after turning coppery red</li> <li>• Black lesion develop on the petiole with a drop of latex</li> <li>• Heavy defoliation may lead to considerable loss of crop and die back of terminal twigs.</li> </ul>	<ul style="list-style-type: none"> <li>• Prophylactic spraying on the foliage prior to the onset of South-West monsoon with, Bordeaux mixture 1% at 4000 - 5000 lit/ha using high volume sprayers.</li> <li>• Oil based Copper oxy chloride using low volume sprayer or through aerial application.</li> </ul>
Powdery Mildew	fungus	<ul style="list-style-type: none"> <li>• Tender leaves with ashy coating.</li> <li>• Curl, crinkle and edges roll inwards and fall leaving the petioles attached to the twigs like a broom stick.</li> </ul>	<ul style="list-style-type: none"> <li>• Dusting sulphur during the defoliation period 3 to 5 rounds at weekly to fortnightly intervals.</li> </ul>

		<ul style="list-style-type: none"> <li>• Die back of twigs</li> <li>• White patches on older leaves reduces photosynthetic efficiency.</li> <li>• Infected flowers and tender fruits are shed.</li> </ul>	
Pink disease (more damaging for plants in the age group of 2-12 yrs)	fungus	<ul style="list-style-type: none"> <li>• Main seat of infection is the fork region.</li> <li>• White or pink coloured cobweb mycelia growth on the bark surface with streaks of latex oozing out from the lesions.</li> <li>• Rotting, drying up and cracking of affected bark follow.</li> <li>• Distal portion of branches dry and dried leaves stick to the dead branches.</li> </ul>	<ul style="list-style-type: none"> <li>• Frequent tree to tree inspection should be done during July - September period for detecting the infected trees and application of Bordeaux paste in the early stages upto 30 cm above and below the affected region. In advanced cases apply Bordeaux paste and when it dries up scrape off the superficial mycelium and damaged bark and apply Bordeaux paste once again. Prune off and burn the dried up branches after disinfecting by Bordeaux spraying.</li> </ul>

### Practical activity

1. Field visit for identifying pests and diseases.
2. Field application of pesticides and botanicals.
3. Identify the given specimen of disease symptoms / pest attack, analyse the situation and suggest suitable management practices.

### Assessment activities

1. Class test on pest and disease of crops detailed in the unit.
2. Collection of specimens and preparation of herbarium.
3. Quiz programme on pest and disease symptoms and management.

### 3.5.3 Agri input centres and biopharmacy

#### Agri input centres

Agri input centres or agribusiness centres are envisaged to provide input supply,

farm equipment on hire and other services.

Agricultural inputs are categorized into 2 types:

1. Consumable inputs
2. Capital inputs
  1. **Consumable inputs:** Manures and fertilizers, seeds, insecticides/pesticides
  2. **Capital inputs:** tractors, tillers, harvesters, threshers, pump sets, sprinklers, dusters and sprayers.

### Biopharmacy

The concept of Agro- biopharmacy is aimed at providing inputs required for organic agriculture. These are outlets for supplying organic inputs like botanicals, bio-pesticides, bio-control agents, biofertilizers, organic nutrient solutions, pheromone traps etc. The bio pharmacy concept is promoted throughout the state of Kerala as the organic farming policy of the government envisages the phasing out of chemical pesticides and fertilizers from the farming sector to convert Kerala into an entirely organic state in five to ten years.

### Assessment activities

Visit to nearby Agri input centers

## 3.5.4 ICT enabled extension services in Agriculture and Various Schemes in Agriculture

ICT Stands for “Information and Communication Technologies.” ICT refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication media. It is important to begin any ICT-in-agriculture intervention by focusing on the need of farmers. The farmers need assistance for better and more timely market information, better access to financial services, timely and appropriate crop and disease management advice, stronger links to agricultural value chains, and so forth

### A. Holistic Information Systems

1. **Harithakeralam:** This forms the first basic work in agricultural software.

It was developed by Kerala. It covers over 50 major crops of Kerala and contains a number of animated videos. The CD version is currently available at [www.celkai.in](http://www.celkai.in).

- 2. Kissan Kerala Information System:** The online information system covers basic details on over 100 major crops of Kerala. The project is run by Department of Agriculture and IITM-K. The contents are available in [www.kissankerala.net](http://www.kissankerala.net)
- 3. Karshikajalakam:** This covers details of major information of crops, animals and fisheries aspects. Developed by KAU originally as a CD version, the contents are now available in [www.celkau.in](http://www.celkau.in).
- 4. KAUAgrri-infotech Portal:** The portal provides detailed information on important crops of Kerala besides fisheries and veterinary aspects. The KAU Fertulator, KAU E- Crop Doctor and media gallery make the portal unique. The link to the website is [www.celkau.in](http://www.celkau.in).
- 5. TNAU Agritech Portal:** The portal provides detailed information on all round production aspects of a number of agricultural crops. The contents are accessible at [www.agritech.tnau.ac.in](http://www.agritech.tnau.ac.in).
- 6. Farmer Portal:** This is a national portal on agriculture maintained by the Government of India. The portal contains region specific information on seeds, fertilizers, pesticides, machineries etc. The link to the website is [www.farmer.gov.in](http://www.farmer.gov.in)
- 7. AGMARKNET Portal:** The portal provides information on price and arrival of important agricultural commodities on a daily basis across the country. The contents are accessible at [www.agmarknet.nic.in](http://www.agmarknet.nic.in)

## B. Specific Information Systems

- 1. Flowering plants of Kerala:** This is a classical work done by Kerala Forest Research Institute, Peechi. It contains botanical information on over 5000 plants of Kerala with good quality photos. CD version is available at KFRI, Peechi for sale.
- 2. Fruitipedia:** It is an encyclopedia of edible fruits of the world developed by Dr Chiranjit Parmar. The fruit information system contains detailed information on over 452 fruit plants identified across the world. The contents are available at [www.fruitipedia.com](http://www.fruitipedia.com).
- 3. Medicinal and aromatic plants:** This is a work in flash platform on over 300 medicinal plants of Kerala. The CD can be purchased from The Aromatic and Medicinal Plants Research Station, Odakkali
- 4. Flowers of India:** The flowers of India' is an online website on flowers. It contains the largest collection of garden plants with good quality photograph. The contents

are available in [www.flowersofindia.net](http://www.flowersofindia.net)

**5. Farmer advisory and KM system for Hi-tech agriculture:** It is a new initiative from Department of Agriculture, Government of Kerala. The users can login and get connected with all poly house growers in Kerala. Similarly there is also a mechanism to contact experts to solve field problems. The link to the information system is [www.keralahitechagri.in](http://www.keralahitechagri.in)

### C. Diagnostic and Calculation Tools

**1. Crop Health Decision Support System:** This software covers plant protection aspects of major crops of Kerala. Good quality original photos with comprehensive management recommendation are the salient features.

**2. Pest doctor:** The diagnostic tool under farm extension manager follows a three step inverted tree diagnostic methodology. Diagnosis starts from the basic plant part where symptoms are noticed. Based on elements of visual perception narrowing of choices is achieved. The contents available in [www.farmextensionmanager.com](http://www.farmextensionmanager.com)

**3. Online rubber clinic:** Developed by rubber board the tool helps to arrive at the problems in rubber cultivation through a series of questions and photographs. The contents can be reached from the website [clinic.rubberboard.org.in](http://clinic.rubberboard.org.in)

**4. KAU Fertulator:** The tool helps to have the fertilizer recommendation for all the crops covered in the package of practice.

**5. Soil based plant nutrient management information system:** It is an outcome of a major project that stores the database of soil fertility data of almost all panchayats of Kerala. Available in [www.keralasoilfertility.net](http://www.keralasoilfertility.net), however the login can be with user name and password only.

**6. Pesticide calculation:** The new tool available under farm extension manager helps to have the recommended pesticide crop wise and pest wise. The details available at [www.farmextensionmanager.com](http://www.farmextensionmanager.com)

**7. KAU E -Crop Doctor:** The tool helps you to have a realistic estimation of the quantity of pesticides recommended for the crop plants of Kerala. The details of trade name and quantity for various units can be easily taken from the information system. The users have to download the software available in the [www.celkau.in](http://www.celkau.in) before use.

**8. Credit Calculator:** The tool helps to have realistic estimate of the eligible finance under crop loan component from nationalized banks. Developed based on the concept of scale of finance, the software also takes care of the loan for intercrops as well.

The final repayment amount with the interest portion is worked automatically based on the area of cultivation. Available at [www.farmextensionmanager.com](http://www.farmextensionmanager.com).

#### D. Kiosk based information systems:

**1. Agricultural Kiosk:** The kiosk version developed by scientists of KAU, covers around 10 crops. The contents cover all aspects of crop production.

**2. Nelkrishi.com:** The tool is developed by a team of KAU scientists exclusively for touch screen kiosk. The information system contains over 500 pages of information on rice cultivation.

**3. Vegetable cultivation:** Developed by Green Touch Media, Trivandrum for the Department of Agriculture, Government of Kerala. The DVD contains information with video clippings on around 15 vegetables. The organic production aspects are also well taken care of. The software available in [www.celkau.in](http://www.celkau.in).

#### E. Types of Mobile Applications

**1. Data Logging and Management:** Apps under this category assist farmers in maintaining data records associated with farm activities. Many farm management apps perform basic cost calculations as well.

**2. Location based Apps:** These apps use map and location details for their operations. These apps are essentially used as Market finder apps for farmers to sell their produce.

**3. Agriculture Specific Calculation Apps:** These are specially designed apps from experts in agriculture. They contain pre-fed data and values according to which calculations are performed regarding agriculture information.

**4. News and Information Specific:** This is the most common app category for any domain. Apps that provide news and information are highly useful and popular among users. Apps like Farm progress, Ag Weather tools etc. serve the purpose of delivering information relevant to agriculture.

#### F. Voice/SMS through phone

**1. Kissan Call Center :** The Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Govt. of India launched Kissan Call Centers on January 21, 2004 across the country to deliver extension services to the farming community. A countrywide common eleven digit Toll Free number 1800 -180 -1551 has been allotted for Kisan Call Centre. This number is accessible through mobile phones and

landlines of all telecom networks including private service providers. Replies to the farmers' queries are given in 22 local languages.

**2. IFFCO Kisan Sanchar Limited :** It is a joint venture between the telecom network operator Airtel and the Indian Farmer's Fertilizer Co -Operative Limited (IFFCO). In addition to crop advice and the weather, IKSL provides advice on animal husbandry, rural health initiatives, and the availability of products such as fertilizers.

**3 mKisan SMS Portal :** enables all Central and State government organizations in agriculture and allied sectors to give information/services/advisories to farmers by SMS in their language. Farmers can register themselves for receiving these messages on their mobiles as per their specific needs and relevance at a particular point of time.

## G. Other services

### 1. E - Learning platform

The development in e -learning platform helps to redefine the distance education programmes. The course materials that were earlier send through post now reach the students online. They can have better tutorials with animated video and text. The students can contact the expert or participate in various discussion forums online. Further, real time objective evaluation process can also be introduced.

The Centre for e -Learning of Kerala Agricultural University offers e -KrishiPatashala online courses. "Organic Agricultural Management", "Plant Propagation and Nursery Management", "Post -Harvest Management and Marketing of Fruits and Vegetables" are the three online courses of six months duration.

### 2. Video and TV Programmes

Farm videos form yet another major area of ICT application in agriculture. With the availability of camcorder and other video production equipments at reduced cost, there is tremendous growth in number of farm videos produced and viewed. Kissan Kerala project itself has uploaded over 450 video on agriculture. These videos give a true representation of real life situation.

### 3. Radio and Other Wireless Technologies

Wireless technologies have numerous applications in agriculture. A number of AM and FM stations are functioning in Kerala. These stations are working under private and public sector. These stations telecast a number of farm programmes at regular intervals.

#### **4. Community Learning Centers**

The opening of community learning centers and running various educative programmes by them is a move happened with the progress in ICT. In the Wayanad district of Kerala, six village resource centers are operating. These centers are connected through local cable networks and offering video conferencing facility.

### **Agricultural schemes implemented by Department of Agriculture**

#### **1. RKVY /RastriyaKrishiVikasYojana**

This special central assistance scheme was launched to rejuvenate agricultural sector during eleven five year plan. RKVY funds are provided to states as 100 % grant by the Govt. of india.

#### **2. Karshaka Pension Scheme for Small and Marginal Farmers**

The state government is implementing monthly pension scheme for small and marginal farmers above 60 years of age.

#### **3. Comprehensive Vegetable Development Programme**

It is implemented with an objective of attaining self-sufficiency in vegetable production in the state.

#### **4. Agroservice Centres**

It function as a single window system to ascertain the availability of farm labor, inputs, planting materials, plant protection agents etc

#### **5. Agricultural wholesale markets**

These markets function as facilitators in conducting auction sale of agricultural products collected directly from farmers without the interference of intermediaries

#### **6. LEADS/Lead farmer centered Extension Advisory and Delivery Services**

Te objective is to utilize potential of lead farmers or transfer of technology and address the field level problems of selected farmers

#### **7. ATMA/Agricultural Technology Management Agency**

It is a registered society of key stakeholders involved in agricultural activities for sustainable agricultural development in the district

#### **8. SAMETI/State Agriculture Management and Extension Training Institute**

It functions as the model training institute at state level in the area of agricultural management. It is located at Thiruvananthapuram.

### **9. Projects for value addition**

Small Farmers Agri Business Consortium (SFAC) has been identified as the implementing agency of the scheme. Individual entrepreneurs, SHGs, Clusters, NGOs, partnership will be considered under this scheme.

### **10. Kuttanad Package**

Govt of India has decided to give assistance to improve the farming condition in Alappuzha and Idukki districts in Kerala., which are identified as the distressed districts .

### **11. Idukki Package**

The report on Dr.MS. Swaminathan commission on Idukki deals with the problem and possible solutions related to Idukki District.

### **12. Wyanad Package**

Various agricultural development Programmes are implemented through Wyanad Package in the District which is considered as the most distressed and Backward District.

### **13. Spices Development Programme**

Implemented for the Promotion of Spices cultivators

### **14. Sustainable Rice Development Scheme**

### **15. Biogas Scheme**

### **16. Quality control Scheme**

### **17. Soil, Fertilizer and Plant Protection chemical analysis**

### **18. People's Plan**

### **19. Area Development Scheme**

### **20. SHM Schemes (State Horticulture Mission)**

Various Projects implemented under SHM- Poly House cultivation, Rain Shelter, Creation of water source, training etc. This scheme envisages an end to end development of the Horticulture sector covering production, post-harvest management, processing and marketing.

### **Other Agencies which implement schemes for farmers**

- Rubber Board
- National Horticultural Board
- Directorate of Arecanut and Spices Development

- Tea Board
- Coconut Development Board
- Spices Board
- Directorate of Cashew nut and Cocoa Development
- National Seeds Corporation
- Save Grain Campaign
- Land Development Corporation
- MILMA
- Land Use Board
- Poultry Development Corporation
- The Kerala Livestock Development Board Ltd
- NABARD
- KERAFED
- Small Farmers Agri Business Consortium
- Kerala Agro Industries Corporation Ltd
- KAMCO
- VFPCK
- Serifed
- Raidco
- Coir Board
- Agricultural and Processed Foods Export Development Authority
- Marine Products Export Development Authority
- Cashew Export Promotion Council

(<http://www.keralaagriculture.gov.in/index.asp>)

(<http://www.agriclinics.net/guidelines2010.pdf>)

### **Practical activity**

Preparation of an interview schedule about different agricultural schemes and further interactions with officials of Krishi Bhavan and prepare a final report.

### Assessment activities

1. Seminar on the schemes implemented by Department of Agriculture.
2. Visit a Krishi Bhavan and prepare a report detailing the schemes implemented by Krishi Bhavan.

### TE Questions

1. A group of VHSE students visited your Krishi Bhavan. As an agriculture assistant how will you explain to them the services rendered by the Krishi Bhavan and the important schemes implemented by dept. of agriculture. Prepare a neat write up.
2. Prepare a chart for the expo in your school, regarding the topic “ IPDM in Rice.

### Extended Activities

1. Awareness programme on rainshelter cultivation to farmer groups/residential colony members to nearby locality.
2. Promotion of organic vegetable garden in the panchayat ward area of the school.
  - i. Prepare a survey schedule detailing the percentage of vegetable consumed produced at home, awareness on Pesticide residues, awareness on the procedure for removing pesticide residues, history of occurrence of cancer in the family, open area available for setting up of a vegetable garden etc.
  - ii. Organizing Training on the awareness of the Pesticide residues and setting up of an Organic vegetable garden.
  - iii. Distribution of vegetable cultivation kit comprising of vegetable seeds, growbags, vermicompost, leaflets etc to all the participants of the training.
  - iv. Selection of 10 families for setting up a vegetable garden- selection to be done based on the criteria of their interest in farming and the availability of open area.
  - v. Students split into ten groups and each group sets a vegetable garden in the selected houses.
3. Training to the women groups on Mushroom cultivation.
4. Conducting Agro clinic in the nearby localities.

**List of Practicals**

- ❖ Practice drip irrigation and identification of different components.
- ❖ Preparation of nutrient solution and practicing fertigation.
- ❖ Visit a high tech farming unit with automated climate control systems.
- ❖ Farmer interaction: Preparation of questionnaire to interview a farmer practicing protected cultivation.
- ❖ Visit to a model organically certified farm and interaction with the farmer
- ❖ Setting up of organic vegetable school garden
- ❖ Preparation of botanicals- Neem oil garlic emulsion
- ❖ Preparation of botanicals Tobacco decoction
- ❖ Seed treatment with Rhizobium
- ❖ Field level multiplication of Trichoderma
- ❖ Visit to an accredited firm that follows FSSAI/GAP/HACCP
- ❖ Method demonstration of mushroom bed preparation
- ❖ Visit to a spawn production unit
- ❖ Marketing and sale of mushroom products
- ❖ Setting up of lawn through different planting methods
- ❖ Practising different styles of Flower arrangement
- ❖ Visit to a silkworm production unit
- ❖ Preparation of an interview schedule and visit to an apiary unit
- ❖ Conduct Agriclincs in School
- ❖ Visit to KrishiBhavan and Interactions with KrishiBhavan Officials
- ❖ Practising ICT enabled softwares

## **MODULE IV**

### **POST HARVEST AND PROCESSING TECHNOLOGY**

India is the second largest producer of food next to China. Having achieved near self sufficiency in primary agriculture, the country's attention is now focused on secondary agriculture, which is basically the processing of products of primary agriculture. Government is investing on secondary agriculture at farm level, village level and at national level. The research institutions are also asked to develop proper post harvest technology to support the growth of secondary agriculture. Owing to the importance given to post harvest and processing technology, the module is designed in such a way so that the learner will get equipped in post harvest handling methods. Various stages in post harvest technology has been elaborated in the syllabus which will make the student aware about the minimization of post harvest losses and value addition. The processing technology of various products are included which has good scope in selfemployabilty. The license and registration protocols are also detailed in the module which are necessary for running small as well as large scale processing units.

## UNIT 1

# POST HARVEST TECHNOLOGY

### Introduction

Post harvest technologies refer to the stabilization and storage of unprocessed or minimally processed foods from the time of harvest until it reaches for human consumption.

As world population has started to relocate among different continents, farm products are getting a global market. Considering the perishable nature and the worldwide demand of farm products post harvest practices are gaining much importance. Although post harvest research and development has advanced significantly in developed countries, many of the post harvest technological innovations are either not used or used inadequately in the developing countries like India, resulted in huge post harvest losses. The unit examines the importance of post harvest technology with reference to agricultural products and its present scenario. The unit also details the reasons for post harvest losses in India and the steps involved in post harvest management.

### Learning outcome

The learner:

- defines post harvest management and understand its scope and present scenario.
- explores the causes of post harvest losses and elaborate the procedure of post harvest handling.

#### 4.1.1 Importance of Post Harvest Technology

### Introduction

India today stands second in the world production of fruits and vegetables. Yet India's share in world trade is miniscule that is less than one per cent. Major constraint in this regard is due to heavy post harvest losses in the range of about 20-30 per cent. Harvesting at proper maturity, adaptation of improved harvesting method and handling techniques have to be looked into as priority. Handling, grading, packaging, storage and transportation are some of the points to be approached systematically to reduce the post harvest loss.

**Fruits and vegetables processing-Present status – a global scenario**

Country	% Processed
Malaysia	83
South Africa	80
Philippines	78
Thailand	72
Brazil	70
USA	65
India	2.2

In India 30% of fruits and vegetables grown get wasted because of lack of cold storage facilities and energy infrastructure and only 2% of the produce is processed when compared to other countries such as Malaysia where 83% of the produce is converted into value added products.

Kerala’s food processing industry serves two markets - the fast emerging domestic market and the steady-growing export market. The Government’s industrial policy seeks to “convert Kerala into a favoured destination for Agro Processing.”

**Kerala plus factors in the scope of agro processing industry**

- Availability of skilled and trained man power
- Availability of high quality water and power
- Very active local market
- A vibrant retail chain
- A high captive market demand abroad.
- The availability of raw materials, especially spices and sea food
- Major producer of spices contributing to 97% of India’s pepper production
- Kerala accounts for 70% of cocoa production and 25% of country’s coffee
- Kerala accounts for 16% cashew production and 35% of cashew nut processing units
- About 42% of coconut is produced in the state
- Unique varieties of certain fruits and other crops special to kerala (Nendran banana, Red banana, Mauritius pineapple, Njavara rice etc)

In agriculture, post harvest handling is the stage of crop production, immediately following harvest, including cooling, cleaning, sorting and packing. Whenever the produce is harvested or separated from its parent plant, begins to deteriorate. Importance of Post harvest technology lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses and making more nutritive food items from raw commodities by proper processing and fortification. Post-harvest technology has potential to create rural industries.

The three main objectives of applying post harvest technology to harvested fruits and vegetables are:

1. To maintain quality (appearance, texture, flavor and nutritive value)
2. To protect food safety
3. To reduce losses (both quantitative and qualitative) between harvest and consumption.

### **Assessment Activity**

The students are assigned the task of collecting paper cuttings and e-information on the importance of Post Harvest Technology and its present scenario in India and a report on the same is to be submitted.

## **4.1.2-Causes of Post Harvest Losses**

### **Post harvest loss**

Post harvest loss of fresh fruits and vegetables are classified mainly into 3 types.

#### **Physical loss**

Poor handling, unsuitable containers, improper packaging and transportation can easily cause bruising, distortion and other forms of injury.

#### **Physiological Loss**

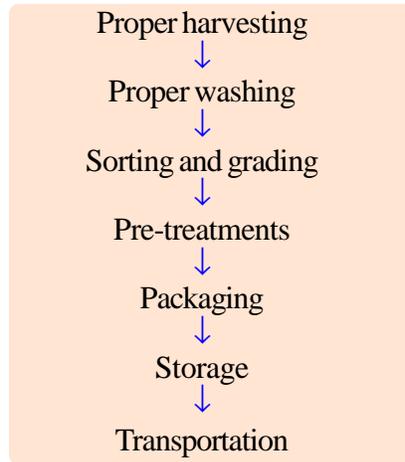
Fruits and vegetables are still alive after harvest and continue their physiological activity. Rate of respiration, transpiration etc are hastened which results in aging of fruit followed by decaying of the produce.

#### **Biological loss**

Post harvest loss of produce occur by invasion of fungi, bacteria, insects and other organisms which lead to decay of perishables during storage. But the control of biological loss using pesticides is difficult due to consumer concern for food safety.

Preharvest factors including selection of crops, planting, fertilizer application, irrigation, pest and disease management and other inter cultural practices also affect the post harvest quality of agricultural produce. Harvesting at proper maturity, careful harvesting techniques, proper handling, reducing the field heat, adequate transportation, packaging, storage etc can reduce losses to a great extent.

### Steps involved in post harvest handling



#### Assessment Activity

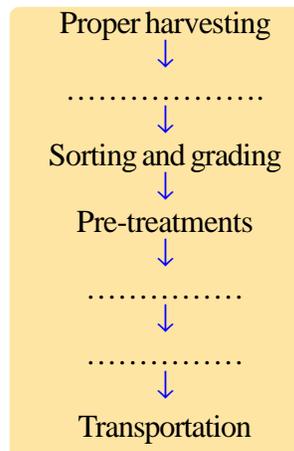
Seminar on causes of post harvest losses & steps involved in post harvest handling.

#### List of Portfolios

1. Album of collected articles on the present scenario of post harvest losses and importance of post harvest technology in India with statistical data.
2. Seminar report on the causes of post harvest losses & steps involved in post harvest handling

#### TE Questions

1. "Although India stands second in fruits and vegetable production in the world, its share in world trade is less than 1 %". Substantiate the statement.
2. Complete the missing terms in the flow chart.



## UNIT 2

# POST HARVEST HANDLING

### Introduction

Post harvest operations like sorting, grading and packaging make the agricultural products more acceptable irrespective of the country in which it is produced. Sorting and grading help farmers to get better prices and makes the mechanized processing easier in commodities like Cashew. Pretreatments like washing, disinfection, modified atmosphere or controlled atmosphere storage increase shelf life of the produce considerably. Many farmers and food handlers are still totally unaware of proper post harvest management and its advantages which results in considerable loss during post harvest handling. The Unit delineates the different stages in post harvest handling viz. harvesting, sorting, grading and important pretreatments before packaging and storage of agricultural produce.

### Learning outcome

The learner :

- identifies the harvesting stages and maturity indices of fruits and vegetables and practice sorting and grading methods.
- familiarizes with the precooling and pretreatments done in post harvest stages and package, storage and transportation methods.

#### 4.2.1-Harvesting stages, washing, sorting & grading

##### Harvesting stage

Method and time of harvesting and the care taken during harvesting are important. Considerable harm to the fruits or vegetables is caused by careless harvesting or exposing the harvested produce to high temperature conditions so that excessive field heat is developed and reduces the shelf life considerably.

##### Points to be considered

- Harvesting is to be done during the early hours of the day or late in the evening.
- Temperature above 27°C during harvesting should be avoided.
- The commodity should not be wet while harvesting.
- Harvested commodity is to be stored under shade until it is packed.
- Harvesting at optimum maturity ensures better self life.

### Harvesting Time

Harvesting is to be done during the early hours of the day or late in the evening.

- For near market-harvest early in the morning.
- For distant market-harvest late in the evening and can be transported during night.

### Method of Harvest

Shelf life is reduced by the impact of harvest or damage caused during harvesting and therefore suitable harvesting methods must be used wherever possible.



Eg:-For harvesting mangoes telescopic type of poles or bamboo poles with net attached to it or prototype hand held mango harvester can be used. A person standing on a hydraulic lift can also directly harvest the mangoes.

### Maturity Indices of Fruits & Vegetables

Maturity Indices help to assess the correct stage at which the commodity may be harvested. If the commodity is not harvested at the optimum stage, the produce may be either over ripen or under ripen which will affect the market preference and quality of produce and also reduces shelf life.

## FRUITS

### BANANA

For judging maturity, some of the indices used in India are

- Pulp to peel ratio
- Days from the emergence of inflorescence to maturity.
- Disappearance of angularity and fullness of fingers(is the standard practice)
- Drying of the leaves
- Brittleness of the floral ends etc.

When Bananas are to be transported,

**To the distant places** - they are picked slightly immature at about 75-80% maturity, with plainly visible angles and will ripen in about 3 weeks.

**To the local or nearby markets** - more mature fruits are harvested and they ripen in less than a week.

**For inter island shipment** - Harvested when about 85-90% maturity, with fruit angles not very well defined and the fruits will ripen from 1-2 weeks after harvest.

## MANGO

Changes associated with maturity of mangoes are

- Fullness of shoulders
- Changes in colour of the pedicel
- Change peel colour from deep green to olive green.
- Specific gravity (between 1.01 and 1.02 is suitable for picking)
- Date from flowering to maturity.

## PAPAYA

For local market, fruits are left on the tree until firm ripe stage. At this stage, a change of colour at the apical end of the fruit occurs. Fruits should be removed when traces of yellow appears on the apex or between the ridges of the fruits. This stage of harvest takes 4-5 days to ripen. Other indices are TSS should be 6% and the surface should be one-third coloured.

## PINEAPPLE

Pine apple is harvested when,

- The colour changes from green to greenish yellow
- The fruit develops smooth surface around the eyes
- The bracts start drying up

Fruits for **home use** are picked when 25% yellowing is obtained. At this stage the fruit has higher TSS and low in acidity.

Fruits for **long distance markets** are usually harvested when all the eyes are still green and have no trace of yellow colour. It takes 2-3 weeks for ripening.

## VEGETABLES

### TOMATO

Harvesting of tomato depends on the purpose.

Three maturity stages recognised are

- 1) Mature Green stage-the blossom end of the fruits at this stage will turn cream in colour,the pulp surrounding the seeds is jelly like and the seeds slip away from the knife.
- 2) Pink or Breaker stage-the blossom end of the fruits will turn pinkish or reddish in colour
- 3) Red ripe stage-the fruit surface is red in colour

**For long distance transport** - harvested at mature green stage

**For local markets and canning purpose** - harvested at breaker or ripe stage

### CUCURBITS

#### a) Water melon

The fruits are judged for maturity by

- i) Tapping the fruits by fingers which will give a dull sound in immature fruits and metallic sound in mature fruits.
- ii) Drying of the tendrils in the node opposite to the fruit.
- iii) Colour changes – pale yellow colour of the fruit portion where it touches touching the ground.

#### b) Bitter gourd

The fruits harvested at pale green or greenish white stage before attaining full maturity.

#### c) Snake Gourd

Harvested at green stage before attaining full maturity. They will be heavier than mature fruits.

#### d) Pumpkin

The greenish yellow skin colour will turn to pale brown and inner flesh attains orange colour. The vines will start drying.

#### e) Ash Gourd

Fruits develop an ashy white colour at maturity.

### BRINJAL

Harvested before it is fully ripened and when it attains good size and colour. The surface should not lose its bright and glossy appearance.

## CHILLIES

- i) For green chillies – Fully mature green fruits will be harvested
- ii) For dry chillies – Fully ripe red fruits will be harvested and dried in sun.
- iii) Sweet peppers- Fully matured green fruits will be harvested.

## OKRA

Tender green fruits which have a length of 7-10 cm and 7 days after pollination will be harvested. The fruit tip will break off easily when bent.

## LEGUMINOUS VEGETABLES

Tender green pods which have attained maximum size, but before the formation of fibre will be harvested.

## Washing

For getting a clean produce, fruits and vegetables have to be washed after harvesting. It improves the appearance of the produce. In order to remove soil, insects, sooty moulds and also the pesticides and fungicide residues, washing the produce is an inevitable process. Washing in cold water can also reduce the field heat hence the storage life is prolonged. Hot water successfully eradicates incipient infections in several fruits. For example dip in hot water (50°C) for 1-2 minutes inactivates the infections of *Colletotrichum* in papaya and mango

### Hand washing

Hand washing is possible when small quantities of produce has to be handled. If large quantities are handled we need mechanical devices to carry out the operations.

**Some of the commercially employed washing techniques are :**

#### a. Soaking tank washing

This is generally done by soaking the produce in soak tank where water is circulated and the produce is agitated. The filtering of water is also done during circulation to remove the dust particles.

#### b. Rotary Barrel Washing

It consists of a cylindrical barrel with holes on periphery; the barrel is generally lined with rubber material for cushioning. The barrel is partially submerged in water and water is circulated and sprayed over the rotary to assist in cleaning. The produce from the soak tank is fed to the rotary barrel washer where it rotates and tumbles the produce in water. The external impurities get removed from the produce by

rubbing of the produce with each other and the lining of the barrel. The water is circulated and filtered. The water is changed when required.

### c. Spray washing

The produce from soak tank or barrel washer is conveyed to spray washer. It consists of roller conveyor and spraying nozzles. The individual fruit is made to rotate and water is sprayed under pressure over this by nozzels.

### d. Brush Washing

When the soak tanks are fitted with rotary brushes to clean the produce they are known as brush washer. is an ideal washer for commodities of hard nature.

### e. Hot water washing

Produce may be immersed in hot water before storage or marketing to control diseases. Fruits after harvest dipped in hot water (45 -55°C) for about few minutes for uniform and rapid ripening and for control of decay. A common disease of fruits, which can be successfully controlled in this way is anthracnose caused by *Collectotrichum sp.*). Low concentration of fungicides can be applied along with hot water treatment, thus allowing more effective control with a reduction in chemicals.



*Soaking Tank Washer*



*Rotary Barrel Washer*



*Brush washer*

## Sorting and Grading

Sorting and grading in fruits and vegetables are developed to identify the degree of quality in the commodities, which aid in establishing their usability and values. These are important tools in the marketing of fresh fruits and vegetables. The primary properties of fruits and vegetables that are used in typical sorting operations are shape, size, colour, ripening degree, mechanical injuries etc.

Advantages of sorting and grading

1. Reduce dispute of quality between seller and buyer.
2. Standardized grades form basis for price fixation and advertisement.

3. Improve marketing efficiency by selling a produce without a personal selection.
4. Provide a basis for securing incentive price for better quality.

### **Grade standards for fruits and vegetables**

The Directorate of Marketing and Inspection (DMI) of the Ministry of Rural Development, Govt. of India, is the pioneer organization in the country in formulation of grade standards (Agmark grades) for agricultural and allied commodities under the provisions of the agricultural produce grading and marketing Act 1937. In respect of fruits and vegetables the DMI has framed grade standards both at producers level at the time of sale and at the consumers level before sale of the commodity. The basic objective of this system of grading is to quicken the process of sale on the basis of grades and to reward the producer with a price commensurate with quality of produce.

Standardized Grades of DMI – Mango Var. Desheri

Poor < 130g

Average 131-170g

Good -171 -200g

Excellent - > 200g

### **Measurement of Quality in Grading**

In the beginning most of the product characteristics which affect grade are determined subjectively by the human sense. He/she estimates colour, shape, firmness and freshness largely by eye and touch, based on the training and experience he/she has received.

Instruments are also developed for mechanical or electronic sorting of products on the basis of external or internal colour, internal defects or even physiological maturity.

Eg : Magness Taylor pressure tester indicates harvest maturity and ripening level of fruits.

### **Practical activity**

1. Identification of maturity indices of fruits and vegetables

Materials Required : Collection of 5 fruits and 5 vegetables which has reached the harvest maturity stage by the students themselves

### Procedure

Display the fruits & vegetables group wise on the table .Check the maturity indices of the fruits and vegetables and record in a tabular form

Fruits	Maturity Index	Vegetables	Maturity Index

### 2. Sorting procedure in vegetables

Sorting procedure : Students grouped into five and each group brings 5 vegetables (tomato,brinjal, cucumber, okra and coccinia). One type of vegetable (for eg.Tomato) is collected from all the other four groups by the first group. Likewise each group collects any one vegetable from the other groups. Sorting procedure is done for each vegetable by the respective groups.

### 3. Washing procedure

#### Assessment activity

Assignment on the harvesting stages, washing, sorting & grading procedure.

### 4.2.2 Precooling, Pretreatment, Packaging, Storage & Transportation

After sorting and grading the most important operation next is the precooling followed by pre-treatments prior to packaging.Pre-cooling is an important pre-treatment in the protocol of any post harvest management of fruits and vegetables.

#### Curing

Curing is essentially a wound healing operation to replace the damaged periderm mainly done for tuber crops like potato, sweet potato, yam etc. Curing is done for onion and garlic for proper colour development, reduction of moisture content etc.

The operation is conducted immediately after harvest and generally done at the farm level itself. In case of yams, the bruised and cut injuries of yams can be cured by exposing the tubers to sun for a short time.

## Precooling

It is the rapid cooling process administered in commodities for removal of field heat. It has to be done immediately after harvest. Pre-cooling reduces the rate of respiration of the freshly harvested commodity accompanied by reduction in metabolic activity and thereby extends the shelf life of the commodity.

### Pre-cooling reduces

1. Field heat
2. Rate of respiration
3. Rate of ripening
4. Loss of moisture
5. Production of ethylene

### Types of Pre-cooling

#### *Room Cooling*

This method simply involves placing the produce in a cold room.

#### *Hydro Cooling*

It can be done by flooding, spraying or immersion of produce in water. The advantages of this method are speed, uniform cooling and no weight loss or dehydration.

#### *Vacuum Cooling*

Produce is cooled in vacuum chamber where water in the product acts as refrigerant under low pressure.

## Pretreatment

All the pre-treatments are not required in all the cases, it will vary depending upon the commodity and purpose.

### a. Irradiation

Irradiation is the process of controlled application of energy from ionizing radiation such as gamma rays, electrons or x-rays. Ionising radiation can be applied to fresh fruits and vegetables for following applications.

1. Inhibition of sprouting
2. Longer retention of quality
3. Insect control
4. Delay in ripening

Ionizing radiation can also be applied in processed food to control microorganisms to inhibit or prevent cell reproduction and increase storage life.

#### **b. Skin coatings**

Waxes are generally used for coating fruits and vegetables to improve the appearance of produce or to delay deterioration. Wax emulsion has been developed to give a protective coating on the skin of fruits and vegetables to reduce transpiration losses, rate of respiration, and prolong the storage life.

Fruits and vegetables should be dry, prior to waxing and are waxed by dipping in wax emulsion for 30 to 60 seconds, removed, allowed to drain and dry. It imparts gloss to commodity and improves marketability. Wax coatings on fresh fruits and vegetables reduce physiological loss in weight due to dehydration.

#### **c. Use of ripening agents**

The rate of ripening can be enhanced or induced by smoking or by the application of ethylene or growth regulator. The use of smoking and ethylene has been in practice to induce uniform ripening of bananas. As a post harvest treatment, 1000 ppm ethephon promotes ripening of tomato, banana, mango etc.

Retarding of ripening of fruits can also be achieved by the effect of growth inhibitors like maleic hydroxide (MH) and methyl esters of naphthalene acetic acid (MENA).

#### **d. Heat Treatments**

Heat treatment is one of the post harvest treatments in certain commodities mainly to destroy the insects and its eggs.

#### **Different Methods of Heat Treatment**

1. Vapour heat treatment
2. Hot water treatment
3. Hot air treatment

### **Packaging**

Packaging is becoming an essential part of value chain analysis regarding food safety. The primary role of packaging is to protect food products from the outside environment and to provide consumers with information about ingredients and nutrition. Fresh produce properly treated, sorted, graded needs proper package for protection during transportation and storage. Methods of packaging can affect the stability of products in the container during shipping depending upon the nature of the container protecting the product. For eg; delicate and high priced products are

packed in trays or in fibre board boxes where as other products are simply put directly in boxes together.

### Importance of packaging

The key functions of packaging are protection, preservation, handling and promotion.

**Protection** : Protect food products from the outside environment

**Preservation** : It extends the keeping quality of products till it is consumed

**Handling** : To assemble the produce in convenient units for handling

**Promotion** : To attract the consumer towards the product.

### Universally standardized requirements for packaging

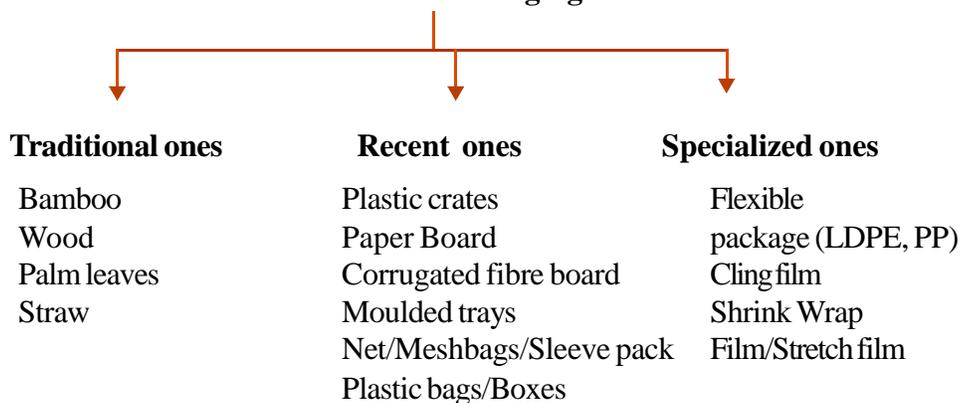
- Package must have sufficient mechanical strength to protect the content
- Package material should not contain any toxic chemicals
- Package should allow rapid cooling of the content
- Package should be stable to moisture and high humidity
- Package should be cost effective
- Package should be reusable or recyclable
- Package should provide adequate ventilation

### Advantages of packaging

Packaging provides a beneficial modified micro environment that helps in:

- Minimizing post harvest loss
- Efficient handling and marketing
- Better appeal so as to promote sale
- Protecting nutritive quality
- Preventing contamination by other commodities
- Providing information about the contents

### Classification of Packaging Materials





*Palm leaves box*



*Mesh bag*



*Cling film*



*Plastic covering*



*Plastic trays*



*Corrugated Box*

### Food Packaging Materials

Major categories of materials used for food packaging are glass, metals, paper, paperboard, and plastics.

#### Types of package

**Vaccum Packaging** : It is a procedure in which air is drawn out of the package prior to sealing but no other gases are introduced. This technique has been used for many years for products such as cured meats and cheese.

**Modified atmosphere packaging (MAP)**: is a procedure which involves replacing air inside a package with a predetermined mixture of gases prior to sealing it. The gases involved in modified atmosphere packaging are carbon dioxide, nitrogen and oxygen.

**Controlled atmosphere packaging (CAP)**: This refers to a storage atmosphere that is different from the normal atmosphere in its composition. The defined mixture of gases is maintained or controlled over time. The system requires sophisticated instruments to monitor the gas levels and is therefore practical only for refrigerated bulk storage or shipment of commodities in large containers.

### SOME NOVEL PACKAGING METHODS:

**Biodegradable Packaging :** Here “Biodegradable plastic” is used in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi and algae.

**Active Packaging :** Active packaging is an innovative concept in which the package, the product and the internal environment in the packaging interact to extend shelf-life while maintaining the quality and safety of the product. In active packaging oxygen scavengers, CO<sub>2</sub> absorbers, ethylene absorbents are used to control the gases in a package.

**Edible Packaging :** In edible packaging a thin layer of edible films formed as a coating on the food. A variety of polysaccharides (starch), proteins (soybean proteins and fish proteins) and lipids have been used to produce edible films.

**Nano Packaging:** Nanotechnology enables designers to alter the structure of packaging materials on the molecular scale, in order to give the material the desired properties.

**Intelligent or Smart Packaging:** Intelligent, or smart packaging is basically designed software to monitor and communicate information about food quality .It is a packaging which sense and informs the consumer about the quality/safety/usability of the produce.

## Storage

Most of the horticultural crops are highly perishable. Fruits and vegetables after harvest, continue to respire by using the stored food materials and accelerates the process of ageing. Their keeping quality are affected by many things such as storage temperature, humidity, composition of the atmosphere, micro organisms etc.

### Purpose of the storage

1. Minimize post harvest loss
2. To tie over the surplus production
3. Make it available where it is unavailable
4. Stabilize the market
5. Make it available during off season

### Storage methods

1. Cold storage (CS)
2. Controlled atmosphere storage (CAS)
3. Modified atmosphere storage (MAs)/ Modified Atmosphere Packages (MAP)
3. Hypobaric Storage (HS)
4. Evaporative cool storage (ECS)

#### 1. Cold Storage (CS)

Removal of heat from freshly harvested commodity without loss of quality is the most desired method for extension of the storage life of perishables. Pre cooling and refrigerated storage at optimum conditions reduce the metabolic rate with relative increase in their storage life. Cold storage maintains low temperature and humidity throughout the storage period. Temperature which is sufficient to lower down metabolic activity of produce is maintained. Care is taken that the inside temperature may not cause chilling injury to the produce. Depending upon type of produce different temperature and humidity are maintained under cold storage.

#### Storage life at optimum temperatures for various fruits and vegetables

Commodity	Optimum storage Temperature(°c)	Optimum storage Life (weeks)
<b>Fruits</b>		
Banana	12-13	3-4
Jack fruit	11-13	7-8
Mango (green)	11-13	4
Tomato (mature breaker stage)	16-20	3
Pineapple	8-10	6
<b>Vegetables</b>		
Brinjal	8-10	4
Cucumber	7-8	2
Lady's finger	8-10	2
Snake gourd	18 - 21	2
Tapioca	0-2	23

**Chilling injury**

When fruits and vegetables are stored below its optimum temperature, chilling injury – a physiological disorder occur leading to reduced shelf life. Many tropical and sub tropical fruits and vegetables exhibit chilling injury if the storage temperature is below 10°C. Due to chilling injury, symptoms like skin discoloration, browning, pitting of the skin, water soaked spots etc will exhibit and the symptoms are visible only after 2 or 3 days of storage at room temperature after cold storage.

**Freezing Injury**

It is also a low temperature storage physiological disorder and it occurs when the commodity is stored below 0° C . The affected fruit has an irregular shape by tissue collapse. The juice will stream out from the injured tissue even under slight pressure.

**2. Controlled Atmosphere Storage (CAS)**

CAS is defined as an atmosphere in which the oxygen level is brought down to low level and carbondioxide level is brought to predetermined level. The gas concentration is controlled accurately throughout the storage period by regular measurements and corrections.

**3. Modified Atmosphere Storage (MAS)/ Modified Atmosphere Package (MAP)**

Here the fruits/ vegetables are enclosed in sealed plastic film, which is slowly permeable to the respiratory gases. Within the package, the gases will change by natural respiration and permeability of the packaging film thus producing lower concentration of O<sub>2</sub> and higher concentration of CO<sub>2</sub> than that in the fresh air.

**4. Hypobaric Storage (HS)**

In hypobaric storage, fruits and vegetables are stored under low pressure by application of vaccum to increase the shelf life.

**5. Evaporative Cooling Storage (ECS)**

Evaporative cooling is a physical phenomenon in which evaporation of water, typically into surrounding air, cools an object or a liquid in contact with it . This maintains low temperature and elevated humidity in the space compared to the surrounding which is essential for maintaining freshness of the commodities. Evaporative cool storage or zero energy cool chamber which is low cost storage structure works on the principle of evaporative cooling.

### **Zero energy cool chamber(ZECC)**

*Considering, the acute energy shortage in rural areas, there is better scope for adoption of small capacity, low cost, on-farm scientific storage structure like Zero Energy Cool Chamber (ZECC) developed at IARI, New Delhi based on the principle of evaporative cooling.*

*The basic structure of the chamber can be built from bricks and river sand, with a cover made from cane or other plant materials and sacks or cloth. There must be a nearby source of water. Construction of the floor is built from a single layer of bricks, and then a cavity wall is constructed with bricks around the outer edge of the floor with a gap of 75 mm between the inner wall and the outer wall. This cavity is then filled with sand. About 400 bricks are needed to build a chamber of the size. A covering for the chamber is made with canes covered in sacking all mounted in a bamboo frame. The whole structure should be protected from sunlight by making a roof to provide shade. After construction of the walls and floor, the sand in the cavity is thoroughly saturated with water. Once the chamber is completely wet, daily sprinkling of water twice daily is done, which is enough to maintain the moisture and temperature of the chamber.*

### **Transportation**

Distribution of agricultural produce from the site of production to the point of consumption without loss in terms of quantity and quality is the prime objective of transportation. The method of transportation is one of the most important factors to be taken into consideration in the choice of packaging to be utilized. Packages designed for a particular distribution pattern will not be suitable for other distribution patterns without some modifications.

The different mode of transport are :

1. Road Transport
2. Rail Transport
3. Air Transport
4. Ship transport

### Minimization of transport losses

Sl. No.	Situation	Recommendations
1	Long distance transport	Use rigid containers to protect commodities better
2	Heat buildup and gas concentration	Arrange the containers to allow air circulation freely in the containers.
3	Use of traditional containers such as bamboo baskets	Use paper or dried leaves or paddy straw to line the sides and bottom
4	Control of respiration and transpiration	Transport the commodities preferably at dawn or night when temperature is low
5	Up and down movement of containers inside the vehicles	Use vehicles with good shock absorbers.
6	To reflect the heat of sun during day transport	Paint the canvas or roof of the truck with white color

### Cold chain management

A cold chain is a temperature controlled supply chain. Perishable goods like fresh fruits, vegetables and flowers follow a cold chain while in transit, storage in warehouses and till it reaches the retail market. Maintenance of cold chain is the best way to maintain the quality of a product and minimize all forms of deterioration after harvesting.

### Practical activities

1. Identification of different packaging materials used for fruits and vegetables
2. The learners are assigned to collect different packaging materials of fruits and vegetables from the market. They are then exhibited in the classroom and the learners identify the different packaging materials.

### **Assessment Activities**

1. Presentation by the learners on the minimization of losses during transport.
2. Preparation of chart on different types of Precooling & Pretreatment in post harvest handling.
3. Class test on Precooling, Pretreatment, Package & storage.

### **List of Portfolios**

1. Recordings of washing, sorting and grading procedure in Practical Record.
2. Completed tabular format of fruits and vegetables with maturity indices in Practical Record.
3. Assignment report on harvesting stage, washing, sorting & grading.
4. List of different packaging materials in the practical record.
4. Seminar report on minimization of transport losses in different situations
5. Chart on Pretreatment and Precooling

### **TE Questions**

1. While visiting a vegetable market, you may have observed the packing materials of vegetables. List down six vegetables with its packing materials
2. A new farmer cultivating vegetables for the first time is not much aware about the correct stage of harvesting of vegetables (cowpea, bhindi, Tomato, Bitter Gourd). As an Agricultural student help the farmer in this aspect.
3. You have accidentally misplaced some fresh vegetables in the freezer compartment of your refrigerator. What will be the condition of the vegetables on the next day. Explain.

## UNIT 3

### POST HARVEST TECHNOLOGY OF MAJOR CROPS

#### Introduction

Unit is intended to provide specific skills to learners on post harvest technology of a set of crops important to Kerala viz. Rice, Mango, Banana, Jack, Spices, Coconut, Cashew and cut flowers. Application of appropriate post harvest technologies is much more complicated than simply the establishment of adequate research and development programmes. General understanding on agronomic practices and pest and diseases of the above mentioned crops in first year of VHSE programme would help learners to be more sensitive to intricacies of post-harvest technology and product diversification of agricultural commodities

#### Learning Outcome

The Learner:

- practices the post-harvest management and product diversification of rice.
- describes the post-harvest management and product diversification of mango, Banana and Jack.
- practices the post-harvest management and product diversification of pepper, ginger and turmeric.
- practices the post-harvest management and product diversification of coconut and cashew .
- familiarizes the post harvest technology of commercial flowers.

#### 4.3.1 Post Harvest Technology & Product Diversification of Rice

Paddy undergoes different process before final consumption. The important steps in indigenous processing are,

1. Harvesting
2. Threshing
3. Winnowing
4. Drying
5. Storing

1. **Threshing** – involves the detachment of grains from the panicle. Done mainly by beating against stones or any other hard materials. Motorized threshers are used for effective threshing. Threshing is done immediately after harvesting.
2. **Winnowing** – separating grain or seed from chaff is known as winnowing. Wind power is used to separate husk and grain.
3. **Drying** – Drying is the process by which moisture content from grains is reduced to safe limit. Moisture content for safe storage is 14% for most of the crops. Sun drying is usually adopted. Heated air dryers are more efficient.
4. **Storing** – the produce is stored for use in future.

#### **Different categories of rice**

- Parboiled rice
- White rice
- Brown rice

#### **a) Processing of Parboiled rice**

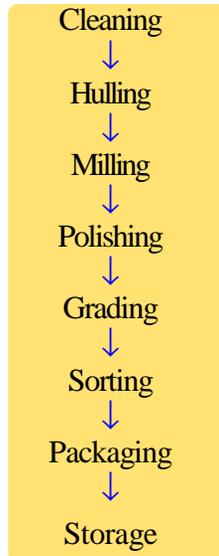
1. *Threshing and winnowing*
2. *Drying* - reduction of moisture to 12-14% to 8% by evaporation.
3. *Parboiling* – Parboiling is done by soaking the paddy in warm water, followed by steaming and drying.
4. *Milling* – Milling refers to the separation of inedible and undesirable portions from food grains which involves cleaning, dehusking, sorting, whitening, polishing etc.
5. *Storage* – proper storage is necessary to prevent the grains from storage pest and to maintain the quality of seeds.

*The most important change during parboiling is the gelatinization of starch and disintegration of protein bodies in the endosperm. Parboiled rice is more nutritious than raw rice because during soaking the nutrients get evenly distributed in the grain.*

#### **b) Processing of white rice (industrial processing)**

Dehusking of paddy and milling of resultant grain gives white rice, which is consumed after cooking.

### Steps in processing of white rice



### c) Processing of Brown Rice

Brown rice processing involves passing the rough rice through sheller machines which remove the hull, producing brown rice with the bran layers still intact around the kernel.

#### Equipments used for processing Rice

Threshers – Olpad thresher, Japanese rotary paddy thresher, *etc*

Winnowers – Paddy harvester cum winnower

Driers - Mechanical drier

#### Practical activities

Preparation of different value added products from rice.

Practice few post harvest methods in Rice

#### Assessment activity

Collection of articles and leaflets on value added products from rice

### 4.3.2 Post Harvest Technology & Product Diversification of Fruits

Post harvest technology includes various treatments and processes applied to fruits and vegetables, after their harvest.

#### Importance of post harvest technology in fruits & vegetables

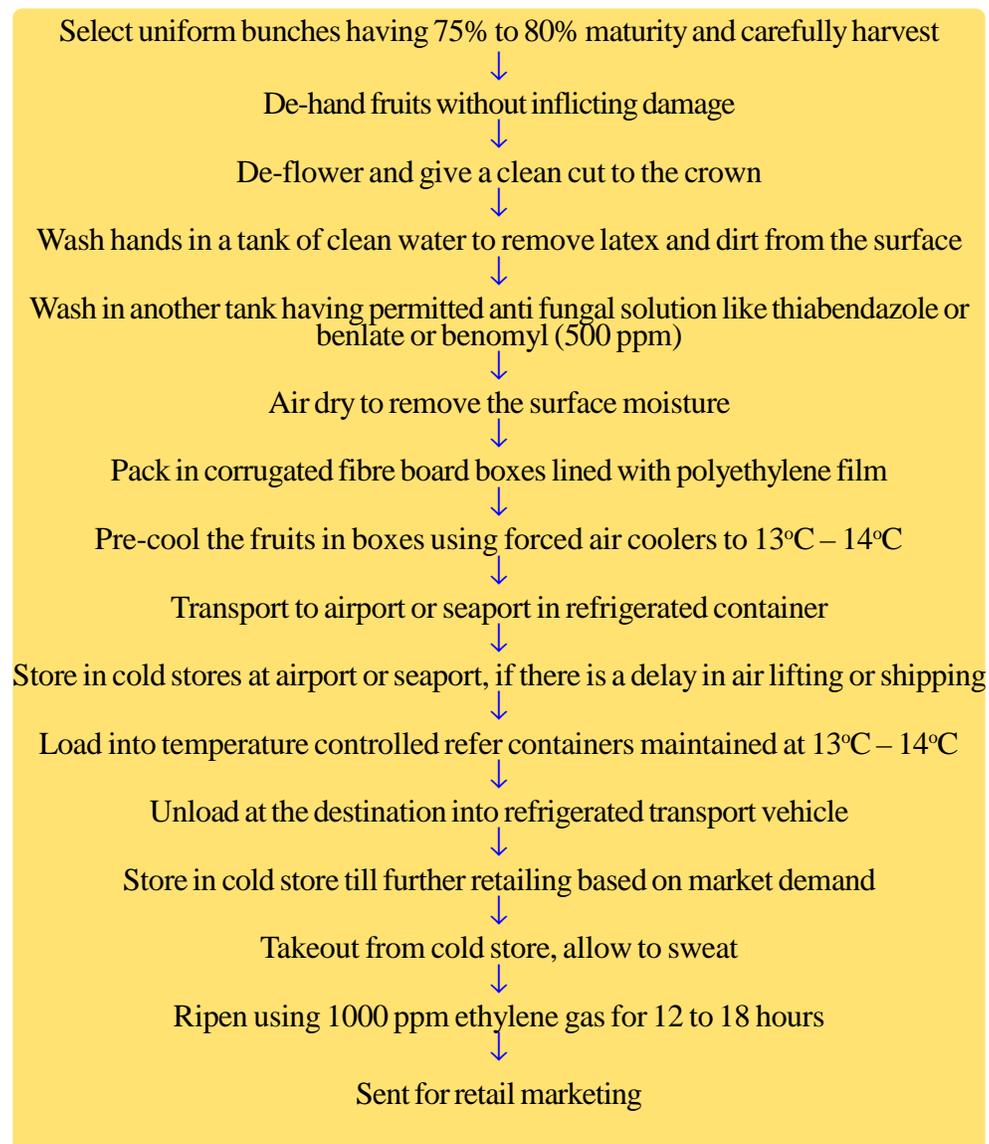
Fruits and vegetables are perishable commodities. These products begin to degrade soon after their harvest. The post harvest treatment prevent or slowdown such

degradation and maintain them in good condition for a reasonable period of time. The production centres are located far away from the market. Proper Post harvest management is essential to maintain the produce in good condition till they are marketed. By proper post harvest management practices we can reduce the post harvest losses

### I. Banana

Adopting improved post harvest technologies could help in minimising the losses to a large extent which would benefit the banana farmers, traders and transporters in minimising the losses and increasing their profit.

#### Flow chart for post harvest handling of Banana



## Ripening

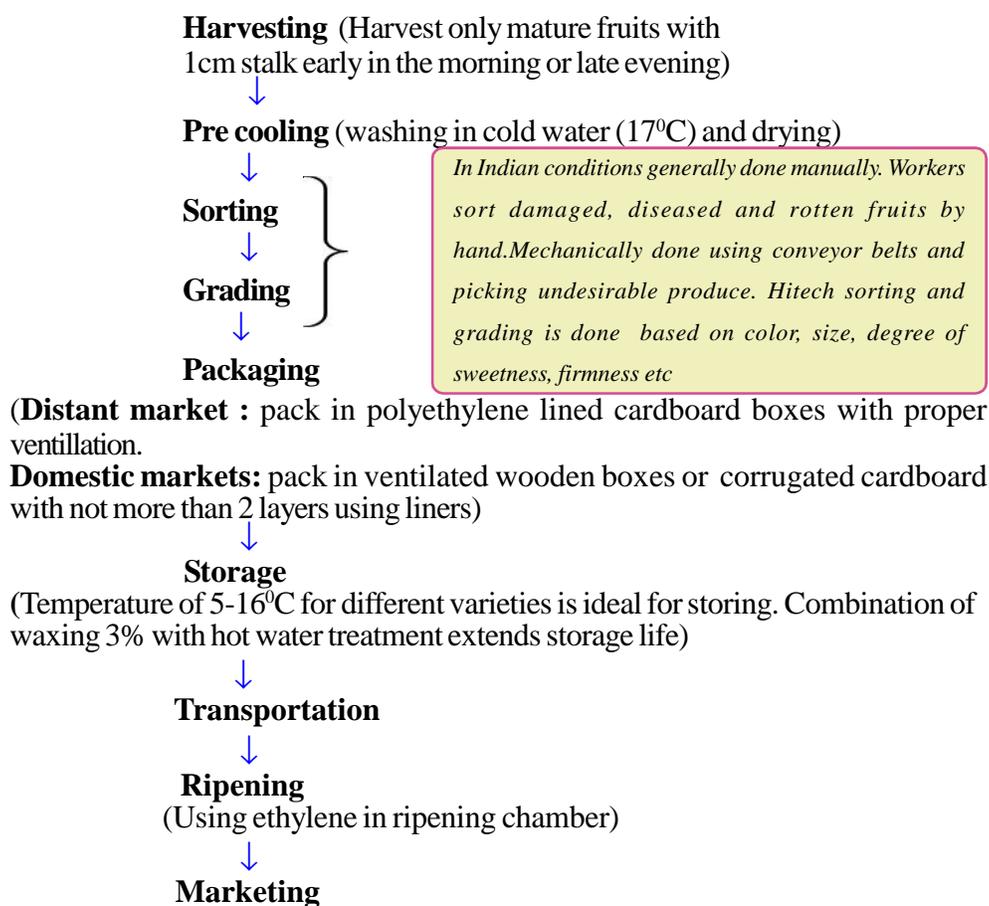
Ripening temperatures are very important for proper colour and flavour development. Commercially viable and legally accepted method of ripening banana is by exposing the fruits to 1000 ppm ethylene gas in an air tight chamber for 12 to 18 hours followed by ventilating the ripening chamber and maintaining the temperature at 18°C to 20°C for proper colour development

## Product Diversification in Banana

Chips/Crisps, Banana Fig, Banana Flour, Banana Powder, Banana Puree, Banana RTS Juice, Banana Fruit Bar, Banana Biscuits, Banana Jam and Jelly, Banana Wine, Alcohol from banana peel, Health Drink and Baby Food, Banana Fibre.

## II. Mango

### Post harvest handling technology in mango



### **Mango products**

The various value added products from Mango are Mango jam, squash, RTS, syrup, Mango fresh juice, Mango candy, Mango Bar, Mango essence, Mango pulp, Mango slice, Mango pickle, sundried Mango slice, Dried mango, Mango chutney

### **III. Jack**

Jack fruit is used both as vegetable and fruit. Immature fruits are used as vegetable. Minimally processed products of Jack fruit are available for both immature and mature fruits. Many products could be made from ripe jackfruit like nectar, jam, pickle, chips and candy.

Pathanamthitta CARD KVK has standardized a dozen technologies for value addition of jackfruits. Out of this 3 are very important – Dehydration of Tender Jack Fruit, Unripe Jackfruit and Seed which are called primary processed products. Once Jack fruit is primary processed, it can be straight away used for culinary preparations or as raw material for hundreds of industrial preparations.

#### **Value added products from jackfruit**

Jam, Jelly, Jackfruit leather, Pickle, Candy, Chips, Jackfruit seed flour, Squash, Syrup, Halwa, Wine, Pappadam, Murukku, Honey Jackfruit, Jackfruit Preserve, Jackfruit Thera, Chakkakkuru Thoran Parippu, Chakkakkuru Puttupodi, Chakkakkuru Avalose Podi, Chakkakkuru Sambar Parippu, Dried jack fruit, Chips

#### **Dehydration technology in jack**

- Dehydrated tender jack
- Dehydrated raw jack bulb
- Dehydrated jack seed
- Dehydrated ripe jack fruit
- Jack fruit bar

#### **Practical activities**

1. Visit to a banana export - packing unit.
2. Preparation of value added products of jack
3. Practising post harvest handling of banana- Demonstrate in a banana bunch the procedure of post harvest handling as per the flow chart given in the unit detailing.

### Assessment activity

1. Prepare a PPT on various value added products from jack fruit/banana/mango
2. Recording of flow chart for post harvest handling in the learners note.

## 4.3.3 Post Harvest Technology and Product Diversification of Spices

### I. Pepper

#### Harvesting and processing Black pepper

Black pepper of commerce is produced from whole, unripe but fully developed berries. The harvested berries are piled up in a heap to initiate browning. Then berries are detached from the stalk by threshing. Then they are spread on suitable drying floor. During sun drying, berries are raked to ensure uniform drying and to avoid mould development. Drying the berries for 3-5 days reduces the moisture content to 10 -12 percent. The dried berries are cleaned, graded and packed in double lined gunny bags.

Blanching the berries in boiling water for one minute prior to sun drying accelerates browning process as well as the rate of drying. It also gives a uniform lustrous black colour to the finished product and prevents mouldiness of berries. Prolonged blanching should be avoided since it can deactivate the enzymes responsible for browning process.

#### White pepper

White pepper is prepared from ripe berries or by decorticating black pepper. Bright red berries, after harvest are detached from the stalk and packed in gunny bags. The bags are allowed to soak in slow running water for about one week during which bacterial rotting occurs and pericarp gets loosened. Then the berries are trampled under feet to remove any adhering pericarp, washed in water and then sun dried to reduce the moisture content to 10 -12 percent and to achieve a cream or white colour. White pepper is garbled, sorted and packed in gunny bags. Approximately 25 kg white pepper is obtained from 100 kg ripe berries.

#### Dehydrated green pepper

In this method, under mature berries are harvested and subjected to heat treatment. Then the berries are dehydrated under controlled conditions wherein maximum retention of green colour is obtained.

### **Canned green pepper**

Green pepper after harvest is preserved in two percent brine solution and the product is heat sterilized.

### **Cured green pepper**

Berries are thoroughly cleaned in water, steeped in saturated brine solution for 2-3 months, drained and packed in suitable flexible polyethylene pouches.

### **Pepper oil**

Black pepper is crushed to coarse powder and steam distilled to obtain 2.5 to 3.5% colourless to pale green essential oil. It is used in perfumery and in flavouring.

### **Pepper oleoresin**

Extraction of black pepper with organic solvents like acetone, ethanol or dichloroethane provides 10-13 % oleoresin possessing the odour, flavour and pungent principles of the spice.

## **II. Turmeric**

### **Harvesting and curing**

Time of harvest depends upon variety and usually extends from January to March. Harvest early varieties at 7-8 months, medium varieties at 8-9 months and long duration varieties at 9-10 months after planting.

### **Improved method of processing**

**Cleaning** : Harvested turmeric rhizomes are cleaned off mud and other extraneous material adhering to them and are subjected to curing within 2-3 days after harvest so as to ensure the quality of the end product.

**Boiling** : Fingers and mother rhizomes will have to be boiled separately. Boiling is usually done in MS pans of suitable size. Cleaned rhizomes (approximately 50 kg) are taken in a perforated trough made of GI or MS sheet with extended handle. The trough containing the rhizomes is then immersed in MS pan containing clean water sufficient to immerse the rhizomes. The whole mass is boiled till the rhizomes become soft. The cooked rhizomes are taken out of the pan by lifting the trough and draining the solution into the pan.

**Drying** : The fingers are then dried in the sun by spreading them as a thin layer on bamboo mats or drying floor. Artificial drying at a maximum temperature of 60°C gives a bright coloured product than that of sun drying.

## Polishing

In order to smoothen the rough and hard outer surface of the boiled dried turmeric and also to improve its colour, it is subjected to polishing. There are two types of polishing: hand polishing and machine polishing.

*i. Hand polishing:* The method of hand polishing consists of rubbing turmeric fingers on hard surface or trampling them under feet wrapped in gunny bags. The improved method is by using hand operated barrel or drum mounted on a central axis. When the drum filled with turmeric is rotated, polishing is effected

*ii. Machine polishing :* This method consists of an octagonal or hexagonal wooden drum mounted on a central axis and rotated by power.

## Turmeric oleoresin

This is obtained by the solvent extraction of the ground spice with organic solvents like acetone, ethylene dichloride and ethanol for 4-5 hours. One kg of oleoresin replaces 8 kg of ground spice.

## III. Ginger

### Harvesting and processing

For vegetable ginger, the crop can be harvested from six month onwards. For dry ginger, harvest the crop between 8-9 months.

### Green ginger

After harvest, the fibrous roots attached to the rhizomes are trimmed off and soil is removed by washing. Rhizomes are soaked in water overnight and then cleaned and marketed as green ginger.

### Dry Ginger

The skin is removed by scrapping with sharp bamboo splits or such other materials. Never use metallic substances since they will discolour the rhizomes. After scrapping, the rhizomes are sun dried for a week with frequent turnings. They are again rubbed well by hand to remove any outer skin.

### Ginger Oil

Ginger oil is prepared commercially by steam distillation of dried powdered ginger. The yield of oil varies from 1.3 to 3.0 percent. The major use of ginger oil is as a flavouring agent for beverages, both alcoholic and non-alcoholic.

### Ginger oleoresin

Oleoresin from ginger is obtained conventionally by extraction of dried powdered ginger with organic solvents like ethyl acetate, ethanol or acetone. Commercial dried ginger yields 3.5 -10.0 % oleoresin. Ginger oleoresin is a dark brown viscous liquid responsible for the flavour and pungency of the spice.

#### Practical activity

1. Curing of turmeric – method demonstration
2. Preparation of dry ginger
3. Practice the production of white pepper(white pepper)

#### Assessment activity

Conduct a quiz programme on the topic- Processing of Ginger, Turmeric and Pepper

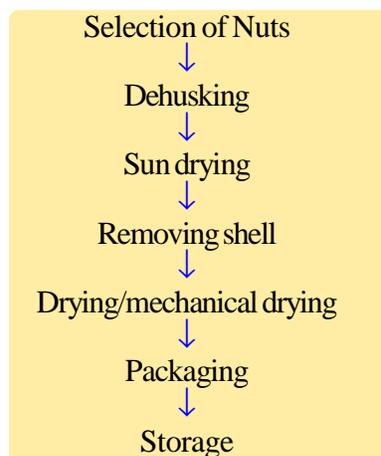
### 4.3.4 Post Harvest Technology & Product Diversification of Plantation Crops

#### I. Coconut

Harvesting in coconut is normally done at 30 days intervals during summer and 45 days intervals during rainy season. After the harvest, the nuts are to be stored in heaps under shade for few days. Storing of nuts in heaps facilitates husking easier, shelling cleaner and obtaining higher output of superior quality copra.

a. **Preparation of copra** - Copra, the dried kernel is the chief commercial product from coconut, which is mainly used for oil extraction. Copra normally has an oil content varying from 65 to 72%.

#### Steps involved in copra making



- b. **Oil preparation from copra** - Well dried copra is cut into small chips and milled for oil extraction. The byproduct obtained after oil extraction is oilcake
- c. **Desiccated coconut** - Desiccated Coconut Powder is obtained by drying ground or shredded coconut kernel after the removal of brown testa.
- d. **Coconut cream** – Coconut cream is the processed coconut milk, extracted from fresh matured coconuts
- e. **Nata- de –Coco** - Nata-de-coco a cellulosic white to creamy yellow substance formed by *Acetobacter aceti sub xylinium* on the surface of sugar enriched coconut water / coconut milk. It is popularly used as a dessert.
- f. **Coconut milk powder** – Spray dried coconut milk powder if dissolved in water will result in coconut milk which can be used in place of fresh coconut milk for food preparations/ beverages in households and food industries.
- g. **Snow ball coconut** - the husk, shell and testa of the tender coconut is removed without breaking the nut and made available for consumption. The white ball contains the tender coconut water, which can be consumed by just inserting a straw through the top of the kernel.
- h. **Bottled tender coconut water** - Coconut water from nuts of 6-7 month stage is first filtered through pressure filters and then mixed with the desired proportion of additives plus sugar and concentrated to the appropriate level. The water is then packed in pouches/cans and retorted in an autoclave, after which it is cooled in a stream of cold water.
- i. **Vinegar** - production of coconut vinegar from matured coconut water using vinegar generators. Vinegar has extensive use as a preservative in the pickle industry and flavouring agent in food processing sector.
- j. **Toddy** - Toddy tapping is an organized industry in traditional coconut growing tracts in the country. Coconut jaggery is made from sweet coconut toddy. Toddy on fermentation becomes an alcoholic drink.
- k. **Neera** - Neera is the sweet, oyster white coloured sap tapped from the 'spathe' of coconut. It is a rich source of sugars, minerals and vitamins. Neera is an unfermented drink which does not contain alcohol. But on fermentation neera becomes toddy. Neera is the raw material for many value added products like palm syrup, palm jaggery and palm sugar.

### Procedure of Neera production

The technique consists of carefully bruising and rupturing the tender tissues of the floral branch by gently hammering and pounding the spathe. The mature spadix appropriate for tapping is identified by observing the swelling appeared at the base of the spadix due to female flowers within an opened inflorescence. After about three days,



*Ideal spadix with swollen base*



*Stroking spadix using a mallet.*

about 5 cm of the apical tissues is sliced off. The commencement of the flow takes place as early as 5 days and as late as 32 days after the tip of the spadix had been cut off for the first time. When the sap starts flowing, a container (coconut sap chiller) which stores the sap in low temperature is placed under the dripping spadix. It is reported that the sap flow gradually increases and may reach a peak after 3-5 weeks. The peak may then continue for 1-3 weeks, after which the flow declines. The flow may continue for about a month until the length of the spathe is reduced to a length of about 10-15 cm after repeated slicing

l. **Coconut chips** : Coconut shavings are baked/roasted with almost no added ingredients.

m. **Virgin coconut oil** :- Virgin coconut oil is extracted from the coconut milk obtained from fresh coconuts using processes such as fermentation, churning (centrifugal separation), refrigeration, and the action of enzymes, the oil is separated from the water or moisture. In traditional method, fresh coconut milk is boiled to obtain the oil by evaporating the water or moisture.

n. **Diversified and value added products from coconut**

#### ❖ Shell products

1 **Shell powder** – manufactured from matured coconut shells. The manufacture of coconut shell powder is not an organized industry in India. The product finds extensive

use in plywood and laminated board industry as a phenolic extruder and as filler in synthetic resin glues, mosquito coils and agarbathis.

**2. Activated charcoal** - The shell charcoal is the raw material required for the manufacture of activated carbon.

❖ **Coir products** - a large number of products like mats, coir, handicraft items *etc.* prepared out of coir which is extracted from the husk.

## II. Cashew

### Post Harvest handling of Cashew nuts

Raw nuts immediately after harvest are to be separated from cashew apple and sundried for two to three days. Nuts after drying can be stored in gunny bags well protected from rodents. Well dried raw nuts (moisture content 8 to 9%) could be stored upto one year without any quality deterioration.



The shell of the nut is really a tough skin and contains juice that causes skin blisters. Roasting destroys the blistering compound and the nuts can then be opened by hand cracking. Roasting improves the flavour. This operation used to be carried out by the pickers who heated a few pounds at a time in a pan over an open fire, but mechanical roasters are now established in the large factories.

The nuts have a soft, mealy texture and have gained great popularity as salted nuts or flavoured nuts and are also used in confectionery.

### Post Harvest Utilization of Cashew Apple

**Cashew Apple:** Cashew Apple is a valuable source of sugars, minerals and vitamins especially vitamin C and can be used for preparation of various products.

**Preliminary Processing:** Select crisp, firm, tight and full colour developed best quality apples. Since highly susceptible to physical injury and microbial spoilage, collect apples every day, after separating the nuts. The selected fruits are washed thoroughly with water. Stainless steel or glass containers should be used for processing, after sterilization. Juice can be extracted from ripe cashew apples, after washing, using screw press/ basket press/ hydraulic press or by hand pressing with the help of juice extractor. The astringent taste of cashew apple is due to the presence of tannin.

The tannin present in the **raw juice** can be removed through clarification by adopting any one of the following methods:

1. Take 5g powdered sago in minimum quantity of water, heat and make into paste by stirring and cool it. Add sago paste into one litre juice and mix well by stirring. Decant the clear juice after 12 hours.
2. Mix gelatin @ 0.5g/ kg of raw juice and allow to settle. Decant the clear juice and discard the sediment (gelatin may be dissolved in water by double boiling).
3. Mix about 125 ml of fresh rice gruel (kanjivellam) and allow to settle. Decant the clear upper layer and repeat the process using 125 ml of rice gruel.

Tannin can be removed from **mature or ripe apples** by adopting the following procedure:

Clean the apples and immerse in 5% salt solution for 3 days with the change of salt solution daily. Takeout the fruit on the 4<sup>th</sup> day and wash thoroughly in water. The fruit is now de-tanned.

### **Cashew apple products**

1. Cashew apple juice
2. Cashew apple squash
3. Cashew apple syrup
4. Blended cashew apple – Pineapple squash.
5. Ready to serve beverage (RTS beverage)
6. Cashew apple – Mango mixed fruit jam.
7. Cashew apple pickle.
8. Cashew apple candy
9. Cashew apple vinegar
10. Cashew apple wine

### **Practical activities**

1. Practicing removal of tannin from cashew apple juice.
2. Practicing the steps involved in copra making.

### **Assessment activity**

1. Collection of articles on value added products of coconut
2. Recording list of products from cashew apple in learners note

### 4.3.5 - Post Harvest Technology of Cut Flowers

#### Harvest of cut flowers and techniques to enhance vase life

Cut Flower	Stage of harvest	Post harvest handling and packing
Anthurium	Spadix $\frac{1}{2}$ to $\frac{3}{4}$ <sup>th</sup> mature. Heart shaped symmetrical spathe with overlapping or fused lobes.	Cut flowers should be kept away from excess heat and cold. Waxing the flowers lengthens the post harvest life considerably. For transport and packing, impregnation of the cut ends of flower stems just after harvest with 150 ppm Silver thiosulphate (STS) for 10 minutes is beneficial.
China aster	3 -4 flower heads should be fully opened and rest flower heads in the sprays show colour.	Prior to transport and packing, the flowers are to be conditioned for 15 hrs at ambient temperature in a solution containing 2% sucrose, 75 ppm citric acid and 25ppm Silver nitrate ( $\text{Ag NO}_3$ ).
Gladiolus	In tight bud stage with 2-3 florets from the bottom fully opened.	Flower spikes are susceptible to grey mould in storage. So they should be stored under light and if not treated with auxins, are to be transported in vertical position.
Orchids – Dendrobium	When all florets except the top most one or two buds are open.	Flowers are sensitive to ethylene. If the base of the stem is dipped in warm water for half a minute, longevity of flower spike increases.
Rose	Red and Pink varieties when 1-2 petals begin to unfold from the tip.	Premature harvesting and excessive water loss cause bent neck. For reviving rose, entire flower should be immersed in water for 2-3 hours.

### Techniques to enhance vase life

Cut Flower	Techniques
Anthurium	Vase life can be further increased by more than 2 weeks using sodium hypochlorite (73 ppm) or benzoic acid (500ppm) in a holding solution along with 1% sucrose.
China aster	Preservative solution is 2% sucrose + 500ppm DICA.
Gladiolus	7- 12 days depending upon the cultivars. Preservative solution containing 4% sucrose + 250ppm 8-HQC further increases longevity of spikes.
Orchids – Dendrobium	14 -21 days. Preservative solution is 2% petal life +200 ppm 8-HQC and 4% sucrose +30ppm AgNO <sub>3</sub>
Rose	4-7 days. Varies with the cultivars. Holding solutions are 3% D-Fructose + 2.5ppm Kinetin/ 3% D-Fructose + 25ppm AgNO <sub>3</sub> / 3% sucrose + 200ppm 8- HQC etc.

#### Practical activity

Demonstrate post harvest handling and techniques to enhance vase life of Anthurium/ Orchid/Rose.

#### Assessment Activity

Prepare a chart showing the techniques to enhance vase life of common cut flower in a tabular form.

#### TE Questions

1. Prepare a flow chart for the expo of your school on the topic “Post harvest handling of Banana”.
2. Your friend is a good cut flower grower. He seeks your advice about its storage while harvesting. How will you help him.
3. As an agri assistant how will help a Kudumsree unit in your Panchayath to make marketable produce from cashew apple.

## UNIT 4

# AGRO-PROCESSING TECHNOLOGY

### Introduction

World is passing through a 'second wave' of globalization through rapid growth in processed and high value agricultural and food products through networks retail supermarkets. Apart from local and national markets there is a global market for processed products. The unit deals with principles of preservation and standardised production flow charts in canning and making of jam, jelly, squashes, pickle, sauce and marmalade

### Learning outcomes

The Learner :

- Elaborates the principles and methods of preservation.
- practices the preparation of Jam, Jelly, pickle, squash, RTS etc and elaborate the steps of Canning.

### 4.4.1 Principles and methods of preservation

Agro-processing Technology deals with engineering and other scientific as well as technical problems involved in transforming edible raw materials and other ingredients into nutritious and appetizing food products. Value addition to food products has assumed vital importance in our country due to diversity in socio-economic conditions, industrial growth, urbanization and globalization

### Principles of preservation

Food preservation can be defined as the science which deals with the method of prevention of decay or spoilage of food, thus allowing it to be stored in a fit condition for future use. In the preservation of foods by various methods, the following principles are involved:

#### 1. Prevention or delay of microbial decomposition

- (a) By keeping out microorganisms (asepsis)
- (b) By removal of microorganisms e.g. by filtration
- (c) By hindering the growth and activity of microorganisms, e.g. by low temperature, drying, anaerobic conditions, chemicals or antibiotics.
- (d) By killing the microorganisms, e.g. by heat or radiation.

## 2. Prevention or delay of self-decomposition of the food

- (a) By destruction or inactivation of enzymes, e.g. by blanching;
- (b) By prevention or delay of chemical reactions, e.g. prevention of oxidation by means of an antioxidant.

## 3. Prevention of damage by insects, animals, mechanical causes etc.

### Methods of preservation

The methods generally used are as under:

#### 1. Asepsis (Absence of infection)

Asepsis means preventing the entry of microorganisms. Washing or wiping of the fruits and vegetables before processing should be strictly followed.

#### 2. Preservation by High Temperature

High temperature results in destruction of microorganisms and inactivation of the enzymes present in the food.

High temperatures used for preservation are usually : (i) pasteurization temperature (below 90°C) and (ii) sterilization temperature (100°C or above).

##### I. Pasteurization

Pasteurization frees the food from human pathogens and most of vegetative microorganisms. Depending upon the nature of the food items and the size of the container to be preserved the temperature may vary. Usually juices, R.T.S. and nectar are pasteurized at about 85°C for 25 to 30 minutes.

*There are three methods of pasteurization.*

- (a) **Bottle or 'Holding' pasteurization :** This method is commonly used for the preservation of fruit juices at home.
- (b) **Overflow method :** *This method is very suitable for grape juice because it minimizes the adverse effect of air on the quality of the juice.*
- (c) **Flash pasteurization :** *The method has been developed specially for the canning of natural orange juice, but can also be used for grape and apple juice.*

## II. Sterilization

Sterilization is the destruction of all viable microorganisms. Heat sterilization is the most effective process of food preservation. It has a severe effect on heat labile nutrients, particularly vitamins; the nutritional quality of proteins is reduced. By this method all microorganisms are completely destroyed due to high temperature. The time and temperature necessary for sterilization vary with the type of food. Fruit and tomato products should be heated at 100°C for 30 minutes. Temperatures above 100°C can only be obtained by using steam pressure sterilizers such as pressure cookers and autoclaves.

The major differences between pasteurization and sterilization are as under:

Sl. No.	Pasteurization	Sterilization
1	Partial destruction of microorganisms	Complete destruction of microorganism
2	Temperature below 90°C	Temperature 100°C and above
3	Normally use for fruits	Normally used for vegetables

### 3. Preservation by Low Temperature

Microbial growth and enzyme reactions are retarded in foods stored at low temperatures. The lower the temperature, the greater the retardation. Low temperatures can be produced by (i) cellar storage (about 15°C), (ii) refrigeration or chilling (0 to 5°C), and (iii) freezing (-18 to -40°C).

- (i) *Cellar storage (about 15°C) : Root crops, potatoes, onions, apples and similar foods can be stored for limited periods during the winter months.*
- (ii) *Refrigeration or chilling (0 to 5°C) : Fruits, vegetables and their products can be preserved for a few days to many weeks when kept at this temperature.*
- (iii) *Freezing method(-18 to -40°C): It is the most harmless method of food preservation. The best way of preserving pure fruit juice is by freezing. Properly frozen juice retains its freshness, colour and aroma for a long time. This method is particularly useful in the case of juices whose flavour is adversely affected by heating.*

#### 4. Preservation by Chemicals

Microbial spoilage of food products is also controlled by using chemical preservatives which interfere with the mechanism of cell division, permeability of cell membrane and activity of enzymes.

The two important chemical preservatives permitted in many countries are

- (i) Sulphur dioxide (including sulphites)
- (ii) Benzoic acid (including benzoate)

##### (i) Sulphur dioxide

Sulphur dioxide is widely used throughout the world in the preservation of juice, pulp, nectar, squash, crush, cordial and other products. It has good preserving action against bacteria and moulds and inhibits enzymes etc. It is generally used in the form of its salts such as sulphite, bisulphite and metabisulphite. Potassium metabisulphite is commonly used as a stable source of sulphur dioxide.

According to FSSAI, the maximum amount of sulphur dioxide allowed in fruit juice is 700 ppm, in squash, crush and cordial 350 ppm.

##### (ii) Benzoic acid

Benzoic acid is more effective against yeasts. According to FSSAI its permitted level in squash, crush and cordial 600 ppm. In the long run benzoic acid may darken the product. It is, therefore, mostly used in coloured products of tomato, pomegranate, coloured grapes, etc. The preservative should never be added in solid form but should be dissolved in a small quantity of juice or water, and the solution added to the bulk of the product. If this care is not taken, the solid may settle undissolved at the bottom of the container with the result that fermentation may start before the action of preservative can begin.

#### 5. Preservation by Drying

Microorganisms need moisture to grow so when the concentration of water in the food is brought down below a certain level, they are unable to grow. Moisture can be removed by the application of heat as in sundrying or by mechanical drying (dehydration). In this method, juices are preserved in the form of powder.

e.g. Mango juice powder

#### 6. Preservation by Filtration

In this method, the juices are clarified by settling or by using ordinary filters, and then passed through special filters which are capable of retaining yeasts and bacteria.

Various types of germ-proof filters are used for this purpose. It is not used in India. This method is used for soft drinks, fruit juices and wine.

### **7. Preservation by Carbonation**

Carbonation is the process of dissolving sufficient carbon dioxide in water or beverage. Carbonation adds to the life of a beverage. Fruit juice beverages are generally bottled with carbon dioxide content varying from 1 to 8 g per litre. Another advantage of carbonation is the removal of air thus creating an anaerobic condition, which reduces the oxidation of ascorbic acid and prevents browning.

### **8. Preservation by sugar**

Syrups containing 66% or more of sugar do not ferment. Sugar absorbs most of the available water which result in very little water for the growth of microorganisms hence their multiplication is inhibited, and even those microbes already present die out gradually. Thus sugar acts as a preservative by osmosis and not as a true poison for microorganisms. Fruit syrup, jam, jelly, marmalade, preserve, candy, crystallized fruit and glazed fruit are preserved by sugar.

### **9. Preservation by Fermentation**

Decomposition of carbohydrates by microorganisms or enzymes is called fermentation. This is one of the oldest methods of preservation. By this method, foods are preserved by the alcohol or organic acid formed by microbial action. Wines, beers, vinegar, fermented drinks, fermented pickles, etc., are prepared by these processes. Fourteen per cent alcohol acts as a preservative in wines. About 2 per cent acetic acid prevents spoilage in many products.

### **10. Preservation by salt**

Salt at a concentration of 15 to 25% is sufficient to preserve most products. It inhibits enzymatic browning and discolouration and also acts as an antioxidant. Salt in the form of brine is used for canning and pickling of vegetables. It exerts its preservative action by:

- (i) causing high osmotic pressure resulting in the plasmolysis of microbial cells
- (ii) Dehydrating food as well as microorganisms by drawing out and moisture.
- (iii) Ionizing to yield the chloride ion which is harmful to microorganisms.

### **11. Preservation by Acids**

Highly acidic environment inhibits the growth of food spoilage organisms.

Acetic (vinegar), citric (lime juice) and lactic acids are commonly used for preservation. About 2 per cent acetic acid prevents spoilage of many products. Onions are bottled in vinegar with a little salt. Vinegar is also added to pickles, chutneys, sauces and ketchups. Citric acid is added to many fruit squashes, jams and jellies to increase the acidity and prevent mould growth.

### **12. Preservation by Oil and Spices**

A layer of oil on the surface of any food produces anaerobic condition which prevents the growth of moulds and yeasts. Thus pickles in which enough oil is added to form a layer at the top can be preserved for long periods. Spices like turmeric, pepper, and asafetida have antibacterial effect.

### **13. Preservation by Antibiotics**

Nisin is an antibiotic commonly found in milk, curd, cheese and other fermented milk products. It is commonly used in canning of mushrooms, tomatoes. Pimaricin, an antifungal antibiotic, can be used for treating fruits and fruit juices.

#### **Assessment activities**

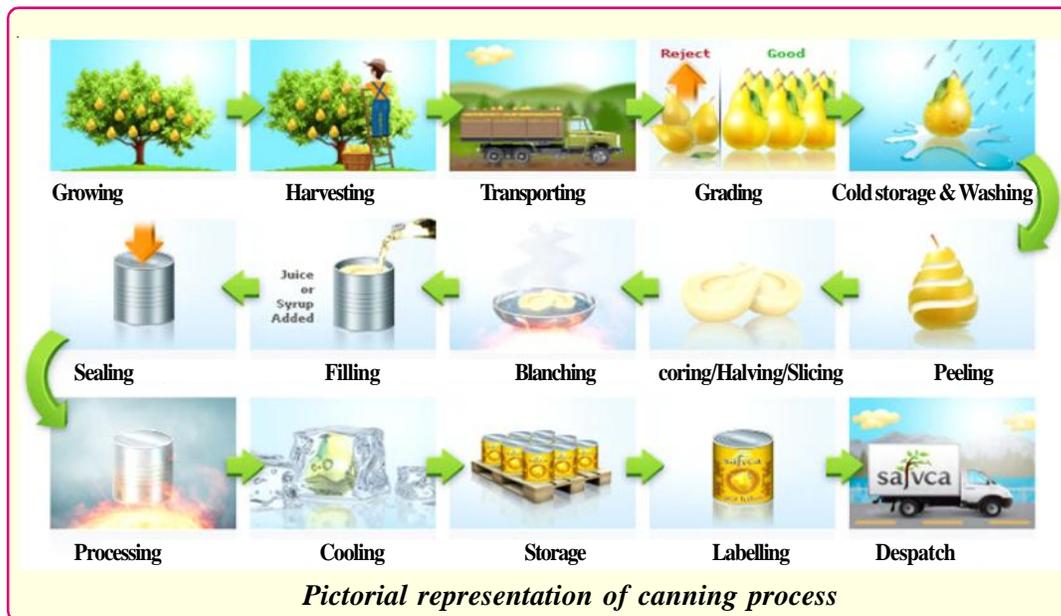
1. Seminar on different methods of preservation with detailed presentation of any one of the preservation methods practiced at home.
2. Class test on “Principles and methods of preservation”

#### **4.4.2. Steps in Canning and preparation of RTS, Squash, Jam, Jelly, pickle and Tomato sauce**

##### **Canning**

It is the process of sealing food stuffs in containers and sterilizing them by heat for long term storage. Fruits and vegetables are canned in the season when the raw material is available in plenty. The canned products are sold in the off season and give better returns to the grower. The principle behind canning is the destruction of spoilage organisms within the sealed container by means of heat.

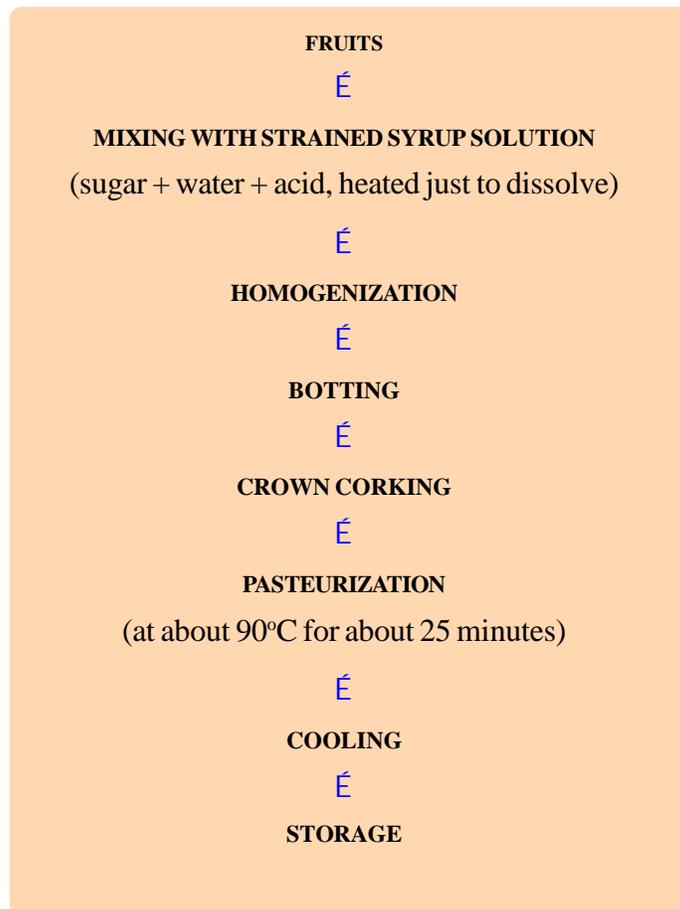
*Flow sheet for Canning Process*



### Ready To- Serve (RTS)

This is a type of fruit beverage which contains at least 10% fruit juice and 10 % total soluble solids besides about 0.3% acidity. It is not diluted before serving, hence it is known as ready- to- serve (RTS).

#### *Flow Sheet for Processing of RTS Beverages*

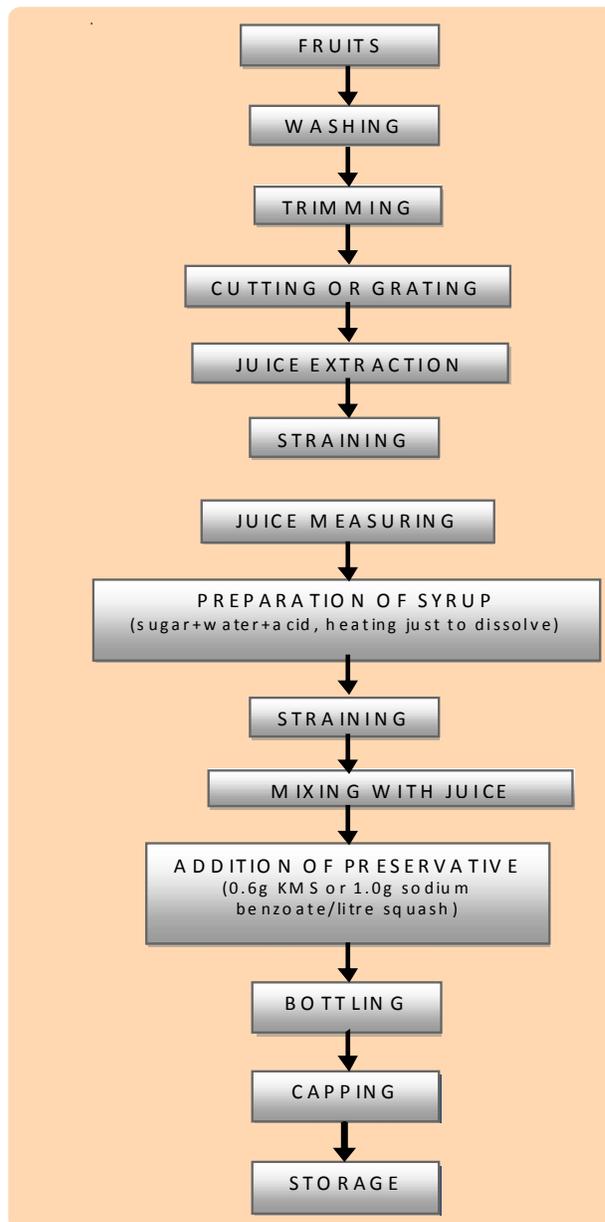


## Squash

This is a type of fruit beverage containing at least 25per cent fruit juice or pulp and 40 to 50per cent total soluble solids, commercially. It is diluted before serving.

Materials required : Strained juice : 1L, Sugar : 2kg, Water : 1L, Citric acid : 20-25g, Essence : 2 drops, KMS : 0.5g, Colour : 0.25g.

### Flow sheet for Processing of Squash

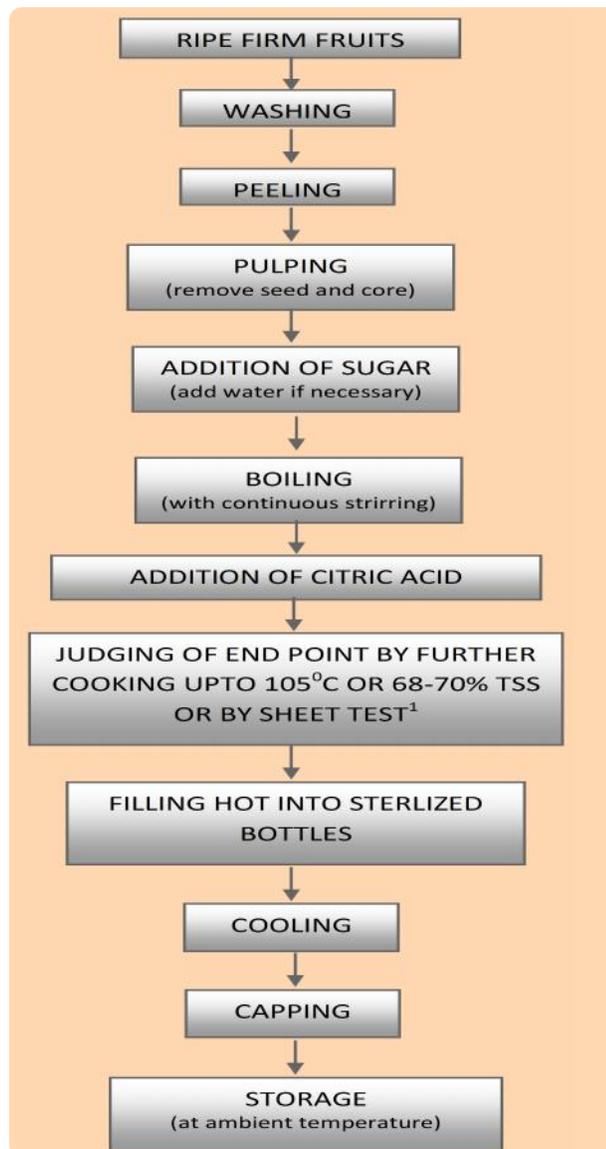


## Jam

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissue in position. It can be prepared from one kind of fruit or from two or more kinds.

Materials required for mixed fruit jam: Fruit pulp: 1kg, Sugar: 1kg, Citric acid: 1-1.5g, Permitted colour: 1 pinch, Essence: 2 drops, Sodium benzoate: 0.5g.

### *Technological flow sheet for Processing of Jam*

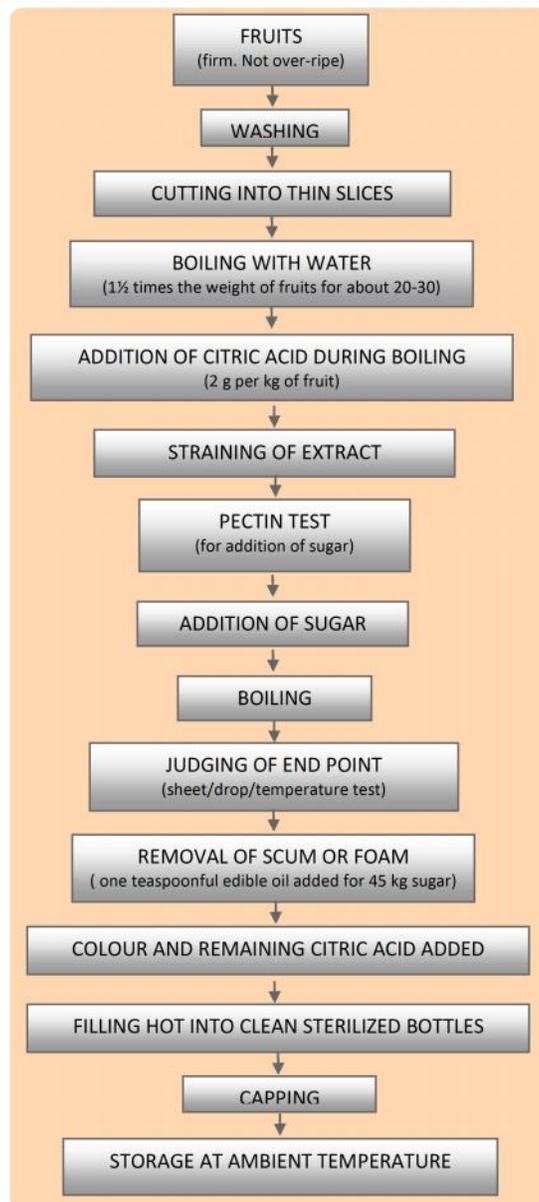


## Jelly

A jelly is a semi solid product prepared by boiling a clear, strained solution of pectin containing fruit extract, free from pulp after the addition of sugar and acid. Pectin extract is made by boiling fruit pieces in water and straining the solution.

Materials required : Fruit extract: 1lit, Sugar: 750g – 1kg, Citric acid: 3-4g, Essence: 0.2 drops, KMS: 0.5g, Water: 1.5lit

### TECHNOLOGICAL FLOW SHEET FOR PROCESSING OF JELLY



### **Judging of end point**

Boiling of jelly should not prolonged, because excessive boiling results in a greater inversion of sugar and destruction of pectin .If the jelly is cooked for a prolonged period , it may become gummy, sticky, syrupy and deteriorate in color flavour. The end point of boiling can be judged in the following way.

#### **(i) Sheet or flake**

A small portion of jelly taken out during boiling , in a spoon or wooden ladle and cooled slightly. It is then allowed to drop. If the product falls off in the form of a sheet or flakes instead of flowing in a continuous stream or syrup, it means that the end-point has been reached and the product is ready, otherwise, boiling is continued till the sheet test is positive.

#### **(ii) Drop test**

A drop of the concentrated mass is poured into a glass containing water. Settling down of the drop without disintegration denotes the end-point

#### **(iii) Temperature test**

A solution containing 65% total soluble solids boils at 105°C. Heating of the jelly to this temperature would automatically bring the concentration of solids to 65 % . This is the easiest way to ascertain the end-point.

## Pickle

Materials required : Mango : 1 kg, Salt :200 g, Chilly powder: 100 gm, Turmeric powder: 4 gm, Gingelly oil : 300 ml, Asafoetida powder : 10 gm, Fenugreek powder: 10 gm, Mustard : 20 gm, Garlic: 50gm, Green chillies : 50 gm, Ginger : 50 gm, Vinegar : 25 ml, Sodium benzoate : 0.5gm

### *Processing flowsheet for mango pickle*

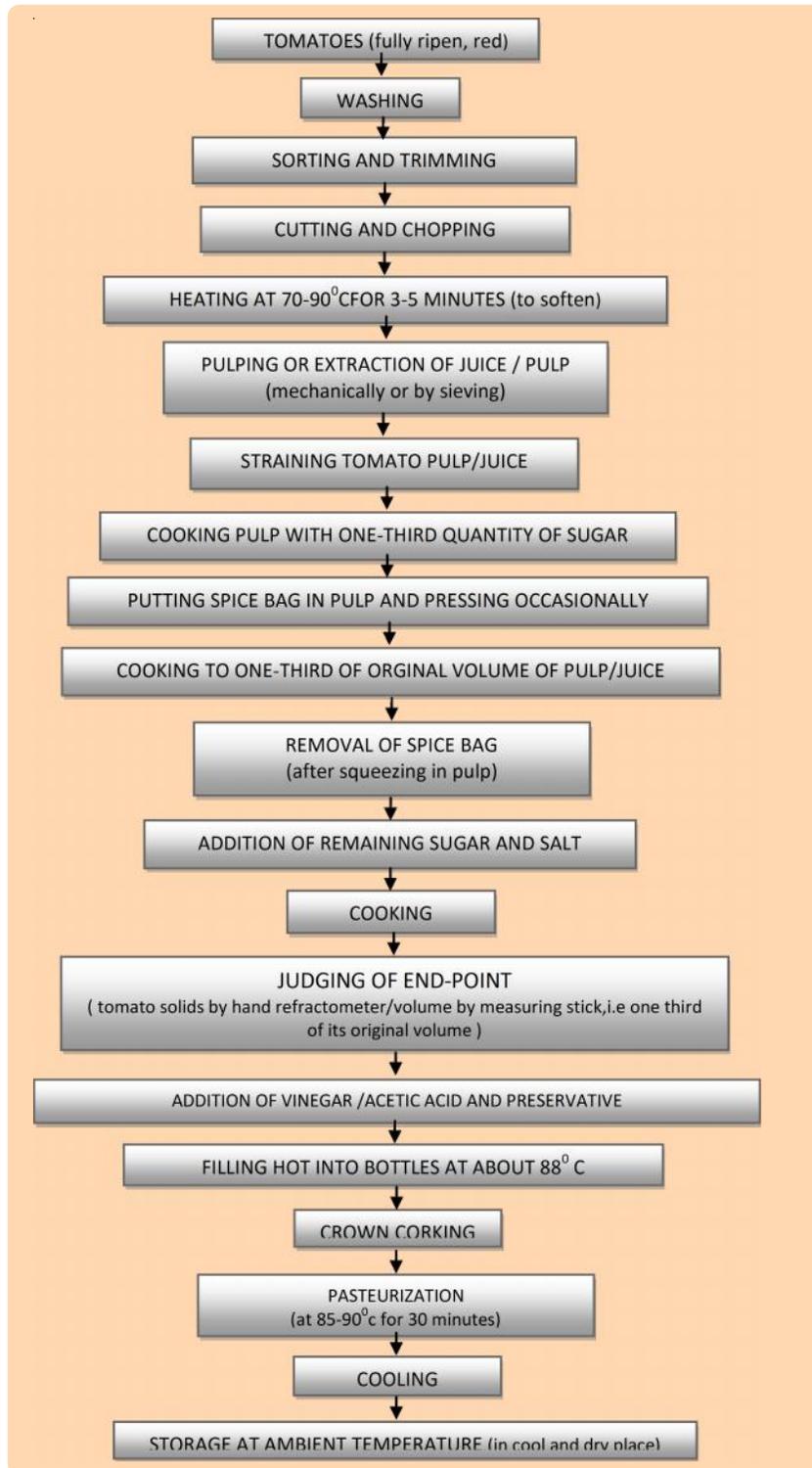


## Tomato sauce/ketchup

It is made from strained tomato juice or pulp and spices, salt, sugar and vinegar with or without onion and garlic and contains not less than 12% tomato solids and 25% total solids.

Materials required: Strained tomato pulp: 1kg, Onion(chopped) : 1 no, Garlic (chopped): 4-5 cloves, Garam masala powder : 0.5g, Red chilly powder : 10g, Salt : 2-3 tspn, Vinegar : 10 tspn, Sodium benzoate : 0.25g, Sugar:100g

*Processing flowsheet for Tomato sauce/ketchup*



## **Marmalade**

It is a fruit jelly in which slices of the fruit or its peel are suspended. The term is generally used for product made from citrus fruits like oranges and lemon in which shredded peel is used as the suspended material. Citrus marmalades are classified into i) jelly marmalade and ii) jam marmalade

### **Practical activity**

Demonstrate the preparation of value added products viz. jam, jelly, squash, RTS, pickles, tomato sauce

### **Assessment activities**

Assignment on preparation of flow chart on the preparation of jam, jelly, squash etc

### **TE Questions**

1. List out the method of preservation and explain in brief.
2. Value addition of food products have assumed vital importance in our country- Substantiate your views.
3. What is canning. Explain the principle and process of canning?
4. You are asked to prepare a flow chart of jelly for displaying in your PTC unit of your school. How will you proceed ?

## UNIT 5

### **Entrepreneurship Development in Agri-based processing industries**

#### **Introduction**

Entrepreneurs taking up Agri based processing industries needs skills in selection of location and power source, adoption of quality control measures, procurement of good quality raw material that does not get out of stock, timely supervision and guidance, proper training of workers, availing finance, proper advertisement, licensing and registration, seeking government support and incentives etc. They also should have high risk taking ability, innovative behavior and high degree of motivation, The Unit intends to give emphasis on scope of self employability, procedure for licensing and registration for initiating small scale enterprises and details the machineries/ equipments needed for starting a small scale unit.

#### **Learning outcome**

The learner :

- analyzes entrepreneurial skills needed for starting agri based processing industries.
- states the general protocols for commercial processing Unit, FSSAI, Licensing and Registration.
- familiarizes with machineries and enlist and explain different processing equipment for fruit and vegetable processing.
- understands the marketing strategies in the marketing of fresh and processed products

#### **4.5.1 Scope of self employability- Food parks**

At present in India, Food Processing Industry has been gaining momentum as the consumer's food industry. This will further boost the growth and development of food processing industries and will generate huge employment opportunities for those who have an aptitude towards this work. Mega Food Parks Scheme (MFPS) was launched in 2008 whereby, the Government provides Financial Assistance up to Rs.50 Crore to set up modern infrastructure facilities for food processing called Mega Food Parks. 500 food parks are planned all over the country.60 Agri Export zones set up for end to end development for export of specific product from

geographically contiguous area. 53 food parks approved to enable small and medium food and beverage units to set up and to use capital intensive common facilities such as cold storage, ware house, quality control labs, efficient treatment plant etc. The key objectives of the scheme are to reduce wastage of perishables; raise processing of food items from 6% to 20% and raise India's share in Food Processing Industry from 1.5% to 3%.

### **What is a Mega Food Park?**

A mega food park is basically a hub and spoke architecture comprising Collection Centres (CCs) and Primary Processing Centres (PPCs) as spokes linked to a Central Processing Centre as hub.

#### **Collection Centres (CCs)**

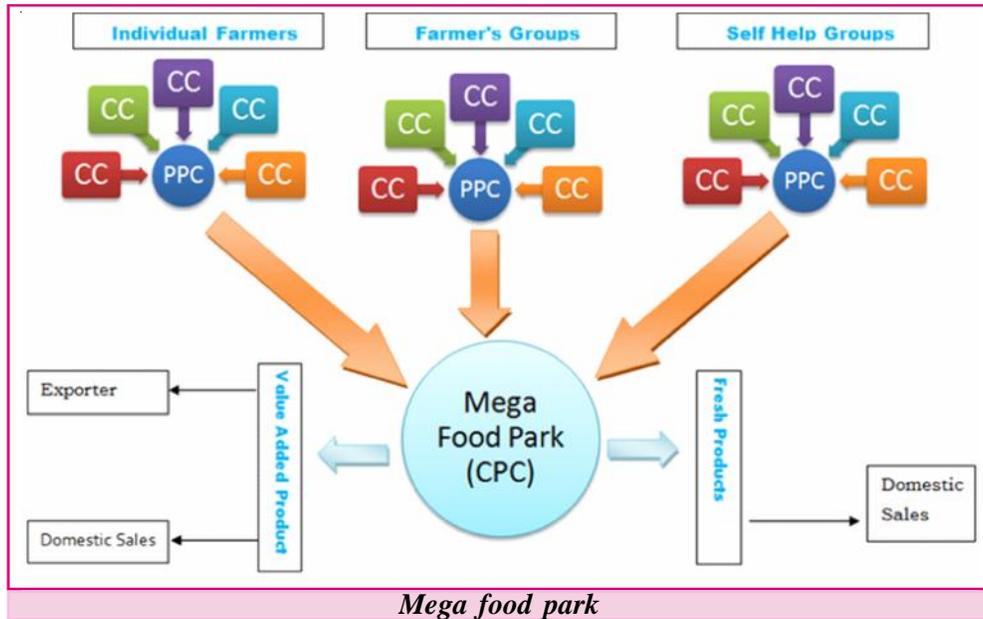
The CCs work as points of aggregation of the produce from individual farmers, farmer's groups and Self Help Groups. They feed the raw material to the PPCs. The collection centres are managed by local entrepreneurs. They serve as farm level aggregation points for adjoining areas within a radius of around 10 kilometres

#### **Primary Processing Centres (PPCs)**

The PPCs work as primary handling centres which use the raw materials to be processed further in central processing centre (CPC.) A PPC serves a number of CCs in proximity. Some PPCs have inhouse facilities such as pulping, juicing etc. They have facilities such as refrigerated vans, trucks etc. to transport material to CPC in shortest possible time.

#### **Central Processing Centre (CPC)**

The Central Processing Centre is an industrial park in an area of around 50 acres and houses a number of processing units owned by different business houses. Here, the developed plots of land will be provided to the large and mid-sized units while Common Design Factory Sheds are provided to small scale units. The park will provide common facilities such as water, electricity and effluent treatment apart from specialized facilities like cold storage, warehousing etc. The above architecture is based on a "hub and spoke" model as shown below:



Thus, Mega Food Park is an inclusive concept that aims at establishing the direct linkages from the farm to processing to consumer markets. The main feature of this scheme is cluster based approach.

<http://www.gktoday.in/mega-food-parks-scheme>

*What\_is\_a\_Mega\_Food\_Park Agri Export Zones and food parks in India*

### Food park development in kerala

Kerala Industrial Infrastructure Development Corporation (KINFRA) is the nodal agency for the promotion of food processing industry in Kerala.

Infrastructure facilities so far developed in this sector are the 3 Food Parks –

Kozhikode

Ernakulam

Pathanamthitta districts

Seafood Park in Alappazha district,

Incubation Centre at Kakkancherry, Kozhikode

### Proposed Food Parks

Mega Food Park, Wayanad

Spices Park, Idukki

Two Quality Control Laboratories.

### **Opportunities in food sector**

- Fruits and vegetable processing Industry
- Food grains milling industry
- Dairy products
- Processing of poultry and eggs, meat products
- Fish processing
- Bread, Oil seeds, meals(edible), breakfast food etc.
- Aerated water / soft drink and other processed foods.
- Special packaging for food processing industries.
- Technical assistance and advice to food processing industries.

### **Assessment activity**

1. Collection of latest reports and statistics on food parks in india.

### **4. 5.2 Licensing and FSSAI registration**

The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. In processing industries, food business operators need to take a license from the state authority of FSSAI operating in each state. Units with production less than or equal to 100 kg/100L per day or an annual term over or less than or equal to 12 lakhs, need to do FSSAI Registration. While units with production more than 100 kg/100L per day have to take up FSSAI license.

#### **Documents for FSSAI registration**

1. Photo of food business operator
2. Documents for identity proof like ration card/ID card/Aadhaar card
3. NOC from municipality/local body

#### **Documents for applying FSSAI license**

1. Form B issued by the FSSAI duly signed and completed
2. Layout of plan of processing unit

3. List of partners / directors/ trust / proprietor with full address and contact details.
4. Name and list of equipments and machineries with number, capacity and power used.
5. Photo ID and address proof of partners / directors/ proprietor
6. List of food category desired to be manufactured
7. Analysis report of water from a recognized lab or public health lab, which is to be used as an ingredient in food
8. Proof of possession of premises.
9. Partnership deed or memorandum of association.
10. Food safety management system plans and certificates
11. NOC certificates from municipality/local body

During the process of scrutiny depending upon the eligibility, the food business operator may fall under Central/State license or registration

### **Central Licensing**

Eligible food business operators like importers, manufacturers, operators in central govt. agencies, airports, seaports etc need to take a license from the central authorities. After issuance of the licence any modification/renewal/request for duplicate licence can be done through the online system. Central license is issued by the FSSAI regional offices operating across the nation.

### **State Licensing**

Eligible food business operators like manufacturers, storage, transporters, retailers, marketers, distributors etc need to take a license from state authorities. State license is issued by the state authorities operating in each state

### **Assessment activity**

Conduct a class test on FSSAI Licensing & registration.

### 4.5.3-Machineries used in processing industry

Tools, machines or equipments, purposes and uses.

Equipment	Purpose
Autoclave	For sterilizing / heating the food
Blenders	For mixing of the ingredients.
Blanchers	For blanching of fruits and vegetables to inactivate enzymes that cause deterioration in colour and flavour during drying and subsequent storage. Blanching may be carried out using water or steam.
Bottle filling machine	For filling the bottles automatically.
Bottle sterilizers	For sterilizing the bottles.
Bottle washing machine	For cleaning and washing of bottles. Bottle washers may be of bristle, hydro or soaker type or a combination of these.
Canning equipment	Aid in canning process which involves filling the food into can, fitting the lid and heating the can in a retort to sterilize the food.
Cap sealing machine	For sealing the bottles
Can opener	For opening of cans
Carbonating equipment	Makes carbonated drinks using high-pressure carbon dioxide.
Centrifuges	Separation of substances like cream, honey and juices using the principle of centrifugal force.
Cheese moulds, presses and kits	For making cheese.
Chopper	For chopping fruits and vegetables.
Cleaners	To wash and clean fruits and vegetables, remove chaff and other impurities from grain.
Cooling tank	For cooling food materials
Crown corking machine	For sealing the bottles
Curd making equipment	For making and storing curds. Specially designed for curd to avoid whey corrosion.
Cutting, slicing and dicing equipment	For cutting, slicing and dicing various food products.

Deaerators	For removal of air present in fruit juices
Decorticators (shellers)	For decortications/shelling of maize, groundnuts, cashew nuts, peas, walnuts, cocoa, coffee, sunflower, etc.
Destoner	Separates grain mass
Dryers	For drying and dehydration.
Enrobers	Used to coat foods in chocolate, butter or other coating materials.
Evaporators	For evaporation of water.
Exhaust box	For removal of air in cans
Expellers	For expression of oil from oilseed sand nuts.
Extruding machines	Used for making extruded products such as snack foods from cereals.
Filling machines	Filling of liquid and solid materials into containers and pouches.
Fillers, sieves and strainers	Used for filtration, sieving and straining of oils, juices, powders/flours etc.
Flaking and splitting machine	For making rice flakes and dhal splits.
Formfill and seal machine	For packaging of the liquid and semi solid foods
Freezer	for freezing of food materials
Fryers	For frying.
Grating equipment	For grating various food materials.
Grills	For grilling of meat, fish and other products.
Heater and hotplates	For heating water and other items.
Homogenizers	To form a stable emulsion form two immiscible liquids.
Ice-cream making equipment	For ice-cream making.
Incubators	To hold food items at a preset temperature.
Kneaders	For mixing the ingredients.
Measuring cylinders/jugs	For measuring of raw and finished food products.
Mills and grinders	For grinding cereals, pulses, spices, sugar etc. Will also reduce liquid suspensions to a finer particle size.
Mincers	For grinding met for sausages and patties.

Mixers	For mixing various ingredients into a homogeneous mixture.
Moulds and baking units	Used in bakery production.
Ovens	For cooking, roasting and baking.
Packaging equipment	Packaging of different food materials.
Pans and kettles	For cooking, coating, etc. of food items.
Pasta machines	For making pasta foods.
Peeling equipment	Used for peeling and coring of fruits and vegetables.
Presses	For extraction of oil, juices, pulp, etc.
Pressure cookers	For cooking of food.
Puffing machines	For puffing grains like cereals and pulses.
Pulpers and juicers	Used for the extraction of pulp and juices especially fruits and vegetables.
Pulverizer	Simple machine that grinds without stone.
Refrigerator	For cooling and preservation of food.
Roasting equipment	For roasting coffee, cocoa, cashew nut, peanut, soybean, etc.
Rolling equipment	To roll pastry and pasta. Papad is also made.
Sealing machine	For sealing the polyethylene bags.
Shrink film packaging machine	For packing the food materials.
Steam boiler	To produce steam with high temperature
Steam jacketed kettles	To concentrate the raw extracted pulp and for cooking of food items
Sorting equipment	Used for grading food items on the basis of size, density or shape, colour sorters are also available.
Spray drier	For drying the liquid food items
Squeezer	For squeezing the juice.
Threshers	For threshing grain and oilseed crops.
Thermometers	For checking the temperature during processing
Tin containers	For canning of food in containers.
Vacuum packaging machine	For packing the food materials under vacuum condition.
Water softener	For removal of hardness of water
Weighing machine	For weighing the food ingredients.
Wooden laddles	For stirring

Sl no	Test Equipment	Purpose
1	Refractometer	To measure total soluble solids (TSS)
2	Jel meter	Used for estimating pectin content to attain proper shape of jelly.
3	Saltometer	To measure presence of salt (NaCl) and its concentration in brine.
4	Hydrometer	To measure water content
5	Thermometer	To measure temperature they are available in different ranges. 0 -100°C - Pasteurization, 0-150°C - Sterilization, 0-20°C & 0-40°C defreezing condition
6	Lactometers	For measuring the lactose content in milk

### Practical activities

Visit a processing unit and familiarize the different machineries and equipments.

Practice use of refractometer

### Assessment activities

1. Prepare chart on the machineries used in processing industry
2. Collection of photos/articles on machineries/equipments

### 4.5.4 Marketing strategies

Marketing is defined as “the total of activities involved in the transfer of goods from the producer or seller to the consumer or buyer, including advertising, shipping, storing, and selling.”

Marketing seeks to satisfy the needs of people (customers or the market) (creating a sense of usefulness or utility) through the exchange process.

The “4 P’s” of marketing are:

- product
- place
- promotion
- price

## Marketing strategies for Inputs

### 1. Product Strategy

- The products should be able to satisfy the expected needs and provide them value for money they spent.
- The product information on the cover packaging and in the user manuals should be expressed in simple and easy to understand local language.

### 2. Pricing Strategy

- The customer is Quality conscious and price sensitive and expects value for money and therefore, the pricing has to be in accordance with their expectation.
- The technique value analysis involves replacing costly raw materials with inexpensive ones, without sacrificing quality and functionality

### 3. Place Strategy .

- Make the products available near the target audience.
- Cooperative societies, public distribution system, feeder markets, village weekly markets fairs and festivals can be utilized to ensure adequate distribution of agri- inputs products.

### 4. Promotion Strategy

The promotional activities should be undertaken through media that are comfortable and appropriate (For e.g., Advertisement through TV, Radiodistribution of pamphlets, advertising through wall posters)

The concept of “the 4 p’s” has been replaced by the concept of the “7 p’s”

#### “7 p’s” of marketing are,

1. product
2. price
3. place
4. promotion
5. people
6. positioning
7. packaging

## Marketing Management Process

This consists of :

- analyzing market opportunities
- selecting target markets
- designing marketing strategies
- planning marketing programs
- managing marketing efforts

### 1. Analyzing marketing opportunities

- Defining the market
- Consumer assessment
- Environmental assessment
- Company resource assessment
- Demand analysis and sales forecast

### 2. Identifying Market Segments and Selecting Target Markets

- Marketers set priorities for business opportunities, concentrating on market segments within which they expect to achieve the best overall economic return from their product or service. Market segmentation and target marketing are the processes used to isolate these opportunities. Market segmentation is the process of grouping customers based on their similarities
- Market segmentation allows a company to:
- Understand the different behavioral patterns and decision-making processes of different groups of consumers
- Select the most attractive segments or customers the company should target
- Develop a strategy to target the selected segments based on their behavior

### 3. Developing marketing strategies

- Positioning
- Develop new product, test and launch
- Modification in the stages of product life cycle
- Strategy choice depends on the strategy pursued by the firm
- Consider changing global opportunities and challenges

### 4. Planning marketing programs

- Transforming strategy into programs
- Managing Product Lines, Brands, and Packaging

- Managing Service Businesses and Ancillary Services
  - Designing Pricing Strategies and Programs
  - Selecting and Managing Marketing Channels
  - Managing Retailing, Wholesaling, and Physical-Distribution Systems
  - Designing Communication and Promotion Mix Strategies
  - Designing Effective Advertising Programs
  - Designing Direct-Marketing, Sales-Promotion, and Public-Relations Programs
  - Managing the Sales force
- 5. Managing marketing efforts**
- Organizing resources
  - Implementation
  - Control - Annual control, Profitability control, Strategic control

## Branding

Branding is an important element of the product in consumer markets. It is a means of linking items within a product line or emphasizing the about what they stand. Brand mark : is specifically the element of the visual brand identity that does not consist of words, but of design and symbols.

### The benefits of branding

#### The consumer

1. Easier product identification
2. Communicates features and benefits
3. Helps products evaluation
4. Establishes product's position in the market
5. Reduces risk in purchasing

#### The manufacturer

1. Helps creates loyalty
2. Defends against competition
3. Creates differential advantage
4. Allows premium pricing
5. Helps targeting/positioning
6. Increases power over retailer

### The retailer

1. Benefits from brand marketing support
2. Attracts customer
3. Helps differentiate the product from competitors

### Packaging and labelling

#### Packaging

Packaging is an important part of the product which act as a means of communicating product information and brand character.

The packaging is often the consumer's first point of contact with the actual product and so it is essential to make it attractive and appropriate for both the products and the customers need.

Packaging has become a potent marketing tool.

Well-designed packages can create convenience and promotional value.

#### Factors that have contributed to packaging growing use as a marketing tool:-

- **Self service :** An increasing number of products are sold on a self-service basis. The packages attract attention, describe the products features, create consumer confidence and make a favorable overall impression
- **Consumer affluence :** Rising consumer affluence means consumers are willing to pay a little more for the convenience, appearance dependability and prestige of better packages.
- **Company and brand image :** packages contribute to instant recognition of the company or brand. It differentiates a product from competitors by its design, color, shapes and methods
- **Innovation opportunity:** Innovative packaging can bring large benefits to consumers and profits to producers. Packaging can be a major element of new-product planning.
- **Promotional tool:** It serves as a promotional tool and is the final form of promotion the consumer sees prior to making purchase decision
- **Reminder:** A package also serves as a reminder after a purchase is made.

Although packaging is expensive, developing effective packaging may cost several hundred thousand dollars and take several months to complete. Companies must

pay attention to growing environmental and safety concerns about packaging. Shortages of paper, aluminum, and other materials suggest that marketers should try to reduce packaging.

### **Labelling**

Labelling is a particular area within the packing field that represents the outermost layer of the product.

Labels include warnings and instructions, as well as information required by law.

Labels state, at least, the weight or volume of the product, a bar code and the name and contact address of the producer, ingredients, nutritional information and the environment friendliness of the product.

The label may be a simple tag attached to the product or an elaborately designed graphic that is part of the package. Even if the seller prefers a simple label, the law may require extra information.

### **Practical activity**

1. Visit a retail outlet and conduct a market survey on the marketing strategies adopted by various products.

### **TE Questions**

1. "Mega food parks in India- A Promising venture in Processing Industry" - is the topic given for you for presenting a seminar. Write down the points you will include in the seminar.
2. List out the names of any five equipments you have seen while visiting a Processing unit. Mention the use of those equipments.

### **Extended activity**

1. Organize a training on the importance of value addition and the preparation of value added products of fruits and vegetables for the Kudumbasree units. Prepare a leaflet on the preparation of value added products of Jack/Mango/banana and distribute to the participants.
2. Publish articles in the school magazines on the recipes of various value added products.
3. The learners identify a rice/coconut/turmeric/cashew farmer and help in the post harvest processes of the crop.
4. Collect traditional or endangered rice varieties, traditionally used post harvest equipments/implements and organize an exhibition in the school on Rice day/farmer's day.

### List of practicals

- ❖ Identify the maturity indices of the fruits and vegetables and record in a tabular form
- ❖ Exhibition of different packing materials used for fruits and vegetables
- ❖ Preparation of different value added products from Rice.
- ❖ Visit to a Banana export - packing unit.
- ❖ Preparation of value added products of Jack
- ❖ Post harvest handling of Banana
- ❖ Curing of turmeric – methods demonstration
- ❖ Preparation of dry Ginger
- ❖ Removal of tannin from Cashew apple juice.
- ❖ Practicing the steps involved in copra making.
- ❖ Post harvest handling and techniques to enhance vase life of Anthurium/ Orchid/ Rose
- ❖ Preparation of value added products viz. Jam, Jelly, Squash, RTS, Pickles, Tomato sauce
- ❖ Visit a processing unit and familiarize the different machineries and equipments.

## REFERENCES

- Amarnath, V. (2007). Nursery and landscaping, New Delhi: Agrobios India.
- Chadha, K.L. (2000). An overview of Hi- Tech Horticulture: Opportunities and constraints. *Proceedings of National Seminar on Hi-Tech Horticulture*, Bangalore, June 26, pp.13.
- Ellips, 2003. Fruit grading system. <http://www.ellips.nl/oem/fruitgrading.h> 27.11.2003
- Falik, E. et al. (1996). A method for simultaneous cleaning and disinfecting agricultural produce. *Israel Patent Application No. 116965*
- Farm Guide (2015). Farm Information Bureau. Department of Agriculture, Govt of Kerala. Thiruvananthapuram.
- Govt of Kerala, Farm Information Bureau. (2014). Green House-Management and Operations. Thiruvananthapuram
- Habibunnisa, (1993). Pre and post harvest treatment of fruits vegetables. *Paper presented in the Advanced Technology Training Programme, 27 September 1993*, CFTRI, Mysore.
- Jacob John, P. (2008). A handbook on Post Harvest Management of Fruits and Vegetables. Daya Publishing House. Delhi
- Jain, R. & Janakiram, T. (2013). Value addition in Ornamentals. *Keralakarshakan*
- Kerala Agricultural University. (2009). Package of practices recommendations (ad hoc) for organic farming: Crops. Thrissur: Kerala Agricultural University
- Kerala Agricultural University. (2011). Package of practices recommendations. Crops. Thrissur: Kerala Agricultural University
- Krishnaprakash, M.S. (1993). Pre-cooling of fruits and vegetables. *Paper presented in the Advanced Technology Training Programme, 27 September 1993*, CFTRI, Mysore.
- Kumar, N. (1997). Introduction to horticulture. Nagercoil: Rajalakshmi Publications.
- Manoranjan kalia & Sangita Sood. (2002). Food Preservation And Processing. Kalyani Publishers, Ludhiana.
- Nair, G.M. (2015). Chemical and biopesticides for crop protection: A handbook for technical officers. Thiruvananthapuram : Department of Agriculture, Govt. of Kerala.

- Narayana.C.K.& Mustafa, M, M.(2006). National Research Centre for Banana.Thiruchirapalli,Tamil Nadu.
- Peethambaran, C.K.&Reghunath, P.(2014). Surveillance Based Pest and Disease Management in Crop Plants.Thiruvananthapuram: Department of Agriculture
- Randhawa, G.S.&Mukhopadhyaya, A . (1986). Floriculture in India. New Delhi:Allied Publishers Limited.
- Rooney, M. L.(1995). Overview of Active Food Packaging.*In* Rooney, M.L.(Ed.).Active Packaging. Glasgow: Blackie Academic and Professional, pp. 120-123.
- Roy, S. K.& Pal, K. (2000). Latest techniques on transportation and storage of horticultural produce. *Souvenir of the National Seminar on Hi-tech Horticulture.26- 28 Jan.2000*. Bangalore. p93.
- Sadhu, M.K.& Chattopadhyay, P.K. (2001). Introductory fruit crops.Calcutta: Naya Prakash.
- Shrivastav, S. (2004). Post harvest handling of horticultural produce and technology adaptation. *Processed fd. ind. 7: 22-36*.
- Srivastava, R.P. & Sanjeev Kumar.(2001). Fruit and vegetable preservation: principles and practices.New Delhi: CBS Publishers and Distributers Private Ltd.
- Subhagan, S.R.& Dhalin, D. (2013). Elements of plant protection. Thiruvananthapuram: FOLIO Publishers.
- Sunil, V.G.&Pathrose, B.(2015). Application of ICT in Agriculture : a Handbook.ICAR KVK Malappuram.Thrissur: Kerala Agricultural University
- Suseela,P. (2013). Hi-tech krishi: oru margadarssi. Thrissur:Kerala Agricultural University.
- Suseela.P.(2015).Design and Management of Hi-tech cultivation in Kerala.Instructional Farm,Vellanikkara.

PEST OF CROPS



Rice stem borer - Adult



Rice stem borer- larva



Gall Midge



Rice BPH



Hopper Burn



Rice case worm



Rhinoceros beetle



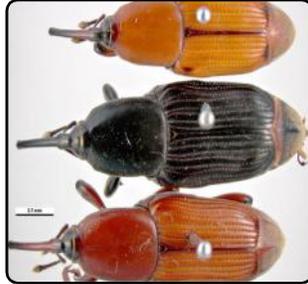
Red Palm Weevil



Leaf eating caterpillar



Coconut Mite



Pseudostem weevil



Banana rhizome weevil



Tea mosquito



Pollu beetle



Marginal thrips



Brinjal Fruit borer



epilachna beetle in Brinjal



Tomato fruit borer



Bhindi shoot & fruit borer



Amaranthus leaf webber and its attack



Fruit fly (Bitter gourd)



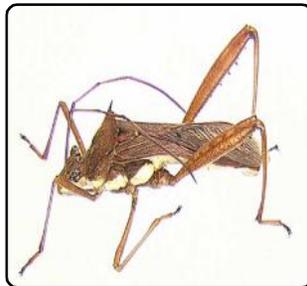
Pumpkin beetle



Snake gourd caterpillar



Cowpea aphid



Cowpea Bug



Cowpea fruit borer



American serpentine leaf miner



Mango fruit fly



Mango Hopper

**DISEASES**



Rice blast



Rice Sheath Blight



BLB of Rice



Coconut leaf rot



Coconut stem bleeding



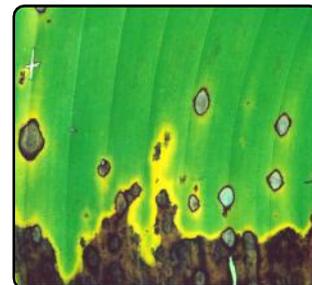
Coconut Root wilt



Banana Bunchy Top



Kokkan Disease in Banana



Sigatoka leaf spot



Pepper Quick wilt



Damping off in vegetables



Little leaf of Brinjal



Phomopsis Blight in Brinjal



Bacterial wilt



Anthracnose in chillies



Leaf curl in chillies



Yellow vein mosaic in Bhindi



Leaf Blight



Fruit rot in cucurbits



Powdery mildew



Mosaic (Cucurbits)



Web blight (cowpea)



Fusarial wilt (cowpea)



Anthracnose (cowpea)



Cowpea mosaic



Anthracnose (mango)



Powdery mildew



Abnormal leaf fall (rubber)



Powdery mildew (rubber)



Pink disease (rubber)