Student READY
Experiential Learning Programme 2020-21

"e REPORT"

HWE.7.1 PROTECTED CULTIVATION OF HIGH VALUE HORTICULTURAL CROPS

ASPEE COLLEGE OF HORTICULTURE AND FORESTRY
NAVSARI AGRICULTURAL UNIVERSITY
NAVSARI 396 450


OF HORTICULTURE AND FORESTRY

"CERTIFICATE"

This is to certify that the following students of B.Sc. (Hons.) Horticulture 7th Semester have successfully completed **"Student READY: Experiential Learning Programme"** entitled "**HWE 7.1: PROTECTED CULTIVATION OF High VALUED Horticultural CROPS**" imparted by **ASPEE College of Horticulture and Forestry, NAU, Navsari** on *virtual mode*. Owing to the unprecedented situation enforced by COVID 19 pandemic, the training report was successfully submitted online for the academic year 2020-21. Mini practical activities manageable at household level were also assigned to these students and all the students performed satisfactorily for fulfilment of the academic requirement.

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HWE.7.1.1 Production of High Valued Crops (0+6)

1. Principle of Protected Cultivation

Protected cultivation is a process of growing crops in a controlled environment.

It is a technique wherein the microclimate around the plant is controlled fully, partially or modified to protect the crop from adverse weather conditions. i.e., the temperature, humidity, light, and such other factors can be regulated as per the requirement of the crop and thereby assists in a healthier and a larger produce.

Protected cultivation ensures:

- Efficient use of energy
- Conservation of soil moisture

There are various types of protected cultivation practices. Some of the commonly used practices are – naturally ventilated greenhouse, forced ventilated greenhouse, insect proof net house, shade net house, plastic tunnel and mulching, raised beds, trellising and drip irrigation.

These practices are used independently or in combination, to provide favourable environment to save plants from harsh climate and to extend duration of cultivation or off-season production.

Greenhouse

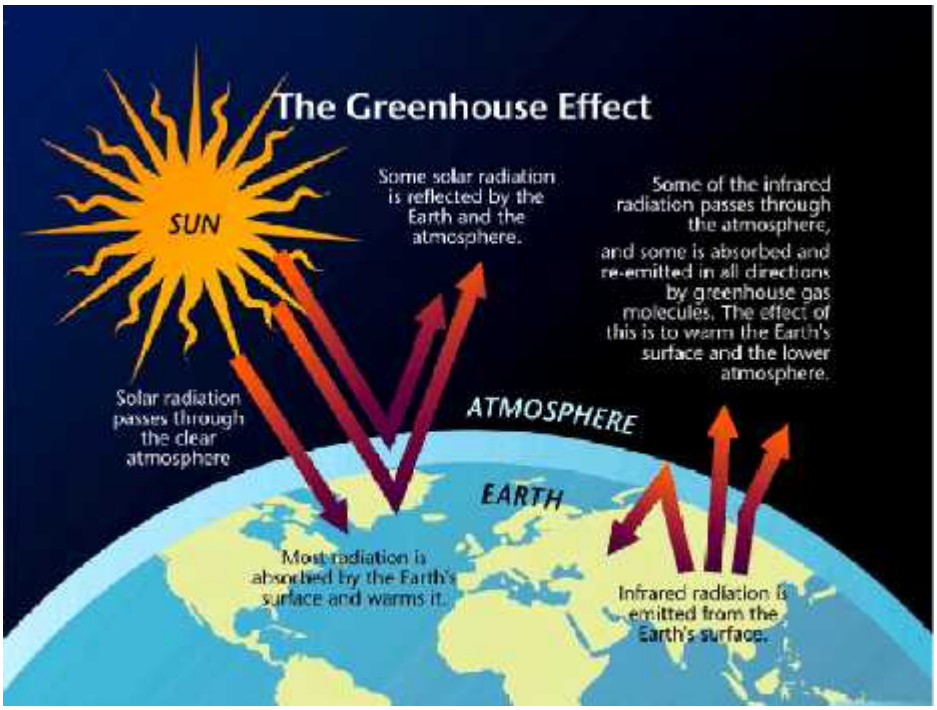
- ❖ Greenhouse is the most practical method of achieving the objectives of protected agriculture, where the natural environment is modified by using sound engineering principles to achieve optimum plant growth and yields.
- ❖ Greenhouses are frames of inflated structure made of GI pipe/ MS angle/ Wood/ Bamboo and covered with a transparent material in which crops are grown under controlled environment conditions to get optimum growth and productivity.
- ❖ Greenhouse is an enclosed area, in which crops are grown under partially or fully controlled conditions.
- ❖ Specifically, where the covering material is glass, the structure may be referred to as a glasshouse.

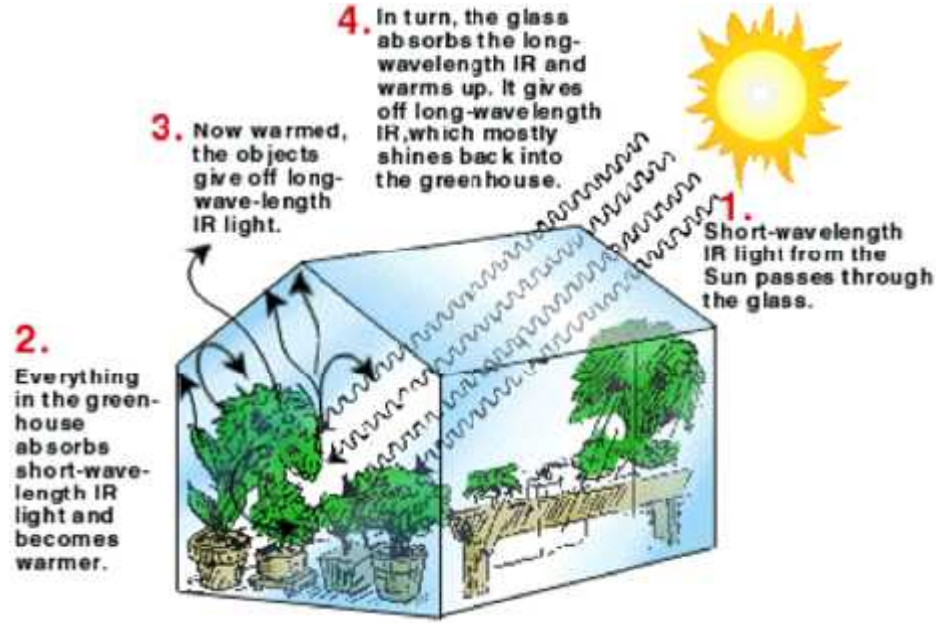
- A greenhouse or polyhouse refers to use of plastic films or sheeting.
- When the enclosing material is woven or otherwise constructed to allow sunlight, moisture and air to pass through the gaps, the structure is known as shade house or screen house.
- The plastic film used in greenhouse act as selective radiation filters.
- Along with irrigation system it has monitoring or controlling equipment for controlling environment factors like temperature, relative humidity, light, carbon dioxide etc., for maximizing plant growth and productivity.
- In greenhouses by raising the humidity and controlling temperature faster growth can be accomplished.
- In a typical modern greenhouse production system the three major cost factors are labour, energy and capital.
- Due to varied agro – climatic conditions greenhouse technology is highly relevant in India.

Greenhouse Effect:

- It is one the important aspect of protected cultivation.
- Greenhouse effect is a natural warming process of the earth.
- It is defined as the rise in temperature that the earth experiences because certain gases in the atmosphere (carbon dioxide, methane, nitrous oxide, ozone, water vapour) trap energy that comes from the sun.
- Sunlight enters the earth's atmosphere, passing through the greenhouse gases.
- It reaches the earth's surface, land, water and biosphere absorb the sun`s energy.

- Some of the energy reflected back to space.





- The absorbed energy warms the earth's surface, which then emits heat energy back towards space as long wave radiation.
- The outgoing long wave radiation is partially trapped by greenhouse gases such as carbon dioxide, methane and water vapor, which then radiate energy in all directions, warming the earth's surface and atmosphere.
- The greenhouse gases consist of Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (NO_2), Chlorofluorocarbons (CFCs), Sulphur hexafluoride and others.
- CO_2 is estimated to account for 50% of the greenhouse gases, Methane for 20%, CFCs for 14% and remaining by other components including water vapor.
- Without these gases all the heat would escape back into space and earth`s average temperature would be about 30^{o}C (54^{o}F) colder.
- This is the phenomenon used to grow plants in the optimum conditions by controlling the plant growth factors.
- Greenhouse makes it possible to control the inside environment or to create suitable environment to grow specific crops.
- Year-round production and off – season production are possible in greenhouse by controlling and manipulating the environment for plant growth.

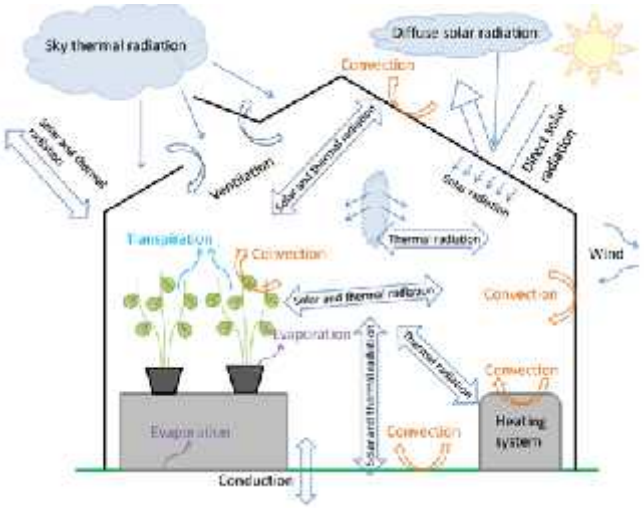
Greenhouse Technology:

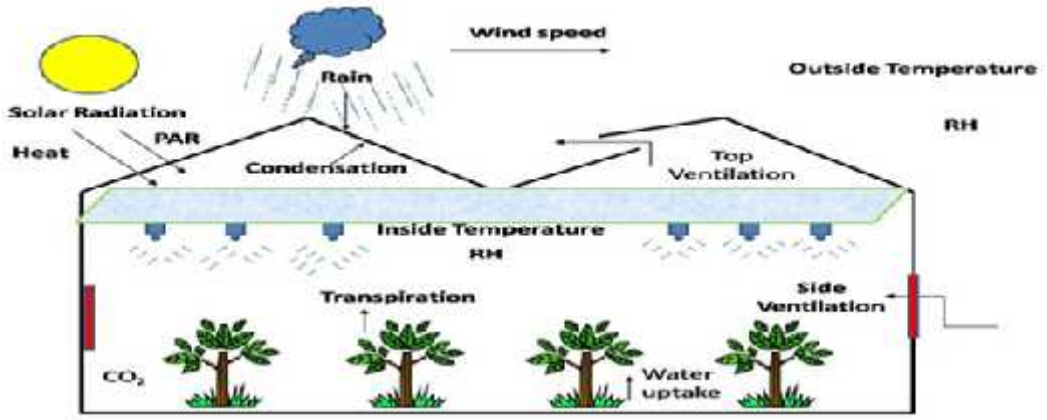
Growing of plants is an art and science. About 95% of plants, either food crops or cash crops are grown in open field. In some of the temperate regions where the climatic conditions are extremely adverse and no crops can be grown, man has developed methods of growing some high value crops continuously by providing protection from excessive cold, which is called as greenhouse technology.

Greenhouse technology may be defined as "The technology required to build a structure, covered fully, partly or porously for manipulating the inside climatic conditions, under which crops/ plants can be grown with special technology."

Scope and Importance:

- Cultivation in problematic agriculture zones such as barren and uncultivable, cultivable wasteland, fallow land, desert, severe cold etc.,
- To meet the demand of fresh vegetables, fruits, ornamental plants throughout the year in big cities.
- Greenhouse cultivation of export-oriented crops seems to be possible source of foreign earnings.
- Greenhouse technology is a suitable approach for raising of seedlings and cuttings which require control environment for their growth.
- Greenhouse technology as a base for other biotechnology.
- Greenhouses provide the right type of environmental condition for intensive cultivation of rare and medicinal plants.





Advantages of Greenhouse Technology:

- Provides favorable micro climatic conditions for the plants
- Yield may be 10 -12 times higher than that of outdoor cultivation with better quality
- Reliability of crop increases
- Ideally suited for vegetables and flower crops
- Year-round production and Off – season production is possible
- Disease free and genetically superior transplants can be produced continuously
- Efficient utilization of chemicals and pesticides
- Water requirement of crops very limited and easy to control
- Maintenance of stock plants, cultivating grafted plant – lets and micro propagated plant – lets.
- Hardening of tissue cultured plants.
- Modern techniques of Hydroponics (soil less culture), Aeroponics, and Nutrient film techniques are possible only under greenhouse cultivation.
- Protects the crops from wind, rain, snow, bird, hail etc.,
- Generates self – employment opportunities for educated youth.

Disadvantages of Greenhouse:

- Lack of major research program on protected vegetable farming.
- Lack of awareness among farmers pertaining to potentials of protected vegetable production
- High initial costs
- Local government regulations
- Concentration of nutrients and chemicals in waste water
- Faster build – up of plant pathogens in soil
- Safety concerns with chemicals used in indoors
- Lack of professional greenhouse manufactures leading to use of improvised structures.

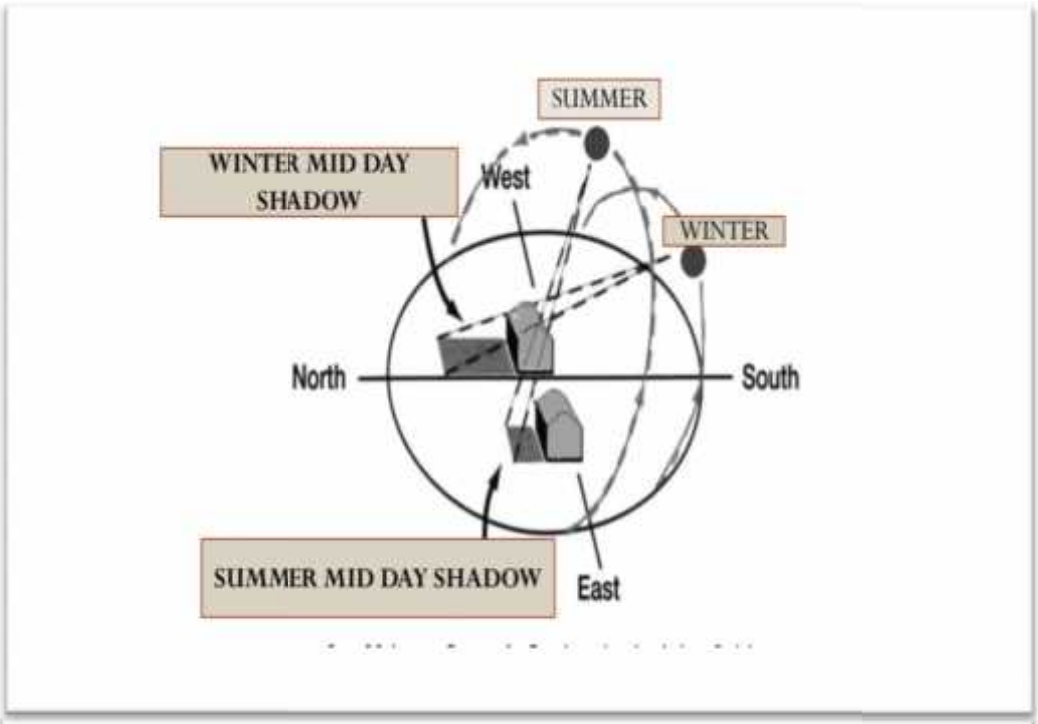
2. Planning and design of protected Structures

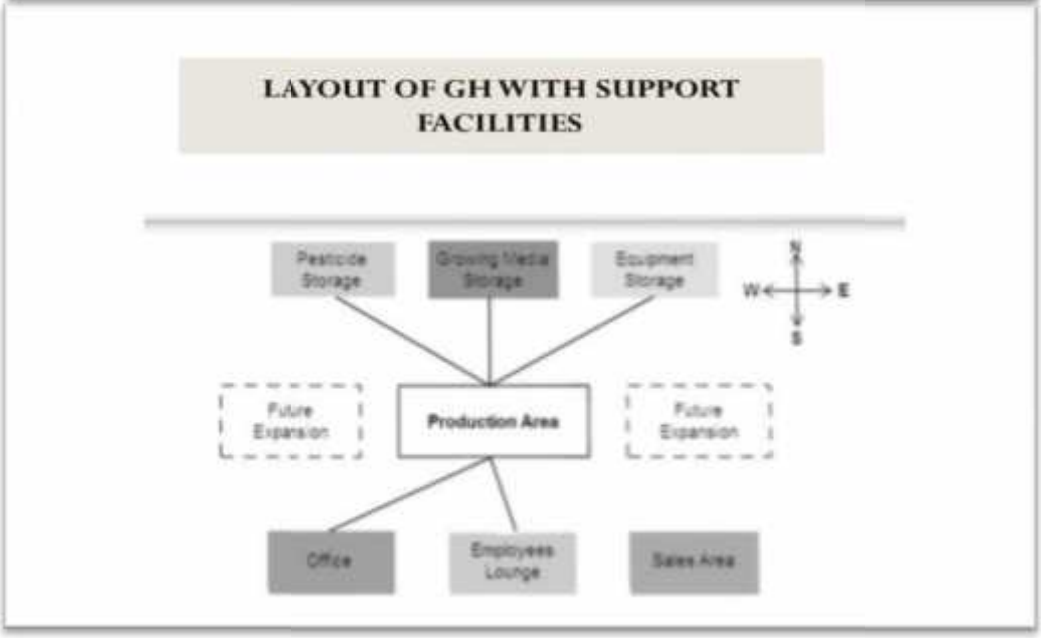
A Greenhouse, is basically the purpose of providing and maintaining a growing environment that will result in optimum production at maximum yield.

They are the semi – permanent structures and the service life is of 10 – 25 years.

It is supposed to withstand the loads like own weight, wind, snow, hanging basket etc.

- **Site selection:**
  - It should withstand local wind, snow and crop loads.
  - The building site should be on leveled ground.
  - Site should be well aerated with good solar radiation.
  - Good drainage system.
  - Site should be with a natural windbreak.
  - Irrigation water should be of pH 5.5 – 7 and EC between 0.1- 0.3 ds/cm.
- **Orientation:**
  - Adequate solar intensity.
  - Sufficient wind for efficient ventilation.
  - In cooler region must be designed with the ridge running east to west so that low – angle light of the winter sun can enter along a side rather than from an end where it would be blocked by the frame trusses.
  - In warm region it can be north – south direction.
  - Naturally ventilated orientation east – west.
  - Wind direction in summer south direction and in winter season is north direction.





❖ **Structural design:**

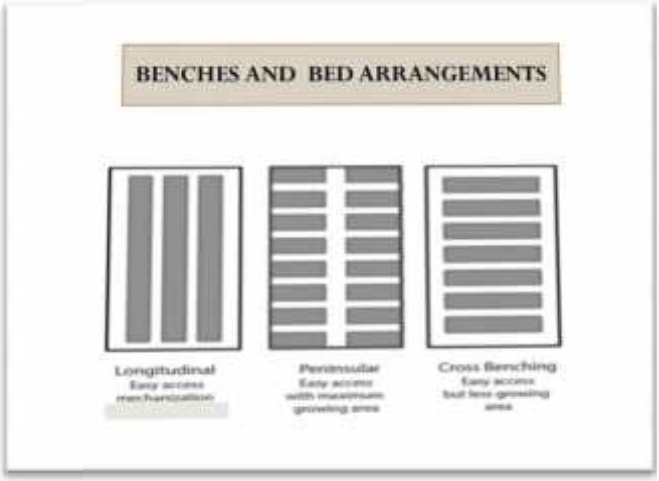
The most important function of the greenhouse structure and its covering is the protection of the crop against hostile weather conditions (low and high temperature, snow, hail, rain and wind) diseases and pests.

❖ **Size:**

- These **greenhouses** are defined by their independent structure and location.
- They can be any shape and size.
- However, the most common freestanding **greenhouse size is 30 feet width and 96 feet long.**

❖ **Height:**

- The height of greenhouse directly impacts natural ventilation, stability of the environment and crop management.
- The ideal height is 3.5 – 4.5 m and 5.5-6.5m in case of large GH.
- The gutter height should be 2.5 - 3m and 4.5 – 5 m for. Small and large GH respectively.
- A multi span GH can be constructed for an area more than 200 m^2



❖ **Indian standards for greenhouse:**

- The **BIS** has formulated following standards with respect to greenhouse technology.
- **IS 14462:1997: - Recommended** for layout, design and construction of greenhouse structures.
- **IS 14485:1998:-**Recommendation for heating, cooling and ventilation of green house.

❖ **Covering materials:-**

- The following factors ate to be considered while selecting the greenhouse covering material.
    1. Light
    2. Transmission,
    3. Resistant to impact and durability to outdoor weathering,
    4. Thermal stability over wide range of temperatures.
- **Before selecting the covering material, two important points should be taken into consideration:**

➢ The purpose of greenhouse.

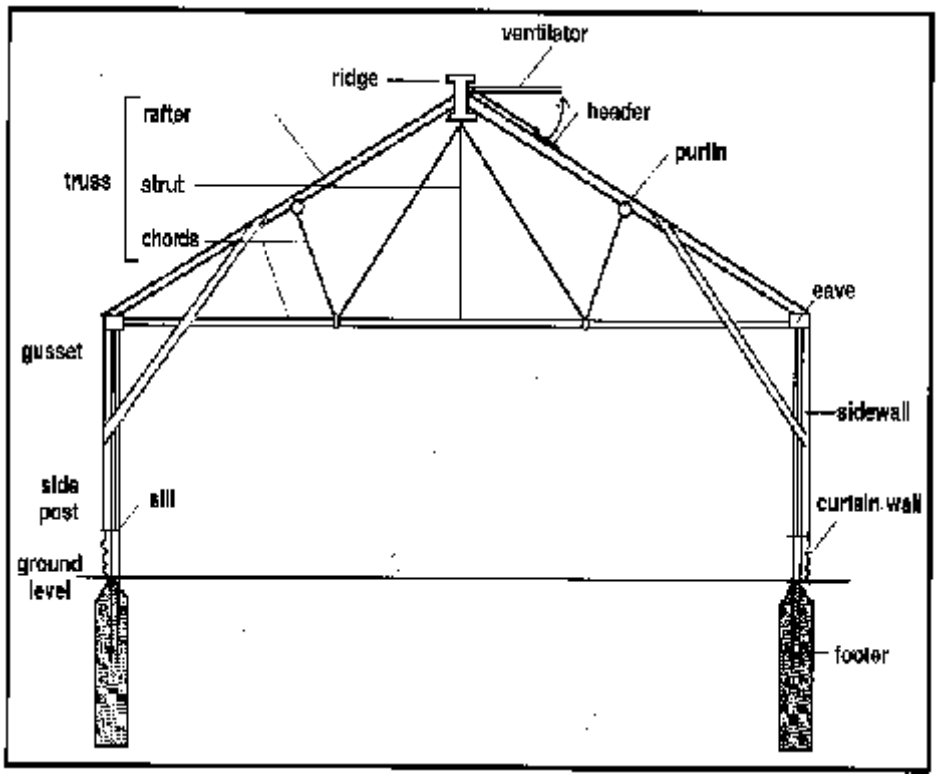
➢ Service life of material.

Sr. No.	Covering material	Life span
1.	Glass and acrylic sheet	20 years
2.	Polyethylene	2 – 6 months
3.	Polyethylene stabilized for UV Rays	2 – 3 years
4.	Polycarbonate and fiberglass	5 -12 years

❖ **Different loads acting on a GH:**

- **Dead load:-** weight of all permanent construction, cladding, heating and cooling equipment, water pipes and all fixed service equipment to the frame.
- **Live load:-** weight superimposed by use (include hanging baskets, shelves and person working on roof.)
- **Wind loaded:-** it depends on wind action. It creates upward thrust.

3. Greenhouse components, accessories and BIS Codes



Greenhouse and its Components:

- **Gable**: Transparent wall of a green house.
- **Roof**: Transparent cover of green house.
- **Cladding material:** Transparent material mounted on the walls and roof of a green house.
- **Rigid cladding material**: Cladding material with such a degree of rigidity that any De-formation of the structure may result in damage to it. Ex. Glass
- **Flexible cladding material**: Cladding material with such a degree of flexibility that any Deformation of the structure won't result in damage to it. Ex. Plastic film
- **Gutter**: Collects and drains rain water and snow which is place at an elevated level between two spans.
- **Column**: Vertical structure member carrying the green house structure.
- **Purlin**: A member who connects cladding supporting bars to the columns.

- **Ridge**: Highest horizontal section in top of the roof.
- **Girder**: Horizontal structure member, connecting columns on gutter height.
- **Arches**: Member supporting covering materials.
- **Foundation pipe:** Connection between the structure and ground**.**
- **Span width**: Center to center distance of the gutters in multi-span houses.
- **Green house length**: dimension of the green house in the direction of gable.
- **Green house width**: dimension of the green house in the direction of the gutter.

Greenhouse Accessories:

System type	**Accessories**
Climate Controls	Heating and Cooling, Thermostats, Variable Speed Controls, Humidistat, Cycle Timers
Ventilation	Evaporative Coolers, Exhaust Fans & Shutters, Automatic Vent Openers, Circulation Fans
Heaters	Gas Heaters, Electric Heaters, Heating Mats & Cables
Misting Systems	Sprinkler System, Misting Systems, Mist Timers & Valves, Water Filter
Watering	Plant Watering Systems, Drip Systems, Professional Water Hoses, Watering Timers, Overhead Watering Systems
Meters	Min./Max. Hygro-Thermometer, Min/Max Thermometer, Soil Thermometer, Thermometer & Hygrometer, Light Intensity Meter, pH Meter, EC Meter, LUX meter
Greenhouse Plastics	Shade Fabric, Greenhouse Film, Patching Tape, Batten Tape, Ground Cover Flooring, Greenhouse Bubble Insulation
Grow Lights	CFL Fluorescent Lights, T5 Fluorescent Light Systems, MH & HPS Light Systems, MH & HPS Bulbs & Supplies
Benches & Shelves	Superior Greenhouse Benches
PVC Fittings & Pipe	PVC Fittings, PVC Pipe
Drip line fittings	Grommet, Elbow, Nipple, Joiner, Reducing Tee, Tee, Reducer, End Cap, Lateral Cock
Greenhouse	Waterproof Outlets, Electrical Wire, Flexible Conduit

Electrical	
Pollination	Electric Pollinator/ Agri. Pollination Tool

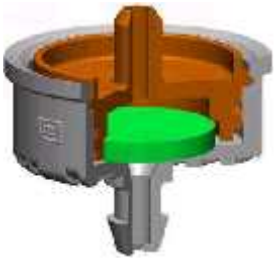
Drippers of different types are available:

- Labyrinth drippers
- Turbo drippers
- Pressure compensating (PC) drippers
- Button drippers- easy and simple to clean

On line dripper

On line dripper- PC type

In line Dripper



No Drain, PC Dripper

Depending upon the type of water, different kinds of filters can be used:

Gravel filter: Used for filtration of water obtained for open canals and reservoirs that are contaminated by organic impurities, algae etc. The filtering is done by beds of basalt or quartz.

Hydro cyclone: Used to filter well or river water that carries sand particles.

Disc filters: Used to remove fine particles suspended in water

Screen filters: Stainless steel screen of 120 mesh (0.13mm) sizes. This is used for second stage filtration of irrigation water.

Sand Filter

Hydro cyclone Filter

Screen Filter

Disc Filter

Equipment for fertigation:

Venturi Injector

Fertilizer tank

Injector pump

Automatic Fertigation Controller

BIS Codes for Protected Cultivation:

Applications	**Component Description**	**BIS Code**
Mulching	Surface covered cultivation-plastics mulching-code of practice	IS 15177:2002
Greenhouse	Plastic film for Greenhouses –specifications	IS 15827:2009
	Recommendations for Layout, Design and Construction of Greenhouse Structures.	IS 14462: 1997
	Recommendation for Heating, Ventilating and cooling of Greenhouses	IS 14485: 1998
	Steel Tubes for Structural Purposes	IS 1161: 1998
Agro Shade nets	Shade-nets for Agriculture & Horticulture Purpose	IS 16008:2012
Protection Nets	Plant protection nets	IS 10106:part 1: section 6:1992

BIS Standards for Micro-irrigation System (MIS) System:

SN	Component Description	BIS Code
1	Polyethylene pipes for Irrigation- Laterals with amendment number 5	IS 12786: 1989 (reaffirmed 1998)
2	Emitters	IS 13487: 1992
3	Emitting pipes system	IS 13488: 2008
4	Strainer type filters	IS 12785: 1994
5	Irrigation equipment rotating sprinkler Part II, Test method for uniformity of distribution (1st revision) (amendment 1) (Including Rain gun)	IS 12232 (Part II) 1995
6	Polyethylene micro tubes for drip irrigation System	IS 14482: 1997
7	Fertilizer and Chemicals Injection system Part I Venturi Injector	IS 14483 (Part 1) 1997
8	Micro Sprayers	IS 14605: 1998
9	Media Filters	IS 14606: 1998
10	Hydro Cyclone separators	IS 14743: 1999
11	PVC pipes for water supply	IS 4985 – 1999
12	Irrigation equipment sprinkler pipes specifications Part I Polyethylene pipes	IS I4151 (Part I) 1999
13	Irrigation equipment sprinkler pipes specifications Part II Quick couples Polyethylene pipes	IS I4151 (Part II) 1999
14	Quality of Irrigation water	IS 11624: 1986
15	HDPE Pipes	IS 4984: 1995
16	Molded PVC Fittings	IS 7834: 1987
17	GI and MS Fittings	IS 1879: 1987
18	GM Valves	IS 778: 1984
19	CI Non-Return Valves	IS 778: 1984
20	Fabricated PVC Fittings	IS 10124: 1988
21	GI Pipes	IS 1879: 1987
22	Sluice Valves	IS 780: 1984

23	PE Fabricated Fittings	IS 8360: 1977
24	PE Molded Fittings	IS 808: 2003
25	PVC Foot Valves and NRV	IS 10805: 1986
26	Irrigation equipment rotating sprinkler Part I, Design and Operational requirements (1st revision)	IS 12232 (Part I) 1996
27	Design, Installation and Field evaluation of MIS	IS 10799: 1999
28	Prevention and treatment of blockages problems in drip irrigation systems	IS 14791: 2000

TECHNICAL SPECIFICATION OF NVPH:

Sr. no.	**Items**	**Description/ Specification**
1	Product	Naturally Ventilated Greenhouse
2	Size	As per 8 x 4 m Length: 8 x 2+4 or 8 x 3+4m Width: 4 x 2 or 4 x 3m
3	Bay size	8m x 4m, Width of greenhouse should be at least 35 % of the Desired length.
4	Ridge height	6.5 m to 7m
5	Ridge Vent	80-90 cm opening fixed with 40 mesh nylon insect screens
6	Gutter height	4 - 4.5 m from floor area
7	Gutter slope	2% slope need be provided in civil foundation work/ structure
8	Gutter material	20 gauge or 1 mm thick GI sheet with perimeter of 500 mm or more preferably of single length without joint
9	Structural design	The structural design needs to be sound enough to withstand wind speed of minimum 150 km/hour and minimum load of 25 kg/m2. There should be provision for

		opening one portion at either side for entry of small tractor/power tiller for intercultural practices.
10	Structure	Complete structure made of galvanized steel tubular pipes or equivalent section having wall thickness 2mm.
•	Columns	76 mm OD, 2 mm thick
•	Trusses	Bottom & top cord 60 mmOD, 2 mm thick
•	Trusses member	48 mm OD, 2 mm thick
•	Purlin	42 mm OD, 2 mm thick
•	Purlin member & others	33/25 mm, 2 mm thick
•	Foundations	Insert GI pipes of minimum 60 mm OD or more to have foundation depth of 75 cm or more depending upon soil type and prevailing wind condition, grouted with cement concrete mixture of 1:2:4 using telescopic insertion of column.
•	Fasteners	All nuts & bolts must be of high tensile strength and galvanized.
11	Entrance room & Door	One entrance room of size 3mx3mx3m (L x W x H) need to be provided and covered with 200-micron UV stabilized transparent plastic film. Two hinge doors of size 2 m width & 2.5 m height double leaf made in plastic/FRP sheets mounted in suitable strong frame.
12	Cladding material	UV stabilized 200-micron transparent Plastics films conforming Indian Standards (IS 15827: 2009), multilayered, anti-drip, anti-fog and anti-Sulphur, diffused, clear and having minimum 85% level of light transmittance.
13	Fixing of cladding materials	All ends/joints of plastic film need to be fixed with two-way aluminum profiles with suitable locking arrangement along with curtain top.

15	Curtains and insect screen	Roll up UV stabilized 200-micron transparent plastic film as curtains need be provided up to 3.0 m height on all sides having automatic type motor operated crank mechanism. However, provision for manual opening and closing of curtains need also be provided.40 mesh nylon insect proof nets (UV stabilized) of equivalent size need to be fixed inside the curtains.
16	Shade net	UN/stabilized 50% shading net with motor/ manually operated mechanism for expanding and retracting. Size of net should be equal to the floor area of greenhouse.
17	Drip Irrigation System with fogging & misting facility	Drip irrigation system under greenhouse need to be selected on the basis of crop spacing along with fogging and misting facilities. The spacing considered for calculation The suggested bill of materials are Sand Filter 5 m^3 /hr, Screen Filter 10 m^3 /hr, Control Valve 63 mm, Control Valve 50mm, By-pass Assembly 1.5", Air Release Valve 1", Non Return Valve 1.5", Throttle Valve 1.5", Flush Valve 50mm, Venturi 1.5" Assembly with manifold, PVC pipe 63 mm/6 kg cm^2, PVC pipe 50 mm/6 kg/cm^2, PE plane lateral 16 mm, Emitting pipe lateral 16mm- @ 0.45 m spacing, hanging type micro sprinkler nozzle (four-way take off assembly) for very fine water particles (foggers& mister) to be fixed in PE pipe of diameter 16mm, Water tank of capacity 5000 liter and fittings & accessories.
18	Footpath	1m wide and 10 cm thick footpaths should be provided in the center (length x width) & made of cement concrete ratio of 1:2:4.
19	Curtain wall/ Apron	22cm brick wall of 1m height (24 cm below and 80 cm above ground level on all the four sides. The wall needs to be plastered and water proofing cement with 1:6 ratio.

4. Classification of Greenhouses

Classification of Greenhouses:

Greenhouse structures of various types are used successfully for crop production. Although there are advantages in each type for a particular application, in general there is no single type greenhouse, which can be considered as the best. Different types of greenhouses are designed to meet the specific needs.

- **Greenhouse type based on shape**

Greenhouses can be classified based on their shape or style. For the purpose of classification, the uniqueness of the cross section of the greenhouses can be considered as a factor. As the longitudinal section tend to be approximately the same for all types, the longitudinal section of the greenhouse cannot be used for classification. The cross sections depict the width and height of the structure and the length is perpendicular to the plane of cross section. Also, the cross section provides information on the overall shape of the structural members, such as truss or hoop, which will be repeated on every bay.

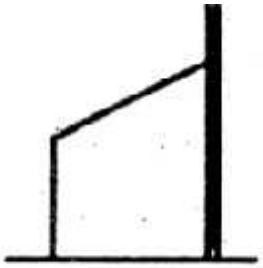
The commonly followed types of greenhouse based on shape are lean-to, even span, uneven span, ridge and furrow, saw tooth and Quonset.

1. **Lean-to type greenhouse**

A lean-to design is used when a greenhouse is placed against the side of an existing building. It is built against a building, using the existing structure for one or more of its sides. It is usually attached to a house, but may be attached to other buildings. The roof of the building is extended with appropriate greenhouse covering material and the area is properly enclosed. It is typically facing south side. The lean-to type greenhouse is limited to single or double-row plant benches with a total width of 7 to 12 feet. It can be as long as the building it is attached to. It should face the best direction for adequate sun exposure.

The advantage of the lean-to type greenhouse is that, it usually is close to available electricity, water, and heat. It is a least expensive structure. This design makes the best use of sunlight and minimizes the requirement of roof supports. It has the following disadvantages: limited space, limited light, limited ventilation and temperature control. The height of the supporting wall limits the potential size of the

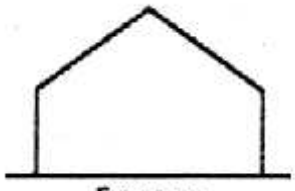
design. Temperature control is more difficult because the wall that the greenhouse is built on, may collect the sun's heat while the translucent cover of the greenhouse may lose heat rapidly. It is a half greenhouse, split along the peak of the roof.



Lean-to

2. Even span type greenhouse

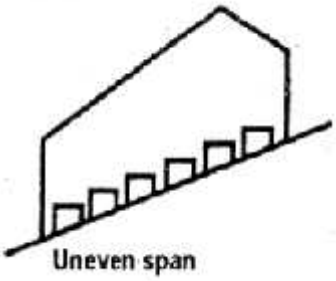
The even-span is the standard type and full-size structure, the two roof slopes are of equal pitch and width. This design is used for the greenhouse of small size, and it is constructed on levelled ground. It is attached to a house at one gable end. It can accommodate 2 or 3 rows of plant benches. The cost of an even-span greenhouse is more than the cost of a lean-to type, but it has greater flexibility in design and provides for more plants. Because of its size and greater amount of exposed glass area, the even-span will cost more to heat. The design has a better shape than a lean-to type for air circulation to maintain uniform temperatures during the winter heating season.. Several single and multiple span types are available for use in various regions of India. For single span type the span in general, varies from 5 to 9 m, whereas the length is around 24 m. The height varies from 2.5 to 4.3 m.



Even span

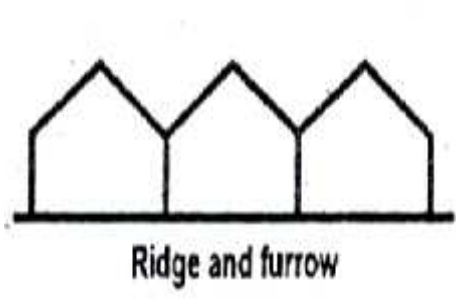
3. Uneven span type greenhouse

This type of greenhouse is constructed on hilly terrain. The roofs are of unequal width; which make the structure adaptable to the side slopes of hill. This type of greenhouse is seldom used now-a-days as it is not adaptable for automation.



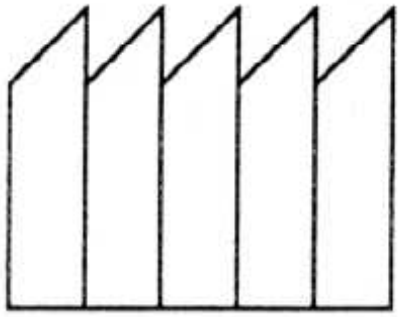
4. Ridge and furrow type greenhouse

Designs of this type use two or more A-frame greenhouses connected to one another along the length of the eave. The eave serves as furrow or gutter to carry rain and melted snow away. The side wall is eliminated between the greenhouses, which results in a structure with a single large interior, Consolidation of interior space reduces labour, lowers the cost of automation, improves personal management and reduces fuel consumption as there is less exposed wall area through which heat escapes. The snow loads must be taken into account in the frame specifications of these greenhouses since the snow cannot slide off the roofs as in case of individual free-standing greenhouses, but melts away. In spite of snow loads, ridge and furrow greenhouses are effectively used in northern countries of Europe and in Canada and are well suited to the Indian conditions.



5. Saw tooth type Greenhouse

These are also similar to ridge and furrow type greenhouses accept that, there is provision for natural ventilation in this type. Specific natural ventilation flow path develops in a saw- tooth type greenhouse.



6. **Quonset greenhouse**

This is a greenhouse, where the pipe arches or trusses are supported by pipe purlins running along the length of the greenhouse. In general, the covering material used for this type of greenhouses is polyethylene. Such greenhouses are typically less expensive than the gutter connected greenhouses and are useful when a small isolated cultural area is required. These houses are connected either in free standing style or arranged in an interlocking ridge and furrow.

In the interlocking type, truss members overlap sufficiently to allow a bed of plants to grow between the overlapping portions of adjacent houses

- **Types based on cladding materials**

Covering materials are the major and important component of the greenhouse structure. Covering materials have direct influence on the greenhouse effect inside the structure and they alter the air temperature inside the house. The types of frames and method of fixing also varies with the covering material. Based on the type of

covering materials, the greenhouses are classified as glass, plastic film and rigid panel greenhouses.

1. **Glass glazed greenhouses**

Only glass greenhouses with glass as the covering material existed prior to 1950. Glass as covering material has the advantage of greater interior light intensity. These greenhouses have higher air infiltration rate which leads to lower interior humidity and better disease prevention. Lean-to type, even span, ridge and furrow type of designs are used for construction of glass greenhouse.

2. **Plastic film greenhouses**

Flexible plastic films including polyethylene, polyester and polyvinyl chloride are used as covering material in this type of greenhouses. Plastics as covering material for greenhouses have become popular, as they are cheap and the cost of heating is less when compared to glass greenhouses. The main disadvantage with plastic films is its short life. For example, the best quality ultraviolet (UV) stabilized film can last for four years only. Quonset design as well as gutter-connected design is suitable for using this covering material.

3. Rigid panel greenhouses

Polyvinyl chloride rigid panels, fiber-glass reinforced plastic (FRP), acrylic and polycarbonate rigid panels are employed as the covering material in the Quonset type frames or ridge and furrow type frames. This material is more resistant to breakage and the light intensity is uniform throughout the greenhouse when compared to glass or plastic. High grade panels have long life even up to 20 years. The main disadvantage is that these panels tend to collect dust as well as to harbour algae, which results in darkening of the panels and subsequent reduction in the light transmission. There is significant danger of fire hazard.

4. Shading nets

There are a great number of types and varieties of plants that grow naturally in the most diverse climate conditions that have been transferred by modern agriculture from their natural habitats to controlled crop conditions. Therefore, conditions similar to the natural ones must be created for each type and variety of plant. Each type of cultivated plant must be given the specific type of shade required for the diverse phases of its development. The shading nets fulfil the task of giving appropriate micro-climate conditions to the plants.

Shade nettings are designed to protect the crops and plants from UV radiation, but they also provide protection from climate conditions, such as temperature variation. Better growth conditions can be achieved for the crop due to the controlled micro-climate conditions “created” in the covered area, with shade netting. All nettings are UV stabilized to fulfil expected lifetime at the area of exposure. They are characterized of high tear resistance, low weight for easy and quick installation with a 30-90% shade value range. A wide range of shading nets are available in the market which are defined on the basis of the percentage of shade they deliver to the plant growing under them.

C. Greenhouse type based on utility

Classification of greenhouses can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating of the greenhouse are more expensive and elaborate. Hence based on the artificial cooling and heating, greenhouses are classified as greenhouses for active heating system and for active cooling system.

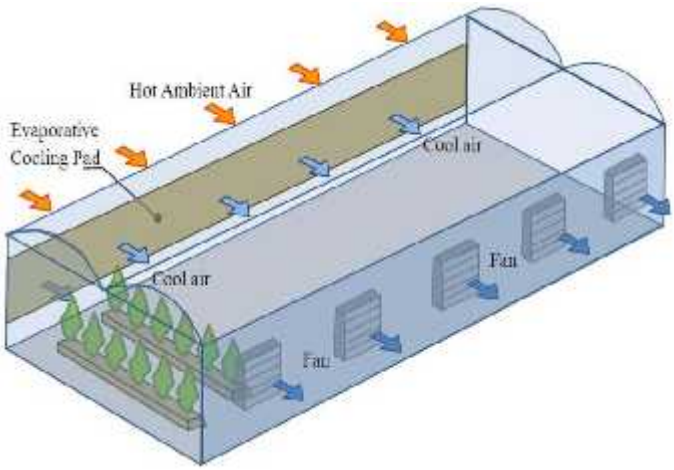
1. Greenhouses for active heating

During the night time, air temperature inside greenhouse decreases. To avoid the cold bite to plants due to freezing, some amount of heat has to be supplied. The requirements for heating greenhouse depend on the rate at which the heat is lost to the outside environment. Various methods are adopted to reduce the heat losses, viz., using double layer polyethylene, thermo pane glasses (Two layers of factory

sealed glass with dead air space) or to use heating systems, such as unit heaters, central heat, radiant heat and solar heating system.

2. Greenhouses for active cooling

During summer season, it is desirable to reduce the temperatures of greenhouse than the ambient temperatures, for effective crop growth. Hence suitable modifications are made in the greenhouse so that a large volume of cooled air is drawn into greenhouse. This type of greenhouse either consists of evaporative cooling pad with fan or fog cooling. This greenhouse is designed in such a way that it permits a roof opening of 40% and in some cases nearly 100%.



D. Greenhouse type based on construction

The type of construction is predominantly influenced by the structural material, though the covering material also influences the type. Higher the span, stronger

should be the material and more structural members are used to make sturdy truss type frames. Therefore based on construction, greenhouses can be broadly classified as wooden framed, pipe framed and truss framed structures.

1. **Wooden framed structures**

In general, for the greenhouses with span less than 6 m, only wooden framed structures are used. Side posts and columns are constructed of wood without the use of a truss. Pine wood is commonly used as it is inexpensive and possesses the required strength. Timber locally available, with good strength, durability also can be used for the construction.

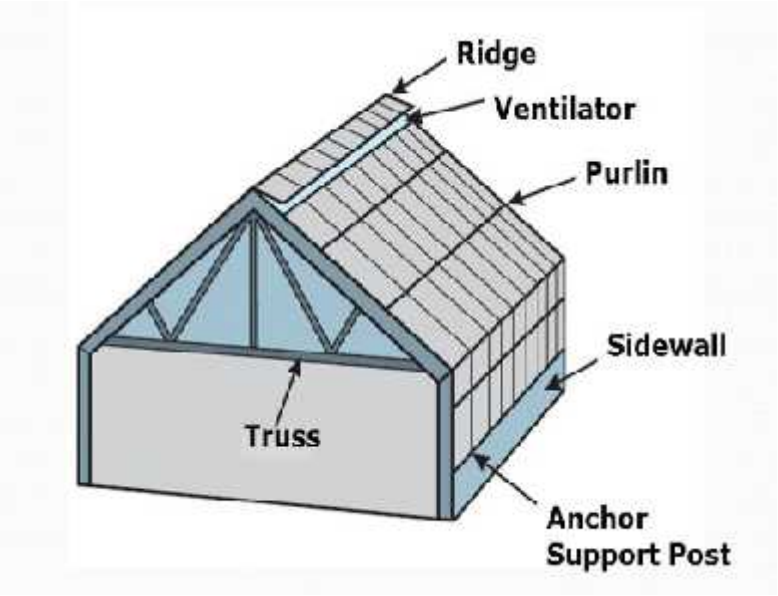
2. **Pipe framed structures**

Pipes are used for construction of greenhouses, when the clear span is around 12m. In general, the side posts, columns, cross ties and purlins are constructed using pipes. In this type, the trusses are not used. The pipe components are not interconnected but depend on the attachment to the sash bars for support.

3. **Truss framed structures**

If the greenhouse span is greater than or equal to 15m, truss frames are used. Flat steel, tubular steel or angular iron is welded together to form a truss encompassing rafters, chords and struts. Struts are support members under

compression and chords are support members under tension. Angle iron purlins running throughout the length of greenhouse are bolted to each truss. Columns are used only in very wide truss frame houses of 21.3 m or more. Most of the glass houses are of truss frame type, as these frames are best suited for pre-fabrication.



5. Environmental control mechanisms for greenhouses

Temperature control system in greenhouse

- Temperature is the most important factor has got a great influence on the other environmental factors and direct effect on plant effect and quality.
- Depending on the crop requirement, season, elevation, and Agro climatic condition, the greenhouse requires temperature control system like heating and cooling system.
- Ex. The greenhouse in north hilly areas have to be artificially heated; whereas the green houses in plains, costal and places where the outside temperature is goes beyond 30 Degree require cooling.

(A) Cooling systems for Greenhouse

- Need for cooling system:
- Green house in the tropics and subtropics especially in the plains and coastal regions in our country needs cooling during hot summer.
- Temperature in the green house will always be higher 4 to 10 degree than the outside temperature.
- Methods of cooling in Greenhouse:

(1) Natural ventilation

(2)Forced ventilation

(3) Evaporative cooling

(a) Fan and pad cooling system

(b)High pressure mist system

(c)Low pressure mist system

(d) Fog cooling

(4) Horizontal air flow fans

(5) Lath shades

(6) Convection tube cooling

(1) Natural ventilation:

- Ventilation is the exchange of the air between the greenhouse and its surrounding. in the other words it is a process of replacing the air in the enclosure with the outside air.
- Ventilation by roof and side venters.
- It is called open circuit ventilation where in the ambient air replaces the enclosed air mass through vents in the side walls and along the rooftops serves as opening for natural ventilation.
- Generally, 20 to 50 % floor area is provided for natural ventilation so that the ambient air by itself enters into the green house after displacing an equal distance.

(2) Forced ventilation:

- Also called as active ventilation.
- In this system the auxiliary power is used to move air through greenhouse.
- in this system, exhaust fans with automatic louvers along the end of the green house is placed.
- The inlet vents are placed opposite to exhaust fans are opened wide when the fans operate. the exhaust fans suck the air inside the green house. the louvers can be gravity louvers have the advantage of protecting the greenhouse from the unprotected wind storm.

(3)Evaporative cooling system:

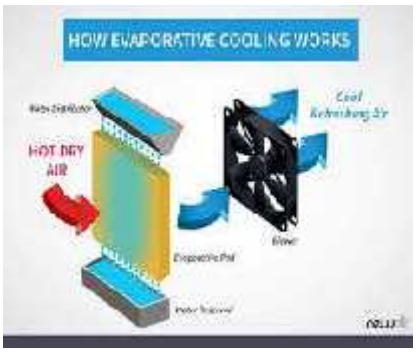
- The degree of evaporative cooling during a day is directly related to the wet bulb temperature that occurs with a given net climatic conditions.
- Evaporative cooling is most effective in the areas of low relative humidity area.

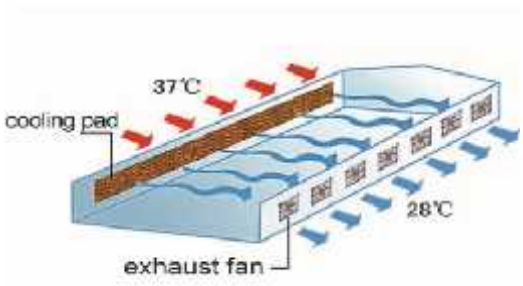
(a)Fan and pad cooling system :

- It is adabtable for large and small greenhouse . here low velocity and large volume fans draw air through the wet fibrous pads mounted on the opposite side wall .
- Both horizontal and vertical pad system are used . most of the greenhouse require 1m pad height and 20 m of fan to pad distance .
- The pad design system should provide 6 lit of water per minute per linear meter of the pad length . the exhaust fans should be placed more than 9m apart .

(b) High pressure mist system :

- Water sprayed above the plant at a pressure of 35 to 70 kg/cm from the low capacity nozzles .
- All the mist evaporate before fall on the plant surface . A temperature difference of 5 to 14 degree can be obtained between high pressure mist and fan cooled greenhouse .





(c) Low pressure mist system:

- The misting with water pressure at less than 7 kg/cm have achieved at air temprature 5 degree in greenhouse . the water droplet from the low pressure misting system are vquite large and not evaporate quickly .
- Leaching of the nutrients from the foliage and the soil is the drawback .

(d) Fog cooling:

- Fog cooling is particularly used in the production of seedling and rooted cuttings.
- The advantage over misting is that water droplets are so small . so they will not settle at thew bottom but they v float on the air until they evaporate.

(4) Horizontal air flow fans :

- Horizontal air flows are frequently installed to ensure proper air mixing . The recommended fan capacity is approximately 3 cubic feet per minute per square foot of growing area . while horizontal airflow fans use a small amount of electricity , they are typically turned off once the ventilation rate exceeds some lower threshold value .

(5) Lath shades :

- Lath shades are constructed from wooden are most flexible than the shading compounds but their cost is considerably higher .
- Lath shades are more effective than the shade provide more shading than shading compound beacause air circulates between leaths and cladding materials .

(6)Convection tube cooling:

- The general components of convection tube are the louvered air inlet, a polyethylene convection tube with air distribution holes, a pressurizing fan to direct air in to the convection tube under pressure, and an exhaust fan to create vacuum.
- When the air temperature inside the greenhouse exceeds the set point, the exhaust fan starts functioning thus create vacuum inside the greenhouse.
- The louver of the inlet in the gable is then opened through which cold air enters /due to the vacuum.
- The pressurizing fan, at the end of the clear polyethylene convection tube, operates to pick up the cool air entering the louver. Heating system for greenhouses.
- Heating system is necessary for temperate region greenhouses for optimum growing conditions.
- The heat must be dispersed uniformly throughout the entire greenhouse according to specific crop requirements.
- Expected heat loss from the greenhouses and covering the temperature differences between exterior and interior of the greenhouse.

(B)Heating method for greenhouse:

(1) Steam heating:

- This method of heating system is very common in Holland and it is very effective heating system.
- Heat is directly applied into the plants by heating pipes, which are laid at regular intervals inside the greenhouse.
- The hot water steam is pumped through the greenhouse via insulated pipes, with the heat exchange maintaining controlled, uniform temperatures throughout the greenhouse.
- The heaters are directly controlled by manually or computer system.

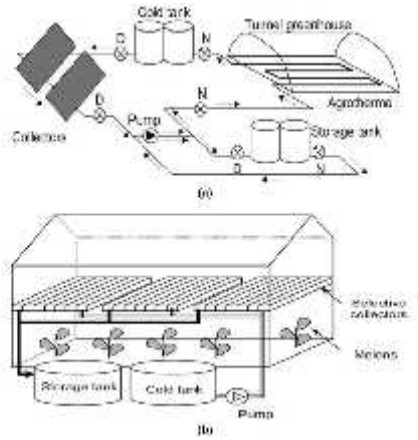
(2) Unit heaters:

These are localized system of heating and a number of unit heaters are to be provided in tube greenhouse at a height of 3m to distribute heat evenly in to the greenhouse.

- The heat is generated is passed through perforated polythene tubing which runs in the center of the greenhouse with the help of fan and jet system.

(3) Solar heating:

- Flat plate solar heaters are used to heat the water during the day time.
- The hot water is stored in insulated tank.
- The hot water is circulated in the pipe provided along with the length of the greenhouse during night.
- Supplementary of emergency heating systems is provided for the heating of the greenhouse during cloudy or rainy days.



Shade control system in greenhouse:

- Shading is another way to reduce the overall heat within a greenhouse. Unfortunately, shading limits the light, the plants receive, thereby reducing overall growth.
- Limiting the amount of shading when temperatures are below 27 degree is the best protocol.
- There are various types of shading greenhouses include:
  (1). Shading screens, (2) Shading paints

(1) Shading screens:

- Whenever shade is required for a part of the growing season shade screen are installed.
- During early days of the greenhouse technology, cheese cloths was used aesthetic shading screens, but in recent years several synthetic materials like polyester, polypropylene and aluminum coated screens etc. Are available in different grades of the shades ranging from 20 to 80 % range.

(2) Shading paints:

Some paints are designed to become translucent when wetted. Ex. Cool glass from brayer.

Cool glass does have a useful future in that it become wet so in rainy weather it allows the all-available light through as it dries it become as reflective again.

6. Plug tray Nursery Raising

Producing quality seedlings is essential for good growth and performance of all kinds of crops, especially vegetable crops. The pro-tray method of raising nursery seedlings is an effective way for commercial production. It is highly economic and successful for large scale production and commercialization. Therefore, the practice of large-scale seedling production is emerging as a profession and commercial activity. The Plug-tray nursery is an upcoming technique for quality seedling production where seedlings are produced under shade net. Such seedlings have better germination, healthier vegetative growth and also, they are free from pest diseases and develop good root system within 25-30 days.

The benefits of pro-tray nursery are as follows:

1. Production of pest free quality seedlings
2. Having independent area for each seed to develop.
3. Reduce the cost by minimizing the seed wastage
4. Improved seed germination
5. Better root development
6. Avoid damage to the roots and shoots of the seedlings during transplanting
7. Minimized seedling mortality and damping off disease
8. Provides uniform, healthy and early maturity
9. Easy handling and cheaper transportation
10. Good main field establishment and crop stand

Plug trays-Different sized trays with varied numbers of cells are used to grow the seedlings in vegetable nurseries. The number of cells in portray varies from 72(warm season vegetables) to 800 cells per standard tray (53.7 X 27.5 cm). These trays are made of polypropylene and re-usable and its life depends on the way we handle them.

Seedling trays have been designed in such a way that a sapling gets a pre-calculated growing media and the right amount of moisture. The trays have pre-punched holes to each cavity for proper drainage of excess water and also right spacing. The cell shapes were: flat, pyramid round hexagonal; holding equal volumes of the growing medium. Root circling and clustering of the plug transplants was fastest in round cells, comparatively very less in pyramidal ones.

Growing Media for Seedling Trays: Sterilized commercial growing media are better as the incidence of seedling diseases is less or nil and they contain right amount of moisture. The most common growing medium used is coco peat, vermiculite and perlite in (3;1;1).

Cocopeat: is a multipurpose growing medium. Fibrous coconut husk is pre washed, machine dried, sieved and made free from sand and other contaminations such as animal and plant residue to get coco peat. Its air-filled porosity and high-water holding capacity make it, an ideal growing medium for the plant crops. It is 100% organic and eco-friendly, free from soil borne pathogen, weed and has a pH of 5.7 – 6.5, EC level <1 mS/cm is ideal for plant growth.

Excess salinity and phenolic compounds in coir can be a problem in areas with inadequate quality control. In addition, some coir sources have reportedly contained chlorides at levels toxic to many plants. Thus, it is very important that salts and other compounds are thoroughly leached with fresh water before shipment and use.

Perlite: is a porous siliceous substance offering both excellent water retention of about 3-4times its own weight. Additionally, perlite also provides proper aeration which is necessary for healthy root growth in plants.

Vermiculite:is the name of a group of micaceous group of hydrated laminar mineral (aluminum-iron magnesium silicates). Horticultural vermiculite is processed with massive heat that expands it into accordion shaped pellets composed of multiple layers of thin plates. It will not rot, deteriorate, or mold and is enduring, odorless, non-toxic and sterile. Vermiculite is generally a neutral 7.0 Ph and is very light in weight and mixes easily with other mediums.



Peat moss -a component of horticultural growing media is partially decomposed aquatic has been very important because of the unique properties of the sphagnum cells to hold (10 times its weight) and release water. It is light in weight and relatively acidic in nature.

Rice hulls are referred to as fresh, aged, composted and parboiled, or carbonized. Fresh rice hulls are typically avoided as a growing media because of the high probability of contaminants such as rice, fungal spores, bacteria, decaying bugs, and weed seeds.

Parboiled rice hulls (PRH) are done by stemming and drying the rice hulls after the rice has been milled from them. This kills any spores, bacteria, and microorganisms, leaving sterile and clean product. Rice hulls are also often used as part of a mix of growing media such as 30%-40% rice hulls and pine bark mix. The overall pH of parboiled and composted rice hulls ranges from 5.7 to 6.5, which is right in the pH range for most hydroponically grown plants.

Sawdust- Raw sawdust, with its high C: N, can negatively affect nutrient availability, especially nitrogen but its properties can be improved with composting. Also,

because of inherent differences in chemical properties between different woods, the suitability of sawdust as an organic growing media component is extremely variable. There are both soft wood (mainly from *Pinus radiata*) and hard wood saw dust. Some species produce sawdust with phytotoxic effects. Only consider using sawdust from sawmills because other wood residues, such as from treated boards, may contain preservatives or harmful chemicals. Sawdust from coastal sawmills can contain high levels of salts, so all potential sources need to be tested before general use in the nursery.

Sand- basic component of soil having particle size between 0.05 mm–2.0 mm in diameter. It improves aeration and drainage and needs minimum cost incurrence. Even though it is vulnerable to diseases and pests, once sterilised, it can prove to be a good medium for both potting and propagation media.

Polystyrene Beads or Flakes Polystyrene is more commonly known by its trademarked name Styrofoam™. These polystyrene beads are a processing by product. They increase aeration and drainage, decrease bulk density, and is highly resistant to decomposition. New polystyrene is unlikely to be a locally available material and many people are phasing out the use of polystyrene for sustainability concerns. It may be possible to recycle polystyrene and use pieces in growing media although it is not biodegradable and is often considered undesirable to out plant on project sites.

Brown coal is readily available as medium for plants in greenhouses. Organic substances contained in brown coal (humic,fulvic, hematogenic acids, humins,

bitumen etc.), combined with water and minerals creates a perfect environment for soilless cultivation of plants. Brown coal as a source of humic substances not only improves the fertility of soils, but also the minerals uptake by plants.

Few other media used are Pine bark, Pumice, Cinder Pumice. Pine bark is now easily available in Poland from paper mills. This bark is treated during the peeling process with hot water and the content of tannins drops from about 6 % to about 0.6 %. Pumice is porous in nature and improves aeration but also retains water within the pores. Cinder (scoria) is a type of volcanic rock and a common growing media component in volcanic areas.

Method of Seedling Raising:

1. Fill the seedling tray with appropriate growing medium such as coco peat. A small depression (0.5 cm) is made with fingertip in the center of the cell of the pro tray for sowing (manual).

2. After treating the seed with Bavistin or captan @2.5g/kg. Sow one seed per cell and cover by coco peat. No irrigation is required before or after sowing, if coco peat contains enough moisture.

3. Keep about 10 trays one over the other for 3 to 6 days in a zig-zag manner depending on the crops. Cover the entire stack of tray with polyethylene sheet or kept in darkened germination room. This arrangement ensures the conservation of moisture in the seedling trays until germination. Therefore, no irrigation is required till seedling emergence.
4. Seeds start emerging after about 3-6 days of sowing depending upon the crops. Then the trays are kept spread over a bed covered with polyethylene sheet.

5. The germinating trays are then irrigated lightly depending upon the prevailing weather conditions using fine sprinkling rose can or hose pipe fitted with rose during preferably morning time to ensure that there is no retainment of droplet, which may lead to fungal infection.

6. The trays are also drenched with fungicides (COC or Carbendazim or Thiram) as a precautionary measure against seedling mortality.

Seedling trays are watered daily, or as needed using water can or a hose with a fine sprinkle attachment. Do not over irrigate the trays to avoid leaching of nutrients which favours microclimate for disease

7. The media may need to be supplemented with the nutrient solution, if the seedlings show deficiency symptom. The seedling growth was encouraged by foliar application of water-soluble fertilizers 19:19:19 @ 3 g/L at 12 and 20 DAS.
8. Protect the trays from rainfall by covering the polyethylene sheets in the form of low tunnel.

9. The seedlings at right stage of planting are hardened by withholding irrigation and reducing the shade before transplanting or selling to the growers. Systemic insecticides are sprayed 7 after germination and before transplanting for managing the insect vectors.

10. When the roots have sufficiently grown, plug pushes can be used to push them out of the tray.

Few points to remember:

Hygiene has a vital role in the control of pests and diseases by preventing the few unnecessary opening and closing of the door always, not letting water stagnation and dumping of waste nearby greenhouse.

Use steam or chemical sterilisation of the growing media, structures, tools and trays. Effective ventilation and air movement is also a sound disease prevention method. U Pests and diseases could affect the growth of healthy seedlings, should be eliminated Care must be taken with the use of pesticides within enclosed areas.

7. Protected Cultivation of cucumber

Botanical name: *Cucumis sativus L.*

Family: Cucurbitaceae

Chromosome number: 2n=14

Origin: India

Soil:

Cucumbers prefer light textured soils that are well drained, high in organic matter and have a pH of 6-6.8. Adapted to a wide-range of soils, but will produce early in sandy soils. Cucumbers are fairly tolerant to acid soils (down to pH 5.5). Most of the greenhouses for crop production use soil-based media. The soil-based medium is composed of 70% red soil, 20% well decomposed organic matter and 10% rice husk. The raised beds of 40 cm height and 90 cm top width are made for successful cultivation of crop. Root medium of a greenhouse is generally pasteurized annually. Formaldehyde is a commonly used chemical to sterilize the root medium. Drenching of root medium with formaldehyde (37-40 %) mixed with water @ 25 ml per litre is the usual practice.

After drenching, the soil or root medium will be covered with plastic film or black polyethylene sheet. Close all ventilation spaces. Three to four days after formaldehyde treatment remove polyethylene cover. Two days after removing the polyethylene cover rake the bed repeatedly to remove trap formaldehyde fumes completely before transplanting.

Climate:

Air temperature is the main environmental component influencing vegetative growth, flower initiation, fruit growth and fruit quality. Growth rate of the crop depends on the average 24-h temperature, higher the average air temperature the faster the growth. The larger the variation in day night air temperature, the taller the plant and the smaller the leaf size. Although maximum growth occurs at a day and night temperature of about 28°C, maximum fruit production is achieved with a night temperature of 19-20°C and a day temperature of 20-22°C

The warm weather reduces air temperature settings, especially during the night by up to 2°C to encourage vegetative growth.

Choice of varieties:

Selection of variety is one of the most important decisions made during crop production process. The cucumber plant displays a variety of sex forms like monoecious, gynomonoecious, gynoecious, andromonoecious, and androecious, predominantly monoecious type of form is present in most of the varieties. There are also cucumber hybrids that produce fruits without pollination. These varieties are called parthenocarpic varieties, resulting in fruits that are called 'seedless', although the fruit often contain soft, white seed coats.

List of parthenocarpic cucumber varieties identified by public and private and sector for cultivation under protected conditions are listed below:

Public Sector varieties	:	Pant Parthenocarpic Cucumber-2, Pant Parthenocarpic Cucumber-3 (G.B. Pant University of Agriculture and Technology, Pantnagar), Pusa Seedless Cucumber-6 (IARI, New Delhi), KPCH-1 (KAU, Thrissur)
Private Sector varieties	:	KUK-9, 24, 29, 35; Kian, Hilton, Valley star; Multistar; RS-03602833, Kafka, Oscar, Dinamik etc.

Sowing time and method:

Cucumber can be grown successfully round the year under greenhouses. Although, Seed is generally sown directly into the soil, but looking into high cost of the seed and problem of competition among the plants during gap filling. Generally, 3000 seeds are sufficient for a greenhouse of 1000 m^2. It is advisable to raise 20 per

cent of total population through plug trays so that these can be used for timely gap filling in order to keep pace with the growth of other plants. There are three ingredients viz., cocopeat, vermiculite and perlite which are used as media for nursery raising. These ingredients are mixed in 3:1:1 ratio before filling the trays. Owing to the cost of these ingredients, cocopeat alone can be used as rooting media. The cocopeat usually comes in bricks of 5 kg, but before using it as growing media it must undergo through various hydration processes with water to remove excess of salt present in it. Next step is to hydrate cocopeat brick with calcium nitrate @ 100 g per brick at least for 24 hrs.

Fertilizer management:

Fertigation schedule for capsicum cultivation under greenhouse is given as under:

9.0:7.5:7.5 kg NPK/ 1000 m^2

Crop Duration	Distribution pattern /ratio of fertilizers			Remarks
	N	P	K	
First Growth Period (Up to 30 days)	2	3	1	• Fertigation should be started at the appearance of 2nd-true leaf stage. • Fertigation should be carried out twice a week.
Second Growth Period (30-60 days)	1	2	3	
Third Growth Period (60-90 days)	1	2	3	

It is also recommended to apply 0.5 kg *Trichoderma viride*, 0.5 l *Pseudomonas fluorescens*, 2.0 t FYM or 0.4 t vermicompost and 5 kg micro-nutrients (Grade-5) at the time of planting.

Irrigation management:

If Drippers are at 30 cm distance with water Discharge Rate of 2 lit/hr, adopt the following irrigation schedule for better results.

Crop Stage	Time of operation of drip system /irrigation (minutes)	Frequency of Irrigation		
		summer	winter	Rainy
Up to initiation of flowering	25	daily	Alternate Day	Every 4th Day
Fruit Setting to First	40	Frequency of Irrigation	Alternate Day	Every 4th Day

Harvesting				
first Harvest to one week prior to last harvest	35	Frequency of Irrigation	Alternate Day	Every 4th Day

Training and Pruning:

Cucumber plants in greenhouse are training to single stem system, which can be achieved by removing all other laterals arising from the axials of leaves, commonly known as suckers at the attainment of 10-12 cm length and only main stem should be allowed to grow vertically along the supporting string.

Fruit thinning:

Overbearing can sometimes be a problem. To prevent the plants becoming exhausted and to improve fruit size, control the number of the fruit per plant through selective fruit thinning. This technique is powerful, so use it with great caution. The optimum number of fruits per plant varies with the cultivar and even more, with the growing conditions. Although, limiting the number of fruits per plant invariably results in premium-priced large fruit, growers risk underestimating the crop's potential or failing to forecast good weather. They may decide to remove too many fruits and thus unnecessarily limit production. Fruit thinning is undoubtedly most useful in the hands of experienced growers who can use it to maximize their financial returns. Fruit to be pruned must be removed as soon as it can be handled, before it grows too large.

Disease and pest management:

Disease management:

(1) Anthracnose

Management

- Always seed should be collected from healthy fruits and disease-free area.
- Seeds must be treated with Carbendazim @ 0.25%.
- Field sanitation by burning of crop debris.
- Grow crop on bower system to avoid soil contact.
- Maintain proper drainage in the fi eld.
- Seed production should be preferably carried out in summer season because

summer crop is often free from pathogen.

- Foliar sprays of Carbendazim @ 0.1% or Chlorothalonil @ 0.2% but spray must be started soon after infection

(2) Downy Mildew

Management

- Air movement and sunlight exposure helps in checking the disease initiation and development. Bower system of cropping reduces the disease incidence.
- Field sanitation by burning crop debris to reduce the inoculums.
- Seed production should be preferably carried out in summer season because summer crop is often free from disease.
- Use tolerant cucumber lines like Summer Prolific.
- Protective spray of Mancozeb @ 0.25% at seven days interval gives good control.

(3) Powdery Mildew

Management

- Foliarspraysof Penconazole@ 0.05% or Tridemorph @ 0.1% or Carbendazim @ 0.1%, give very good control of the disease.
- Use tolerant line.

(4) Fruit Rots

Management

- Avoid soil contact of fruit by using bower system of cultivation and staking of plant. Provide proper drainage in the field.
- Green manuring followed by soil application of *Trichoderma* @ 5 kg/ha in soil is very effective in checking most of the fruit rotting.
- Collect affected fruits and burn them to reduce primary inoculum.

(5) Gummy Stem Blight

Management

- Avoid exotic hybrids and varieties due to high degree of susceptibility.
- Summer ploughing and green manuring followed by *Trichoderma* application.
- Maintain proper drainage and aeration in the field.

- Seed treatment with Carbendazim @ 0.25%.
- One drenching of Carbendazim @ 0.1% near collar region.
- Avoid injury near collar region.

(6) Leaf Spots

Management

- Field sanitation, selection of healthy seeds and crop rotation reduces disease incidence.
- Fungicidal sprays of Mancozeb @ 0.25% alternated with one spray of Hexaconazole @ 0.05%.
- Seed production should be preferably carried out in summer season because summer crop is often free from disease.

(7) Mosaic and Leaf Distortion

Management

- Management of the disease involves destruction of diseased hosts and weeds. Virus free seeds must be used to check the seed transmission.
- Initial rouging of the infected plants.

Pest management:

(1) Serpentine Leaf Miner

Management

- Soil application of neem cake @ 250 kg/ha immediately after germination.
- Destroy cotyledon leaves with leaf mining at 7 days after germination.

(2) Red Spider Mite

Management

- Spray neem or pongamia soap at 1% on lower surface thoroughly.
- Alternately, spray Dimethoate 30 EC @ 2ml/l or Ethion 50 EC @ 1ml/l or Wettable Sulphur 80 WP @ 3g/l.

(3) Thrips

Management

- Soil application of neem cake (once immediately after germination and again at flowering) followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval.

- Spray any systemic insecticides like Acephate 75 SP @ lg/l or Dimethoate 30 EC @ 2ml/l.

(4) Leaf Eating Caterpillar

Management

- Apply neem cake to soil immediately after germination.
- Spray any contact insecticides like Carbaryl 50 WP @ 3g/l. Neem or pongamia soap @ 0.75% also effectively manages this pest.
- Soil application of neem cake (once immediately after germination and again at flowering) followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval.
- Spray Carbaryl 50 WP @ 3g/l or Indoxacarb 0.5 ml/l.

(5) Root-knot Nematodes

Management

- Seed treatment with bio-pesticide *Pseudomonas fluorescens* @ 10g/kg seed.
- Apply Carbofuran 3 G @ 1kg ai/ha at sowing and repeat after 45 days.
- Apply 2 tons of FYM enriched with *Pochoniachlamydosporia* and *Paecilomyceslilacinus* per acre before sowing, along with 100-200 kg of neem or pongamia cake.

Yield:

Generally, cucumber is ready for first harvesting in 35 to 40 days of planting depending upon climatic conditions and crop management practices. Harvesting is done when fruits are more or less cylindrical and well filled and should be carried out in early morning or late evening. The produce should immediately be moved to cool, shaded and ventilated area. As fruits are harvested manually, so these should be clipped or snapped with a slight twist motion and should not be pulled off the vines to minimize 'pulled ends'. Yield of 10-15 t/1000 m^2 can be obtained from greenhouse cucumber.

8. Protected Cultivation of tomato

Botanical Name: *Solanum lycopersicum L.*

Family: Solanaceae

Origin: Peru, South America

Chromosome No.: 2n=24

Type of fruit: Berry

Flower cluster: Truss

Lycopene is responsible for red pigment in tomato and it is the highest at 21-24^{0}C and drops rapidly above 27^{0}C. Yellow colour is due to carotenoid pigment.

Importance and uses:

- Protective food due to its Nutritive value & wide spread production.
- Grown throughout the year.
- Cultivation is very easy.
- Use as a vegetable, soup, salads, pickles, ketchup.
- Good source of Vitamin – A, B, C and helps in appetite, promoter of gastric secretion, cure constipation and blood purifier.

Soil:

Tomatoes can be produced across a wide range of soils as long as drainage and physical soil structure is good. Optimum soil pH is between 6.0-6.5, but crops can thrive well in soils with a pH of 5.0-7.5. The Soil based medium should be composed of 70% red soil, 20% well decomposed organic matter and 10% rice husk. The raised beds of 40 cm height and 90 cm top width are made for successful cultivation of crop. Now -a-days, it is an essential practice for all the greenhouses. Growing medium of a greenhouse is generally pasteurized annually**.** Formaldehyde

is a commonly used chemical to sterilize the soil medium. The formaldehyde (37-41 %)used for sterilization. After drenching, the soil medium will be covered with plastic film or black polyethylene sheet and all ventilation spaces be closed. Three to four days after formaldehyde treatment, polyethylene cover is removed and media is watered properly to drain excess/remove trapped formaldehyde fumes completely before transplanting.

Climate:

Temperature is the primary factor influencing all stages of development of the plant: vegetative growth, flowering, fruit setting and fruit ripening. Growth requires temperatures between 10°C and 30°C. Temperature and light intensity affect germination, vegetative growth, fruit set, pigmentation and nutritive value of fruits. The minimum temperature for germination of seeds ranges from 8 to 10°C. Light intensity is one of the major factors affecting the amounts of sugars produced in leaves during the photosynthesis, and this, in turn, affects the number of fruits that the plant can support and the total yield. Optimum relative humidity in glasshouse crops range from 60- 80%.

According to growth habit two types of tomato plant:

Indeterminate Type	**Determinate Type**
1.Growth remain continue	1. Growth up to certain limit
2. Main axis does not end in a flower cluster	2. Main axis ends in a floral bud
3.Tall plant 7 to 15 ft	3. Medium plant 3 to 4 ft in height
4. Spreading in nature hence staking is requiring	4. Moderately spreading
5. Season for flowering is not specific but observed flowering throughout the life period	5. Specific season for flowering
7. Life span long	7. Life span short
6. Fruits production in cluster e.g., Gujarat Tomato-1, Marglove, Sioux, Best of All	6. Fruits are not producing in cluster e.g., Gujarat Tomato-2, Anand Tomato-3, Pusa Red Plum

Choice of varieties:

Selection of the most suitable cultivar is a pre-requisite for successful tomato cultivation in a greenhouse. The greenhouse cultivars are indeterminate in growth habit and plants may reach to a length of 10 feet or even more during the growing period. The first step in raising any crop is to choose the best variety.

Criteria for the selection of variety for greenhouse cultivation:

- Size of fruit desired.
- Disease resistance.
- Lack of physiological problems, *i.e.,* cracking, cat facing, blossom end rot.
- Yield uniformity.
- Market demand.

Tomatoes grown in the greenhouses are generally divided into different categories as mentioned below:

1. Beefsteak cultivars

- Large Slicing type Fruits.
- Weight -180 – 250 gm
- Harvest-Individually or with Calyx
- Growing in: -European & American countries

2. Big fruited cultivars

- Small to medium cluster type Fruit
- Weight -80 -150 gm
- Growing in-Israel, Turkey, USA, India
- Varieties

Public sector	Pusa Ruby, Arka Abhijit, Pant polyhouse Tomato hybrid-1
Private sector	Naveen, Heemsohna, Anup, Rakshita, Trishul

3. Hand type or cluster type

- Clusters have Breaker to Ripe stage fruits.
- Fruit produces in cluster of 5 to 7 or more.
- Weight -50-70 gm



4. Cherry Tomato

- Use- Table Purpose
- Getting highly attention from Growers
- Size- Small
- Shape-Round to Oval
- Weight: - 12-20 gm
- Cultivars: - Solan Red Round, Shreeja, Ruhi, NS575(Namdhari seeds)

5. Coloured tomato

- Rich in Antioxidant & Vitamin-A.
- Outstanding Flavour.
- Gain better price due to attractiveness.
- Yellow,Brown,Blue,Green,Blue,Purple colour culrivars available.



Cultivars Raised Under NAU Protected Farm:

- Arka Rakshak, NS-4266(Big Fruited Cultivar)

Land preparation:

Land should be well prepared with 3–4 ploughing and harrowing followed by one planking to make soil friable. Raking is done to open up the beds.

Nursery management:

Tomato can be grown throughout the year under greenhouse conditions but special attention has to pay during off-season. Nursery for greenhouse tomato is raised under protected structure, mostly in soil less media in plug trays to produce disease free and mainly virus free seedlings.

Spacing: Indeterminate varieties: 60 cm x 45 cm

Manures & Fertilizer:

The keys to a successful nutrition program include the following:

- Use fertilizer designed specifically for greenhouse tomatoes.
- Be observant for signs that plants may be deficient or have an excess of a nutrient.
- If possible, monitor plant nutrient status by periodically taking samples for tissue analysis.
- Be observant for signs that plants may be deficient or have an excess of a nutrient.
- The crop is fertigated with N: P: K at the rate of 25:12.5:12.5 kg per 1000 m^2 along with farmyard manure (2t/1000 m^2). The fertigation is scheduled after 10-15 days of planting at weekly interval. The common dose of micronutrient (G-5) at the rate of 5 kg per 1000 m^2 was applied before transplanting of crop.

Crop Duration	Application ratio of fertilizers			Time of fertigation Initiation	Fertigation frequency
	N	P	K		
1st Growth Period (Up to 30 days)	2	3	1	10-15 days of planting	Once a week
2nd Growth Period (30-60 days)	1	2	2		
3rd Growth Period (60-90 days)	1	1	3		
4th Growth Period (90-120 days)	1	1	2		
5th Growth Period (120-150 days)	1	1	1		
6th Growth Period (150-180 days)	1	1	1		
7th Growth Period (180-210 days)	1	1	1		

Irrigation:

If Drippers are at 30 cm distance with water Discharge Rate of 2 lit/hr, adopt the following irrigation schedule for better results.

Crop Stage	Time of operation of drip system /irrigation (minutes)	Frequency of Irrigation		
		summer	Winter	Rainy
Up to Fruit Setting	60	Alternate Day	Every 4th Day	Every 4th Day
fruit Setting to First Harvesting	75	Alternate Day	Every 4th Day	Every 4th Day
first Harvest to one week prior to last harvest	60	Alternate Day	Every 4th Day	Every 4th Day

Training &Pruning:

For best production, prune tomato plants to a single stem, two stem or three stems by removing all lateral shoots, commonly referred to as suckers. Allowing all suckers to grow and bear fruit would increase the total number of fruits, but they would be small and of poor quality. It is better to have one main stem that bears fruit, as this will produce larger, more uniform, and higher quality fruit. Do this Once per week.

Plants are trained vertically along the supporting wire to exploit full potential of indeterminate varieties. When the plant reaches the wire height, it should be leaned and dropped.

Prune the plant to one main stem, wrap it around the support string. Always wrap in the same direction, if you start clockwise, continue clockwise; otherwise, when the plant gets heavy with fruit, it may slip down the string and break.

Cluster pruning will also improve size and uniformity. This involves removing small, Misshaped & Diseased fruit from some clusters, leaving three to five of the best.

Advantages of staking:

- Keeps the fruits above ground.
- Producing healthy, Clean, Large sized, Disease and pest free & firm fruits.
- Facilitates rapid picking and collection of fruits.

Disadvantages of staking:

- Adds more cost of cultivation.
- More cracking of fruits.
- Spreading of virus infection.

Pollination:

Tomato flowers have both male and female parts within every flower. Botanically, these are termed perfect flowers. In the greenhouse, wind is not strong enough to shake the flowers sufficiently to transfer the pollen. Greenhouse tomato growers should use an electric pollinator to ensure good fruit set. Vibrate the Cluster for about half a second during morning hours, when stigma receptivity and dehiscence are at their peak.

The optimum temperature for pollination is within the range 21 to 27°C. Optimum relative humidity is 70 percent.

Different growth hormones may facilitate fruit setting under the conditions, which are otherwise not conducive for proper release of pollens grains. Different growth hormones along with their role in tomato production are listed below.

Use of plant growth regulators in tomato cultivation:

Chemicals	**Common name**	**Dose (mg/l)**	**Effectiveness**
2-Chloroethyl-phosponic acid	Ethephon	200-500 whole plant spray	Flowering induction, better rooting and setting of plants
2,4-Dichlorophenoxy acetic acid	2,4-D	2-5 as seed treatment or whole plant spray	Increase fruit set, earliness and Parthenocarpy
3- Indole Butyric acid	IBA	50-100	Increase fruit set
3-Indole acetic acid	IAA	Foliage spray	For good fruit size and yield
4-Cholorophenoxy Acetic Acid	**4-CPAA**	**30**	**Increase fruit set, parthenocarpy**

Harvesting:

- By twisting of fruits with hand rather than pulling it from vine.
- Fruits are harvested according to use in following stages.

1. **Mature green stage**: Light green to yellow green for distant market.
2. **Pink stage / Breaker stage***:* Turning ¼ the surface at blossom end shows pink: For local market.
3. **Ripe stage**: For home or table use
4. **Full ripe stage**: Used for canning and pickling

Physiological disorders:

1. Blossom end rot:

Brown Water-soaked discoloration appears at the blossom end of the fruit occur due to high evapotranspiration.

Control:

This disorder is decreased by increasing the frequency of irrigation.

2. Fruit Cracking:

surface of the full ripe fruit's cracks radially from the stem end of the fruit. occur due to BORON deficiency.

Control:

Spraying seedlings before transplanting with 0.3-0.4% borax solution.

3. Puffiness:

Outer wall of the grown-up fruits (two-third normal size) continues to develop normally but growth of the remaining internal tissues (Placenta, mesocarp) is retarded resulting in partially filled fruit which is light in weight and lacks in firmness. Cross section of the affected fruit shows emptiness or pockets.

- Occur due to High temperature and high soil moisture.
- Non fertilization of ovules.
- Embryo abortion after normal fertilization.

Control:

1) Over irrigation should be avoided.

2) Less nitrogen should be applied.



Disease Management:

1. **Early blight** (*Alternaria solani,* A. *alternataf.sp. lycopersici*)

Management:

- Crop rotation with non-solanaceous host is essential for effective reduction of inoculum.
- Spray the crop with 0.3% mancozeb at 10-15 days interval starting from 45 days after transplanting.

2. **Late blight** (*Phytophthora infestans* (Mont) de Bary)

Management:

- Always use healthy and certified seeds collected from disease free area.
- Infected crop debris and fruits must be collected and burnt.
- Preventive sprays of Mancozeb @ 0.25% provide good control in cloudy, cold and drizzling weather but spray interval should be 5 to 7 days.

3. **Leaf Curl Complex (Virus-transmitted by white fly as well as by mechanical injury)**

Management:

1. Removal of weed host from field near surrounding areas.
2. Cover the nursery area or plug trays with 40-60 mesh fine nylon net and spray the seedlings with imidacloprid (3.5 ml/ 10lt).
3. Root dipping in Imidacloprid solution @ 4-5 ml per litre of water for one hour during transplanting of the seedlings.
4. Seed treatment with hot water at 50°C or 10% trisodium phosphate solution for 25 minutes.



Insect-pests Management:

1. Serpentine Leaf Miner (*Liromyza trifolii* Burgess)

Management

- Often the incidence starts from nursery itself. Hence, remove infected leaves at the time of planting or within a week of transplanting.
- Apply neem cake to beds in polyhouse @ 250 kg/ha at planting and repeat after 25 days.
- Spray neem seed powder extract 4% or neem soap 1% at 15-20 DAP.

2.Greenhouse whitefly (*Trialeurodes vaporariorum*)

Management

- Use virus resistant hybrids, if available.
- Raise nurseries in seedling trays under nylon netsor polyhouses.
- Spray Imidacloprid 200 SL (0.3ml/l) or Thiamethoxam 25 WP (0.3 g/l) in nursery at 15 days after sowing.

3. **Root-knot Nematodes *(Meloidogyne incognita, M. avania*)**

Management

- Use nematode resistant variety/hybrid if available.
- Follow crop rotation with marigold, wherever possible.
- Seed treatment with bio-pesticides- *Pseudomonas fluorescens* @ 10g/kg seed.

4. **Red Spider Mites (*Tetranychus urticae*)**

Management

- Remove and destroy the affected leaves.
- Spray neem oil/neem soap/ pongamia soap 1%.
- Spray need-based application of acaricides like Abamectin 1.9 EC @ 0.5 ml/l.




Grading:

- After removing green, over ripe, rotten and injured fruits they should be graded in to four grades.
- As per ISI standard:
  1. Super A
  2. Super
  3. Fancy
  4. Commercial

Post-harvest handling:

- Pre-cooling of tomato at 12-13°C on the farm prolongs their storage life.
- Keeping pedicel intact with fruits increase shelf life by 3-4 days.

- Evaporative cool storage (Pusa Zero Energy Cool Chamber) extends shelf life of tomato at breaker stage by 4-5 days.
- Fruit dip in 0.5% calcium nitrate or calcium chloride extends the shelf life by checking $CO_2$and ethylene production.
- Usually, bamboo basket and wooden boxes of various size and shapes are used for packing of tomatoes. Wooden boxes are generally used for packing for long distance markets.
- Corrugated boxes are best for packing of tomatoes.

Yield:

Harvesting of tomato fruits is a continual process throughout the growing season. Generally, most of the varieties are ready for first picking in 75-85 days after transplanting.

- The fruits should be harvested preferably early in the morning or late in the evening to avoid post-harvest losses and are then graded, packed according to grades.
- Cherry tomatoes are mostly harvested with stems attached or sometimes singly with calyx attached with the fruits and are packed in the containers of 400-500g capacity.
- On the whole, 25-30 tons of big fruited tomatoes and 10-15 tons of cherry tomatoes can be harvested from 1000 m^2 greenhouse cultivated area.

9. Protected Cultivation of melons

Climate:

Melons can be grown in hot and dry atmosphere but plants are sensitive to low temperature and frost. A humid climate may favour the development of foliar diseases. High humidity and excess moisture at the time of fruit maturity may hamper the quality of fruits. The optimum temperature for plant growth is 28-30^{o}C.Comparatively, low humidity and high day temperature during ripening period with enough sunshine are conducive for the development of flavour and total soluble solids (TSS) in fruits. These conditions are also suitable for reducing the chances of foliar diseases.

A well-drained sandy loam soil is most suitable for the cultivation of melons. Melons are slightly tolerant to soil acidity and prefer a soil pH of 6.0 to7.0.

Selection of variety:

Musk melon	**Water melon**
Varieties having netted fruits are mostly grown under greenhouse conditions in Israel and other countries for off-season cultivation and export to high markets	Varieties with medium sized fruits are preferred.
Majority of varieties bears andromonoecious flowers except PusaRasraj (Monoecious flower), thus requires artificial pollination for fruit set	All varieties bear monoecious flowers, also requires artificial pollination for fruit set.

"List of the open pollinated varieties identified/released in India by public Sector"

Crop	National level	State level
Musk melon	Kashi Madhu, PusaSarbati, Hara Madhu, Pusa, MHY-5, Madhuras, ArkaRajhans, Arka Jeet, Durgapura Madhu, NDM-15, PusaRasraj (F_1)	Punjab Sunehari, Punjab Rasila, ArkaRajhans, Hisar Madhur, RM-43, MHY-3, RM-50, Kashi Madhu **Hybrids:** Punjab Hybrid-1, MHY-3, MHL-10, DMH-4
Water melon	DurgapuraMeetha, Sugar Baby, ArkaManik, Arka Jyoti	Durgapura Kesar, Durgapura Lal RHRWH-12 (F_1)

	(F_1)	

"List of cultivars/ hybrids identified by Private Sector for general cultivation"

Crop	Name of cultivars/ hybrids
Musk melon	NS-915, NS- 89, NS- 931, NS-972, Dipti, Madhuras, Madhurima, Urvashi, Madhulika, MHC-5, MHC-6, DMH-4, Bobby,
Water melon	Nutan, Madhubala, Madhuri, Aashtha, Mithasnina, Khushboo, NS-701, NS-702, NS-705, NS-200, Madhu, Milan Nath- 101, MHW- 4, 5, 6, 11, Mohini, Amrit, Hanoey, Suman- 235, Netravati

Planting:

Under greenhouse conditions, melons are usually planted as off-season crop. Seeds of melons can be planted directly on the beds. However, in case of costlier seeds, first of all seedlings should be in pro-trays or polyethylene under protected conditions. Plants get ready for transplanting in 28-32 days. Melons are planted in paired rows on each bed at plant spacing of 60 cm x 45 or 60 cm x 50 cm.

Crop	Seed Rate (per 1000 m^2)
Musk melon	100-150 g
Water melon	200-250 g

Training and Pruning:

Melon plants are trained up wards, so that the main stem of plants is allowed to climb the overhead wires along with a polyethylene twine. The base of the twine is anchored loosely to the base of the stem with a non-slip noose and the plants are trellised on the twine vertically. After the plant reaches the horizontal support wires, it can be trained along with the steel wire (running on the length of the rows at a height of 8-9 feet) and then plants are rained down wards.

Removal of secondary shoot up to the seventh node is found optimal in musk melon to improve plant growth and fruit set and induce early flowering

The side branches are pruned up to 45-60 cm above the bed surface in water melon. Then side branches are pruned only after leaving one or two fruit buds (female flowers), which will bear the fruits. Plants are trellised, carefully, without any damage to the side branches and female flower on the main stem.

Use of Plant growth regulators (PGR) for early appearance of female flowers:

Crop	PGR	Dose	Stage of Application
Musk melon	Ethrel	250 ppm	First spray at 2-true leaf stage second at 4-true leaf stage
Water melon	2,3,5- Triiodobenzoic Acid (TIBA)	25-50 ppm	-do-

Pollination:

Both the melons require artificial pollination for better set owing their flower structure i.e., andromonoecious in musk melon and monoecious in water melon. Honeybees are the best pollinators for greenhouse grown muskmelon crop. One colony of honey bees *(Apismelifera)* having 20000 bees is sufficient for effective pollination in 1000 m^2 area of greenhouse. The direction of the beehive and proper ventilation are important factors for efficient working of the bees. Sometimes, honey bees may not respond well to greenhouse environment, so hand pollination can also be employed to affect artificial pollination. As stigma in both the crops is receptive in early morning, so hand pollination must be attempted during peak hours of stigma receptivity. Maximum of 3 fruits are retained per vine in musk melon while in water melon plants support the crop load of 2 fruits only.

Fruit Support:

Small, mesh bags (onion sacks), cheesecloth or nylons can be used as slings to support the fruit. The bags can be tied to the trellis or the support wire. The bag should allow light penetration and not hold moisture. When the fruit is ripe, the bag can be cut from the trellis. Micro seedless (or seeded) watermelons can be trellised within a high tunnel. If so, the fruit must be supported. Other types of watermelons (large, seeded or seedless) can be grown without a trellis and left to vine throughout the high tunnel.

Fertigation:

Fertigation schedule for melon cultivation under greenhouse is given as under:

25:20:30 kg NPK/ 1000 m^2

Crop Duration	Distribution pattern /ratio of fertilizers			Remarks
	N	P	K	
First Growth Period (Up to 30 days)	2	3	1	• Fertigation should be started at the appearance of 2nd-true leaf stage. • Fertigation should be carried out twice a week.
Second Growth Period (30-60 days)	1	2	2	
Third Growth Period (60 onwards)	1	1	3	

It is also recommended to apply 0.4 t vermicompost and 5 kg micro-nutrients (Grade-5) at the time of planting.

Irrigation management:

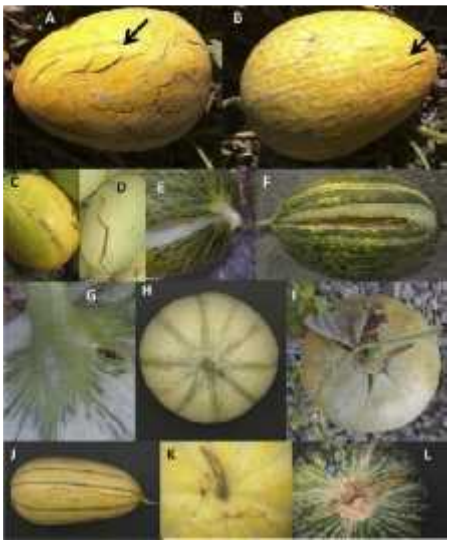
If Drippers are at 30 cm distance with water Discharge Rate of 2 lph, adopt the following irrigation schedule for better results.

Musk melon:

Crop Stage	Time of operation of drip system /irrigation (minutes)	Frequency of Irrigation
Up to 30 days	25	Alternate Day
31 to 60 days	40	Alternate Day
After 60 days	35	Alternate Day

Water melon:

Crop Stage	Time of operation of drip system/irrigation (minutes)	Frequency of Irrigation
Up to initiation of flowering	30	Alternate Day
Fruit Setting to First Harvesting	50	Alternate Day
First Harvest to one week prior to last harvest	40	Alternate Day



Melon splitting symptoms. (A, B) The black arrow is the typical net cracking with deep furrow as seen in Cartagena, Spain. (C) Transportation splitting. (D) Splitting in packing house. (E) Splitting following in part the netting cracks (F) Splitting with signs of direct sun exposure. (G) Start of cracking (H) Cracking around the peduncle immediately after harvest (I) Splitting in senescent fruit. (J) Cracking associated to full maturity (K) Cracking (L) Blossom-end.

Fruit drops in muskmelon:

Blossom-End Rot

Hollow heart

Sun scald

Stem splitting

Physiological disorders in musk melon:

A) Fruit cracking: Fruit cracking in musk melon should be observed due to boron deficiency. Spraying of Boron @ 50 g /25 l water should be done to control fruit cracking. Fertigation with 50g boron should be also done at weekly interval.

B) Fruit drop: Fruit drop occurred due to improper pollination. Care should be taken during hand pollination.

Physiological disorder in water melon:

1) Blossom End Rot (BER):

Blossom-End Rot (BER) is a physiological or non-parasitic disorder related to calcium deficiency, moisture stress or both. Prevention recommendations include adequate amounts of calcium, proper soil pH (6 to 6.5), and a uniform and sufficient supply of moisture. The incidence of BER usually is quite variable from season to *Commercial Water melon Production* season and tends to occur more readily in oblong melons. Water melons having BER are considered unmarketable.

2) Hollow heart and white heart:

HH & WH are two physiological disorders influenced by genetics, environment and, probably, a number of nutritional factors. To decrease the incidence of these two problems, only cultivars that have not shown unusually high incidences of HH or WH should be planted. In addition, the crop should be grown under optimal (as close as possible) nutritional and moisture conditions. HH and WH harm water melon quality and may be severe enough to cause potential buyers to reject melons.

3) Sunscald:

Sunscald is damage to the melons caused by intense sunlight. Sunscald can be particularly severe on dark-coloured melons. Developing and maintaining adequate canopy cover to afford protection (shade) to the melons may prevent sunscald. Sunscald reduces quality by making melons less attractive and may predispose the melon to rot.

4) Stem Splitting:

Stem Splitting can occur in seedlings grown for transplanting. This problem seems to be associated with high humidity and moisture that can occur under greenhouse conditions watering evenly to maintain soil moisture, avoiding wet-dry cycles in the media and good air circulation may help alleviate these problems.

Plant Protection:

Insect Pests	**Management Practices**
Serpentine Leaf Miner (*Liriomyza trifolii* Burgess)	• Soil application of neem cake @ 250 kg/ha immediately after germination. • Destroy cotyledon leaves with leaf mining at 7 days after germination. • . • If the incidence is high first remove all severely infected leaves and destroy. Then mix neem soap 5 gm and hostothion 1 ml/l and spray. After one week, spray neem soap 1% or PNSPE or neem formulation with 10000 ppm or more (2ml/l).
Red Spider Mite (*Tetranychus neocaledonicus* Andre)	• Spray neem or pongamia soap at 1% on lower surface thoroughly. • Alternately, spray Spiromesifen @ 1ml/l or Fenazaquin @ 3g/l.
Thrips (*Thrips palmi Karny*)	• Soil application of neem cake (once immediately after germination and again at flowering)

	followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval. • Spray any systemic insecticides like Acephate 75 SP @ lg/l or Dimethoate 30 EC @ 2ml/l.
Leaf Eating Caterpillars	• Soil application of neem cake (once immediately after germination and again at flowering) followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval. • Spray Indoxacarb 0.5 ml/l.
Root-knot Nematodes (*Meloidogyne incognita)*	• Seed treatment with bio-pesticide *Pseudomonas fluorescens* @ 10g/kg seed. • Apply Carbofuran 3 G @ 1kg ai/ha at sowing and repeat after 45 days. • Apply 2 tons of FYM enriched with *Pochoniachlamydosporia*and *Paecilomyceslilacinus*per acre before sowing, along with 100-200 kg of neem or pongamia cake.
Diseases	**Management Practices**
Anthracnose *(Colletotrichum orbiculare& C. lagenarium)*	• Always seed should be collected from healthy fruits and disease-free area. • Seeds must be treated with Carbendazim @ 0.25%. • Field sanitation by burning of crop debris. • Grow crop on bower system to avoid soil contact. • Maintain proper drainage in the field. .
Downy Mildew *(Pseudoperonospora cubensis)*	• Crop should be grown with wide spacing in well-drained soil. • Air movement and sunlight exposure helps in checking the disease initiation and development. • Bower system of cropping reduces the disease incidence. • Field sanitation by burning crop debris to reduce the inoculums.
Powdery Mildew (*Sphaerotheca fuligena and Erysiphe cichoracearum*)	• Foliar sprays of Penconazole @ 0.05% or Tridemorph @ 0.1% or Carbendazim @ 0.1%, give very good control of the disease. • Use tolerant line.
Leaf Spots (*Cercospora citrullina, Alternaria cucumerina and Corynespora*	• Field sanitation, selection of healthy seeds and crop rotation reduces disease incidence. • Fungicidal sprays of Mancozeb @ 0.25% alternated with one spray of Hexaconazole @

melonis, *Didymella bryoniae* (teleomorph) and *Phoma cucurbitacearum* Anamorph)	0.05%. • Seed production should be preferably carried out in summer season because summer crop is often free from disease.
Mosaic and Leaf Distortion	• Management of the disease involves destruction of diseased hosts and weeds. • Virus free seeds must be used to check the seed transmission. • Initial rouging of the infected plants. • Periodical spray of systemic insecticides up to flowering stage to control vectors.

Harvesting:
Harvesting Indices:

Harvesting stage of melons is given as under:

Crop	Days to first harvest	Harvesting indices/stage	Yield per 1000 m^2
Musk melon	75-80	When the fruits slip easily from the vine. Fruit should show changes in color and degree of netting, and a softening at the blossom end. Best eating maturity follows in one to three days; and best flavor is attained if musk melons are held near 21 °C for this final ripening then chilled for serving.	6-8 ton
Water melon	90-110	Fruits are harvested when they attain full size. At this stage the curly tendril closest to the point of fruit attachment is often shriveled or dried	18-20 ton

10. Protected Cultivation of bell pepper

Botanical name – *Capsicum annuum*

Family – Solanaceae

Chromosome no- 2n = 24

Origin – South America

Fruit type – Berry

Nutrient value - Vitamin A (8493 I U), Vitamin C (283 mg), and minerals like Ca, P, Mg, K etc. *Capsicum* is also known as bell pepper or sweet pepper (*Capsicum annum*), the most important vegetable crop in India. Owing to its high nutritive value, it is often looked as a luxury vegetable. In India, it is cultivated over an area of 29.14 thousand ha with a production of 153.35 MT. High quality, coloured bell pepper can be produced year-round and especially during the high-priced off season in protected environment. Fruit of bell pepper can be harvested with green, red, orange or yellow depending on cultivar used and the stage of harvesting. Coloured *Capsicum* are in great demand in urban market. The demand is mostly by hotels and catering industry.

Selection of site:

Place having high rainfall and high humidity are not suitable for its cultivation, since it encourages much foliar disease.

Climate:

Capsicum is cool season crop and day temperature less than 30 °© favourable for growth and yield. Higher temperature result in rapid plant growth and affect fruit set. Lower night temperature 20 °© favour flowering and fruit set. Shading and misting is required during summer to avoid temperature build up in green house. Moderately high RH (50-60%) is preferred, which can be maintained by managing the *ventilation.*

Soil: Well drained sandy loam soil having good percolation is most suitable for *Capsicum*. The soil pH 6-7 and EC < 7 m mhos /cm is ideal for growing capsicums. Most of green *house for* crop production use soil-based media. The soil-based medium is composed of 70 % red soil, 20%well decomposed organic matter and 10% rice husk.

Structure: Poly house gives better protection to net house due to total avoidance of rain water entry into poly house; hence leaf disease can be easily controlled. Yield is normally 15-20 % more in poly house compared to net house.

Selection of cultivar:

Growing of capsicum hybrid in green house is useful to obtain continuous and regular flower and fruit setting relatively for a long period of 8 to 10 months. Most of the capsicum hybrids produce green fruits that mature to red, orange or yellow depending on hybrid. The fruit should have characters such as uniform size and shape preferably four lobes, fruit weight of > 150 g, uniform colouring after attaining complete maturity with better shelf life of more than 5 day under ambient conditions. Selected hybrid should be high yielding, with potential yield > 40 t/acre.

➢ **Popularly grown commercial hybrids in India:**	
➢ Green color: Indra, Yamuna	➢ Orange: sympathy
➢ Red: Bombay, Triple star, Natasha, Passarella.	➢ White: white 1

➢ Yellow: Sunnyez, Swarna, Orobelle, Bachata.	➢ Chocolate: chocolate wonder

Nursery raising:

- Good quality seeds are required for better seedling. The seedlings are raised in pro- trays of 98 cells or cavities.
- About 16,000 – 20,000 seedlings are required to plant one acre for which 160-200 g of seeds is required.
- The pro-trays are filled with sterilized cocopeat and seeds are sown, one seed per cell to a depth of ½ cm and covered with the same media.
- Seeds germinate in about a week's time after sowing. The trays are shifted to net house /poly house and lightly watered. After 15 day of sowing mono ammonium phosphate (3g/l) and 22 day of sowing 19: 19: 19 (3g/l) solution has to be drenched.
- The seedlings will be ready for transplanting in 30-35 days.

Land preparation:

The land should be thoroughly ploughed and soil should be brought to a fine tilth. Well decomposed organic matter at the rate of 20-25 kg per sq. meter is mixed with soil. Raised beds are formed and size should be 90-100 cm wide and 15-22 cm height. Between the bed walking space of 45 -50 cm need to be provide.

Fumigation: the beds are drenched with 4% formaldehyde (@4L / m² bed) and covered with black polyethylene mulch sheet. Four day after fumigation, the polyethylene cover should be removed; the beds are raked every day to remove the trapped formalin fumes completely, prior to transplanting.

Transplanting:

The planting beds are watered to field capacity before transplanting. Seedlings of 30-35 days old are used for transplanting. Care should be taken to see that no damage is occurred to roots, while taking out the seedlings from cells of portray. Seedlings are transplanted into holes made in polyethylene mulch film at a depth of 5 cm at 45 ×30 cm spacing. After transplanting, seedlings are drenched with 3 g/L

copper oxy chloride solution to the base of seedlings at the rate of 25-30 ml per plant. Watering the beds daily during afternoon by using hose pipe for a week continuously is essential.

Fertilizer management:

Fertigation schedule for capsicum cultivation under greenhouse is given as under:

25:25:25 kg NPK/ 1000 m^2

Crop Duration	Distribution ratio of nutrients			Time of fertigation Initiation	Fertigation frequency
	N	P	K		
1st Growth Period (Up to 30 days)	2	3	1	10-15 days of planting	Once a week
2nd Growth Period (31-60 days)	1	2	2		
3rd Growth Period (61-90 days)	1	1	3		
4th Growth Period (91-120 days)	1	1	2		
5th Growth Period (121-150 days)	1	1	1		
6th Growth Period (15-180 days)	1	1	1		

It is also recommended to apply 0.5 kg *Trichoderma viride*, Phosphorous Solubilizing Bacteria (*Bacillus megaterium*), Azotobacter, *Pseudomonas fluorescens* each, 0.4t vermicompost and 5.0 kg micro-nutrients (Grade-5) per 1000 m^2 at the time of planting.

Irrigation management:

If drippers are at 30 cm distance with water Discharge Rate of 2 lit/hr, adopt the following irrigation schedule for better results.

Crop Stage	Operational Time of MIS (minutes)	Frequency of Irrigation		
		Summer	Winter	Rainy
Up to Fruit Setting	60-75	Alternate Day	Every 4th Day	Every 4th Day
fruit Setting to First	75-90	Alternate	Every 4th	Every 4th

Harvesting		Day	Day	Day
first Harvest to one week prior to last harvest	60-75	Alternate Day	Every 4th Day	Every 4th Day

Pruning:

The growing point at the top of the plant is removed after 20-25 days of plating, which is known as is called topping. This technique is adopted for producing more branches**. Pepper plants develop initially develop single stem and after 7-11 leaves, a terminal flower develops where after main stem divides into two or sometimes into three/ four. The flower in the first branching is called crown bud. The bud is not allowed to develop into fruit and it is removed after appearance.**

Pinching of apical bud after 20 to 25 days of planting for emergence of side shoots

Training:

The main stem of plant is tied with four plastic twine to train along and tied to GI wire grid provided on the top of the plants. This is practiced after four weeks of transplanting. The new branches and plants are trained along the plastic twines. The

most appropriate system for green bell pepper grown for consumption in local market is four shoot systems, whereas coloured bell pepper should be trained in two shoot system for getting appropriate fruit size actable at market.

Fruit thinning:

When there are too many fruits on the plant, it is necessary to remove some fruits to promote the development of remaining fruits. Fruit thinning is done when the fruit is of pea size. This practice is normally followed to increase the size of fruit thus by increasing the quality of production.

Integrated Pest Management:

1. Mites

Symptoms: Young larvae and adults feed on leaves, bud and fruits, suck sap from plants parts, cause downward curling of leaves. This pest infestation increases with increased temperature coupled with high humidity.

Management: Remove the pest damaged plant parts including leaves, flowers and fruits and spray Pongamia oil (5-8 ml/L) / Neem soap (8-10 g/L) or chlorophenapyriphos (1ml/ L) or fenazaquin (1 ml/L).

2. Aphids

Symptoms: Nymphs and adult aphids suck sap from leaf veins and younger leaves resulting in reduced plant growth and decrease in yield. Its infestation not only causes curling of leaves but also spreads viral diseases.

Management: Keep a close watch on the plants at regular intervals for aphids' infestation. Spray Pongamia / Neem soap (8-10 g/L) or imidacloprid (0.5ml/L) or thiamethoxam (0.5g/L) or dimethoate (2ml/L).

3. Fruit borer

Symptoms: Fruit borers are very active during night. The adults lay eggs on fruits, flowers and leaves in large number and the nymphs that 14 come out of eggs, feed on fruits and leaves causing heavy destruction of crops and severely affects the quality of the produce. Whenever night temperature is low, coupled with cool and high humidity the infestation is increased.

Management: Pick and destroy nymphs and adult insects. Generally, eggs are laid and hatch in groups, which is easy to identify from a distance. Hence, they should be identified and destroyed immediately. Spray thiodicarb (1ml/L) or carbaryl (3g/L) or fipronil (1ml/L).

4. Nematodes

Symptoms: Initially yellowing of leaves can be observed followed by reduction in leaf size, count and drastic reduction in size of fruits. When infected plant is uprooted and observed, small and big nodes filled with large number of nematodes nodules can be observed on roots depending on the level of infestation.

Management: Go for crop rotation with non-solanaceous crops like marigold, sweet corn and cabbage to avoid nematode. Bio-pesticides enriched Neem cake is to be applied @ 800 kg/ acre 4-5 days before transplanting to the beds. Apply carbofuran (furadan) granules @ 20kg /acre at the time of planting.

5. **Thrips**

Symptoms: Thrips cause upward curling of leaves, sucks sap and reduce leaf growth, plant growth, yield and market value of produce.

Management: Remove affected plant parts including leaves, flowers and fruits. Keep the plots clean by removing all the dropped plant parts. Spray Pongamia oil (5-8 ml/L) or Neem seeds kernel extract (NSKE 4%) or fipronil (1ml/L) or chlorpyriphos (2 ml/L) or acephate (1.5g/L). Drenching of soil using chlorpyriphos (4ml/l) or imidacloprid.

Integrated disease management:

1. **Damping off**

Symptoms: Infection takes place at the base of the young seedlings just above the ground level which leads to wilting and later death of seedlings.

Management: Drench carbendazim (1g/L) or metalaxyl MZ (2g/L) or copper oxychloride (3g/L) or captan (3g/L) drenched to the base of the plant at about 25-50 ml/plant.

2. Powdery mildew

Symptoms: The disease initially appears as tiny yellow spots on surface of leaf and powder like material on the lower surface leading to a powdery growth covering the entire lower surface of leaf which leads to drying and dropping of leaves at later stages.

Management: Spray Neem oil (7ml/L) + sulphur WDG-80 (2g/L) or wettable sulphur (2g/L) or hexaconazole (0.5ml/L) or dinocap (1 ml/L).

3. **Cercospora leaf spot**

Symptoms: Cercospora appears initially as tiny yellow spot-on leaf surface leading to increased dark grey spots which spreads on entire leaf resulting in dropping of leaf.

Management: Spray chlorothalonil (2.5g/L) or mancozeb (2.5g/L) or carbendazim (1g/L).

4 .Phytophthora rot

Symptoms: This disease appears during fruiting and flowering stage resulting in tiny oil like spot on leaf surface resulting in rotting and blackening of plants. Later plant weakens and dies in 2-3 days. Heavy and continuous rainfalls coupled with high humidity favor disease appearance and its quick spread.

Management: Spray copper hydroxy chloride (3g/L) or Bordeaux mixture (1%) or metalaxyl MZ (2g/L) or dimethomorph + mancozeb (1 g + 2.5g/L. Severely infected plant parts should be destroyed. It is better to avoid capsicum cultivation in severely affected net-houses.

5. Viral diseases

Symptoms: Viral diseases are transmitted through aphids and thrips leading to upward and downward curling of leaves with yellow spot in the middle of leaf and sometimes on fruit also. Heavy infestation leads to dropping up of leaves, stunted plant growth and reduces quality and quantity of fruits. Virus affected fruits are unmarketable.

Management: Grow nursery beds under nylon cover (50mesh), proper management of aphids, mites and thrips which acts as disease transmitting vectors and disposal of infected plants, control infestations of viral diseases.





Harvesting and yield:

Early morning hours are best suited for capsicum harvest. Green capsicum can be harvested at 55 to 60 days after transplanting, yellow capsicum at 70-75 days whereas red capsicum at 80-90 days. Fruits can be harvested once in 3 to 4 days. Yellow and red fruits can be harvested when they have gained 50-80 per cent of the colour development. The average yield of capsicum per acre is 30-40 tons.

Post-harvest management:

Grading:

Capsicums are highly perishable in nature and lose water very rapidly due to shrivelling, drying & softening of the fruit which accelerates deterioration. Good quality fruits are selected and are cleaned with clean, dry and soft cloth to remove

water drops or wetness or powdery residues of pesticides/ fungicides, if any, found on the fruits and infected, damaged and diseased fruit should be discarded. Good quality fruits with 2-3 lobes weighing < 150 gram are graded as B grade fruits. Generally, fruits with 3-4 lobes weighing 150 gram and more are grouped as A grade fruits. Only the graded fruits are packed in the cartoon boxes.

Packing and storage:

Graded fruits should be packed in CFB cartons (5/7 ply thick) in single or in multiple layers with paper shreds as cushioning material for long distance transport. The optimum conditions for storage of capsicum is 7- 8°C temperature with high relative humidity (90 to 95 %) where the shelf life of fruits can be extended for 2 to 3 weeks. Capsicums are sensitive to chilling injury below 5° C which leads to softening, pitting, and decay of fruits.

Shrink wrapping technology of capsicum:

Shrink wrapping is advantageous over normal storage as it reduces weight loss, maintains firmness and reduces chilling injury, blemishes and secondary infection of fruits. Under low temperature storage (8-12°©), the shelf life of shrink-wrapped fruits can be extended up to 6 weeks. It also delays ripening & senescence and thereby extends storage life of fruits.

11. Protected Cultivation of Rose

- **Botanical name:** *Rosa spp.*
- **Family:** Rosaceae
- **Origin:** India (northern hemisphere)
- **Queen of Flower**

Rose is a leading cut flower grown commercially all over the world. It ranks first in global cut flower trade. This flower has a worldwide consumption of more than 40 billion (Singh, 2009). The heavy demand for rose cut flowers in the European markets is mainly from November to March due to the shortage of local production because of severe winter. Fortunately, this is the most congenial condition for successful production of most of the flowers, including roses in India. It is pointed out that buyer at international market prefers a very high-quality rose cut flowers. As it is difficult to obtain good quality cut flowers under open conditions throughout the year, the crops should be cultivated under the greenhouse to get good quality produce. Greenhouse cultivation in India is of recent origin and is being increasingly practiced

for production of quality produce in the off-season for export. The crops grown in the greenhouse remain unaffected with the outer atmosphere and thus optimum and controlled use of sunlight is made

- **Uses:**

i. Garden display
ii. Climber
iii. Hedges
iv. Edges
v. Rockeries
vi. Pot plant
vii. Loose flower
viii. Cut flower
ix. Perfume and Allied product etc.

- **Types of greenhouses required:**

Under mild climatic conditions (Bangalore and Pune) roses can be successfully cultivated under Naturally Ventilated Polyhouses.

However, under warm and high temperatures (Hyderabad and Delhi) it needs forced ventilation system (Cool-Cell Pad) to get quality flowers.

- **Climate Requirement:**
- **Light intensity:**

Light is important factor affecting growth.6000-8000 ft candles or 6-8K Lux is good for roses. Sunshine for six hours is ideal for better growth and flowering.

❖ **Temperature:**

It is another important factor regulating growth and flowering of roses. It affects both quality and quantity of flowers. Maximum of 28□ in day and 15-18□ in the night will be ideal for rose production. The growth slows down with the fall of temperature below 15□ and high temperature above 28□, quality of flower is adversely affected.

❖ **Humidity:**

RH is very important with respect to pests and disease incidence especially mildews and black spot as they are closely associated with high RH in greenhouses as the high humidity results in condensation of water on flowers and leaves. About 60% RH is the most ideal for rose production.

❖ **CO2 requirement:**

Vegetative growth, yield and quality of flowers can be improved by introduction of supplementary CO2 up to 1000ppm. Beneficial response of CO2 however depends on proper temperature and light management.

❖ **Ideal growing media:**

The growing media for roses under poly houses may be soil, sand, coco peat and rock wood. Media should contain Red soil (70%), FYM (20%), Rice husk(10%). Ideal pH for the media is 6.0-6.5.

❖ **Soil sterilization:**

To save the crop from soil borne diseases, soil sterilization must be carried out well before rose cultivation. The soil should be fumigated with Formaldehyde (2%) (100

ml Formalin in 5 lit of water/sq m.). Cover the soil with polyfilm for a week at least. Leach the soil with water before preparing beds.

❖ **Preparation of beds:**

Grasses and any perennial weeds should be removed along with their roots, knots, rhizomes, etc. by deep digging. Pits or trenches are to be made and basal dusting with Malathion has to be done. The pit / trench should be filled with soil and FYM.

Generally, bed length should be according to size of greenhouse, 60 cm wide and 30-50cm height. The distance between two beds should be 40-50 cm. Double rows systems is followed and double row system is better than that of 3-4 rows beds. Spacing should be30cm×30cm.

The plants are planted leaving 15 cm space from the edge of the bed. Planting density is 7.5 plants/ m2 or 70000 plants/ha.

❖ **Planting:**

- 6-18 months old budded or grafted plants may be planted during May-June. The soil should be loose and humid but not too wet nor muddy. Planting may be in 2-row system. The distance between the plants in one row varies around 15-20 cm. Accommodates 7 to 8 plants per meter square (Depending upon cultivar and cultivation system).

❖ **Schedule for Fertilizer:**

Calcium nitrate	Urea	00:00:50	Humic acid
100gm	50gm	100gm	50ml

Mon, Wed, Fri

Magnesium Sulphate	Urea	12:61:00	Humic acid
100gm	50gm	100gm	50ml

Tue, Thu, Sat

❖ **After care of rose:**

❖ **Removal of young and wild shoots:**

This practice is also known as de-shooting. It is generally followed in HT roses. Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoots. It is important from the point of stalk length.

❖ **Bending:**

- After planting, shoots will develop quickly. Only after the flower bud becomes clearly visible the shoots are bend-out towards the path and the flowers are removed, this process is known as bending.
- Since the plants grow about 40 cm above the ground, it is possible to bend down the stems deeply.
- The shoots should be bending down so the grafting place or, if a cutting is used, the old top of the cutting will become the top of the plant. The flower buds on these bend-out shoots have to be removed. This system allows the leaves to continue their production of energy. When the dominating primary shoots (apical dominance) is removed, causing the plant to respond by developing more basal buds. In the plant hormonal changes take place, which promote shoot development (balance cytokinins/ auxins).

❖ **Primary bending / Mother bending:**

- Have to be taken up 5-6 weeks after planting.
- The branch which arises from the main shoot of the plant leaving two healthy leaves, the portion above is pressed hard with twist to split the inner stem portion then again pressed with thumb and bend smoothly towards the path side of the bed with thumb and index finger.
- The two leaf axil buds later produce strong, healthy, tall shoots with flowers. This process is repeated. By this process stronger shoots are selected and weak ones left as pinched stems to provide leaf cover.

- **Secondary bending:**4-5 weeks after first bending to get a greater number of strong shoots. It is done at around 40-45 cm plant height.

- **Disbudding/Thinning:**
  - Removal of undesirable buds is known as disbudding. Keeping only the central bud and removal of others causes development of a quality bloom. It is done in standard/HT roses to reduce number of flowers.
- **Removal of yellow and diseased leaves:**
  - This process helps in nutrient translocation and prevention of further spreading of diseases.

❖ **Bud Capping:**

The flower buds are inserted with nylon a cap which helps for maintaining compact bud size, avoids damage in transportation and maintains the microclimate in package.

❖ **Irrigation:**

- Each plant has to be watered @ 0.75 -1.0 liter/plant/day. A capacity of 2 liters per hour is preferred as the chance of congestion is smaller. By using a drip system, a wet (water) column is created through which the roots grow.

❖ **Harvesting and yield:**

- Yield starts 4-5 months after planting.
- Harvest the flower buds at tight bud stage for longer distance.
- Stem length vary from 40-90cm.
- At harvest it is often a practice to cut back the first 5-leaves.
- Hence, it is recommended for cutting back to just above the original cutting.
- The length of the remaining stem decides the number of shoots (flower stems) which will grow back.

- If too much (4-6 cm) stem is left, many shoots are formed of a poor quality. Therefore, it is advised to cut back to 1 cm.
- Flower yield ranges from 150-200 stems per m2 in large hybrid tea, medium types and small and sprays, respectively.

❖ **Post-harvest technology:**

- Immediately after cutting the stem should be dipped in clean water up to the neck or base of the flower bud. The delay in keeping the cut flowers in water will leads to air entry and results in vascular blockage.

(1)Pre-cooling:

- In a cold storage at the temperature of 4.4 to 7.2oC the flowers have to be kept. immediately after harvesting to remove latent heat which enhances the keeping quality of flowers Then they have to be dispatched to market with maintaining cold chain. It should be transported to Airport by “Refrigerated Van‟ and store them in cold storage at airport and directly shifted to refrigerated cargo flights. Usually, pre-cooling is done for 6-8 hours in winter and 8-12 hours in summer.

(2) Pulsing:

- Treating of cut flowers with 2-4% sucrose solution for 3-4 hours. This in turn makes the cut flower very hardy and turgid to improve the quality of cut flowers, also have les neck bending.

(3) Grading:

- The flowers which are in uniform stem length and developing flower buds should be grouped together at the time of cutting and kept them in separate container. For easy handling the basal foliage and thorns may be removed up

to 20 cm at the time of cutting of the flowers. It is necessary to dispatch the flowers within 24-30 hours after harvesting.

(4) Packing:

- The graded cut blooms have to be packed in corrugated cardboard boxes (CCB). The size of the boxes varies with the quality and quantity of roses to be packed. A box of 100cm length, 32.5cm width and 6.5cm height will accommodate 250-300 roses of 65-70cm long stem. The inside area of the box is lined with thin polythene film and very fine newspaper. Moist tissue papers are spread out end to end of the box to provide a cushion to blooms. The blooms are generally packed in bundles of 20 each and bundles are tied with string or rubber band. The upper portion of each bundle having flower buds and are wrapped in a corrugated paper which is fixed with an adhesive tape or rubber sheet. The labeling of cultivars is made on the paper. The lower half of the bundle is wrapped with tissue paper. Two bundles are placed opposite to one another all along the length of the boxes in such a way that their flower buds will face the side of the box and their stem end towards the center of the boxes and at the sides there will be cushioning have to be provided. After this the stem ends of two bundles on either side are secured firmly with a wooden stick fixed along the width of the box. This wooden stick is placed over a strip of foam rubber to avoid damage of stem. The inside of the box is finally covered with a sheet of tissue paper before putting the cover of the box. Labelling is done with all details including cultivars, colour, stem length, number of flower/bundles, total quantity of flowers in a box and the firm,

etc. all along the outer edges of the boxes either adhesive tapes or plastic tying strips with tying machine. The final box will weigh about 5-6 kg.

❖ **Pests and diseases:**

❖ **Pests:**

i. White Flies,
ii. Red Sales,
iii. Aphids,
iv. Thrips,
v. Mealy Bugs,
vi. White Flies, Jassids (Leaf Hoppers),
vii. Nematodes (Root knot & lesion nematodes) etc.

❖ **Disease:**

i. Die back (Diplodiarosarum + Collectotrichumsp)
ii. Powdery mildew (Sphaerothecapannosa var. Rose)
iii. Black spot (Diplocarponrosae)
iv. Leaf spot (Alternaria alternata)
v. Botrytis blight (Botrytis cineria)
vi. Root Fungus

vii. Root wilt & Root Mosaic Virus

viii. Root wilt & Root Mosaic Virus

❖ **Physiological disorder:**

i. Bent neck

ii. Blind wood Nau

iii. Bull heads

iv. Color fading

v. Blackening of rose petals

12. Protected Cultivation of gerbera

- **Botanical name –** *Gerbera jamesonii*
- **Family –** Asteraceae
- **Chromosome** No: 2n = 50
- **Origin** – South Africa & Asia

Introduction:

- Gerbera, commonly known as Transvaal Daisy, Barberton Daisy or African daisy is cultivated throughout the world under a wide range of climatic conditions for its attractive flowers. It is highly suitable for beds, borders, pots and rock gardens.
- In India gerbera is commercially grown for export as well as domestic market. Tropical Flori. tech Pvt. Ltd. in Bangalore is the leading player in commercial cultivation in India.
- The leading producers of gerbera are the Netherlands, Germany, Italy, France and California. In India it is mainly cultivated in West Bengal, Karnataka, Tamil Nadu, NE states, Maharashtra and Andhra Pradesh.

Botanical Description:

- The plants bear flowers like daisy, 7-10 cm long across flower heads, many flowers have the conspicuous rays in 1 or 2 rows. The flowers may be single or double and are available in various single-colored cultivars as well as in double color.

- The wide range of colors include yellow, orange, cream, white, pink, brick red, scarlet, salmon, maroon, terracotta and various intermediate shades. Flower stalks are long, slender and leafless. Achenes are beaked and pappus.

Species and cultivars:

The genus Gerbera is named after the German botanist, Traugott Gerber in 1743. In 1880, Captain Jameson discovered a wild species of gerbera from South Africa and took it to Great Britain. The present cultivated varieties originated from crossing the progenies of two species, *G. jamesonii* and *G. viridifolia.* They mostly inhabit Temperate or mountain regions. The genus Gerbera consists of about 40 species of which half are hardy and perennial flowering plants. Some of the species are:

1. *Gerbera asplenifolia*
2. *Gerbera aurantiaca*
3. *Gerbera jamensonii*
4. *Gerbera kunzeana*
5. *Gerbera viridifloia*
6. *Gerbera hintonii*
7. *Gerbera maxima*

Cultivars:

Some of the commercially important varieties are:

Flower colour	Varieties
Bicolor	Papov, Sunway
Cream	Farida, Dalma, Snow Flake, Winter Queen, Dana Ellen, Manmut
Yellow	Uranus,Cabana,Deliana,Essandre,Fredking,Nadja,Doni,Supernova, Talasa
Rose	Rosalin, Salvadore
Pink	Marmara,Esmara,Pink Elegance, Fredaisy, TerraQueen,Valentine
Orange	Maron Clementine, Goliath,Marasol, Carrera
Lilac	Labalga,Banesa,Malibu
Red	Ruby red,Dusty,Shania,Vesta, Tamara, Salvadore
White	Delphi, White Maria

Important greenhouse varieties are Terra Juba, Ambassador, Faith, Barok, Latara, Basic, Dakoia, Terra Kalina and Vasuvius.

Varieties cultivated in ACHF, NAU Protected Cultivation

- Terra Kalina
- Breakdance
- Livia
- Basic
- Terra country

Climatic requirement:

- Gerbera is a fairly hardy plant and can be grown both in plain and in hills. In tropical and sub-tropical conditions, gerbera are grown in open, but in temperate climate they are protected from frost and cultivated in green house. They like sunny conditions in cool weather but during the summer months they should be lightly shaded if left out in beds.
- Production of quality flowers requires shade house 50% or naturally ventilated polyhouse. Day temperature of 22-25^{o}C and night temperature of 12-16^{o}C are ideal. The ideal temperature for flower bud initiation is 23^{o}C.

Preparation of beds:

- Bring soil to fine tilth by ploughing 3 times. Gerbera is usually grown in raised beds of 30-50 cm height, 60 width and leaving the space of 40-50 cm between the beds.

- The beds should be well drained, highly porous, should provide aeration to the root system. Add well rotten FYM, sand and paddy straw in 2:1:1 proportion to the prepared bed.

Planting season:

- Gerbera planting can be done in spring season (Jan-march) for 1.5-year tissue culture plants in good light intensity. June-July is suitable for 1, 1.5 and 2 year tissue culture plants. Planting in autumn and winter (Nov-Dec) is not recommended due to low light intensity and high heating cost. Planting should be avoided in late August-September.

Planting distance:

- While planting 65% portion of root ball should be kept below ground and rest of the portion i.e., 35% should be kept above the ground for better air circulation in the root zones. Ideal planting density and spacing: 8-10 plants/sqm or 30 X 30 cm or 40 x 25 cm.

Planting methods:

- Soil should be dug to depth of 45-60 cm. A layer of rotted FYM (5-7 cm thick), leaf mould or humus should be prepared over the surface and then incorporated with the soil at the time of digging and manuring should be done at fortnight ahead of planting time. The plants should be set with the crowns well above the soil surface to avoid occurrence of crown rot. The plants must be 30 cm apart within the rows and rows are spaced 30-35 cm apart.

Irrigation:

- Immediate irrigation is required after planting and continue to irrigate for a month to enable a good root establishment. Thereafter irrigation should be

given by drips once in 2 days @4 lit/drip/plant for 15 minutes. An average requirement of water is about 500-700 ml/day/plant (4-6 liter/m^2) depending on the season and stage of crop.

- Irrigate young plants first with mist for about 10 days and then through drip. It is preferred to have two drip lines running adjacent to the rows in the center. Drippers (2 lit/hr.) should coincide with plants for proper irrigation and fertigation. Too wet soil will invite phytophthora root rot and too dry will invites mites.

Manure and fertilizers:

- Basal Application of Fertilizers before Planting**.**
- First fertilization should be made about 10-14 DAP. Apply 8-10 kg of FYM /sq m. Apply NPK 19:19:19 @ 1.5 g/lit once in 2 days during 1st 3 months for better foliage. When flowering commences apply NPK 15:8:35 @ 1.5 g/lit daily after 3 months after planting for good quality of flowers.
- Apply micronutrients like B, Ca, Mg, Cu, Fe @ 0.15% which is 1.5 g/lit of water once in 4 weeks give excellent quality gerbera flowers. Mg and Fe deficiency results in interveinal chlorosis in lower and upper leaves respectively. Low pH (<5.5) results in Mn toxicity.

Cultural practices:

- Remove flower buds up to 8 weeks and then allow for flowering when plants have 12 leaves.
- Remove old and infected leaves regularly.
- Scout for any pest and diseases symptoms daily.
- Keep the shade net 50% close when the plants are younger during summer.
- For easy absorption of water and fertilizer, to provide air circulation to the roots, rake the soil once in a week.
- Hand weeding should be done whenever required.
- Humidity and temperature is maintained by operating foggers.

Harvesting and post-harvest handling:

- Harvesting is done when the outer 2-3 rows of disc florets are perpendicular to the stalk.

- Gerbera respond well to re-cutting of stem before placing in water or preservative solution. Gerbera are not suitable for long-term storage as the flowers lose 40 per cent of their vase life even handling and use of floral preservatives improve the keeping quality of flowers.
- Gerbera are the only cut flowers that are not damaged by chlorinated water. Cut flowers should be placed, in fresh water or chrysal-VB solution, immediately after harvest but not in previously used water. The noxious effect of used water could not be corrected even if the flowers were transferred 24 hr later into fresh water.

Good flower:

- Stalk length: 45-55 cm
- Diameter :10-12 cm
- Vase life.: 8-10 days
- Bundle :10 stem

Yield: Average yield under polyhouse is 250-300 flowers/m^2/year.

Grading and packaging:

- After picking, the flowers are graded according to quality, stage of maturity, flower diameter and stem length. The most important thing for packing is that the sensitive and vulnerable flower head is protected during transport. The flowers damage easily, which is visible to the customer.
- Different ways of packing are: carton boxes, plastic cups, plastic netting or plastic covers. One of them is the gerbera flower racket. When necessary, the flowers can be stored in a cooling room. The optimum temperature is 8^oC. With lower temperature, the colour and quality of the flowers are decreased. Botrytis might occur with a high humidity in the cooler or with large variationin temperature.

Diseases

Foot Rot: (*Phytophthoracryptogea)*

The infection occurs just at the soil surface on the collar portion of the stem. In some cases, the leaves turn yellow and the entire plant wilts. The disease can be controlled by drenching the soil in the root zone of the plants either with metalaxyl (0.4-1.6 g/m^2)

Root rot:

Several fungi *Pythiumirregulare, Sclreotiumrolfsii* and *Rhizoctoniasolani* affect the root system of gerbera. Sterilizing soil before planting and regular application of fungicides such as copperoxychloride to the soil may help in disease control.

Blight or Grey mould: *(Botrytiscineria)*

The fungus infects young apical portion of the plants and also flowers. The infection causes white powder coating on the foliage. Humid and wet conditions are favourable to the disease. Spraying Benlate or Carbandazim gives good control of disease.

Downey mildew :*(Bremialactucae)*

The disease can be controlled with the use of Metalaxyl @0.1-0.15 % by spraying 3 to 6 times at fortnightly intervals.

Powdery Mildew :(*Erysiphe cichoracearum)*

The species most often reported on gerbera is *Erysiphecichoracearum*. Powdery mildew is more severe on older plants because they have a denser, humidity-retaining growth. Temperature optimum for *E. Cichoracearum* is 20-25ºC. Air circulation between plants helps to reduce disease.

Bacterial blight:

A severe leaf blight disease which limited gerbera production it is characterized by small to large, circular to irregular brownish black leaf spots with or without concentric rings.

Mosaic:

Gerbera mosaic virus causes mottling of leaves.

White rust:

White rust found on gerbera in Villa Guerrero, was caused by *Albugotragopogonis*. This is the first and sole report of White rust of Gerbera caused by *Albugotragopogonis*and may represent a new disease problem for species of important flower crop in the future.

Pests:

Mites:

Phytoseiuluspersimilis, predator of the spidermite, could be used in biological control programs. Jasmonic acid is a plant hormone that is involved in the induction of plant defence in response to herbivore attack. This predator is a very effective biological control agent of spidermite.

Aphid:

This insect infests young leaves and buds and causes injury by sucking sap, which results in distortion of tissues.

Whitefly:

In greenhouses, gerbera is subject to heavy infestation of whitefly *Trialeurodesvaporariorum,* a sucking insect. Small and fragile white adults lay ash-coloured eggs on the lower surface of young leaves. Nymphs and adults suck sap from the lower side of leaves.

Leaf miner:

The leaf mining fly (*Liriomyzatrifolii)* is a serious pest of gerbera. Dimetheoate 0.1% gives good control. Integrated control measures with the

*Dacnusagibirica*and the *Diglyphusisaea*gives effective protection. Two applications of imidacloprid, pyrazophos or fenvalerate in two week intervals is effective.

Nematode:

Root knot nematode is occasionally serious in gerbera causing stunting of plants, leaf yellowing and premature drooping and root galling. Integration of neem cake at 0.5 kg per m^2 with *Trichodermaviridae*at 100 gm per m2 effectively controls the nematode. Application of Phenamiphos increased the gerbera flower yield by 31.1%.

Thrips:

- Thrips suck the cell sap and due to which upward curling of leaf is observed. Paste of garlic and chili is effective on thrips (1litre paste solution in 100litre water).
- Among other insects pest that occasionally infests gerbera are *Heliothisarmigera*, *Mamestrabrassicae* and *Spodopteralitura.*





Physiological Disorder

- **Scape bending:** Insufficient flower stem hardening or maturation of stem tissue below the harvested flower can result in stem collapse. Poor winter growing condition contributes to the problem.

- **Bushiness:** An abnormality characterized by numerous leaves, short petioles and small lamina and gives some cultivars of gerbera bushy appearance known as bushiness. Nodes are clearly distinguished and internodes elongation is seen.
- **Pre harvest stem break:** It is a common post-harvest disorder in cut gerberas. It is mainly caused by water imbalances.
- **Yellowing and purple margin:** Nitrogen deficiency causes yellowing and early senescence of leaves. Phosphorous deficiency causes pale yellow color with purple margins. Increases in level of nitrogen and phosphorous are found to promote development of suckers and improve flowering in gerbera.
- **Premature flower wilt:** It occurs in flowers while stems are still attached to plants and often develops gestures when petals are in full expansion.The cause of problem is suspected to be lack of storage carbohydrates needed to attain the integrity of rapidly developing flower.

13. Protected Cultivation of orchids

Orchids belong to large family of monocotyledons known as Orchidaceae. Orchids, with over 800 described genera and 2500 species come under the largest and most diverse flowering plants families. The few world checklist of orchids listed 24000 accepted species. There are more than 100000 hybrid and cultivars produced by breeder and orchids enthusiasts.

Genera and varieties:

Selection of genera: some of the important tropical genera that are in great demand include *dendrobium,* oncidium, *mokara*, vanda*, aranda, Aranthera* in the order of preference.

Orchid dived in to two major types:

Monopodial : *ArachinsRenanthera, vanda, etc.*

Sympodial: *dendrobium, oncidium, cymbidium, peristeria, etc.*

Dendrobium species is a tropical orchids species suitable for humid tropics and other coastal areas where the humidity is high. *Dendrobium* is a genus containing mostly epiphytic and lithophytic orchids in the family Orchidaceae.

- It is a very large genus, containing more than 1800 species that are found in diverse habitats throughout much of south, east and Southeast Asia, including china, Japan, India, the Philippines, Indonesia, Australia, Newguinea, Vietnam and many of the islands of the Pacific.

- Up to six leaves developed in a tuft at the tip of a shoot and from one to a large number of flowers are arranged along an unbranded flowering stem.
- Varieties of orchids Sonia red, Sonia white, sultana white, somak white.

CLIMATE:

75% green shade net with 70- 80% humidity, 18 C - 28□ temperate and light intensity of 1500-2000-foot candles is ideal for growing this tropical orchid.

GROWING ENVIRONMENT:

75% shade net house with 70-80% humidity, day temperate of 21-29□ and night temperatures of 18-21□ is ideal for growing this tropical orchid. In high rainfall zones, the shade net house should be provided with a rain shelter.

PROPAGATION:

Division of clumps, back bulbs and tissue culture plants

CONTAINER & SUPPORT:

Perforated earthen pots are ideal and plants are staked with bamboo sticks.

GROWING MEDIA:

Most common potting mixtures consist of charcoal, broken pieces of bricks and tiles, coconut hunk and fibre.

Growing media

PLANTING:

Planting is done in coconut husks arranged in beds at some height and also in blocks made of coconut husks. Single block can hold up to four plants. When compared, plants in block show better growth results.

IRRIGATION:

Mist or overhead sprinkle to provide water and to maintain humidity. Irrigation can also be given by cans. Humidity is must for good growth of the plants.

NUTRIENTS:

Foliar applications of NPK 19:19:19 @ 0.2% at two days intervals starting from 30 days after planting.

GROWTH REGULATORS:

Amino acid spray of 0.2% at monthly intervals.

SPIKE REMOVAL:

After planting, the emerging flower spike are nipped off for 6 months to get good growth of plants.

SPLITTING OR DIVISION OF PLANTS

Plants grow to a large clump with 2or 3 old cans and new shoots divided before repotting, each division at least one old cans of two years growth, one shoots & some new roots.

HARVESTING:

Dendrobium flower fully matured only 3or 4 days after it opens.

Flowers are harvested when they are fully open as the flowers cut prior to their maturity will wilt before reaching the wholesaler. Immediately after harvest the lower 0.75 cm of the peduncle is cut off, and the flower is inserted into a fresh tube of water containing preservative. Harvesting the spike when 75 per cent of the flower are open and remaining buds are un open.

POST HARVEST HANDLING:

Pulsing: 8 HCQ +500 ppm + sucrose 5 % for 12 hrs.

Holding solutions: AgNo3 25 ppm+ 8 HCQ 400 PPM+ sucrose 5 %

Wrapping:50-gauge polythene with base of spike dipped in8 HCQ 25 ppm.

YIELD: 8 – 10 spike /plant/year.

PESTS:

SNAIL AND SLUG: Hand picks and destroys them immediately. Lanate balt is useful to some extent.

DISEASES:

- **BACTERIAL SOFT & BROWN ROT**: (*Erwinia spp*.)
  Foliar application with streptomycin sulphate @ 0.5 +copper oxychloride @2g/l
- **Anthracnose**: Foliar applications of Thiphonate methyl 2g/l or Difenoconazole 0.5 ml/l.
- **BACTERIAL BROWN SPOT**: (Acidovorax sp.)

  Foliar applications with streptomycin sulphate @ 0.5 g +copper oxychloride @2g/l.

- **BLACKROT**: (pythiumsp.and*phyothora sp.*

  Foliar applications of metalaxyl 2g/ lit. Dimethomorph 50% WP 0.5 g/lit.

PACKAGING:

- An ideal package should be air tight, water proof, strong enough to withstand handling and small in volume.
- Standard florist boxes are used for the packing of flowers.
- Keeping of a wet cotton at the cut end the flower stem which is wrapped with a polythene wrapper helps to maintain humidity

14. Protected Cultivation of chrysanthemum

Botanical Name: *Chrysanthemum morifolium*

Family: Asteraceae

Origin: China

Uses:

- As a back grounds border planting erect and tall varieties.
- Dwarf and compact varieties are suitable for front row planting of borders and as pot culture.
- As a cut flower and loose flower for making garland and hair adornment.
- Extra-large bloom varieties used for exhibition.

Area and Distribution:

- The chrysanthemum is one of the most important flower crops commercially grown in
- different parts of the world. The Netherlands, Italy, Colombia, Spain, Germany and USA are the
- important countries where it is mainly grown under greenhouse conditions. In India, it is commercially grown in Tamil Nadu, Karnataka, and Maharashtra. In different states of India, it is grown with different names, Guldaudi in Hindi belt, Chandra Malika, in the eastern state, Samanti in the southern states and Shevanti in the western states. It is grown in on area of about 4,000 ha.

Botanical description:

- It belongs to family Asteraceae. The species of chrysanthemum have fibrous root
- system (shallow rooted plant), herbaceous perennial plant growing to 50-150 cm tall, with deeply lobed leaves and large flower heads, white, yellow or pink.

There are 13 different classes of chrysanthemums with varying flower forms defined by the National Chrysanthemum Society, as described below.

Classifications of the National Chrysanthemum Society:

Class 1 - Irregular Incurve class

These are the giant blooms of the chrysanthemum genus. The florets (petals) loosely incurve and make fully closed centres. The lower florets present an irregular appearance and may give a skirted effect. Bola de Oro (1992) Flower Size: 6-8 inches. Flower Characteristics: Grown as a disbud, plant moderately short.

Class 2 Reflex

The florets in this class curve downward and overlap, similar to bird plumage. The tops of these blooms are full, but somewhat flattened. Doreen Statham (1995) Flower Size: 4-6 inches. Flower Characteristics: Grown as a disbud, plant medium height.

Class 3 Regular Incurve

A true globular bloom equal in breadth and depth. The florets smoothly incurve and form a ball. Heather James (1972) Flower Size: 4-6 inches. Flower Characteristics: Grown as a disbud, plant moderately short.

Class 4 Decorative

A flattened bloom with short petals. As in classes 1-3 the centre disk should not be visible. The upper florets tend to incurve, but the lower petals generally reflex. Chime (1994) Flower Size: 5 inches or greater. Flower Characteristics: Grown as a pot mum or disbud, plant height short.

Class 5 Intermediate Incurve

This bloom class is smaller than the irregular incurve, with shorter florets, only partially incurving with full centres, but giving a more open appearance.

Class 6 Pompon

A small globular bloom, somewhat flat when young but fully round when mature. Size ranges from small button types to large disbudded blooms almost 4 inches in diameter. The florets incurve or reflex in a regular manner and fully conceal the centre. Lakeside (1972) Flower Size: 1-4 inches. Flower Characteristics: Grown as a spray, plant height tall.

Class 7 Single and Semi-Double

A daisy-like flower with a centre disk and one or more rows of ray florets.

Class 8 Anemone

These blooms are similar to the semi-doubles, but have a raised cushion-like centre.

Class 9 Spoon

Essentially the same as the semi-double, except the ray florets are like spoons at the tips. The centre disk is round and visible.

Class 10 Quill

The florets in this Class are straight and tubular with open tips. The bloom is fully double with no open centre.

Class 11 Spider

Spiders have long tubular ray florets which may coil or hook at the ends. The florets may be very fine to coarse.

Class 12 Brush or Thistle

Fine tubular florets which grow parallel to the stem and resemble an artist's paint brushes or in the thistle form the florets are flattened, twisted and dropping.

Class 13 Unclassified or Exotic

Those blooms which fit in none of the other classes. They are often exotic, with twisted florets. They may also exhibit characteristics of more than one bloom class.

Important varieties:

Casa Grande, Snowdon White, Vesuvius, Melody Lane, Dancer, Kikubiori, Super Giant, Christmas Carol, Gloria Red, Silvia Green, Dream Castle, Taiching Queen, Helmy Pot, Sancho, Green Goddess, Golden. Splender and Bronze Turner.

Climate Requirement:

Chrysanthemum requires long days for good vegetative growth and short days for Flowering. The most important environmental factors influencing the growth and flowering of these plants are light and temperature. The rate of vegetative growth and flowering are also affected by temperature. The optimum temperature of 15.6 °C is required. The relative humidity of 70 to 90% is suitable for the plants.

Soil Requirement:

The ideal soil for chrysanthemum growing is a well-drained, sandy loam of good texture and aeration. Good amount of organic matter and pH of 6.5 is essential. It is a shallow fibrous rooted plant and is very sensible to water logged conditions.

Preparation of field:

The field is ploughed two to three times before preparation of beds for planting. Trials conducted under All India Coordinated Research Project on Floriculture recommended a basal application of FYM @ 5kg/m2.

Time of planting:

Terminal cuttings of stock plants are taken in June and they are transplanted after rooting in 15 cm pots at the end of July. These plants are ready for pinching during end of August or beginning of September.

Spacing:

30 x 30 cm (plant to plant and row to row)

Propagation:

Chrysanthemum is propagated vegetatively through suckers, cuttings or by micro-Propagation.

Suckers:

After flowering, the stem is cut back just above the ground. This induces the formation of side suckers which are separated from the mother plant and are planted in sand bed. Well rooted suckers can be directly transplanted in the field.

To plant one hectare of land, 1, 11,000 suckers obtained from 15 cents of the previous crop are required. Dip the roots of the suckers in 1 g Emisan in 1 lit of water to protect against wilt. The suckers are planted during June – July at 30 x 30 cm spacing on one side of the ridges. Pinching is done once in 4 weeks after planting to induce more branching.

Terminal Cuttings:

These cuttings are taken from a healthy stock plant. Length of cuttings is about 5-7 cm. The cuttings are dipped in 2500 ppm indole butyric acid (IBA) or in seradex/ keradex (rooting hormone). These cuttings are put in sand beds in shade conditions.

Nutrient Management:

As the crop responds well to manuring, add 8-10 tonnes of well rotten FYM per acre. Apply 50 kg of Nitrogen, 160 kg P2O5 and 80 kg K2O as a basal dose. Spray GA3 at 50 ppm at 30, 45 and 60 days after planting to increase the flower yield.

Irrigation Management:

The frequency of irrigation depends on the stage of growth, soil and weather conditions. Proper drainage system should be maintained for chrysanthemum grown both in beds and in pots. The height and vigour of the chrysanthemum plant can be influenced by regulating quantity and frequency of irrigation. In our country, the method of irrigating the fields is by channel system and for pots manual bucket system.

Weed Management:

Weeds should be avoided in the greenhouse as well as fields. They deplete moisture and nourishment from plants. Shortly after cuttings are established, carefully scratch the ground to uproot the weeds when they are small. 2-3 hand weeding are required for proper growth of the plant. First weeding should be done one month after planting. Herbicide can also be applied to control weeds from the field.

Best Practices of Crop Cultivation:

Pinching

After planting the growth is mostly upwards with very little branching. To arrest such tall growth, a single procedure called ‘pinching’ is used. Only soft vegetative shoot tips 1.5 to 3.0 cm long are removed. Pinching is one of the most important operations in chrysanthemum culture. Pinching is most essential for small flowered chrysanthemum. Pinching increases the number of flowering stems in each plant.

Disbudding & De-shooting

These operations are mostly performed for long flowering & decorative type chrysanthemum. Disbudding of spray varieties is very easy because in this case only

the large apical bud is removed and the auxiliary buds are allowed to develop, while in standard varieties remove all axillary buds & apical bud is allowed to develop.

Staking of plants

Staking is necessary to keep plants erect and to maintain proper shape of plants and bloom. Stakes are prepared mostly from bamboo sticks. Staking of plants is required for vertical support of the plants. Only one stake is used when a grower needs single bloom per plant.

De suckering

For proper and vigorous growth of the plant; suckers are removed from time to time. Without de-suckering, the main plant will lose vigour and become weak.

Harvest

Harvest index:

Flowers are cut soon after the disappearance of green colour in the centre of the flowers and the centre petals are fully expanded. Pompons are cut when they are fully developed. Spray types should be cut when the central flower is open and the surrounding flowers are well developed and the varieties which shed pollen badly will have to be cut before they become unsightly. Cutting the stem while the flowers are slightly on the “green” side is preferred because it offers a better-quality product for the customer. Harvested flowers are to be kept immediately in a bucket containing water and preservatives to avoid desiccation.

Harvesting:

Depending upon the varieties plant start yielding flower after 3-4 months of transplanting. For cut flower purpose, stem is cut about 10 cm above the soil to avoid cutting into wooden tissue. The lower 1/3 of stem are placed in water to extend the vase life of cut flowers. The best way to protect the flowers is to sleeve the bunch with a transparent plastic sleeve. The correct stages of harvest depend up on the cultivar, marketing and purpose etc.

Yield:

Flowering seasons vary from region to region. The natural blooming seasons for most of the regions lasts from July to February. One can harvest the flowers around 15 times. The yield ranges from 9 to 10 tonnes of loose flowers per acre.

Post-Harvest Activities:

Loose flowers are packed in bamboo baskets or gunny bags for marketing. The capacity of bamboo baskets ranges from 1 to 7 kg while gunny bags can accommodate 30 kg of loose flowers.

Post-harvest technology:

Grading of flowers depends on colour, diameter of flower and on stem length.

Pulsing: Sucrose 4 % for 24 hrs

(Vase life: 18 days: Control: 8.5 days)

Holding solution: BA 10 ppm + Bavistin 0.1 % + Sucrose 2 %

(Vase life: 17 days; Control: 8.5 days)

Wrapping material: Polysleeves with holes (50-gauge thickness)

(Shelf life: 9.25 days; Control: 6.5 days)

After harvest, the stem has to be cut at equal length (90 cm is the standard), bunched in five, putting a rubber band at the base and sliding them into a plastic sleeve and putting bunches in plastic buckets filled with water. The mature chrysanthemum can be stored dry for 6-8 weeks at a temperature of 0.5 0 C. Early morning on the day of shipment (or night before), bunches can be packed in boxes.

Important Tips and best practices for crop cultivation:

• Always use disease free planting material

• Crop rotation should be practiced

• Proper pinching and disbudding should be followed for standard/spray chrysanthemum production.

• Maintain proper temperature for quality flower production.

• Use bamboo stick for the support of tender stem of the plant.

Pest Management

Common pest their Control measures:

Aphids (Myzuspersicae)

This are small greenish to black dot like insects which are seen in large number sucking the sap from the tender parts like stem tips, flower buds and young leaves. The affected flower buds fail to open and dry up before opening. Damage begins in December and is in peak during Feb-March.

Control measures:

Spraying at fortnightly interval with 0. 5% Monocrotophos or 0.1% Malathion or 0.02% Phosphomidon.

Mites (Tetranychusurticae)

Very minute dot-like insects of red colour seen on the under surface of leaves, particularly in hot dry season. The affected flower buds fail to open and dry up even before opening.

Control measures:

Spray of 0.05% Dicofol or 0.05% Vertimac or Pentac at fortnightly interval.

Thrips (Thrips tabaci)

Thrips cause damage to summer blooming varieties. Infected flowers become discoloured & dry.

Control measures:

Spraying Dimethoate at 0.05 per cent 2 or 3 times at 15 days interval.

Leaf miners (Phythomgzasyngenesiae):

Incidence is maximum during March-June. The infestation is more severe in polyhouse. The young maggot stage attacks the leaves by making tunnels in between the upper and lower surface of the leaf. In severe cases, the leaves completely dry up and fall off.

Control measures:

1. Removal & destruction of affected leaves help in containing the spread.

2. Spraying of 0.05% Monocrotophos or 0.05% Triazophos.

Leaf folder:

All the larval stage attacks the plant with the help of silky threads, the larve folds the leaves starts feeding on leaves from inside.

Control measures:

Spray 0.02% Cypermethrin or 0.02% Decamethrin or 0.05% Quinalphos at fortnightly interval.

Disease Management

Common Diseases & their Control Measures:

Root rot:

(*Pythium spp* or *Phytophthora spp*) In this disease the infected plant suddenly wilts the plant parts like roots, stems, leaves.

Control measures:

1. Provide good drainage conditions to prevent water logging.

2. Soil drench with Thiram or Captan or mixture of both at the rate of 2.5 g/m2 area prevents the infection.

3. Mancozeb, Metalaxyl and Fosetyl also used for control.

Leaf spot: (Septoria chrysanthemella)

Greyish brown spots appear on leaves which turn yellow surroundings. When flowering starts, the infection occurs on flower buds, which rot completely. The disease spreads from down to upwards.

Control measures:

1. Spraying with Mancozeb at fortnightly interval helps in controlling the disease.

2. Burning and destroying of infected leaves.

3. Spray of Copper Oxychloride (0.2%)

Wilt: (Verticillium dahliae.)

The leaves turn yellow to grey and the branch or whole plant wilts gradually. It may occur due to a number of diseases, disorders or even just lack of water.

Control measures

1. Solarization of soil by using black polythene mulch during summer months.

2. Soil treatment with Dithane M-45 (0.2%)

3. Dipping of rooted cuttings in Benomyl suspension before planting.

4. Use of resistant varieties.

Rust: (*Puccinia spp*)

It is serious disease especially in the early spring. Brown spores appear in the underside of the leaves. Severely infected plants become very weak and fail to bloom properly.

Control measures:

1. Sanitation and clean cultivation prevent the disease.

2. Early removal of infected leaves. 3. Dusting plants either with sulphur and other fungicides such as Zineb, Captan etc. can be used.

Powdery mildew: (Oidiumchrysanthemi)

There is powdery coating on the leaves appear. It may lead to defoliation.

Control measures: Use of Sulphur fungicides or Carbendazim

Viral disease

Chrysanthemum stunt

Overall reduction in plant size, foliage become pale in colour, flower may open prematurely. Disease occurs diving pinching. This disease occurs during pinching.

Control measures:

Use of cuttings from virus free plants. Chrysanthemum mosaic disease

1. Cuttings should be obtained from virus – free indexed stocks.

2. Removal and destruction of infected plants.

3. Destruction of the weed host.

4. Spraying Monocrotophos 0.05 per cent controls the vector and reduces the disease.

Alternative Use and Value Addition:

Besides being used for cut/loose flower purpose, it is also used for garlands, bouquet, greeting cards, dry flower etc.

15. Pot plant cultivation

Container gardening or pot gardening/farming is the practice of growing plants, including edible plants, exclusively in containers instead of planting them in the ground. A container in gardening is a small, enclosed and usually portable object used for displaying live flowers or plants. It may take the form of a pot, box, tub, basket, tin, barrel or hanging basket. Vegetable, herb, shrub, bonsai cultivated in pot.

Introduction to Growing Vegetables in Pots / Containers:

Well, in the current world, as the population is increasing, demand for food is also increasing in parallel. We are seeing the apartment culture is going up especially in cities and even in towns. People are hardly having any space for their gardening needs. Most of the people are dreaming of growing vegetables on their own which can be healthy, can see a good amount. Apart from these, home gardening is one of the best things to relieve from stress. You can place these pots on roofs/terrace, a patio, deck, parking space, balcony. It all depends on what kind of vegetables are we growing. Some may be ok to be grown under shade and some may need full day sun. These pots can be placed indoors/ outdoors or even in greenhouse or polyhouse or under shade net. Pots/containers can be anything made of clay, metal, plastic, or wood. Grow bags, plastic buckets, and hanging pots can also be used to grow vegetables at home. Make sure to have well-drainage and good aeration of these pots.

Basic Requirements to Growing Vegetables in Pots:

Well, the following are the basic requirements for growing vegetables in pots.

- Big pot/ container
- Potting soil
- The place to get at least 5 to 6 hours of sun

Best Suited Crops for Pot growing:

The following crops best suited for container/pot gardening.

- Beans,Beets,Tomatoes,Cucumber,Onions,Peas,Radish,Carrots,Potatoes,Squash,Brinjal (Eggplant),Ladies Finger (Okra), Capsicum/Pepper/Green chillies
- Leafy Vegetables such as Lettuce, Kale,Methi (Fenugreek), Coriander (cilantro), Mint, Basil, Spinach, Amaranthus, and similar kind.

Some vegetables require and grow under full sunlight, whereas some can be grown under partial shade.

Vegetable require full sun	Vegetable those can tolerate of some shade
Tomato	Lettuce
Onion	Collard
Carrots	Radishes
Corn	Peas
Eggplant	Beets
Melons	Beans
Most herb	Cauliflower

There are mainly 4 phases of growing vegetables, seed sowing, plant maintenance, watering, and harvesting. Defiantly growing vegetables can bring out the farmer in you or give some insights into farming or cultivation practices. You till the soil and tend the plants, then reap the rewards when the plants bear fruit.

First and foremost, select a good spot which receives at least 5 to 6 hours of sunlight and gets a good size of container depending on space. Buy good potting soil from your local nurseries.

Another advantage of growing vegetables in pots is it warm up quickly in spring when compared to ground growing. With this, some vegetables like tomato or chillies can be obtained fast. Due to limited mobility, tall pots can make easier for gardeners to tend vegetable plants without kneeling.

Preparation of soil and Plant care in growing vegetables in Pots:

Growing Vegetables in Pots – Potting medium:

It is essential to use a high-quality mix that contains 'peat moss' & 'perlite' for quality produce and healthy plant growth. Blend in a complete fertilizer, either a dry organic matter like one containing alfalfa meal, kelp meal, bone meal or a controlled-release type that supplies nutrients over a 3-6-month period. If you plan to water pots by hand, add soil polymers like 'Broadleaf P4' which are available at nurseries /online or most garden centres to the mix before planting. This will help in alleviating (making less severe) the wet-dry cycle. As the soil dries out, these small crystals, which can absorb more times their weight in water, supply moisture to the plant roots.

Growing Vegetables in Pots – Feeding (Manures & Fertilizers):

Timely application of manures and fertilizers is important for healthy plant cycle. If you want to grow vegetables organically and used an organic fertilizer at planting time, it is advised to supplement it with weekly applications of fish emulsion. You can also reapply dry organic fertilizer as per package directions. If you use controlled-release fertilizers for your plants, apply fish emulsion every 15 days (2 weeks) to boost vegetable growth.

Growing Vegetables in Pots – Training:

Some vegetables like beans (creepers), vine tomatoes, any gourd vegetables like bottle gourd, ridge gourd and bitter gourd needs a good framework for growing support. You can arrange bamboo support or any wired kind of frame to support the wines.

Growing Vegetables in Pots – Watering:

If you have more containers/pots to grow then the best way to irrigate the plants is with a drip irrigation method operated by an automatic controller. There are drip irrigation emitters you can buy in the market. You can set the controller to water often enough to keep the soil moist. The frequency of watering depends on plant base soil moist and climatic conditions. In case of dry and summer season, increase the frequency of water in the containers. If you have a couple of pots/containers, you can hand-water based on soil moisture. Simple and thumb rule is, never allow to dry out the soil and make sure to maintain uniform moisture conditions. Sometimes you may find the situation where the soil starts drying and becoming hard. In this case, water it lightly and using any sharp tool (fork) to dig the soil lightly without doing any harm to roots. You can use any mulch material like dry grass from protecting moisture loss.

Growing Vegetables in Pots – Pests:

It is very natural to see the vegetable plants attacked by many pests and diseases whether they are grown on the ground or in containers/pots. If any peats such as aphids, mites, or whiteflies attack, spray them with insecticidal soap or horticultural oil like neem oil. You can prune the diseased branches or dead branches on a frequent basis. Use organic based pesticides rather chemical pesticides for growing organic vegetables.

Growing Vegetables in Pots – Harvesting:

Maturity or Vegetable picking time depends on the type of vegetable and variety. Use sharp sickle (knife kind) to pick the vegetables. You can keep harvesting depending on maturity. Don't pull the plant or vines while picking the vegetables and care should be taken for not disturbing the plant base in the pot.



Growing Vegetables in Pots – Tips for Planning a Vegetable Garden:

If you are planning for a vegetable gardening on the ground, the following tips may be useful.

- Soils rich in organic matter (fertile) and well-prepared soil is essential for establishing a good vegetable garden. Soil should be stone and weed free and must well-drainage. Vegetables grow faster in moisture retentive soils

- It is very important to have enough sunlight and good air movement around the vegetable garden for better plant growth and good crop.
- Garden should be designed in such a way that you can move all the sides of the garden easily with comfort
- Before sowing the seeds, watering should be done thoroughly the day before you intend to sow the seed on the beds
- Most of the time people make mistake by sowing seeds deeper level. Avoid too much of plant depth and maintain about 2 to 4 cm seeding depth.
- Make sure to firm the soil over the seeds for good moisture contact. Spray the water very gently by covering all areas of the garden or planting area. Make sure to have soil intact without making seeds to appear out after watering.
- Frequent watering is necessary until seeds start germinating and start sprouting. Maintain uniform moisture during this period
- As we said before weeds compete with your vegetables for water and nutrients (manures and fertilizers), so it's important to keep them to a minimum. Organic control of weeds or natural mulching should be used to control weeds in your vegetable garden.
- Keep the garden from insects/pests and any other predators. Harvest vegetables at right time depending on the usage.

❖ **Choose containers with drainage holes:**

Pots come in plenty of colours, shapes, and sizes, but the most important consideration is drainage. Make sure any container you purchase has small holes at the bottom so your plants' roots won't drown.

- If you can't live without a pot that doesn't have drainage holes, purchase a slightly smaller plastic container that has drainage holes and fits inside the pot without holes.
- Grab the saucer that matches your pot. A saucer fits under the pot, collects drained water, and prevents messes.

Select light-loving plants if you plan to put them in full sun:

The best location where you'll keep the pot depends on the type of plants you purchase. Keep plants with tags labelled "full-sun" in outdoor sun-soaked spots and indoor areas by windows.

- If you have a spot for the pot in mind, observe the area before purchasing your plants. Make sure it gets at least 6 hours of direct sunlight. If it doesn't, go for a plant marked for shade or partial sun.
- Full-sun options include most flowering plants, such as petunias, geraniums, salvias, true lilies, canna lilies, and lilacs. Other sun-loving plants include those that bear fruits and vegetables, like tomatoes, peppers, and cucumbers. Most herbs, including basil, lavender, and thyme, also require lots of sun.
- **opt for shade plants to put in spots that don't get much sunlight**. When you're at the nursery or home improvement store, check for plant tags marked "shade-tolerant" or "moderate sun." This means the plants need around 3 hours of sunlight or less per day.
- Good flowering options include begonias, impatiens, crocuses, periwinkle, lilies of the valley, and some tulips. Ajuga and coleus are shade tolerant and produce attractive leaves in a range of colours.
- **Use potting soil that has the right drainage requirements for your plants**. Topsoil from your yard would dry out and clump, and store-bought garden soil is too dense to allow proper drainage. If you have a bag of garden soil and don't want to splurge on potting soil, combine equal parts of garden soil, peat moss, and perlite.
- Store-bought potting soil is the best choice for most plants. However, some have specific requirements. If you're planting orchids, you'll need to get a growing medium that's full of bark and other large chunks of organic matter.
- Fruits and vegetables prefer nutrient-rich clay or loam soils that retain moisture.

- Cacti and other succulents prefer well-drained, sandy soil. Go for a store-bought cactus mix or combine equal parts of sand and potting soil.

Provide the right amount of space for your plants:

Shrubs, like hibiscus, fuchsia, and bougainvillea, and plants that bear fruits and vegetables typically need lots of room to grow. Go for containers that are at least 1 to 2 feet (30 to 61 cm) deep and hold at least 5 to 10 gallons (19 to 38 L) of soil.[9]

- Plants like rubber trees, tomatoes, peppers, and carrots usually do best on their own. They have large root systems and consume lots of nutrients.

- Plants with more modest root systems, like pansies, dusty millers, daisies, ajugas, creeping Jenny, and succulents, do well with other plants. To allow room for growth, space them about 4 to 6 inches (10 to 15 cm) apart, or according to the instructions on their tags.

Preparing your planter:

Fill the bottom third of the pot with rocks, broken pots, or foam peanuts. Unless you're planting a small tree or shrub with an extensive root system, line the bottom of the container with rocks, shards of broken pots, foam packing peanuts, or crushed cans and milk jugs

Filler material will encourage drainage and reduce the amount of soil you'll need, which can get expensive. Smaller objects, like rocks and pieces of broken pots, are great for drainage-loving succulents and herbs planted in small pots. Use larger objects, like cans and milk jugs, for larger containers.

Add soil to within 2 inches (5.1 cm) of the container's rim:

- Dump the bag of potting soil into a large container, or use a trowel to fill a small pot. Keep the soil loose, and shake the pot to even out mounds instead of packing it. Leaving about 2 inches (5.1 cm) between the top of the soil and the container's rim will allow you to water the container without it spilling over the edge.

- The space between the soil and rim will also give you room to scoop out holes for the plants.

Dig a hole equal in size to the plant's root ball:

Dig a hole in the centre of the soil bed large enough to accommodate the root ball. It should be deep enough so the crown (where the roots meet the stem) will be level with the top of the soil. Place the root ball in the hole, then fill in soil to level the surface.

- If you're just growing one plant in an individual pot, you don't have to worry about planning the arrangement or spacing other plants.

Place the tallest plants in the middle, if you're using a variety of plants.

- Start by scooping a hole in the centre for the tallest plant. Place the root system in the hole so the plant's crown is level with the top of the soil, then fill in the hole so the surface is even.[16]

- For example, if you have tall grass, spiky Dracaena, or phormium, plant it in the centre of the pot. Provided you have a deep enough pot, azaleas, hibiscus, and elephant ears work well as tall focal points.

Soak the soil when you finish planting:

Thoroughly soaking the soil will help prevent transplant shock. Water the container until the pot starts to drain and the top of the soil is saturated. Depending on the container's size, it could take several minutes to water it completely. Water will drain from the bottom of the container, so be sure to place the pot on a saucer.

- Stop watering when you see water leaking from the drainage holes at the bottom.

- Room temperature water is ideal, especially for tropical plants, like elephant ear, bougainvillea, and orchids. If water from your hose or faucet feels ice cold, fill a pitcher or watering can and allow it to warm to room temperature.

- Tap water is usually fine, as long as you don't use water softeners. Water treated with softeners can cause salt build-up. Distilled water is best for carnivorous plants, like pitcher plants and Venus fly traps. They prefer low-nutrient soil and don't like the minerals in tap water.

Caring your plant

Keep a saucer under the pot to catch drained water:

A saucer will prevent dirty water from pooling on your floor, windowsill or desk. Empty the saucer about an hour after watering to prevent root rot.

- If the container is too heavy to lift and you can’t remove the saucer, use a bulb baster to suck up the water.

Add slow-release fertilizer beads monthly, or as the tag recommends:

Nutrients leech from the soil every time you water, so you’ll need to fertilize your potted plant regularly. All-purpose fertilizer beads that release nutrients over time are good for most plants, but you should check plant tags for specific instructions.

- Use about 1/2 teaspoon of fertilizer beads for 1 gallon (3.8 L) of soil. Spread the granules over the soil, and use your fingers or a small trowel to work it about 2 inches (5.1 cm) deep.

- In general, flowering plants, fruits, and vegetables need more nutrients than herbs and succulents. During mid-season, or when they produce ripe fruit, fertilize plants like tomatoes and peppers every 1 to 2 weeks. Keep an eye out for yellow leaves, which could indicate you're over-fertilizing.

- You don't have to be fussy about fertilizing herbs, like basil, cilantro, lavender, and rosemary. They're prone to over-fertilization, so 1 application every 3 to 4 months is best.

- Cacti and other succulents only need to be fertilized once or twice a year.

Prune your plants whenever you see dead leaves:

Use clean pruning shears to cut dead flowers and leaves. Trim them at a 45-degree angle just below the brown or dead area. Clip new growth at a 45-degreeangle about 1⁄2 inch (1.3 cm) above the nodule to keep a rapidly growing plant in check.

- The nodule looks like a small bump or bud where new growth emerges.
- If you're clipping herbs or pruning a rapid grower, avoid removing more than 30% of the plant at a time. Clipping too much can shock and kill the plant.
- Pruning encourages new growth and will lead to fuller, more robust plants

Apply insecticide, if the plant becomes infested with pests:

If you need to deal with pests, look for a plant insecticide at a garden centre. If you keep your plant indoors, make sure the product is labelled for houseplants. Read your product's instructions and use it as directed.

- Most plant insecticides are recommended for specific plants, which are listed on the label. Check labels for your plants or ask an employee at the garden centre for help.
- Common pests include aphids, ants, gnats, spider mites, and whiteflies.
- While aphids, ants, and flies are visible, mites are tough to spot. Look for patches of fine webbing with tiny, barely visible specks. Signs of mite infestation include tiny light green spots on leaves and stems, yellow discoloration, and curled or dead leaves.

10 Beautiful potted ornamental plants with name:

Silver nerve plant, Fibre optic grass plant, Snake plant, String of pearl, Peace lily, Chinese money plant, Air plant, Water bamboo, Bonsai, Bunny ear cactus

16. Vegetable grafting

INTRODUCTION

Vegetable grafting is a process involves joining together two parts (a rootstock and scion) from different plants to form a single, living plant.

Grafting is an ancient technique, in vegetables first literature reports available in 17th century book written by Hong. The production of grafted vegetables first started in Japan and Korea in the beginning of 20th century with watermelon (*Citrullus lanatus*) grafted onto pumpkin (*Cucurbita moschata*) rootstock. Eggplant (*Solanum melongena*) was grafted onto scarlet eggplant (*Solanum integrifoliumPoir.*) middle of 20th century Later, grafting was introduced in Asia, parts of Europe and the Middle East in late 20th century.

Rootstock is a plant already has an established, healthy root system and is selected for their ability to resist under abiotic and biotic stress condition or their ability to increase vigour, precocity and enhanced yield and quality. The scion of the grafted represents the upper portion of the plant and is selected for its fruit quality characteristics. Grafting may affect the vegetative growth, flowering, flower modification due to regulating the growth hormone, increase the vigor of the crop, resulting in earlier or higher yields and superior quality. Grafting in vegetable crops provides ample of advantages viz., eliminates incompatible barriers in distant hybridization, manage soil-borne diseases, improve fruit quality [appearance, size, shape, color, firmness, texture, pH, carotenoid content, flavor (sugar, acids, and aroma volatiles)], improve crop response to abiotic stresses such as salinity, drought, flooding and tolerance against heat and cold stress. In the past, vegetable growers commonly used fumigation by using methyl bromide to control many of the most problematic soil borne disease and nematode problems. Now-a-days grafting is an alternative to pesticides also fits in with the growing interest in organic or pesticide free production the use of this technique is mainly carried out for intensive cropping systems like greenhouse production. It is ecofriendly in nature and imparting the resistance, reduces the need of soil disinfectants and provides opportunity to produce vegetables in biotic and abiotic stress condition without use of chemicals and has new vista in organic farming of vegetables.

IMPORTANCE OF VEGETABLE GRAFTING

1. **Achieve soil borne disease and pest resistances/tolerances**: *Solanumtorvum*was more resistant than *S.sisymbriifolium* to *V.dahliae*,

when grown on both fumigated and Verticillium-infested soil. Hybrid squashes (*Cucurbita maxima Duchesne* × *Cucurbita moschata Duchesne*) are widely used as melon rootstocks are highly resistant to fusarium wilt and tolerant to verticillium wilt, monosporascus sudden wilt, and gummy stem blight. Cucurbita *maxima* were highly resistant and resistant to M. incognita in soil infested with nematode.

2. **Acquire tolerance to abiotic stresses:** Investigated the effects of grafting a commercial tomato hybrid onto three new commercial tomato rootstocks – 'Beaufort', 'He-Man', and 'Resistar' – with respect to plant growth, yield, and fruit quality, under low to moderate salt-stress conditions. Grafted watermelons had a greater tolerance when watered with saline water than did the non-grafted plants and also resistant to flood.
3. **Increase vigor and yields**: Grafting eggplant onto interspecific eggplant hybrids, especially the *Solanum incanum*(SI) × *Solanum melongena* (SM) with, has proved advantageous for eggplant production, because the high vigor and good rootstock/scion compatibility resulted in improved early and total yields, without apparently impairing fruit quality or composition. In tomato rootstock like Efialto', 'Heman' and 'Maxifort increase the marketable yield and enhance the lycopene content. The average yield of melon (44%) and watermelon (84%) plants grafted on different Cucurbita hybrids (C. *maxima* x C. *moschata*) as rootstocks were much higher than the yields of the non-grafted plants. By grafting watermelons on to different rootstocks, the quality of the fruit has been known to increase fruit firmness and thus increase shelf life.
4. **Minimizing the auto toxic effect**: Phenolic acid of root tissue and root exudates act as toxin in cucurbits Resistant (*Cucurbita ficifolia*).
5. **Survival of grafts under excessive moisture**: Intergeneric grafting imparts the attributes of flood tolerance in cucurbits. Generally flooding reduces photosynthetic rate, stomatal conductance, transpiration, soluble protein. But this reaction minimized by intergeneric grafting of flood in tolerant bitter melon onto flood tolerance.
6. **Improving quality traits**: Flavor, pH, sugar, color, carotenoid concentration, texture can be affected by type of rootstock used in watermelon stated by. observed that different rootstocks affect grafted cucumber quality characteristics such as fruit shape, skin and flesh color and texture, skin smoothness, firmness, rind thickness, and soluble solids content.
7. **Effect of grafting on flowering and harvest**: Influence early flowering: [8] state that compared with other rootstocks, watermelon grafted onto bottle gourd causes early formation of female flower.

Cucumber varieties grafted onto a squash interspecific hybrid rootstock inhibited flowering.

8. **High and low temperature Tolerance**: Brinjal grafted on heat tolerant rootstock of brinjal seemed promising and resulted in prolonged growth stage and yield increase up to 10%. In low temperature cucurbit crops are not germinate so use of grafting for off season crop. Grafted watermelon seedlings under low temperature stress have higher antioxidants and antioxidative enzyme activities in leaves than self-rooted watermelon seedlings.

GRAFTING TECHNIQUES

Different grafting techniques were adopted for different scions and rootstocks; they depend on grafting objectives, farmers' experience, and post grafting management conditions; and moreover, the survival rate of grafted plants depends on compatibility between scion and rootstock, quality and age of seedlings, quality of the joined section, and post-grafting management.

The initial grafting method used for melon was cleft grafting but after the introduction of the tongue approach grafting method, its use diminished greatly. The tongue approach method became widespread in Asia because of its higher success rate and the uniform growth of grafted seedlings. In Spain, high proportions (more than 90%) of watermelon plants are grafted using the one cotyledon method.

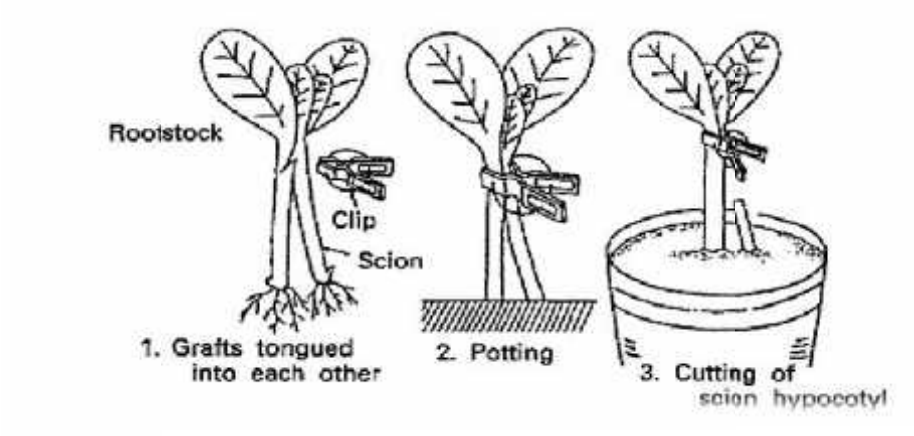
Choice of Rootstock: Root system more vigorous than scion. Overcome to low soil moisture. Overcome low fertility stress and salt stress. Hardiness in low and high temperature. Resistant to soil borne pathogen, pest and nematode. Increase vigor and precocity.

Choice of scion: Ability to produce higher yield and quality fruit.

1. **Tongue approach grafting (TAG):**

   It is easy to use and has a high success rate and the grafted seedlings have uniform growth rate shown in Fig. 1. The scions and rootstocks should be approximately the same diameter in the TAG method. This is usually the case after the rootstock has fully developed cotyledons and the scion has cotyledons and the first true leaf. Cut 45 degree downward slit halfway through the stem below the cotyledons, and cut an identically angled upward slit in the scion stem. The angle and location of the cuts must be relatively precise so the scion can be placed on top of the rootstock. Bring the two cut stems together so they overlap, then attach a clip or securely wrap the joined stems in plastic wrap, foil, or parafilm.

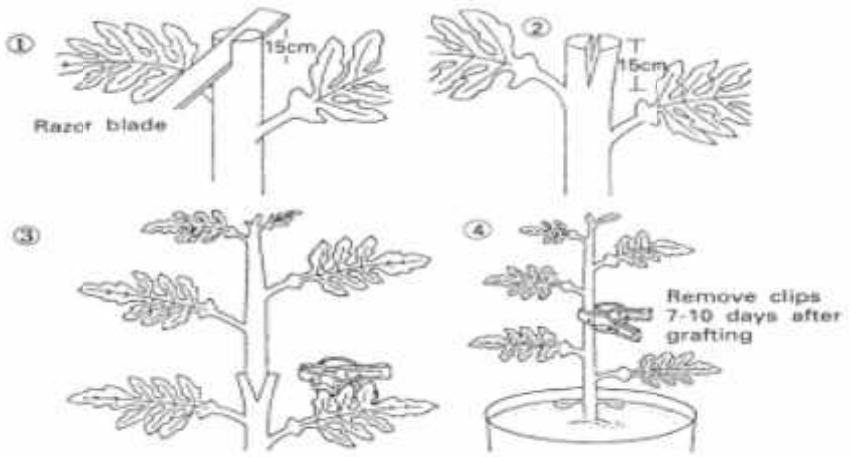
Place the joined plant in a transplant tray or small pot. Mist the plant with water and place it on a greenhouse bench. Water the plant as needed. Cut off the top of the rootstock 5 days after grafting. Wait 7 days, and then cut off the bottom portion of the scion. Advantages of TAG are relatively simple technique favored by less experienced farmers, grafting clip is not essential and high humidity and low light environment is not required for successful healing of the graft union; a normal greenhouse environment is sufficient.



2. Cleft grafting:

In cleft grafting a small cut is made in the stock and then the pointed end of the scion is inserted in the stock. This is best done in the early spring and is useful for joining a thin scion about 1 cm (3⁄8 in) diameter to a thicker branch or stock. It is best if the former has 3–5 buds and the latter is 2–7 cm (3⁄4–2 3⁄4 in) in diameter. The branch or stock should be split carefully down the middle to form a cleft about 3 cm (1 1⁄8 in) deep. If it is a branch that is not vertical then the cleft should be cut horizontally. The end of the scion should be cut cleanly to a long shallow wedge, preferably with a single cut for each wedge surface, and not whittled. A third cut may be made across the end of the wedge to make it straight across.

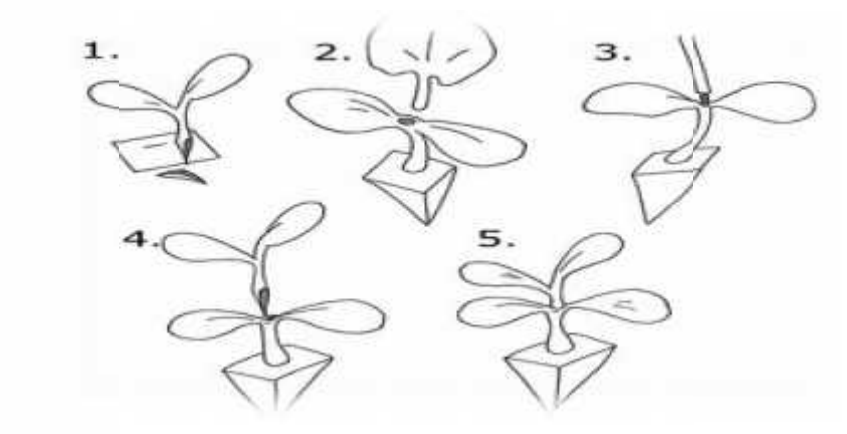
Slide the wedge into the cleft so that it is at the edge of the stock and the centre of the wedge faces are against the cambium layer between the bark and the wood. It is preferable if a second scion is inserted in a similar way into the other side of the cleft. This helps to seal off the cleft. Tape around the top of the stock to hold the scion in place and cover with grafting wax or sealing compound. This stops the cambium layers from drying out and also prevents the ingress of water into the cleft.



Cleft Grafting – (Source: Oda, 1999)

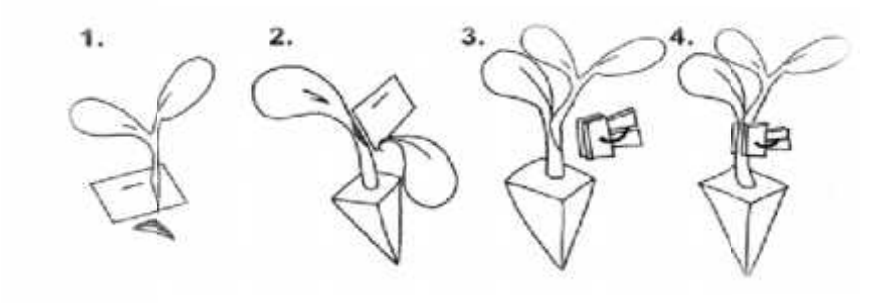
3. **Hole Insertion Grafting**:

Rootstock seedlings should have one small true leaf, and scion seedlings should have one or two true leaves. With a pointed probe, remove the true leaf, the apical meristem (undifferentiated cells), and the axillary buds from the topmost growing point of the rootstock plant (refer back to Figure 1 for location of plant parts). It is important to remove all of the apical meristem and the axillary buds to prevent future shoot growth of the rootstock. Use the probe to create a hole in the top of the rootstock where the tissue was removed (Figure 5A). Cut the scion below the cotyledons at a 45° angle on two sides to form a wedge (Figure 5B) and insert it into the rootstock (Figure 5C). Figure 6 shows this grafting technique with actual plants. Mist with water and place in healing chamber.



4. One Cotyledon Grafting:

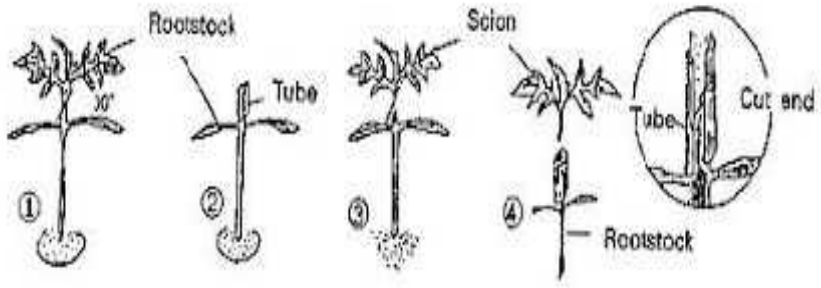
This method (also known as the splice graft) was originally developed by Japanese engineers for use with automated grafting. Due to the procedure's simplicity, it has become the most commonly used manual grafting method. Rootstock seedlings should have at least one true leaf, and scion seedlings should have one or two true leaves. Cut the rootstock at a 45° angle so one cotyledon remains and one is removed (Figures 7A and 8A). Cut carefully so as to keep the remaining cotyledon firmly attached to the rootstock stem. The angled cut should also remove the apical meristem and both axillary buds (refer back to Figure 1 for location of plant parts). It is important to remove all of the apical meristem and the axillary buds to prevent future shoot growth of the rootstock. If all of the axillary bud tissue was not removed with the cut, use the probe to dig it out. Cut the scion at a 45° angle below the cotyledons (Figures 7B and 8B), where its diameter matches that of the rootstock. Bring the two cut stem surfaces together, and hold them in place with a grafting clip (Figures 7C, 8C and 8D). Mist with water and place in healing chamber.



5. Tube Grafting:-

Sow seed for the rootstock 1-2 days prior to seed for the shoot. Because smaller plants are used in tube grafting, you should be able to graft plants two or three times faster than with the more conventional cleft method. Also, the smaller plants take up less room during the healing and acclimation process. The optimum growth stage for grafting varies according to the kind of plug tray used and your ability to handle the small plants. [Because of limits to my manual dexterity, I find it hard to handle plants smaller than about 4" in height and 1/8" stem diameter. However, you can graft smaller plants as long as you can physically work with them]. Also note that plants in small cells must be grafted at an earlier growth stage, and require tubes with a smaller inside diameter. The steps in Figure 3 are used for tube grafting. First, the rootstock is cut at a slant (you can also use a blunt

cut but the slant allows more surface contact on the graft). The shoot is cut in the same way. Place the two cut ends in direct contact and use a small clip to hold the cut surfaces together. If you plan to have the rootstock support a double leader in the production house (Figure 6), the graft MUST be made below the cotyledons or seed leaves on both the rootstock and the shoot or scion.



6. **Pin grafting:**

Pin grafting is similar to splice grafting, the only difference being that specially designed pins are used instead of clips to fix the grafted position of the scion and rootstock (see Plate 1h and i). These pins are made of a natural ceramic material so that they can remain within the plant without causing problems. The Taki Seed Company in Japan has designed ceramic pins of 15 mm length and 0.5 mm width with a hexagonal cross-section. This method saves time and labour, as clips need removal while pins do not.

7. **Double Grafting:**

Grafting is placing two cut surfaces of one or different plants under conditions which cause them to grow together. Double grafting inserts the intermediate growth into the first stock, which is ultimately grafted with the one it is intended to propogate.

Conclusion:

Grafting provides a site-specific management tool for soil borne diseases. Grafting can affect various quality aspects of vegetables. Rootstock/scion combinations should be carefully selected for specific and geographic conditions. It fits well into the organic and integrated crop production system. It reduces the need for soil disinfectants and thereby environmental pollution. Grafting technology has a potential in promotion of cultivation in non-traditional and fragile agro-eco system. Grafting is a rapid alternative tool to the relatively slow breeding methodology aimed at increasing biotic and abiotic stress tolerance of fruit vegetables. Since grafting gives increased disease tolerance and vigour to crops, it will be useful in the low input sustainable horticulture of the future.

17. Microgreens: A New class of edibles

India is a second largest county in the production of vegetables which occupies 10.32 million hectares area and producing 189.46 million ton of vegetables. But national food security is becoming a matter of increasing concern and poverty is reflected in the nutritional status of the people. The present per capita availability of vegetables in India is only 210g against the requirement of 300g/capita/day for normal health as per the Recommended Daily Allowance (RDA).

What is the option for this?

MICROGREENS

They're small, but microgreens are packed with a high concentration of nutrients and some varieties also offer an intense flavour.

Microgreens can easily be grown with or without soil in any area within a short period span of 10-15 days.

Concentrated with bio-active compounds like vitamins, minerals, antioxidants.

What are Microgreens?

Microgreens are vegetables or herbs that are harvested just after they've sprouted and produced their first set of true leaves.

Most microgreens are between one and three inches tall when they're harvested.

Historical Development:

- ***1930 – When Wheatgrass was grown dried and sold as a medical in North America pharmacies.***
- ***1960 – Sunflower, buckwheat and radish were frequently grown as a winter green.***
- ***1970 – During this time the home-grown grasses were popularized for their health benefits.***
- ***1980 – Chef started growing Cresses and Seedlings for Garnishing***
- ***1998 – First documented use of word "MICROGREENS "started in USA.***
- ***2000 – Microgreens were produced locally.***

Microgreens vs. Sprouts

- Don't confuse microgreens with sprouts. Sprouts are seeds that have just been soaked in water long enough to germinate.

- With sprouts you eat the entire thing, including the root, and they haven't produced their first true set of leaves yet,

- Microgreens are typically grown in soil and cut off at stem level.

Some Important/Popular Microgreens:

(1) Amaranth –

- **Pre-soak:** N/A
- **Suitable Growth Medium:** Soil or Hydroponic
- **Germ time:** 2-3 Days
- **Harvest time:** 8-12 Days
- **Colour:** The most vibrant red/pink of any microgreen
- **Flavour:** A mild, sweet flavour
- **Nutrients:** Vitamins K, E, and C, calcium, iron, and beta-carotenes

(2) Arugula / Rocket –

- **Pre-soak:** N/A
- **Suitable Growth Medium:** Soil or Hydroponic
- **Harvest time:** 6-8 Days
- **Colour:** A deep green stem and leaves
- **Flavour:** A strong peppery flavour, slightly buttery and cabbage-like
- **Texture:** Crisp and fresh
- **Nutrients:** Vitamins A and C, calcium, iron, and phosphorus

(3) Barley -

- **Best temperature:** Best at 16 - 25 °C; avoid hot weather
- **Soak:** Wash seed then soak for 8-12 hours.
- **Suitable Growth Medium:** Soil or Hydroponic
- **Germ time:** 2-3 Days
- **Harvest time:** 6 - 9 Days
- **Colour:** Bright green
- **Flavour:** Sweet
- **Texture:** Tender and fresh

(4) Basil -

- **Seed Pre-soak:** No
- **Growing Medium:** hydroponic, soil
- **Preferred Medium:** hydroponic for microgreens, soil for baby greens and adult stage
- **Germination Rate:** high

- **Germination Time:** 3 to 4 days
- **Microgreens Harvest time:** 8 to 12 days
- **Microgreens Ideal Harvest:** 10 days
- **Baby Salad / Adult Stage Harvest:** 16+ days (grow in soil) **Micro Greens Colour:** purple with some green/green **Micro Greens Flavor:** intense basil

(5) Beets –

- **Latin Name:** *beta vulgaris var. Detroit Dark Red*
- **Seed Pre-soak:** 4-10 hours in cold water
- **Days to Maturity:** 11-21 days
- **Growth Medium:** Soil
- **Colour:** Vibrant red stems with a neon green top
- **Flavour:** Sweet and earthy, similar flavour to swiss chard microgreens
- **Nutrients:** Vitamins A, B, C, E, and K, Calcium, Magnesium, Potassium, Iron, Zinc, and protein

(6) Broccoli -

- **Latin Name:** *Brassica oleracea var. italica*
- **Pre-soak:** No
- **Suitable Growth Medium:** Hydroponic and Soil
- **Germ time:** 2-3 Days
- **Harvest time:** 8-12 Days
- **Colour:** A thin white stem with shades of purple and a green top

- **Flavour:** a strong broccoli flavour
- **Texture:** Soft
- **Nutrients:** Vitamins A and C, calcium, iron, and phosphorus

(7) Cilantro/Coriander

- **Germ time:** 2-3 Days
- **Harvest time:** 21-28 Days
- **Colour:** A long green stem with a very leafy top
- **Flavour:** Full cilantro flavour
- **Texture:** Crisp and fresh
- **Nutrients:** Vitamins A and C, calcium, iron, and phosphorus

(8) Cress -

- **Pre-soak: No Soak**
- **Other Names:**
- **Days to Maturity**: 7-14 days
- **Growth Medium**: Soil or Hydroponic
- **Colour:** White stems and green leaves
- **Flavour:** intense peppery, hint of sweet
- **Nutrients:** Vitamins B, C, and K, folic acid, and fibre

(9**) Dill -**

- **Dill Seeds:** *Anethum graveolens*
  Seed Pre-soak: no
  Growing Medium: soil or hydroponic
  Germination Rate: high
  Germination Time: 1 to 2 days
  Microgreens Harvest time: 10 to 14 days
  Micro Greens Colour: green
  Micro Greens Flavor: fresh, with sweetness like adult Dill

(10)Mustard -

- **Latin Name:** *brassica juncea*
- **Other Names:**
- **Days to Maturity:** 8-12 days
- **Growth Medium:** Soil or Hydroponic
- **Colour:** A green stem and leaves with intense red shades
- **Flavour:** A bold mustard flavour with spice
- **Nutrients:** antioxidants, fibre, Vitamins A, C, E, and K

(11) Radish -

- **Pre-soak:** 4-6 hours
- **Suitable Growth Medium:** Hydroponic & Soil
- **Germ time:** 1-2 Days
- **Harvest time:** 6-12 Days
- **Colour:** A vibrant red stem with a deep green top
- **Flavour:** Spicy & slightly floral
- **Shape:** Leafy
- **Texture:** Crunchy, succulent

Nutrients: Vitamins A, B, C, E, & K, folic acid, niacin, potassium, iron, phosphorus, pantothenic acid, calcium, magnesium, zinc, carotenes.



Media: Cocopeat, Vermiculite and cocopeat alone or in combination of 3:1:1.

Container: 1) Plastic boxes, growing (2)Growing tray with small hole for better drainage (3)Disposable tray for homestead production



Sowing: one essential practice followed before sowing or spreading of seeds in media is soaking. Like seeds of spinach and fenugreek require soaking for getting good germination percentage.

Aftercare: Though, microgreens do not require much care after the spreading of seeds, however sufficient moisture should be maintained through fine spray. High light requirement of 12-16 hours.

Dishes made with Microgreens & steps taken for its cultivation:




18. Roof top garden and Kitchen garden

Roof top garden

INTRODUCTION:

- A roof garden system is a roof area where plants or a landscape is installed above a waterproofed substrate.
- Rooftop Gardening is not considered as a modern concept. It is believed that they have a long history. The ancient Mesopotamians are regarded as the first known culture who developed this type of gardening around 600 BC. The plantation started with decorative plants which they would plant in their terrace as most of them had terraces. Romans and Egyptians were also the other cultures who practiced rooftop gardening.
- Egyptians used to complete their buildings with the roof gardens. They also used to have water wheels in order to irrigate their gardens.
- In the modern time, rooftop gardens are very popular among the city population. People in the city area crave for greenery and fresh fruits and vegetables. There are various irrigation systems and roof tops practiced at the moment. The irrigation could be manual or through some systems so that watering could be done automatically. When talking about rooftop gardens, drainage system should be considered. This is one of the biggest risks one can have when building the roof gardens.

BENEFFITS:

1) **Ecological Benefits**:

It is very rare that one gets a chance to return what environment has given to us. By practicing roof gardens, in the urban areas, one can restore the lost ecological values. Roof gardens and ecological benefits are directly related to each other, more the merrier. One of the first ecological benefits is that the plants absorb pollutants that rainwater brings with it. This way the heavy metals and nutrients are absorbed by soil instead of wasting away. Similarly, Green roofs are very beneficial in reducing air temperatures. These also increase humidity levels in the surrounding areas. Green roofs can work as a filter. They can filter dust particles and airborne toxins. Green Roofs for Healthy Cities states that, **"One square meter of grass roof can remove approximately 0.2 kg of airborne particles from the air every year."** Green roofs also provide habitats for various species.

2) **Economic Benefits**:

The use of wasted space can be one of the benefits. As it can be costly when needing a garden at ground level, unused roof tops can save that cost. Similarly, the building is beautified which can increase the number of people interested in the building. Use of recycles materials is another benefit. As people use more recycles materials, disposing of the material is saved. There could be job opportunities (local people could get job easily) for the locals if these types of farming are done in a large or medium scale. Also, being green can increase brand value. As the food is produced within the community, one can buy food from the locals. The result is transportation costs and time is saved. Also, one can enjoy the fresh food.

3) **Aesthetic Benefits**

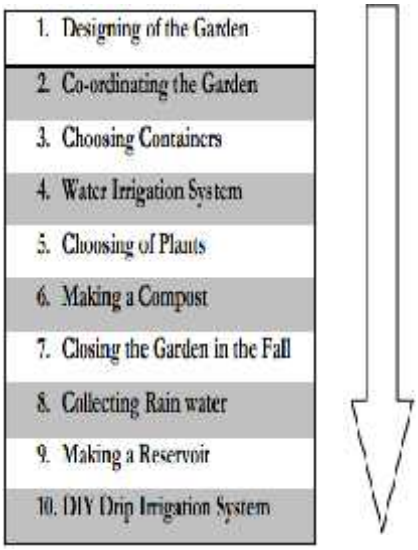
Like ecological and economic, there are also aesthetic benefits of roof gardens with the green surrounding. It is easier to forget the crowd of the city. The Greenery brings the countryside memories or feelings alive. Similarly, fresh air can give a positive energy. Also, the visual image of these roof gardens provides various opportunities for any individual/company with endless design possibilities.

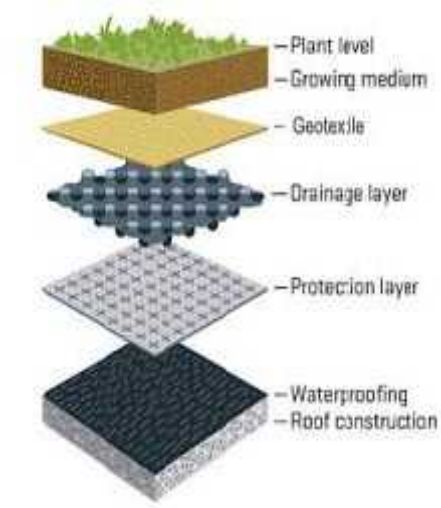
4) **Psychological Benefits**

It is reported that the quality of life can be enhanced with the increase in green surroundings. Doing the rooftop gardens helps in communication between each Other within a society. It brings a bond between a farmer and a consumer. This is very much needed in an urban society as people are going farther away from each other with the virtually that technology has bought.

Setting up the Garden:

There are several procedures involved when building a Rooftop Garden. One has to be very careful since choosing a site to build a garden to what to plant in the garden. The process/procedure on how to build a Rooftop Garden is explained below.





Designing of the Garden:

The first and foremost thing before starting any projects, planning is very necessary. A very good design of the garden in this case is the basics before starting running it. As this is just a pilot project and in a small-scale DIY design can be used. The design can be created by oneself without so much of professional help.

Coordination of the Garden:

Another important thing will be coordinating the garden. What types of plants to be planted, which kinds can be planted together, what type of soil to be used, basic information on gardening, etc. are very much needed while doing this. Hence, co-ordination is very necessary.

Containers:

Containers must be chosen in such a way that there are possibilities to find some used stuffs which will encourage the re-use and also lowers the cost. For e.g. used car tyres which cannot be further used can be a good container. But also, some farming bags can be used. These bags are nature friendly as well as cheaper to purchase.

Irrigation System:

There are various types of water irrigation system when searched in the internet. Some are very costly while some can be done with near to no cost. When

choosing the irrigation system, the drainage system, water connections, the condition of roofs, etc. should be carefully studied.

Choosing Plants:

When choosing a plant, some studies should be made about the regional vegetation. This means what kind of plants can grow in that environment. Also, one should know about the seeds and seedlings and how to plant them. Basically, sufficient knowledge is necessary while choosing a plant.

Compost:

Some place has to be separated in order to prepare a compost manure.

Water Reservoir:

In order to save water, we can collect rain water and reserve them for the watering purpose. A reservoir is needed to collect the rain water and pass them to the plants.

Drip Irrigation:

Drip Irrigation system is the method of watering a plant in such a way that very little water is used beneficially. With this system, water drips very slowly and reaches to the root of the plants.

Choosing the Rooftop Vegetation: There are various factors that should be considered when doing vegetation in roof. light weight growing media is preferred. The light weight consists of high-quality compost and other recycled materials. Main reason behind choosing this material is to allow air and water to pass, to provide nutrients which are appropriate to the plants and to keep plants from drying due to the wind.

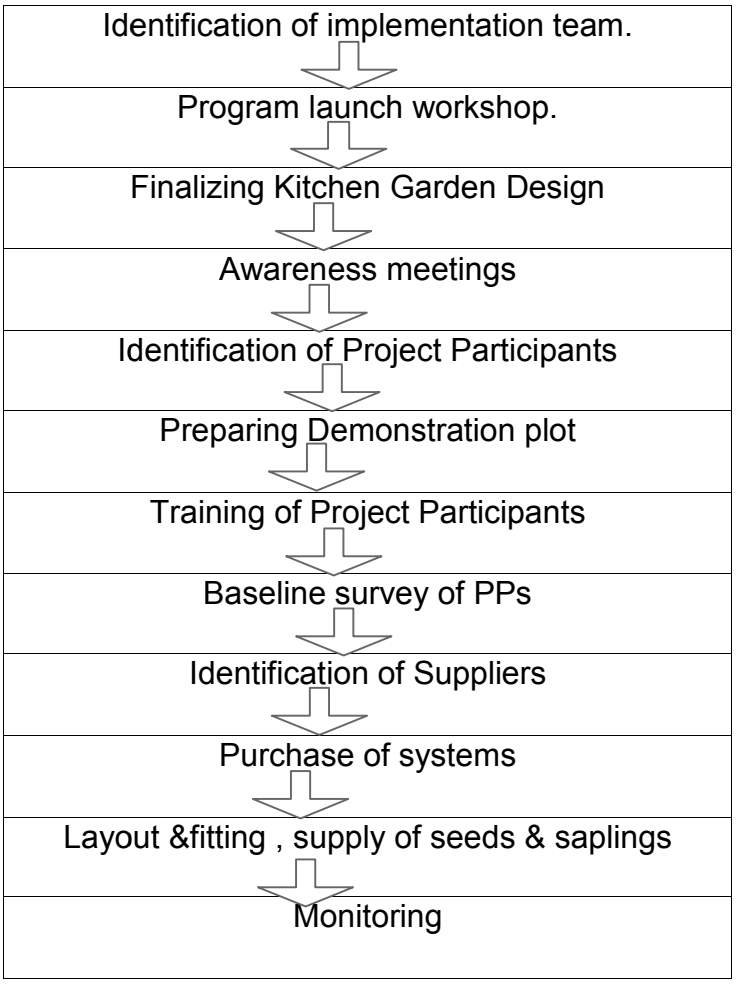
Different types of vegetation suitable for the rooftop

- Tomatoes, as they can survive extreme heat and also that they can grow very well in containers.
- Cucumbers are the best vegetables that could grow in the roof. They only need a support to grow
- Carrots, lettuce and radishes are some of the shallow
- rooted vegetables that can grow even in the small containers being another best option for the rooftop vegetation.
- Basil, rosemary, oregano and thyme are other edible products that can be grown.
- Pine trees, Apple trees and other decorative flowers according to the season.

Kitchen garden

Kitchen Garden program has been launched in a systematic way. As described in the project proposal rural people even though they are farmers, use very few food combinations in their diet. This is because they lack in knowledge and they don't have access to the required ingredients. We focused the program on these two aspects.

Implementation:



To reach up to needy families we took the help of village women's groups, teachers, and local medical practitioners in the beneficiary identification process.

1. Awareness building meeting:

We have organized meetings at Morbagi, Pandozari, Tinkondi, Balgaon, Bhivargi, Karjagi, Motewadi, Jalihal (Bk), Asangiturk, karewadi (K.B), karewadi (T), Motewadi (K.B), Gulguenaletc. Total 348 women, farmers were present in the meeting. In the meeting it was explained that the aim of this project is to ensure balanced diet to the malnourished and poor families. The project is to inculcate preventive health care habits among rural people, nutritious food intake will be a prominent part of this program. In the meetings the present food intake and it's effect on the body was discussed. Also, various diseases and health disorders caused by insufficient diet was discussed. At every place people were made to establish link

between their food intake and their health. Teachers were invited in the meeting so that they could suggest the names of the children who are malnourished. In the meeting names of the probable project participants were selected.

In the meeting names of the probable project participants were selected. Local bodies like SHGs, farmer's groups, teachers and VEC members participated in the beneficiary selection process. Participating families should have about 2000 sq.ft. land near their house. They should have some source of water required to maintain kitchen garden. The beneficiary family must be willing to participate in training, learn and adopt the new practices.

2. Training to the project participants:

After the selection of beneficiaries, we arranged one day training on kitchen garden. In the first batch 43 project participates including 35 women 5 farmers and 3 students were present. We discuss concept of kitchen garden, objectives, it's need etc. Direct access to nutritionally rich food, savings on food and decrease in health expenses were discussed. One of the easiest ways of ensuring access to a healthy diet that contains adequate macro-and micronutrients is to produce many different kinds of foods in the kitchen garden. This is especially important in rural areas where people have limited income-earning opportunities. Kitchen gardens are also becoming an increasingly important source of food and income for poor households' urban areas.

Consuming a nutritionally adequate diet is vital for a healthy and active life. Promoting appropriate diets and healthy lifestyles are central activities in reducing malnutrition, and promoting nutritional well-being for all.

First the theory part of the project was taken. Then the design of kitchen garden was discussed. Location of every plant and the reason to plant at particular place was discussed. To gain practical experience, the participants made the layout of demonstration plot at NAU campus

.

3. Demonstration unit:

A model kitchen garden has been established for demonstration purpose at NAU campus, Navsari. The kitchen garden is designed to provide sufficient vegetables to the common staff mess run at the campus. We are getting fresh and sufficient quantity of vegetables from 15th November 20. Fresh vegetable is picked twice a day (just before cooking the food!). Following vegetables are planted

- **Spinach**
- **Brinjal**
- **Okra Vegetable**
- **Fenugreek**
- **Beans**
- **Bitter gourd**
- **Tomatoes**
- **Chole, Rajma**
- **Fruit plants**

4. Kitchen garden plots:

Once the project participant is identified, we conduct the baseline survey for all the participants. This survey is essential to measure the impact and the progress of the program. In the baseline survey format contains information about the family, their economic condition, present access to nutritional ingredients/ vegetables, present health status of all the family members, present medical expenses etc.

5. People's participation:

There has been overwhelming response from the villages to this program. Selection of beneficiaries was a tough job. Still with the support of local people only needy families were selected to participate in the program.

The beneficiaries do their role of preparing the land, applying manure, preparing the beds with a lot of interest. As entire support is being provided in kind,

they come to NAU campus to collect the material. We have seen that there has been exchange of seeds among the beneficiaries!

6. Difficulties faced:

Initially when the project was announced, people thought that this will be an income generating activity like another project “sub-soil irrigation” which is being implemented by NAU. People attended the meeting with that intension. However, we had guessed the same before, so our team was prepared to convince the participants. Now every project participant is involved in the program to ensure good health of his/her family.

During the training it was shown to all the training how to fit the irrigation system. When our staff visited first plots who installed the system, we found lots of flaws. So, we decided to train local youth who are already into plumping activity. We identified three youths and after training them they have been assigned the job of fitting the system.

Beneficiaries are inclined to use chemical fertilizers to get maximum output. In the training program Mr. Velapurkar explained the bad effects of chemical fertilizers on human body. He also explained that the kitchen garden project has been designed by considering organic inputs. He also assured that if prescribed practices are adopted, everyone will get the output enough to feed the family as planned in project.

HWE.7.1.2 Packing and Marketing of High Valued Horticultural Crops (0+4)

1. Introduction to New Farmers' Bill, 2020

THE FARMERS (EMPOWERMENT AND PROTECTION) AGREEMENT ONPRICE ASSURANCE ANDFARM SERVICES BILL, 2020

A BILL to provide for a national framework on farming agreements that protects and empowers farmers to engage with agri-business firms, processors, wholesalers, exporters or large retailers for farm services and sale of future farming produce at a mutually agreed remunerative price framework in a fair and transparent manner and for matters connected therewith or incidental there to. BE it enacted by Parliament in the Seventy-first Year of the Republic of India as follow: -

- **PRELIMINARY:**

  This Act may be called the Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020&come into force on the 5th June, 2020.

- In this Act, unless the context otherwise requires: -
  - ✓ "APMC yard" means the physical premises covering Agriculture Produce Market Committee Yard, by whatever name called, established for regulating markets and trade in farming produce under any State Act;
  - ✓ "electronic trading and transaction platform" mean a platform set up to facilitate direct and online buying and selling for conduct of trade and commerce of farming produce through a network of electronic devices and internet applications.
  - ✓ "farming agreement" means a written agreement entered into between a farmer and a Sponsor, or a farmer, a Sponsor and any third party, prior to the production or rearing of any farming produce of a predetermined quality, in which the Sponsor agrees to purchase such farming produce from the farmer and to provide farm services.

    Explanation.—For the purposes of this clause, the term "farming agreement "may include: -

    (a) "trade and commerce agreement", where the ownership of commodity remains with the farmer during production and he gets the price of produce units delivery as per the agreed terms with the Sponsor.

    (b) "production agreement", where the Sponsor agrees to provide farm services, either fully or partially and to bear the risk of output, but agrees to make payment to the farmer for the services rendered by such farmer

    (j) "force majeure" means any unforeseen external event, including flood, drought, bad weather, earthquake, epidemic outbreak of disease, insect-pests and such other events, which is unavoidable and beyond the control of parties entering into a far.

❖ FARMING AGREEMENT:

- ✓ A farmer may enter into a written farming agreement in respect of any farming produce and such agreement may provide for—
  - the terms and conditions for supply of such produce, including the time of supply, quality, grade, standards, price and such other matters; and
  - The terms related to supply of farm services: Provided that the responsibility for compliance of any legal requirement for providing such farm services shall be with the Sponsor or the farm service provider, as the case may be.
- ✓ The minimum period of the farming agreement shall be for one crop season or one production cycle of livestock, as the case may be, and the maximum period shall be five years:
  - Provided that where the production cycle of any farming produce is longer and may go beyond five years, in such case, the maximum period of farming agreement may be mutually decided by the farmer and the Sponsor and explicitly mentioned in the farming agreement.
  - For the purposes of facilitating farmers to enter into written farming agreements, the Central Government may issue necessary guidelines along with model farming agreements, in such manner, as it deems fit.

- ✓ The parties entering into a farming agreement may identify and require as a condition for the performance of such agreement compliance with mutually acceptable quality, grade and standards of a farming produce.
  - a guaranteed price to be paid for such produce.
- ✓ A farming agreement may be linked with insurance or credit instrument under any scheme of the Central Government or the State Government or any financial service provider to ensure risk mitigation and flow of credit to farmer or Sponsor or both.
- ✓ A State Government may notify a Registration Authority to provide for electronic registry for that State that provides facilitative framework for registration of farming agreements.
  - The constitution, composition, powers and functions of the Registration Authority and the procedure for registration shall be such as may be prescribed by the State Government.

❖ DISPUTE SETTLEMENT:

Every farming agreement shall explicitly provide for a conciliation process and formation of a conciliation board consisting of representatives of parties to the agreement: Provided that representation of parties in such conciliation board shall be fair and balanced.

- ✓ Where, the farming agreement does not provide for conciliation process as required under sub-section (1) of section 13, or the parties to the farming agreement fail to settle their dispute under that section within a period of thirty days, then, any such party may approach the concerned Sub-Divisional Magistrate who shall be the Sub-Divisional Authority for deciding the disputes under farming agreements.

  (2) On receipt of a dispute under sub-section (1), the Sub-Divisional Authority may,

  if—

  - the farming agreement did not provide for conciliation process, constitute a conciliation board for bringing about settlement of such dispute; or the parties failed to settle their dispute through conciliation process, decide the dispute in a summary manner within thirty days from the date of receipt of such dispute, after giving the parties a reasonable opportunity of being heard and pass an order for recovery of the amount under dispute, with such penalty and interest, as it deems fit, subject to the following conditions, namely:—
  - where the Sponsor fails to make payment of the amount due to the farmer, such penalty may extend to one and half times the amount due;
  - where the order is against the farmer for recovery of the amount due to the Sponsor on account of any advance payment or cost of inputs, as per terms of farming agreement, such amount shall not exceed the actual cost incurred by the Sponsor;
  - where the farming agreement in dispute is in contravention of the provisions of this Act, or default by the farmer is due to force majeure, then, no order for recovery of amount shall be passed against the farmer.
- ✓ Every order passed by the Sub-Divisional Authority under this section shall have same force as a decree of a civil court and be enforceable in the same manner as that of a decree under the Code of Civil Procedure, 1908, unless an appeal is preferred under sub-section (4).
- ✓ Any party aggrieved by the order of the Sub-Divisional Authority may prefer an appeal to the Appellate Authority, which shall be presided over by the Collector or Additional Collector nominated by the Collector, within thirty days from the date of such order.

❖ **MISCELLANEOUS:**

- ✓ The Central Government may, from time to time, give such directions, as it may consider necessary, to the State Governments for effective implementation of the provisions of this Act and the State Governments shall comply with such directions.

- ✓ All authorities, including Registration Authority, Sub-Divisional Authority and Appellate Authority, constituted or prescribed under this Act, shall be deemed to be public servants within the meaning of section 21 of the Indian Penal Code.
- ✓ Provided that a farming agreement or such contract entered into under any State law for the time being in force, or any rules made there under, before the date of coming into force of this Act, shall continue to be valid for the period of such agreement or contract.
- ✓ Every rule made by the Central Government under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

❖ STATEMENT OF OBJECTS AND REASONS:

Indian Agriculture is characterised by fragmentation due to small holdings and has certain weaknesses such as dependence on weather, uncertainties in production and unpredictable market. This makes agriculture risky and inefficient in respect of both input and output management. These challenges needed to be addressed by way of realising higher productivity, cost effective production and efficient monetisation of the produce to increase the farmers' income. It was felt that promotion of agreements for farming produce may strengthen the process of monetisation whose primary objective is to de-risk agriculture at various stages, enable scaling of investment by industry for production and processing of high value agriculture produces, give fillip to exports and help farmers to enjoy the additional benefits of operational efficiency.

- The COVID-19 pandemic and resultant lockdown also threw up challenges for agriculture and impacted the livelihood of farmers. As agriculture sector has immense potential to make significant contribution to the economic growth, there was a need to find long term solutions for farmers and for agriculture as a whole. Therefore, to achieve these objectives and to mitigate risks for farmers, enhance their income, put in place an effective and conducive policy regime for agreements and for holistic development of the agriculture sector, there was a need for immediate legislation.

- The Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Bill, 2020 which seeks to replace the Farmers (Empowerment and Protection)Agreement on Price Assurance and Farm Services Ordinance, 2020 (Ord. 11 of 2020) provides for—
  (a) facilitating written farming agreement to be entered into in respect of a farming produce, except where such agreement derogates the rights of a share cropper;
  (b) the conditions for performance of farming agreement, including compliance with mutually acceptable quality, grade and standards of farming produce;
  (c) the pricing of farming produce;
  (d) the manner of delivery of farming produce;
  (f) prohibiting the Sponsor from acquiring ownership rights or making permanent modification on farmers' land or premises;
  (g) the Sponsor to ensure timely acceptance of delivery and payment for such farming produce.

2. Harvesting of vegetables and flowers

The determination of maturity varies with the types of vegetable, but in general, size is the principal criteria. Virtually all leaf vegetables are cut by hand. For fruit vegetables, the solidness of the fruit determines harvest maturity. Stem vegetables are also hand harvested. Asparagus is hand cut when spears are at least 23 cm (9 inches) above the soil surface. All floral vegetables are hand harvested also. The maturity of flower vegetables (e.g., broccoli and variations in harvesting and post harvesting handling procedures, on the types of vegetable, the size and efficiency of farm resources and whether the vegetables are for local or export markets. Some vegetables are picked at immature stages in order to tolerate shipping and handling. It is important to harvest vegetables at the proper stage, size and at peak quality. A proper postharvest handling procedure is important to prolong the shelf life of the vegetables. Currently, there are no specific standards in Malaysia for postharvest handling of organic produce.

- **Tomato:**

Harvesting maturity is based on internal fruit structure indices. Seeds are fully developed and are not cut upon slicing the fruit. Gel formation is advanced in at least one Locule with jelly-like material forming in other locals. The standard tomato quality is primarily based on uniform shapes and free from growth or handling defects. The quality of the tomato can be commercially graded according to the following criteria:

Shape – well rounded, globe, flattened globe and Roma types.

Colour – uniform orange-red, deep red and light yellow. No green shoulders.

Appearance – smooth with small blossom-end scar and stem-end scar. Absence of

Growth cracks, cat-face shape, sunscald, insect injury and mechanical

Injury or bruises.

Firmness – firm when press by hand pressure. Not soft or easily deformed due to an

Overripe condition

- **Chili:**

Chilli is harvested based on fruit size and colour (colour breaking stage). Quality chilli fruit should have uniform shape, size, typical colour of the variety and free from defects such AS cracks, decays and sunburn.

- **Brinjal:**

Brinjal is harvested at various development stages depending on the cultivar and weather. The time interval from flowering to harvest is around 10–40 days. Generally, brinjal is harvested at the immature stage, before the seeds begin to

enlarge and harden. The firmness and external glossiness are also indicators of a pre-maturity condition. The brinjal fruits become pithy if overripe. The diversity of brinjal types being marketed has increased greatly in recent years. The Federal Agriculture Marketing Authority (FAMA) standards for quality are primarily based on uniform shape, firmness and dark purple skin colour. Additional quality indices are size, free from handling defects and decay. The current types of brinjal planted in.

Long brinjal – elongated, slender, light to dark purple, highly perishable.

White brinjal – small egg shaped to globular, thin skinned.

Mini brinjal – small elongate, striated purple and violet.

Round brinjal – round and light purple.

- **Okra:**

Okra is harvested when the fruits are still growing. Fruits can be harvested at 3–7 days after flowering when they are bright green, fleshy and with small seeds. After that period, the fruits become dark green, pithy, tough, and the mucilage content decreases. The fruits should be well formed, straight, have a fresh appearance and no signs of dehydration. The fruits should not be broken, especially at the tips, have no insect damage or mechanical injury. The tender fruits are easily damaged during harvest and these results in the formation of brown and black discoloration. Quality losses that occur during marketing are often associated with mechanical damage, water loss and decay of fruits.

- **Cabbage:**

The cabbage maturity is based on head compactness. A compact head will compress slightly with moderate hand pressure. Immature heads are loose and mature heads are very firm or hard. Cabbage heads should have the typical colour of the cultivar (green, purple or pale green-yellow), firm, heavy, and free of insect and decay. Leaves should be crisp and turgid, with the outer leaves trimmed.

- **Cauliflower:**

Cauliflowers are selected for size and compactness of the head or curd. Mature curds are at least 15 cm (6 inches) in diameter. The colour of the curd should be white to cream white. Loose or protruding floral parts, creating a 'ricy' appearance, are signs of over ripeness. Cauliflower is primarily marketed with closely trimmed leaves and wrapped with perforated film. Wraps should have 4–6 of 1 cm holes per head to allow adequate ventilation. Compact cauliflower curd, must be surrounded by well-trimmed, turgid green leaves. Additional quality indices are size, no severe yellowing due to sunlight exposure, no handling defects and decay, and no 'richness'.

❖ **Broccoli:**

The head should be compacted and all florets should be closed. Good quality broccoli should have dark or bright green closed florets, the head should be compact (firm to hand pressure) with a cleanly cut stalk of the required length.

❖ **Cucumber:**

Cucumber is harvested at various development stages. Depending on the cultivar and temperature, the time interval from flowering to harvest is around 55–60 days. Generally, fruits are harvested at a slightly premature stage when the fruits are near to full size, but before seeds are fully enlarged and hardened. Firmness and external glossiness are also indicators of a pre-maturity condition. At maturity, a jelly-like material begins to form in the seed cavity. Table cucumber quality is primarily based on uniform shape, firmness and dark green skin colour. Additional quality indices are size, no growth or handling defects and no decay.

❖ **Headed Lettuce:**

The maturity of lettuce is based on head compactness. Ideal maturity is when the head can be compressed with moderate hand pressure. Immature lettuce heads are loose and over matured heads are very firm or hard.

❖ **Pumpkin:**

Corking of the stalk and changes in the rind colour are the main external indications of maturity. Immature fruit has a fleshy stalk while matured fruit has a corky stalk. The internal colour should be typical of the cultivar. The intensity of the yellow and orange carotene, increases during storage. Pumpkins should be harvested at full size and well formed with the stalk intact. They should be well matured with a good rind development. Internal quality attributes are deep yellow colour due to the high carotene, dry weight, sugar and starch contents.

❖ **Radish:**

The number of days after transplanting, which vary between 30–60 days and plant types, determines the maturity of radish. Current crop management practices a stressed and rapid growth condition to ensure that the radish has a mild flavour and crisp texture. Fertilisation, irrigation or environmental conditions that cause slow growth may result in radish having a woody texture and high pungent flavour. Over matured radish tends to be pithy or spongy in texture and may develop harsh flavours. Roots should ideally be uniform, similar in shape, well formed, smooth, firm, of tender texture and free from harvest damages, diseases and insects. Radish tops should be fresh in appearance, turgid, green and free from diseases or insects.

- **Beans:**

The beans are harvested at about 8–10 days after flowering or when the pod is bright green, and fleshy and seeds are still small and green. Further seed development will reduce the quality of the beans. The pod becomes tough and loses its green colour. Beans should be well formed, straight, bright in colour with a fresh appearance, tender, but firm. They should snap easily when bent. Decreased quality during postharvest handling is most often associated with water loss and decay.

- **Ridge gourd:**

The Ridge gourd becomes ready for harvest from 45 to 60 days of sowing depending on the Varity. Cut the full-grown ridge gourd with knife and this can be done weekly.

- **Pointed gourd:**

Generally, pointed gourd vines start fruiting in about 120 to 140 after transplanting typically in Feb month & continues till Sept. These vegetables can be harvested about 15–18 days after pollination before reaching full maturity. Weekly harvesting is preferred in this crop.

- **Peas:**

The green peas pods should be harvested at proper stage. Harvesting of peas may start as soon as peas started changing colour from dark to green. Multiple pickings like, 4 to 5 pickling can be done within the 6 to 10 days interval. Yield depends on the variety, soil fertility and management of the field.

- **Rose:**

Stage of flower harvesting: For local market: When outer one/two petals start unfurling. For distant market: Fully coloured tight buds White, pink and yellow cultivars are harvested earlier to red as red may not open if harvested at tight bud stage

- **Carnation:**

Standard cultivars for local market are harvested when flowers are half opened or at painting brush or outer petal is perpendicular to stem, while for distant market cross is developed on buds and colour is visible. Spray cultivars are harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour

- **Chrysanthemum:**

Standards: When outer row of florets start unfurling for distant market and for local market half opened flowers. Sprays: Harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour.

Loose flowers: Fully open flowers

Pot mums: 50% buds have developed colour

- **Gerbera:**
  - Before outer row of ray florets show pollen
  - When outer row of petals is perpendicular on stalk.
- **Ilium:**
  - Local market: When 1-2 florets open
  - Distant market: When 1-2 florets show colour.
  - Cut stems few cm above ground level for increasing bulb size.
- **Gladiolus:**

If you're growing gladiolus so you can cut blooms for bouquets, flower spikes should be cut on a slant when the lowest flowers on the stalk begin to show colour. When cutting the flower stalk, leave at least four leaves on the plant to feed the corm.

- **Tuberose:**

Harvesting stage of tuberose bulb is important for storage of bulbs and their growth. The bulbs are harvested when the flowering is over and plant ceases to grow. At this stage, the old leaves become dry and bulbs are almost dormant. Irrigation is withheld and soil is allowed to dry before digging out the bulbs. After digging, the bulbs are lifted out; the bullbats are separated and used as seed stock for the bulbs are graded based on their size and are placed on shelves to dry or cure. The bulbs must be stored or have their position changed every few days to prevent fungal attack and rotting. Curing can also be done by tying the bulbs in bunches and hanging them on frames and walls.

- **Carnation:**

Flower starts after 4 months of planting and continues up to one and half years. Standard carnation flowers are harvested when the outer petals unfold nearly perpendicular to the stem. Spray types are harvested when two flowers open and the remaining buds show colour. Daily harvest is made leaving bottom 5 nodes of stalk to facilitate side shoot development.

- **Orchid:**

The optimum harvesting stage of the commercial orchids is mostly fully open and mature flowers. The stage of harvest, spike length and number of flowers of some commercial orchids.

- **Marigold:**

Marigold flowers will be ready for harvest in about 2.5 months' time from the date of transplanting. The plant continues to bear flowers for another 2-2.5 months from the date of first harvest. The flowers are harvested when they have attained full

size. Harvest the flowers in the evening along with a portion of stalk. Field should be irrigated before plucking so that flowers keep well for longer period after harvest. Regular picking improves the yield. Fresh flowers are packed in bamboo baskets or gunny bags for transporting to the local markets.

- **Jasmine:**

Harvesting is done with sharp secateurs at the tight bud stage when the colour is fully developed and the petals have not yet started unfolding. There should be 1-2 mature leaves (those with five leaflets) left on the plant after the flower has been cut. The reason for leaving these matures leaves is to encourage production of new strong shoots. Harvesting is done preferably during early morning hours.

3. Grading of Vegetables and flowers

(A) Grading of Vegetables crops:

❖ Grading of Tomato

Grade	Fruit weight (g)
Small	<100
Medium	100-255
Large	>255

❖ Grading of chili

Grade	Colour	Damaged and discolored pod	Pod without stack	Moisture %	Loose seed	Foreign matter	Broken chili
Special	Characteristics of the variety	2	2	11.5	2	1	4
General		4	3	11.5	3	2	6
Fair		6	4	11.5	3	2	8

❖ Grading of Brinjal

As per ISI recommendations, the Brinjal fruits are graded into three grades viz. Super, Fancy and Commercial

❖ Grading of Okra

Classes	Length (cm)
Small	6-8
Medium	9-15
Large	16-21
Extra large	>22

❖ **Grading of Potato**

Size code	Diameter (mm)
A	18.1-28.0
B	28.1-45.0
C	45.1-65.0
D	65.1-80.0
E	More than 80

❖ **Grading of Cabbage**

Size code	Weight (gm)
A	201-600
B	601-1200
C	1201 and above

❖ **Grading of Onion**

Size code	Diameter (mm)
A	10-20
B	21-40
C	41-70
D	71 and above

❖ **Grading of Sweet pepper**

Size code	Weight(mm)
Elongated (Pointed)	20
Square (blunt) and square tapering	40
Flat (Tomato pepper)	55

❖ **Grade of Cucumber**

Size code	Weight (g)
A	Up to 180
B	181-250
C	251 and above

❖ **Grading of Asparagus**

Class	Diameter measured 1 inch from butt
Very small	Less than 5/16 in.
Small	5/16 into less than 8/16in.
Medium	8/16 into Less than 11/16 in.
Large	11/16 into Less than 14/16 in.
Very large	14/16 in and larger

(B) Grading of floral crops:

❖ **Grading of Gerbera**

Grade No.	Stem length (cm)	Diameter of flowers(cm)	Colour
1	>60	>12	Pink
2	50-60	9-11	Red Orange
3	40-50	9-10	Orange
4	30-40	8-9	Red
5	<30	7-8	Yellow

❖ **Grading of Chrysanthemum**

Commodity	Grade Blue	Green	Yellow	Red
Stem length	75	75	60	75
Flower diameter (cm)	15	12.5		12.5
Stem strength	Strong			

❖ **Grading of Gladiolus**

Grade	Spike length (cm)	Minimum No. of florets
Fancy (Grade A)	107	16
Special (Grade B)	96-107	14
Standard (Grade C)	81-96	12
Utility (Grade D)	<81	10

❖ **Grading of Carnation**

Grade	Flower diameter	Stem length
Blue	Tight 50	55
Red	Tight <50	43
Green	Fairly tight <50	30

❖ **Grading of Anthurium**

Grade	Holland (inches)	USA (cm)
Extra large	>6	>15
Large	5-6	13-15
Medium	4-5	10-13
Small	3-4	8-10
Tiny	>3	<8

❖ **Grading of Orchids**

Grade	No. of flowers per spike
A	3-5
B	6-8
C	9-11
D	>11

❖ **Grading of Mogra**

- There are no standard grades available for jasmine.
- The flowers crops may be graded according to the Corolla tube length,bud size, shape and fragrance
- Grading of Tuberose

  The flowers spikes are graded according to spike length, length of the flowering zone and quality of individual flowers

4. Packaging of Vegetables and Flowers

Definition: Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale and use.

- After grading it is essential to put the vegetable and flower into suitable containers of required and desired sizes.
- Generally, packaging is done as per demands of the local market and transport facilities and distance of markets.

Why Packaging?

- Horticultural produce has limited shelf life of few hours to few weeks at ambient conditions.
- Packaging is required for food preservation, protection and for sale transportation of products during storage and handling.

The Function of Packaging:

- To assemble the produce into convenient units for handling.
- A properly designed produce container should contain, protect, and identify the produce, satisfying everyone from grower to consumer.

Importance of Packaging:

- Packaging is used in moving fresh produce from farm to market.
- It is the key solution in delivering produce of good quality to consumers.
- Packaging also adds value to fresh produce.

Features of Packaging material:

- Non-toxic and compatible with the specific foods
- Low cost
- Moisture and fat protection
- Gas and odor protection
- Transparency

Types of Packaging:

Classification based on stages of distribution system for which it is primarily intended.

(1) Consumer packaging
(2) Transport packaging

(1) Consumer Packaging:

- **Bags: -** Paper bags and Plastic bags
- **Extruded nets and Rachel bags:**
  Nets will be used to pack Onion, Potato, Garlic and Ginger and Rachel bag will help to Retail Businesses to pack 20-25 Kg produce at farm.
    - They have colorful look and are available in different size.
    - These bags are recyclable and reusable.
    - Good aeration & strength.
- **Plastic bags:**
    - Plastic bags are the predominant material for fruit and vegetable consumer packaging.
    - Beside the very low material costs, also reduce packing costs.
    - Film bags are clear, allowing for easy inspection of the content and readily accept high quality graphics.
- **Shrink wrap:**
    - Shrink wrap – potatoes, sweet potatoes, apples, onions, sweet corn.
    - Shrink wrapping with an engineered plastic wrap can reduce shrinkage, protect the produce from disease, reduce mechanical damage and provide a good surface for stick-on labels.
- **Rigid Plastic Packages**
- **Plastic Punnett with lids**
- **Trays**
- **Foam Sleeve packs**

- **Polymeric Films**



(2) Transport Packaging:

- **Sacks:**
    - Sacks are traditionally made of jute fiber or similar natural materials.
    - For one-ton transportation of vegetable, materials of 250 grams per square meter or less are used.
    - Sacks made of polypropylene of type plain weave are extensively used for root vegetables.
- **Wooden wire-Bound Crates:**
    - Wooden wire-bound crates are used for commodities that require hydro cooling.
    - Wire bound crates are sturdy, rigid, and have very high stacking strength.
- **Corrugated fiber board boxes:**
    - Corrugated Fiber Board is made from Bamboo, grasses and various types of agricultural residues as well as by recycling.

✓ **Advantages of CFB Boxes:**

1) They are light in weight.
2) They cause much less damage.
3) They are easy to handle and print.
4) They improve the product image.
5) They reduce the freight cost.

- **Plastic Crates**
- **Wooden Creates and Lungs**

❖ **Flowers Packing Material:**

- ✓ Cellophane paper
- ✓ Butter paper
- ✓ CFB paper
- ✓ Aluminum laminated foil
- ✓ Polyethylene sheet

5. Marketing of Vegetables and Flowers

Marketing is one of the most important factors in determining the success of any flower and vegetable farming enterprise. Marketing includes all the operations and decisions made by producers. These decisions range from deter-mining the most marketable crops for production to deciding how to best deliver quality produce to the consumers at a profit.

This definition emphasizes that marketing is a series of inter-connected activities. In the case of horticultural marketing these include:

- planning production
- growing and harvesting
- grading of products and their packing, transport, storage, processing, distribution and sale
- Sending information from production area to market (e.g., products available, volumes) and from market back to producing areas (e.g., prices and supply levels, consumer preferences and changes in taste).

❖ **Types of Market:**

- **Primary or Local Markets:** These markets are organized by village *Panchayats* who charge some rent from shopkeepers for the space occupied. Haggling and bargaining is a common feature of these markets. The village *bania* acts as a middleman in these markets.
- **Secondary Markets:** These are also known as ‘wholesale’ or ‘assembling’ markets and are called ‘*mandis*’. The produce is handled in large quantities and specialized operators become necessary for the performance of different services. The markets provide facilities of storage, handling and banking services and are well-served by roads and railways.

- **Terminal Markets:** These markets perform the function of carrying goods to consumers, final buyers or to places of processing. Such markets are to be found in big cities or at ports. The area of their operation extends over a state.

- **Fairs:** Fairs held on religious occasions at pilgrim centers are important sources of marketing of agricultural produce in India. Such fairs are held annually and are organized by district officers, local bodies or private agencies.
- **Regulated Markets:** In these markets, the rules and regulations are prescribed by the Government marketing practices.
- **Co-Operative Marketing:** These markets function on the basis of principles of cooperation. A cooperative marketing society carry the agricultural produce direct to the consumers thus eliminating a large army of middlemen and intermediaries.
- **Road side selling** It is also commonly seen that some vegetables are sold on road side by growers to the consumers. The fields attached or nearer to roads. Growers harvest their vegetables fresh and sell them. At this point, some retailers may also buy vegetable and sell them to nearby market.
- **Processing market:** This involves production of certain vegetables on large scale maintaining continuity in their supply. Producers can directly contact the processor for getting all information about the production. Sometimes, processor wants to have vegetable of a particular variety, with which the producer should be well acquainted. Processor also provides guidance for cultivation practices and takes

responsibility to accept the produce. It is usually contractual agreements between the processor and the grower. Even the processor pays a sizeable percentage of money in advance to the grower. Doing so, processor becomes sure of getting vegetables and the grower has no disposal problem, though settlement of the final prices is done later. The main use of vegetables in processing units is for freezing, canning, pickling and dehydration.

❖ **Functions of Marketing:**

- Collection and assembling
- Grading and standardization
- Storage
- Transportation
- Processing
- Wholesaling and Retailing.

❖ **Problems in Marketing:**

- Lack of Organization
- Forced Sales
- Existence of Large Number of Middlemen
- Multiplicity of Market Charges
- Adulteration
- Inadequate Storage Facility
- Lack of Transport Facility
- Absence of Grading and Standardization
- Lack of Market Information
- Lack of Financial Facility

❖ **Practices to Enhance Marketing of Vegetables:**

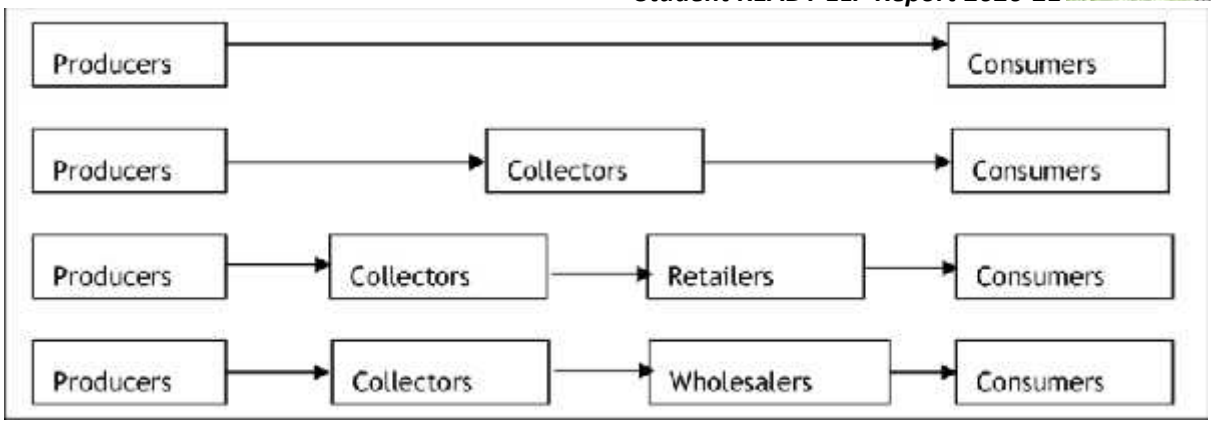
- **Harvesting:** Harvest vegetable crops at the proper maturity are essential. Many crops have a very narrow harvest window, and proper maturity is needed to insure a marketable product. Crops that producers tend to harvest early are sweet corn and bell pepper. Sweet corn that is not fully mature has less flavour, and little usable grain. Immature bell

pepper pods wilt rapidly and are not attractive. Crops that can easily be harvested too late are sweet corn, bell pepper, and green beans. Bell pepper may be harvested with some color showing. Tomatoes are best harvested in the pink stage and harvesting twice a week may be needed for proper maturity. Pink tomatoes have full flavour.

- **Packaging:** Packaging of produce is a critical factor in marketing. Containers should protect the product and be attractive. Standard packs vary according to the type of product and the market demand, but many buyers require the use of standard size containers. Some routine container sizes are half bushels, bushels, 1 + 1/9-bushel, standard sweet corn crates to hold 4 Ã‚Â½ dozen ears, and pints or quarts for berries. Waxed pasteboard cartons are very widely used. Snap bean and sweet corn buyers often prefer wire bound wooden boxes. Melons are often sold in bulk cardboard boxes that hold approximately 250 muskmelons.
- **Storage:** Harvested vegetables are perishable, and quality loss starts immediately after harvest. Rapid marketing to ensure freshness is a desirable feature of locally grown produce. Produce, not sold immediately, needs to be stored properly to maintain appearance, flavor, and quality. Time of harvest, cooling, and storing in shaded areas will help retain quality. Produce harvested early in the morning is cooler than if harvest is later in the day. Quality of products such as green beans, sweet corn, peppers & benefit from hydrocooling. Hydrocooled produce needs to be kept in a cooler to maintain the proper storage temperature after hydro-cooling.

❖ **Marketing Channels of Vegetables:**

- Producers–consumer (village sale)
- Producer–retailer–consumer (local sale)
- Producer–Trader–commission agent–retailer–consumer.
- Producer–commission agent–retailer–consumer



Examples of Marketing channels :

TOMATO

Channel-1: Producer – Consumer

Channel-2: Producer – Retailer – Consumer

Channel-3: Producer – Trader – Commission Agent – Retailer - Consumer

Channel-4: Producer – Trader – Retailer – Consumer

Channel-5: Producer – Primary Wholesaler – Secondary Wholesaler – Retailer - Consumer

Channel-6: Producer – Rural Assembler – Retailer – Consumer

Channel-7: Producer – Contracting Agency – Processing unit – Processed products – Retailer – Consumer

- **Marketing of Flowers:**

  Simple Floral Marketing Strategies

  - Attract/Engage customers.
  - Work with Local Business
  - Offer Free Marketing Gift with Purchase
  - Floral Marketing on Social Media

Flower cultivation is concentrated in the hinterland of big cities like Mumbai, Pune, Bangalore, Mysore, Chennai, Calcutta, Delhi etc. But with the development of quick transport vehicles and refrigerated or insulated vans, flowers are transported to distant markets including foreign markets. For successful marketing of flowers, well-

developed markets and well-organised marketing system is necessary. In the marketing of flowers, the aspects involved are –

1. Channels of marketing,
2. Costs and margins and price spread and
3. Producer's share in consumer's rupee.

Few Examples of Marketing of Flowers in India

Roses

In Haryana, in the marketing of roses three channels were observed.

Channel I - Producer – Commission agent - Retailer – Consumer (in Delhi market)

Channel II - Producer- Retailer – Consumer

Channel III - Producer - Consumer (Local market)

Since Delhi is a big market, 65% flowers were sold through Channel I and remaining 32% and 3% were sold through Channels II and Channels III. Thus the local market sale was only 3%.

Orchid

In Kerala, cultivation of orchids has now assumed commercial status. In the marketing of orchids, there existed two main agencies. (1) Local buyers and (2) Distant market florists, indicating two Channels.

Channel I - Producer – Local buyer – Consumer

Channel II - Producer - Wholesaler - Retailer – Consumer

The cost of marketing worked out to Rs. 3.00 per spike.

Gladiolus

Channel I - Producer – Wholesaler – Retailer – Consumer

Channel II - Producer – Contractor – Retailer – Consumer

Channel I was more important with 84% produce passing through this channel than channel II with 16%produce passing through it.



Marketing Ideas for flowers:

The floral market can be very competitive, and florists need to continually be alert; to ways to make their business stand out from the competition. Marketing ideas that put your flowers in front of your target consumers can yield good results for your floral shop. Here we have tailored the best flower shop marketing for florists that will help you stand out from the competition.


1. **Weddings and Special Events** – If you create floral designs for weddings and events; connect with other professionals, such as event planners, photographers and venue managers. Many of these business owners will be willing to let you leave business cards or brochures.

2. **Build Your Flower Shop Brand on Social Media to Become Known** – Instagram. Works very well for florist, spend time on it.
3. **Donating Flowers to Community Events** – Sponsor a local business event by providing flowers. Or donate flowers to a charity event to help market your floral shop.
4. **Use the Phone to Work Your Network;** – Always make sure your first calls are to friends, family, or those you have a close working relationship with.
5. **Be Creative** – Create arrangements that provoke current topics like President Trump flower arrangement look alike and share it out widely.
6. **Email marketing** – email is also an effective way to build the kind of know, like, and trust that sells flowers
7. **Giving branded corporate Gifts** – give clients free mouse pads imprinted with a floral arrangement and his company's contact information.

6. Quality parameters of vegetables and flowers

Food quality: The totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs

- To meet expectations of consumers, producers need to provide fresh, high quality produce. Be sure the produce is clean and free from defects such as insect damage. Harvest timing and postharvest handling are two important factors affecting the quality of the produce. Many producers harvest crops in the late evening before the market day or early morning on the market day. When determining harvesting time, producers should consider each individual crop. In some cases, postharvest deterioration poses significant quality problems for evening harvested produce. For many of these crops, however, evening is the grower's only practical harvest time. Cold storage can assist in maintaining produce quality. Some produce should be harvested when it is not completely ripened, since it may mature more at the market.
- After the crops are harvested, they should be graded according to size and quality and held under the best conditions of available quality. Sometimes smaller and second quality produce (if properly identified at the market) may be happily accepted by buyers because it is quite adequate for canning or immediate fresh use. However, producers should not sell any produce that they would not use themselves. It is probably better for the seller to take any picked over residual "junk" produce home than move it at bargain basement prices. This price cutting may cause ill will between the seller and the buyer and between the price cutter and other sellers. A reputation for price cutting will soon develop, and patrons will try to bargain even for first quality items. Also, severe price cutting late in the selling day will soon cause a group to develop that tries to wait out the seller in anticipation of price cutting.

❖ **Class of attribute**

- **External:**
  - **Appearance(sight)** - Visual evaluation of size, shape, gloss and colour May be accompanied by visual guides and colorimeters

- **Feel (touch)** - Manual evaluation of firmness and texture May be accompanied by mechanical texture analysis.
- **Defects** - Visual evaluation of absence of defects or deterioration of colour May be accompanied by mechanical methods (e.g. ultrasound)

- **Internal**:
  - **Odour**- Mostly Qualitative and subjective evaluation by smelling. May be accompanied by technical methods.
  - **Taste** - Oral tasting (Sweetness, bitterness, sourness and saltiness) Technical qualification of taste compounds (e.g., chromatography.)
  - **Texture** - Includes tenderness, firmness, crispness, crunchiness, chewiness, fibrousness which are measured by applying force to the produce; additionally, textural characteristics are evaluated as "mouth feel".
- **Hidden**:
  - **Wholesomeness** - Wholesomeness is difficult to measure objectively, it can be described as "freshness" "produce integrity", it also has a "sanitary" component meaning how clean/ hygienic the product is.
  - **Nutritive Value** - Nutritive value is measured by the content of nutrients such as fat, carbohydrates, protein as well as essential vitamins, minerals and other substances that influence human well-being.

❖ **Food safety**: Food safety can be measured via the examination of food items with regards to their pathogenic microbial load, content of chemical contaminants or presence of physical foreign matter in the produce.

- External attributes play an important role in a consumer's purchasing decision, whereas internal or hidden attributes often affects a consumer's decision to repurchase a product. The combination of external, internal and hidden attributes determines the overall acceptability of a product.

❖ **Food standards:**

- Standards provide common frames of reference for defining products. Food standards specify precise criteria to ensure that products fit their stated purposes and meet the legitimate expectations of consumers. This makes standards useful to consumers, the food industry and regulatory bodies. Food standards may include specifications for product appearance, quality, nutritional value, product safety, labeling, packaging, methods of analysis and sampling.
- Food standards are used to maintain uniformity of product quality and safety, to gain market access and establish market presence, to provide different consumers with equal information about the product and to prevent economic fraud or market exclusion. Standardization allows for correct food labeling – the basis for consumer confidence.
- In recent years, various bodies have developed food standards. Depending on where products are to be sold, these might include national and international entities as well as public or private bodies. In order to harmonize standards and coordinate joint efforts by public and private bodies, the Codex Alimentarius Commission (CAC) of the United Nations Organization should be taken as the main reference and common basis for food standards today.

❖ **Why International quality standards?**

- To define a common trading language for all actors in the supply chain.
- To facilitate fair international trade
- To avoid bad quality products on the market
- To guide producers to meet market requirements
- To build trust and market opportunities
- To encourage high quality production
- To improve producers' profitability
- Remove technical trade barriers.

❖ **Quality components for foods are related to:**

Characteristics of the food:

- hygienic quality and safety
- nutritional quality
- organoleptic quality

Use or service quality:

- convenience (easy to use)
- conservation
- Satisfaction and pleasure

❖ **Characteristics of the Marketing Standards:**

- The standard allows to describe products without physical presentation.
- The standard gives an indicator of the market value of the product
- The standard includes quality, sizing, tolerances packaging and presentation requirements.

❖ **What does consumer demand?**

In the first place there is a worldwide tendency towards a greater consumption of fruits and vegetables because of a growing concern for a more balanced diet, with a lower proportion of carbohydrates, fats and oils and a higher proportion of dietary fibre, vitamins and minerals.

- Consumption patterns are also influenced by the increasing market segmentation through the expansion in shapes, colours, flavours and ways of preparation and packaging of the product. There is also an increasing supply of exotic or non-conventional fruits and vegetables, which notably expands the purchase options.

- Lastly, there is a growing demand for higher external and internal quality. External aspects are the main components in the decision to purchase, which is usually taken when the consumer sees the product exhibited at the sales point.

❖ **Obtaining a product of quality**

Producing a quality product begins well before planting the seed. Soil selection and preparation, its fertility and irrigation potential, weed control and crop rotations, variety selection and other decisions have an influence on the quality of the product. In the same way, quality is affected by the climatic conditions during the growing period, as well as irrigation, fertilization, control of pests and diseases and other cultural practices. Harvest is the end of cultivation and the beginning of post-harvest actions during which preparation for the market, distribution and sale take place.

- Fruits and vegetables are highly perishable products that demand water and nutrients before being detached from the mother plant. Once harvested, however, they depend on their reserves to continue living. Respiration, transpiration and the continuous changes taking place determine the internal and external quality. Deterioration rates depend on the type of product, growing conditions and other factors, but mainly on the conditions in which the produce is maintained after harvest, such as temperature, relative humidity, movement and composition of the air. Post-harvest changes can only be delayed within certain limits and thus preparation for the fresh market should be quick and efficiently performed in order to avoid quality losses.

❖ **Towards total quality in fruits and vegetables:**

The concept of quality as a way to differentiate products has been recognized for years. As local or regional trade internationalizes, quality consolidates as the main competitive tool for excellence. Nowadays, domestic and international trade of fruits and vegetables is regulated by quality standards in most countries, providing a common language among the different participants of the production-commercialization-consumption chain.

The quality system established by the standards is known as "Inspection for quality" (Table 16) where representative samples at the final stage of preparation for the market should fulfil the specified limits and their tolerances.

❖ **Comparison of the main quality systems:**

Aspects	Quality inspection	Quality assurance	Total quality
System	Reactive	Preventive	Preventive
Quality is	A control procedure at the end of the process	The objective of an explicit policy	A philosophy
Application of regulations	Only the mandatory ones (Standards)	Mandatory + voluntaryones as ISO, HACCP	Mandatory + voluntary of own design
Quality is based on	The final product	The organization	Human resources
Quality control is performed by	A quality laboratory	Quality management level	All
Documentation on processes and methods	No	Yes	Yes
Internal auditing	No	Yes	Yes
Certification of conformity	No	Yes	Not necessary

India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2015-16, India produced 90.2 million metric tonnes of fruits and 169.1 million metric tonnes of vegetables. The area under cultivation of fruits stood at 6.3 million hectares while vegetables were cultivated at 10.1 million hectares.

- India grows the largest number of vegetables from temperate to humid tropics and from sea-level to snowline; Vegetables are excellent source of vitamins, particularly niacin, riboflavin, Thiamin and vitamins A and C. They also supply minerals such as calcium and iron besides proteins and carbohydrates. Vegetables combat under nourishment and are known to be cheapest source of natural protective tools. Most of the vegetables, being short duration crops, fit very well in the intensive cropping system and are capable of giving very high yields and very high economic returns to the growers. Major vegetables grown in India are Potato, Onion, Tomato, Cauliflower, Cabbage, Bean, Egg Plants, Cucumber and Garkin, Frozen Peas, Garlic and okra.
- The vast production base offers India tremendous opportunities for export. During 2019-20, India exported fruits and vegetables worth Rs. 9,182.88crores/ 1,277.38 USD Millions and vegetables worth Rs. 4,350.13crores/ 608.48 USD Millions. Onions, Mixed Vegetables, Potatoes, Tomatoes, and Green Chilly contribute largely to the vegetable export basket. Though India's share in the global market is still nearly 1% only, there is increasing acceptance of horticulture produce from the country. This has occurred due to concurrent developments in the areas of state-of-the-art cold chain infrastructure and quality assurance measures. Apart from large investment pumped in by the private sector, public sector has also taken initiatives and with APEDA's assistance several Centers for Perishable Cargoes and integrated post-harvest handling facilities have been set up in the country. Capacity building initiatives at the farmers, processors and exporters' levels has also contributed towards this effort.

❖ **The basic principles of total quality can be summarized in the following way:**

- The consumer is always first
- Each operation is part of a process
- Quality improvement never ends
- Quality is made, not controlled
- Prevention of quality problems is made through planning.
- The desired product should be obtained at the desired moment. Post harvest handling should be appropriate to reach the desired market under the desired conditions.

7. Value addition in cut flowers

Value addition is a process in which for the same volume of a primary product, and high price is realized by means of processing, picking, upgrading the quality or other such methods.

- increase the value of primary commodities.
- Value-added floriculture may also refer to increasing the economic value of a commodity through particular production process e.g., Organic produce, or through regionally branded products that increase consumer appeal and willingness to pay a premium over similar but differentiated products.

➢ Value addition in flowers is a good source of income by

- Self – employment.

It includes fresh flower and products from cut flower arrangement like bouquets, baskets, bunch, boutonniere, corsage, etc.

- Value added products

Essential oils, flavors, fragrances and aromatherapy, pharmaceutical added ND nutraceutical compounds; pigments added nondescript natural dyes; *gulkand*, rose water, vanilla products etc.; insecticidal and nematocidal compounds.

IMPORTANT CUT FLOWERS:

- ➢ Rose
- ➢ Tuberose
- ➢ Gerbera
- ➢ Orchid
- ➢ Anthurium
- ➢ Carnation

❖ **CUT FLOWER ARRANGEMENTS:**

- Floral arrangement is not only a mode of value addition to flowers but holds the key to the ultimate fate of the commercial flower industry.
- Cut flowers can be used for making various flower arrangements with fillers.

- Flowers like roses, carnation, chrysanthemum, Lilium and other high value crops are suitable for making different types of flower arrangements.
- The flower arrangements can be Japanese style of arrangements namely ikebana, moribana, English style like upright, slanting, regular, irregular, curved shape, Hogarth S shaped etc.

➢ **NEED FOR VALUE ADDITION:**

- To improve the profitability of farmers
- To empower the farmers and other weaker sections of society especially women through gainful employment opportunities and revitalize rural communities.
- To provide better quality, safe and branded products to the consumers.
- To emphasise primary and secondary processing.
- To reduce post-harvest losses.

➢ **OBJECTIVES OF VALUE ADDITION:**

- To improve quality.
- To enhance selling.
- To gain higher profit.
- To reduce post-harvest losses.
- Can provide demand for high quality
- Use of unsold flowers(unmarketable) roses used gulkand.
- Increase export.
- To generate employment.

- **WAYS TO ADD VALUE:**
  - Process the raw material
  - Pre-cut wrap and package
  - Take a unique approach
  - Label the product
  - Distinct product appearance
  - Increase shelf life
  - Provide recipes/cookbook
  - Gift basket or multi-pack
  - Build reputation, relationship
- **FACTOR REQUIRED FOR VALUE ADDED ENTERPRISES:**
  - A unique product
  - An enthusiastic promoter of the product
  - The right kind of labelling and packaging
  - Aggressive marketing
  - Strong agricultural or livestock knowledge
  - Assistance from agencies and universities
  - A strong relationship with the local community
  - Product liability insurance
- **DIFFERENT VALUE-ADDED PRODUCTS:**
  - Flower Ornamentals
  - Flower bouquets

- Floral handicrafts
- Garlands
- Flower baskets
- Flower arrangements
- Edible flowers
- Essential oils
- Herbal medicine
- Dye yielding
- Tinting of flowers
- Drying of flowers

➢ **METHODS OF VALUE ADDITION OF FLOWERS:**

- Flower arrangement
- Value-addition of flower crops also includes post-harvest and processing technologies.
- Stage of harvest
- Grading
- Pulsing
- Packing
- Increasing the vase life
- Drying of flowers
- Tinting of flowers
- Extraction of essential oil dyes and drugs.

➢ **VALUE ADDITION OF CUT FLOWERS ROSE:**

- **Perfume**

  Rose perfumes are made from attar of roses or rose oil.

- **Food and drink**

  Rose hips are occasionally made into jam jelly marmalade and syrup.

Rose hips seed oil which is used in skin products and some makeup products.

- **Rose water**

  Rose water is also an important product obtained from the rose petal.

It's used as a perfume and medicinal purposes.

- **FLOWERS BOUQUETS**
  - ✓ A flower bouquet is a collection of flowers in a creative arrangement.
  - ✓ Use in special occasions such as birthday, wedding or anniversaries.
  - ✓ Bouquets arranged in vases or planters for home decor can be arranged in either traditional or modern styles.

- **GARLANDS**
  - ✓ Used for various auspicious occasions and religious functions or festivals.
  - ✓ These are prepared by tying the flowers together with the help of needle in a string pr thread by using one type or different types of flowers.
  - ✓ Sometimes foliage can also be added with flowers to make garlands.
  - ✓ The flowers mostly used for making garlands are roses, chrysanthemum, marigold, jasmine, Tuberose, orchids etc.

- **VALUE ADDITION IN TUBEROSE**

✓ I order to increase the value and appeal of flowers along with fragrance the spikes of tuberose can be tinted with artificial colours. Due to single colour, it has a fewer Acceptances to the people.

✓ So tinting or artificial colouring of tuberose May be a potential Value addition venture.

✓ Tinting is an important value addition technique in flowers crops. Where Colour pigments are absent or light or dull.

TINTING IS AN IMPORTANT VALUE ADDITION TECHNIQUES IN CUT FLOWERS

✓ Artificial colouration of flowers (tinting) Can be done in two ways Viz, Through the stem absorption method (for carnation, gerbera, orchid) And dipping flowers heads (for other flowers principally daisies) Mostly the colours retention Will be good in flowers Tinted through stem.

✓ All white colour cut flowers used tinting techniques e.g., Rose, gerbera, anthurium, orchid, tulip, carnation, Tuberose, gladiolus

THE FLOWER ARRANGEMENTS JAPANEE STYLES IKEBANA, MORIBANA UPRIGHT STYLE

8. Cost concept and economic analysis of protected cultivation

With the advent of modern technologies, the scenario of protected cultivation industry in India is changing at a fast rate. Now, it is not only the question of providing enough produce, but also to ensure quality production throughout the year that are acceptable and competitive in international market. But due to erratic behaviour of weather, the crops grown in open field are often exposed to fluctuating levels of temperature, humidity, wind flow etc., which ultimately affect the crop productivity and quality adversely. Protected cultivation being the most efficient means to overcome climatic diversity, has the potential of fulfilling the requirements of small growers as it can increase the yield manifolds and at the same time improve the quality of the produce significantly as per the demand of the market. In the recent times, introduction of parthenocarpic varieties in cucumber for instance has revolutionized its cultivation under protected culture in India. Simultaneously, implementation of protected cultivation through various assistance under Mission for Integrated Development of Horticulture (MIDH), Rastriya Krishi Vikas yojana (RKVY), National Horticulture Board (NHB) and many more at state level have bolstered the adoption of protected cultivation across the country.

Economics of a greenhouse is governed by various facilities as well the location selected for greenhouse structures. Another important economic component is structural dimensions of a greenhouse with the facility of partially or fully controlled environment enabling round the year and off-season production leading to higher net realization. Greenhouse technology is emerging as an industry and ensuring self-employment as well as employment to labourers because of the possibility of producing crops round the year. Different types of structure have differential response towards production potential depending upon crops, which ultimately decide the amount of revenue generated from a particular protected structure.

❖ **Points to ponder for improving the economy of protected cultivation:**

Selection of appropriate location with good accessibility to transportation facilities, when combined with the following factors can direct or indirect investment thereby minimizing the cost.

- Availability of plenty of sunshine hours.
- Presence of mild winters.
- Stability in weather parameters over a period of time.
- Appropriate level of humidity in the environment.
- Availability of good quality water with appropriate level of EC and pH, which will obviate expenditure on installation of RO plant.

In addition to selection of site, there are also some other factors which can be taken into consideration for improving the economy through protected cultivation and these are:

- Mechanization of certain horticultural operations training, pruning, harvesting, grading, packaging etc.
- Efficient use of labour.
- Proper packing and marketing of produce i.e., branding of produce.
- Managerial Skills.

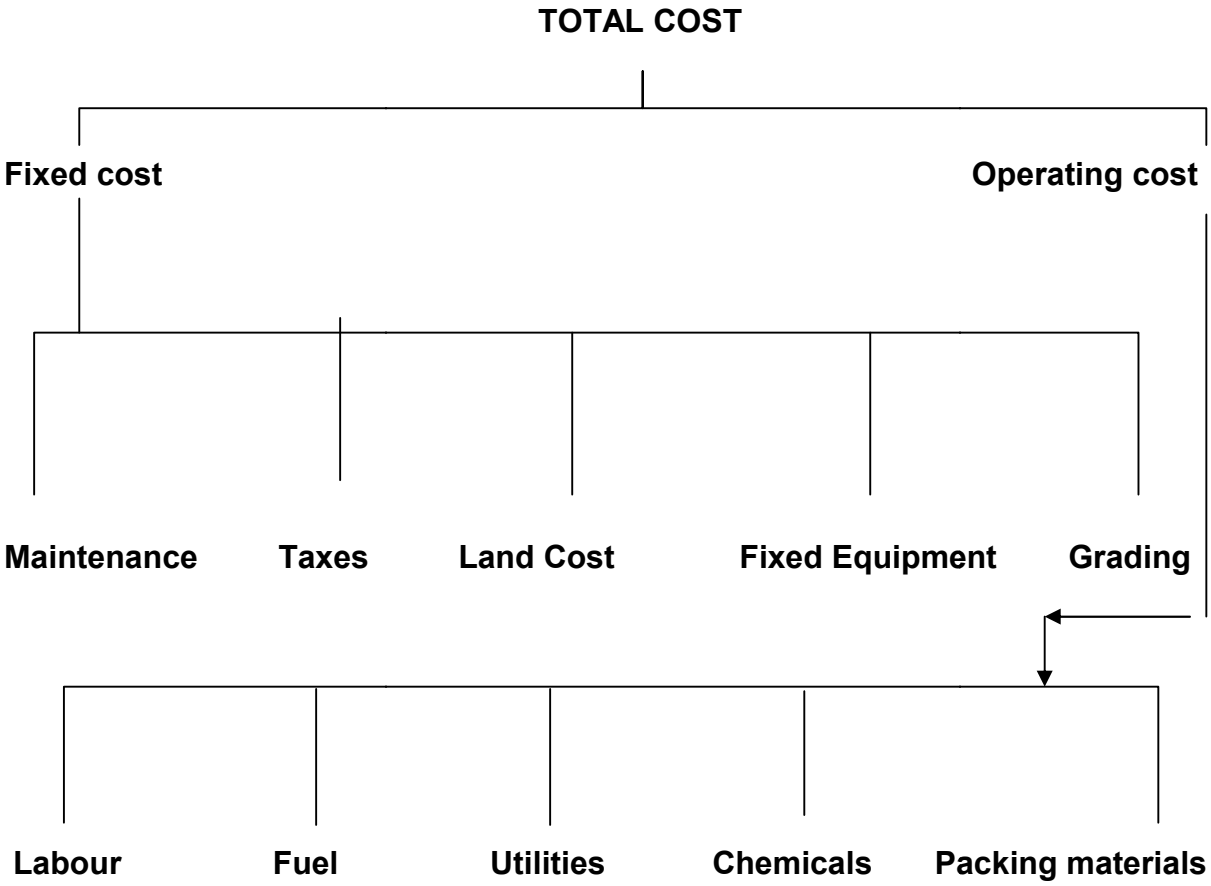
Cropping pattern does have remarkable impact on the economic gain from protected cultivation. For instance, selection of crops for the year-round production under protected environment particularly in naturally ventilated polyhouses is very important to get better returns out of cultivation. while, hi-tech greenhouses provide an added benefit over low tech greenhouses in relation to cultivation of crops as per the active demand of consumers not only in the nearby markets but also at distant markets. Thus, demand driven production of a particular crop will definitely ensure higher returns. Certain unprecedented situation (s) as observed during corona pandemic (COVID-19) may also offer opportunities to the growers for thinking of alternative crops particularly the ones becoming popular amongst consumers at certain point of time. Simultaneously, there has also been an increase of demand for

protective food, which is actually allowing the growers to change the plan of action involving cultivation of vegetables and fruits.

It becomes imperative to work out the economic feasibility of greenhouse production system taking all the factors into account so that an optimal tool for decision support in real life situation could be worked out in helping out the decision farmers and makers.

- **Cost Concepts and Components of Cost**

Broadly, the costs are divided into 2 broad categories viz., **Fixed costs** and **Variable costs**



Fixed costs:

These are fixed i.e.; Fixed cost remain the same irrespective of level of production. These costs remain invariant in the short run but in the long run there are no fixed costs as all the inputs may vary. Fixed cost in soil-based greenhouse

production system includes greenhouse structure, red soil, plant support system, interest on fixed capital and rental value of land. These are also known as indirect costs, sunk costs and overhead costs.

These could be fixed cash costs such as land taxes, interest, insurance premiums, permanently hired labour, etc. Non-cash fixed costs include depreciation on buildings, machinery interest on capital investment, cost of family labour & management, etc.

Assumptions for the calculation of fixed components of cost (Amortized Cost)

Particulars	**Useful life (yrs.)**	**Remark**
Polyhouse Structure	10	*Conditional life of red soil has been considered equivalent to that of structure's life assuming that sufficient organic matter will be incorporated into it over the period of time.
Red soil*	10	
Plant support system	5	

Fixed Cost = Rental value of land + Interest on fixed capital + Amortized Cost

Variable costs:

The costs that vary with the production or the costs which vary with the level of output. These include costs incurred on seeds, fertilizers, plant protection chemicals, micronutrient, bio-fertilizers and labours etc. These are also known as operating costs, working cost, direct costs, prime costs, circulating costs and running costs. The cost of production of a crop is considered at three different levels viz., Cost A, Cost-B and Cost-C. These cost concepts are generally followed in the studies of production cost of crops.

The costs that are incurred on variable inputs and hence vary with the level of production are called variable costs. Higher the production more will be VC and vice-versa. Expenses on fertilizer, seed, chemical, fuel consumption, etc.

Total costs = FC+VC

Total costs (TC) are required to compute net revenue (NR)

NR = TR-TC

The input items included under each category of cost are given below:

Cost-A:

Actual paid-out costs for owner cultivator, inclusive of both cash and kind expenditure which include following cost items,

- Hired human labor: a) Male b) Female
- Total bullock labor: a) Owned b) Hired
- Seeds
- Manures
- Fertilizers
- Insecticides and pesticides
- Irrigation charges
- Land revenue and other taxes
- Depreciation or capital assets
- Transport
- Interest on working capital

In broad sense:

Cost A = Variable cost + Interest on working capital [7% Interest on working capital (Variable Cost) per annum]

Based on crop duration, the actual interest on working capital:

Cost B:

If the amount invested in purchase of land would have been put in some other long-term enterprise or in a bank, it would have yielded some returns or interest. But due to the investment of the amount in purchase of land, the farmer has to scarify returns or interest that he would have otherwise gained. As such this loss is considered as interest on fixed capital. Similarly, the hypothetical interest that the capital invested in farm business would have earned, if invested alternatively is also considered as cost. Rental value of land and interest on fixed capital represent imputed costs which are added to Cost A to give Cost B

Cost B = Cost A + imputed rental value of land (1/15th of Yield Appraisal/Gross Returns) + Interest on fixed capital (10% of fixed cost) + Amortized Cost.

Cost C:

It is the total cost of production which includes all cost items including actual as well as imputed. The value of holding's own labour is to be imputed and added to cost B to workout Cost C.

Cost C = Cost B + imputed value of family human labour.

Gross Returns = Production x selling rate

Net Returns = Gross Returns – Cost C

Benefit Cost Ratio (BCR) = Net Returns/ Cost C

Government policies also influence the financial returns from the crops. The component of protected cultivation is being strengthened under Mission for Integrated Development of Horticulture (MIDH) by Government of India through 50% subsidy to the farmers. Incentives in terms of subsidy to the tune of 65 and 75% are further disseminated by Government of Gujarat State (India) to encourage the farmers for adopting protected cultivation by adding its share of 15 and 25% in Union Government subsidy depending upon socio-economic status of the farmers. Cost norms and pattern of assistance under Mission for Integrated Development of Horticulture (MIDH) during XII FY Plan for Protected Cultivation.

Sr. No.	Item	Cost Norms (Rs.)	Patter of Assistance
Green House structure			
1.	Fan & Pad system	1650/m^2 (up to area 500 $m^{2)}$	50% of cost for a maximum area of
		1465/ m^2 (>500 m^2 up to 1008 m2)	4000 m^2 per beneficiary
		1420/ m^2 (>1008 m^2 up to 2080 m2)	
		1400/ m^2 (>2080 m^2upto 4000 m^2)	

*** Above rates will be 15% higher for hilly areas.**			
2.	**Naturally ventilated system**		
	i) Tubular structure	1060/ m^2 (up to area 500 m^2)	50% of cost limited 4000 sq. m. per beneficiary.
		935/ m^2 (>500 m^2upto 1008 m^2)	
		935/ m^2 (>500 m^2 up to 1008 m^2)	
		890/ m^2 (>1008 m^2upto 2080 m^2)	

	*** Above rates will be 15% higher for hilly areas.**		
	ii) Wooden structure	540/ m^2 621/ m^2 for hilly areas	50% of the cost limited to 20 units per beneficiary (each unit not to exceed 200 m^2).
	iii) Bamboo structure	450/ m^2 518/ m^2 for hilly areas	50% of the cost limited to 20 units per beneficiary (each unit should not exceed 200 m2).
3.	**Shade Net House**		
	(a) Tubular structure	710/ m^2 816/ m^2 for hilly areas	50% of cost limited to 4000 m^2 per beneficiary.
	(b) Wooden structure	492/ m^2 566/ m^2 for hilly areas	50% of cost limited to 20 units per beneficiary (each unit not to exceed

			200 m^2).
	c) Bamboo structure	360/ m^2 414/ m^2 for hilly areas	50% of cost limited to 20 units per beneficiary (each unit not to exceed 200 m^2).
4.	Plastic Tunnels	60/ m^2 75/ m^2 for hilly areas.	50% of cost limited 1000 m^2 per beneficiary.

5.	Walk in tunnels	600/m	50% of the cost limited to 5 units per beneficiary (each 21 unit not to exceed 800 m^2).
6.	Cost of planting material & cultivation of high value vegetables grown in poly house	140/ m^2	50% of cost limited to 4000 m^2 per beneficiary.

7.	Cost of planting material & cultivation of Orchid & Anthurium under poly house/ shade net house.	700/ m^2	50% of cost limited to 4000 m^2 per beneficiary.
8.	Cost of planting material & cultivation of Carnation & Gerbera under poly house/ shade net house.	610/ m^2	50% of cost limited to 4000 m^2 per beneficiary.
9.	Cost of planting material & cultivation of Rose and lilium under poly house/ shade net house	426/ m^2	50% of cost limited to 4000 m^2 per beneficiary

❖ **Solved Numerical**:

Calculation of net returns and Benefit-Cost Ratio for greenhouse cucumber raised under naturally ventilated polyhouse- tubular structure of 2000 m^2 area using following information;

Crop Span of greenhouse crop: 100 days & Production per 2000 m^2= 28 ton

Rs. per 2000 m^2			
Particulars	**Without subsidy**	**With 65% subsidy**	**With 75% subsidy**
Polyhouse structure @ 890 per m^2	1780000	1157000	1335000
Interest on fixed capital (10% of Fixed cost)	178000	110700	133500

Sr No.	**Fixed Investment**	**Rate (Rs.)**	**Requirement**	**Total Cost**	**Useful Life (yrs.)**	**Season specific Investment (Rs.)**
1.	Naturally ventilated system-Tubular Structure	890/ m^2	2000	1780000	10	48950
2.	Red soil 70 tractor trolleys or 9000 cubic ft	800/100 cubic feet	90	72000	10	1980
3.	Plant support system @ 10/m^2	10/m^2	2000	20000	5	1100
Total						**52030**

- **Calculation of components of variable cost**:

Quantity of Inputs and their respective cost:

Fertilizers	Requirement per 2000 m^2 (kg)	Rate (Rs.)	Cost (Rs.)
19:19:19	20	176	1760
00:52:34	4.4	111.20	489.28
00:00:50	2.88	70.00	201.6
$CaNO_3$	16	42.00	672
12:61:00	7.52	92.00	691.84
Urea	2.4	6.30	15.12
00:00:50	12.8	70.00	896
Urea	4.8	6.30	30.24
CaNO3	14.4	42.00	604.08
00:52:34	8.4	111.20	934.08
00:00:50	7.2	70.00	504
		Total (Rs.)	**6790.96**

Particulars	Rate (Rs.)	Requirement	Total Amount (Rs.)
Labour (1 labour is sufficient to carry out the operations in 2000 m^2 NVPH)	250	100	25000
Pesticides (For 2000 m^2)	2500	2	5000
Vermicompost 0.4t (8 Bags)	200	16	3200
Requirement of Formaldehyde (liters)	50	150	7500
Application of formaldehyde (For 1000 m2)	2000	2	4000
Trichoderma viridi (kg)	120	1	120
Pseudomonas inflorescens (kg)	163	1	163
Micro-nutrients (kg)	200	10	2000
Bed preparation (man days)	178	30	5340
Miscellaneous (For 2000 m^2)	4000	2	3000
Seed Cost (Nos.)	5	6000	30000
		Total	**90324**

- **Calculation of packing material cost:**

Production (kg/1000 m^2)	No. of bags of 20 kg capacity (Packing of 20 kg is made for local market)	1 kg accommodates no. of bags	No. of bags required	Cost of 20 kg packing	Cost of packing material (Rs.)
1	***2***	***3***	***4 (2/3)***	***5***	***6 (4X5)***
28000.00	1400	35	40	160	6400 (Total)

- **Calculation of UV stabilized supporting string:**

UV stabilized supporting string (Nos.)	Wt.of single string (g)	Plants per 2000 m^2	Wt. of string (kg)	Cost of string per kg	Total Cost of string per 1000	Life of string (Season)	So, Cost Per Season (Rs.)
1	1.38	5800	4.0	220	880	3	293 (Total IV)

Hence, Total Variable Cost = Total (I + II + III + IV)

= 6790 + 90324 + 6400+293

= 103807

Summary of economic analysis for greenhouse cucumber production system:

Production from greenhouse system (kg)	**Selling Rate (Rs.)**	**Gross Returns (Rs.)**	**Amortized Cost for a single season**	**Cost A (Variable cost + Interest on working capital @ 7%)**	**Cost B (Cost A + imputed rental value of land + Interest on fixed capital + Amortized Cost)**	**Cost C (Cost B + imputed value of family human labour)**	**Net Returns (Rs.) [3-7]**	**BCR (Gross Returns/ Cost C) [8/7]**
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***
28000	20	560000	520030	111073 (103307+7266.49)	378436 (111073+178000+52030)	378436	181363.18	0.47
***In current calculation, family labour has not been taken into consideration**								

Motivational Approaches under Student READY- ELP

1. MOTIVATIONAL APPROACHES UNDER STUDENT READY ELP

WEBINAR SERIES
(2020-21)
under
Student READY (EXPERIENTIAL LEARNING PROGRAM)
(Rural Entrepreneurship Awareness Development Yojana)

A motivational Initiative leading to Entrepreneurship during COVID 19 Pandemic

ASPEE College of Horticulture & Forestry took an initiative under the dynamic Leadership of **Dr. Z.P. Patel**, Hon'ble Vice-Chancellor, Navsari Agricultural University, Navsari to organize a Webinar Series under Student READY-EXPERIENTIAL LEARNING PROGRAM (Rural Entrepreneurship Awareness Development Yojana) on e platform, which was proposed as a motivational Initiative leading to Entrepreneurship during COVID 19 Pandemic and officially inaugurated on November 06, 2020. The inaugural ceremony of the Series was presided over by **Dr. Z.P. Patel**, Hon'ble Vice Chancellor, Navsari Agricultural University, Navsari and the Chief Guest was **Dr. R. C. Agrawal,** Hon'ble Deputy Director General (Agri. Education), ICAR, New Delhi. **Padma Shri Prof Brahma Singh,** Former Director, Life Science, DRDO, New Delhi and Dr. Naveen Patle, Additional Commissioner (Horticulture), Government of India, New Delhi were the c Guest of Honour of this ceremony. The online ceremony of this Series was enlightened by the gracious presence of dignitaries Hon'ble Vice Chancellor and the President of ceremony, Dr. Z.P. Patel; Hon'ble Deputy Director General (Agri. Education), ICAR, New Delhi, **Dr. R. C. Agrawal,**; Former Director of DRDO, Former Director, Life Science, DRDO, New Delhi and Guest of Honour, Padma Shree Prof. Brahma Singh; **Additional Commissioner (Horticulture), Government of India, New Delhi, Dr. Naveen Patle and Guest of Honour;** Director of Research, Navsari Agricultural University, Dr. S. R. Chaudhary; **Principal & Dean cum CEO (Student READY),** ASPEE College of Horticulture and Forestry, **Dr. P.K Shrivastava**; NAU ELP Coordinator, Dr. T.R. Ahlawat, ADR, NAU, Navsari and Series Coordinator, Dr. Sanjeev Kumar.

The Sessions under this Webinar Series commenced from November 10, 2020 and continued till December 03, 2020 highlighting the technical talks on various aspects like Basic requirements for project formulation in terms of loan and subsidy for Agri projects , NABARD Initiates on Agri Entrepreneurship, Agriculture Entrepreneurship and Banking Synergy Program, including the technical and practical approaches related to 4 ELP Modules namely Protected Cultivation of High Valued Horticultural Crops, Commercial Production of Horticultural Planting Materials, Post Harvest Handling and Value Addition in Horticultural Crops, Floriculture and Landscape Architecture.

Learning 1

Lead Speaker : **CA Vinod Chandra G. Desai,** Agro Projects- Finance Consultant, Navsari
Topic : Basic requirements for project formulation in terms of loan and subsidy for Agri projects
YouTube Link : https://youtu.be/MnH0MykyCgI
Brief Summary:
Entrepreneurship is a creative and innovative response to the environment. It is also the process of setting up a new venture. Entrepreneurship is a composite skill that is a mixture of qualities and traits such as imagination and risk-taking ability to harness factors of production, i.e., land, labour, technology and various intangible factors. Government of India motivates the youngsters to go for Entrepreneurship. Various concepts of Entrepreneurship are Start – Up, Make in India, Atmanirbhar etc.,

While going for an entrepreneurship small or big we have to make the search of market research, market status of the product and the product, type of market (small and long term), technology for manufacturing a particular item out the raw material, raw material to be used and place for procuration of raw material etc.,

Steps for Agri Infrastructure/ Food Processing Project Implementation:

- Decide the product or project and land for the factory
- Decide the business status (individually i.e., proprietorship or for long time partnership up to 20 members whereas in bigger firm we can move on to limited liability partnership i.e., public limited and private limited)
- Drafting of Partnership Deed/ Pvt. Ltd./ LLP etc. with signature of Partners/ Directors and Witness for Registration.
- Application for PAN and TDS
- On allotment of PAN, we have to open the bank account
- Application for firm registration
- Application for GST
- Application and allotment of Udyog Aadhaar
- Professional tax registration from local authority
- In case of Import Export, we have to apply for Import Export Code
- Online registration of project for subsidy on I – kisan Portal
- Purchasing of land for an industry
- Permission for direct purchase from the farmers
- Application U/s.63 of Tenancy Act for direct sale of partnership firm
- Sale deed to partnership firm and payment by Cheque to land owners by partners' capital
- Obtaining of N.A. permission
- Planning for industry premises.
- Approval of plan of industry from town planning office
- Drawing of plan and cost estimates by architect
- Decision for technology and machinery, quotations for machinery and penal, finalization of purchase machinery, technology and suppliers.

- Quotations for electric connection and D.G Set
- Selection of Bank for Loan, Rate of Interest, Capital Margin, Repayment Period, Processing Fees
- Preparation of DPR and CMA data (DPR – Detailed Project Report, CMA – Credit Monitory Arrangement
- Application for Loan and CC to Bank with Applicant/ Partner/ Guarantors with their Personal Details
- Sanctioning of loan along with documentation and mortgage of primary and collateral security and guarantor signature.
- Disbursement of loan
- Application for Agri Business Registration as well as Subsidy application
- Sanction of subsidy
- Claim of subsidy
- Joint inspection
- Disbursement of capital subsidy
- Application for FSSI

This is the board line for project implementation.

Various schemes of Government funds and subsidy are capital grant/ subsidy, venture capital, interest subsidy, equity participation and term loan / soft loan.

Capital Grant / Subsidy is a form of financial aid or support by the Government to individuals or businesses in the form of cash, grants or tax direct.

Venture capital is the amount required for starting / investing in a new line. Government of India through Ministry of Agriculture and SFAC provides venture capital based on certain norms.

Interest subsidy is the value of the tax deductions of an Individual`s or company`s` earnings resulting from interest payments on its debt over the course of the year.

Equity participation is the scheme of farmer producer company in which there is no interest for the amount granted.
Term Loan / Soft Loan is the loan with 3 – 4% interest.

Schemes of Various Departments / Institutions:

- NCDC: National Co - operative Development Corporation
- NABARD: National Bank for Agriculture and Rural Development
- MOFPI: Ministry of Food Processing Industries
- Ministry of Agriculture and Farmers Welfare
- AIF: Agri Infrastructure Fund
- NHB: National Horticulture Board
- NHM: National Horticulture Mission
- SFAC: Small Farmers Agri Business Consortium
- RGM: Rastriya Gokul Mission
- Ministry of Food Processing

- Ministry of Commerce and Industries
- APEDA: Agriculture and Processed Food Products Export Development Authority
- MPEDA: The Marine Products Export Development Authority
- Ministry of Small and Medium Industries
- KVIC: Khadi and Village Industries Commission

Various Kind of Projects for Co-operatives:

- Cold storage
- Cold chain
- Pre – cooling units
- Ripening chamber
- Rural godown
- Collection centers
- Primary processing units
- Food processing units
- Retail outlets
- Mobile outlets / pre – cooling

Various schemes are made available by the Government of India for the promoting the upcoming entrepreneurs for the development of society and economy.

Learning 2

Lead Speaker : **Mr. Anil Purohit**, District Development Manager, NABARD, Surat
Topic : NABARD Initiates on Agri Entrepreneurship
YouTube Link : https://youtu.be/d-lOna-NmC4
Brief Summary:
It is important to promote sustainable and equitable agriculture and rural development in India. It is possible through financial and non-financial interventions, innovations, technology and institutional development.
The need for a new organizational device for providing undivided attention, forceful direction and pointed focus to credit related issues with rural development led to the formation of a unique development financial institution NABARD (National Bank for Agriculture and Rural Development) which was approved by Parliament through Act 61 of 1981.
Focus of NABARD is to develop rural areas, increase productivity, develop new products from farmers to get sufficient income, to decrease the migration from rural areas to urban areas etc.,

Initiatives by NABARD for Agri – Entrepreneurship:
NABARD doesn't go directly to the farmers, but it always goes through the bank. i.e., it is banker`s bank. It provides finance and refinancing facilities to the banks and rural regional banks. They identify the credit potentials in districts and prepares credit plans for all districts. It also helps all regional banks and institutes under its governance with the preparation of their own credit plans and policies. They provide

fund for rural infrastructure development, for creation of dams, for roads and for solar panels etc., They have a lot of schemes for Agri – entrepreneurship.

Agri - Entrepreneurship through NABARD:
NABARD not only supports farmers but also youth to become entrepreneurs.

NABARD have introduced a scheme for agriculture students and graduates so that they can setup Agri - clinics or Agri – business centres. Agri - clinics or Agri – business centres are an extension services for helping farmers in acquiring latest knowledge and using them practically in soil testing, procure latest seeds, financial assistance etc., To establish Agri – clinics or Agri – business centres (ACABC) they have to attend a training from MANAGE in Hyderabad.

Agri-Clinics are envisaged to provide expert advice and services to farmers on various aspects to enhance productivity of crops/animals and increase the incomes of farmers. Agri-Clinics provide support in the following areas like soil health, cropping practices, plant protection, crop insurance, post-harvest technology, clinical services for animals, feed and fodder management, prices of various crops in the market, etc.

Agri-Business Centres are commercial units of Agri-ventures established by trained agriculture professionals. Such ventures may include maintenance and custom hiring of farm equipment, sale of inputs and other services in agriculture and allied areas, including post-harvest management and market linkages for income generation and entrepreneurship development. The scheme covers full financial support for training and handholding, provision of loan and credit-linked back ended composite subsidy.
Another scheme introduced by NABARD is Self Help Group (SHG), a cost – effective mechanism for providing financial services to the unreached and underserved poor households. It was started as a pilot to link around 500 SHGs of poor to the formal financial institutions during the year 1992-93 and has now become the largest microfinance program in the world, in terms of the client base and outreach.

Skill Development Programs of NABARD:
- Make in India
- Startup India
- Stand - Up India
- Pradhan Mantri Kaushal Vikas Yojana (PMKVY)
- Ministry of Food Processing Industries
- Ministry of Agriculture Welfare

Government of India developed various institutions and schemes for the development of agriculture in India. Realizing the importance of rural youth in agricultural development of the country, ICAR has initiated a program on “Attracting and Retaining Youth in Agriculture” (ARYA).
Skill development of rural youths will help in improving their confidence levels and encourage them to pursue farming as profession, generate additional employment opportunities to attract under employed and unemployed rural youth in secondary agriculture and service-related activities in rural areas.

Learning 3

Lead Speaker : **Dr. Balraj Singh**, project coordinator honey bees & pollinators, ICAR-IARI, New Delhi.

Topic : Protected cultivation of high value vegetable crops, cut flower, and on farm handling and marketing of produce.

YouTube Link : https://youtu.be/d-lOna-NmC4

Brief Summary:

Prospect & challenges in protected cultivation of vegetable crop in India.

Present scenario of vegetable cultivation India vs China.

Particulars	**China**	**India**
Total Area	24.5 m ha	10.2 m ha
Area under protected cultivation	3.5 m ha (95.62%)	0.14m ha (0.6%)
Ave. Productivity	24 tones/ha	17.8 tones/ha

The dismal growth in India was due to poor agreement between the design of protected structures and prevailing agro-climatic condition of the regions.

✓ In south India protected structure is fully successful due to added advantage of mild climate.

✓ In case of Northern Indian protected structure is not fully successful due to harsh climate.

Why protected cultivation:

- Increasing pressure on agricultural land.
- Increasing pressure on water available for agriculture sector.
- Poor quality under open field condition.
- Change in climate.
- Threat of new viruses, diseases and pest.

- Fast change in food habit in urban area.

Structures use for protected cultivation of vegetables:

1) **Greenhouses:**

a) Climate controlled

b) Semi- climate controlled

c) Naturally ventilated

2) Net houses:

a) Insect – proof net houses

b) Shade net houses

c) Rain shelter

3) Other Temporary structures:

a) Walk-in-tunnels

b) Plastic low tunnels

c) Plastic mulches

Major problem under open field cultivation:

1) Biotic stresses

2) Abiotic stresses

Choosing protected structure based on:

1) Climatic condition of area.

2) Which crop actually we want to grow.

3) What is the market available for that vegetable?

❖ **Nursery under protected structure:**

Inverted pyramid shape plug tray is used for growing seedlings.

For fill up tray use media like cocopeat, vermiculite and perlite in ratio of 3:1:1 on volume basis.

Size of plug trays for tomato/ cucurbit: - 20 cubic meter square.

Size of plug trays for chilli: - 8 -10 cubic meter square.

- **Advantages of Nursery raising:**
  - We can get Healthy and disease-free seedling.
  - Any kind of vegetable seed grow under different climate.
  - Reduce seed rate.
  - Nursery work as Agri. Entrepreneur.
  - **Grafting: - Non chemical solution of soil-borne diseases. like Pythium, Phytophthora, rhizoctonia, etc.**
  - **Grafting is commercially practice on melon and tomato.**
  - ***Solanum torvum* is use as root stock for solanaceous family.**

- **Type of grafting:**
  - **a) Cleft grafting**
  - **b) Tube grafting**
  - **c) Tongue approach grafting**
  - **d) Slant grafting (e) Hole insertion grafting**
- **Plastic Mulches:**

Plastic sheet cover over the crop not only reduces the evaporation loss from the soil upper layer but it also as a barrier for weed emergence.

Yellow + black mulches = in white fly infection

Silver + black mulches = in aphid fly infection

White + black mulches

Thickness of mulches is 25 – 30 microns

Nowadays mulching is top most requirement across the country.

- **Plastic Low Tunnels:**

It is very effective in early crop stage a physical barrier of air flow and against winter cold breezes and low temperature.

- **Color shade nets for vegetable:**
  - Black, White, Green, Red (Use for Tuber Crops)

Shading intensity in leafy veg. = 70 – 75 %.

For tomato = 30 – 35 %

- **Insect proof net house**
- **Walk in tunnels**
- **Rain shelter**

❖**Drying of vegetable crop:**

Traditional system of drying chilli is unhygienic and that creates the problem of **Aflatoxins**which is a major barrier in export of chilli but drying under walk-in-tunnels is hygienic and a part of **GAP.**

Learning 4

Lead Speaker : **Swasti Sarita Kundu**, IDBI Bank Ltd., AGM- Assets, Kolkata Zone

Topic : Agriculture Entrepreneurship and Banking Synergy Program
YouTube Link : https://youtu.be/pFVFOj9dof4

Brief Summary: The basic agenda behind this seminar according to Ms. Swasti mam was related to start-up business in agriculture sector. Then she briefly gave an idea related success story of Agriculture sector in COVID-19 pandemic. Agriculture, Forestry, and fishery sectors are 2nd largest contributor to Indian GDP during this pandemic.

Following the seminar, she gave some basic knowledge about agriculture entrepreneurs who have great contributions, those are SHRI RAJENDRA BHAT (agriculturist), SHRI RAHUL DHOKA (green Rush organics and aqua farms), SHRI PARTHASARADHI NARA (founder and CEO ananth naturals).

After discussing about the entrepreneurs, she gave ideas about financial

requirements and about bank loans and subsidies. Like, development of loan, loan for cultivation of crops and loan for allied activities. Then she explained the role of banks in promoting agri-business.

Banks are always referred as a backbone for developing countries, even bank is promoting agri-business and welcoming people who wants to start a new business. Banks ensure proper future help to agriculture community and also ensures profit and loss we can face and helps to overcome that. Banks take help from ICAR & NABARD.

Then she gave a brief explanation regarding planning and actions to take for new start-up and how to get help from banks and government. Points are: -

- A business plan or report of projects
- Finding suitable location
- Obtain permission & license
- Financial arrangements
- Storage & transportation
- Marketing of the produce.

Taking the example, she explained about Gerbera production in greenhouse: -

- Cost includes
- Land development
- Civil structure
- Polyhouse structure
- Drop irrigation & fogger system
- Plantation development
- Miscellaneous farm equipment
- Recurring cost.

After this mam explained government subsidies and bank loan one can use for development in particular sector.

1. Subsidies: - all horticulture schemes are subsidized under MIDH. It provides credit linked back ended subsidy for various activities of horticulture. Also, national horticulture board provides 50% subsidy on project cost.
2. Bank loan: - There are two types of loan provided by banks: - medium- or long-term loan and short-term loan or KCC facility.

Eligibility: -

- borrowers should have cultivable land
- Borrowers shall not have overdue with banks
- Repayment tenure may vary from 4-12 years depending on activities.
- 75% help by bank and 25% own money should be included so one can never depend totally on bank and also this can make them feel their involvement in money or projects.

Then mam explained various problems faced in production of fruits and Vegetables and criteria of different industries like: -

- Types of storage facilities and major criteria of cost.
- Subsidies and bank loan
- Financing under agriculture infrastructure fund
- Financing under animal husbandry infrastructure cost

- Also related loan in farming.

Recently PM atmanirbhar bharat abhiyan stimulus package mentioned about setting up of Rs.15000 crore fund. About 90% by bank and 10% own.

In poultry farming: - cost includes 75% by bank and 25% own

In solar financing: - about 85%loan is given for about 7 years including different subsides.

List of statutory clearance: -

- Local authorities' clearance as per state requirements
- No objections from land authority
- COE&CO from state pollution control board
- Trade license
- Food safety & standard authority of India
- Water & air acts
- State electricity board
- MSME registration
- Registration under companies act
- Registration under labour act
- Any other statutory clearance

Documentation for loan application: -

- KYC of individual
- Firm registration
- Other permissions and license certificates
- Food safety license
- Layout map of projects area
- Detailed project report
- Copies of land records with NA permission
- Approved plan& estimate for all civil marks
- Water yield certificate of Wells, water test report

Documents for individual

- Address proof
- ID proof

Documents for partnership

- Trade license or GST registration
- PAN card
- Identity & address proof

Guidelines for obtaining subsidies: -

- Create detailed project report
- Apply for loans
- Receive loan
- Apply for subsidy with DPR

Learning 5

Lead Speaker : **Dr. Awani Kumar Singh**, Principal Scientist, ICAR-CPCT, IARI, New Delhi

Topic : Experiences in Vegetables production and protection through protected cultivation technologies in Indian Climatic Conditions and situations.

YouTube Link : https://youtu.be/xwoO-JSNOPU

Brief Summary: With 24 years of experience Dr. Awani Kumar sir shared ppt presentation regarding experience in protected cultivation.

How many technologies involved & hi-tech?

Protected cultivation technologies are a covered production system of crop with suitable protection from biotic and abiotic stress as to increase productivity, quality with Optimum resources utilization, also known secondary agriculture i.e., Hi-tech.

Protected cultivation tremendous scope for high value vegetables, flowers, fruits & Climatic variations to have adverse effects on them.

China is 1st leading country with 3 lac Hectare area, followed by India with 2 lac hectare area. The sir gave details regarding objectives and advantages of protected cultivation.

Other name is hi-tech, plasticulture, polyculture, covered cultivation, smart horticulture.

Different types in protected cultivation: -

- Classification: - greenhouse, tunnel, surface cover, vertical staking.
- Theme: - engineering 50%, physiology 25%, horticulture 25%.

Government policies: -

- Per-drop-more crop
- P. M. *Sichai yojana*
- P. M. *Rozgar yojana*
- Policy on climate change
- Doubling farming income
- 80% subsidy

Material used for making protected structure: -

- Plastic: - for covering materials
- Non plastic: - for structure making

5 J that are strength and weakness of protected cultivation: -

Jal- water
Jameen- soil
Jang as - forest
Jalwanu - climate
Javan - young youth

Plants requirements are light, temperature, humidity, CO2, water and nutrients.

Factors of microclimate: - temp 10-30 Celsius, sunshine 400-800 w/m2, RH 50-80%, CO2 300-500 ppm.

Innovation in protected cultivation: -

- Zone wise fan and pad & naturally ventilated greenhouse

- Solar panels design of green house and others
- Temporary structures
- Combination of U. V stabilized covering material
- Plant density & canopy
- Robotic grafting, pollination & production system
- Micro irrigation & fertigation
- Year-round production
- Vertical production system
- Roof rain water harvesting

Different greenhouse design: -

- For plain: multi span
- For hills: single span

Then sir explained regarding latest design coming i.e., Cravo rectangular roof system or mobile system. This system can allow roof to open & close according to climatic requirements by plants, reduce disease problems, reduce irrigation, temperature control. It is based on climate and crop requirements. Negative impact is its only made for commercial farming.

Polyhouse: -

- Semi control: fan pad or force Ventilation
- Natural ventilated: 0 electric device

Suitable in India: - single span and multi span
Important points regarding it: - ratio of L-W 80:20 / 75:25, SH 3-5 m, CH 3-9 m
Also, sir explained regarding smart technologies used nowadays: -

- Soil less technology: coco peat, vermiculite, perlite, etc.
- Hydroponics
- Aquaponics: rainwater harvesting or water tank
- Aeroponics: water savings is done
- Vertical gardening
- Hanging gardening
- Soil based production techniques innovation
- Robotic methods
- Pollination

Then sir gave brief about Uttarakhand success story where farmers receive net returns of Rs.15000 – 50000 / year by protected cultivation. Also, farmers installed 2-5 numbers of Polyhouse.

Minus points: -

- High cost
- Lack of materials
- Lack of technical knowledge
- Long pay -back period
- Additional maintenance cost

Learning 6

Lead speaker ; **Dr. Ajay Sood**, Principal Scientist, Department of Entomology CSK HPKV Palampur(HP)
Topic ; Insect, pest and their management under protected cultivation.
YouTube link ; https://www.youtube.com/watch?v=xwoO-JSNOPU

Summary:

Pest attack is a major problem when we consider crop production whether the cultivation is under protected cultivation or in the open field. There are many objectives for protected cultivation like increase yield, off season cultivation etc.one among them is to bring down the pest infestation. Studies done on this topic revealed that pest infestation was less compared to open field. In crop tomato case study conducted, it was explained that fruit borer prominent on the open field has been very less under greenhouse. Similarly, in case of capsicums, aphids and whiteflies which were the major pest on open field shows a reduction in occurrence.

But under the protected cultivation once the pest enters, it will be very difficult to control them and they will be a challenging factor as the pest level may rise due to increased availability of more food and congenial environment and also due lack of natural enemies.

There are many pest

White fly - There are two types of whitefly under protected cultivation are greenhouse whitefly (*Trialeurodes vaporariorum*) and cotton whitefly *(Bemisia tabacci*). The greenhouse whitefly are prevalent at temperate region. They don't transmit large number of diseases like cotton whitefly but have a very high multiplication rate.

Green aphids (*Myzus persicae*) -These are major pest of capsicum, potato. They affect the crop by excreting honey dew which may affect the photosynthetic activity of the crop by accumulating sooty mould and also by transmission of several diseases. Usually affect terminal shoots and also flowers.

Mites - Mainly there are three types of mites namely red spider mite (*Tetranychus urticae*), yellow mite, russet mites. Webbing leads to an unhealthy appearance, white specks on upper leaf surface and on the later stages complete destruction of

the green matter leading to photosynthetic inefficiency. On capsicum, mainly yellow mites leads to development of fruits which are corky in appearance and also inward curling of older leaves. Red spider mites are prominent on cucumber. Russet mites have a peculiarity of starting infestation from lower region.

Thrips – Main pest on chilly. They infect the plant creating upward curling of leaves and corkiness of developing fruits.

Mealy bug – *Phoenococcus solenopsis* commonly called cotton mealy bug as they are significant pest of cotton.

Tobacco caterpillar (*Spodoptera litura*) - Even though lepidopteran insect they may become uncontrollable if proper agricultural practices are not followed or due to structural defects of greenhouse.

Tomato pinworm they are a type of leaf miner and on fruit they create pin sized holes. The holes made are comparatively smaller than those made by tobacco caterpillar.

Leaf miner (*Liriomyza trifolli*) - These can be easily controlled by early destruction of infected leaves as they appear.

Management of pest require many aspects of consideration. Firstly, there is requirement of pre requisite knowledge like pest details, EIL value, knowledge about bio-control etc. A study conducted at Himachal Pradesh also explains the reason for occurrence of pest under protected cultivation, such as greenhouse grower's skill and technology, green house structure and also insect characteristics. The green house with a double door is a far better option than a greenhouse with single door.

The concept of IPM paradigm emphasis pest management under three phases as avoidance, early detection and application of curative measures. Avoidance includes measures like preventing usage of infested planting, usage of insect nets, cultural measures, sanitation measures, etc. Avoidance of polyculture is also important to avoid alternate hosts.

Early detection includes traps installation, monitoring and scouting. Traps (both colour attracting and pheromone trap) are used and such low-cost sticky traps can be locally prepared by smearing mustard oil over a thick chart paper. Monitoring and scouting are done usually for leaf miner, aphids etc.

Learning 7

Lead speaker : **Er. P. S. Pandit (PHT), ACHF, NAU, Navsari.**
Topic : Packaging and marketing of processed food products
YouTube link : https://www.youtube.com/watch?v=Zxez7a1lvP4
Summary;

Packaging and marketing are considered as an important part of food pipeline. Food packaging literally means the packaging of food products. The most important aim of packaging is the protection from damage, contamination and also to maintain the wholesomeness of the food item. Packaging also makes the handling of food item easier which may also avoid the economic losses. Packaging is of three types primary, secondary and tertiary packaging. Packaging directly in contact with the product is primary packaging and its main objective is protection. Secondary packaging is just exterior to primary packaging and mainly done for the purpose of distribution. The tertiary packaging is done for secondary packed materials mainly for enabling the easy transport.

There are different materials for the purpose of packaging like plastic, glass, metals, natural fibres etc. Plastics may be available as rigid or in flexible form. They have partial permeability to water vapour, carbon dioxide, oxygen, good sealable property but less printability. Different types of plastics low density polyethylene (LDPE), high density polyethylene (HDPE), Linear low-density polyethylene (LLDPE), Poly vinyl chloride (PVC) etc. These types are used as per the requirement. For example, shrink wrapping requires linear low-density polyethylene is used, for freeze drying polypropylenes and HDPE etc. are used. If PVC is used for freeze products, they may become brittle.

Metals are impermeable to moisture and light, hermetically sealable packaging material, having good stacking strength while storing and also property of resisting thermal processing. Metals like aluminum, tin, copper, brass etc. are generally used either in rigid cans or flexible form. If proper packing in cans is done then with requirements like proper head spacing etc., highest storage life can achieve. Another advantage of this type of packing is sterilization after packing.

Paper used for a packaging material has a good property of printability but it lacks strength and sealable property. Paper pulp can be used in the form of paper bags or corrugated fibre board box Good packaging can be achieved by the combination of all the three, that is commonly available as tetra pouches

(7 layered). Other materials used are clay, glass, sacks made out of naturalfibres like jute etc. Clay packaging generally gives a traditional look to the packaged product and this may create more demand among the customers. Glass packing is usually available in the form of bottles or jars. Bottles are with narrow mouth but jars are with a wide opening at the top. Major disadvantage of glass is that it is not comfortably sealable. Natural fibres like jute, banana, cotton etc. are used for making sacks for packing commodities like potato, onion etc. which require good aeration.

Marketing is also equally important to make the product available to the consumers. There are different types of marketing like relationship marketing which include marketing by giving importance to consumer review about product. Transactional marketing is purely profit oriented and tries only to increase its turnover. Creating marketing by developing different ideas to make the product acceptable among different people and different areas is called diversified marketing. Undercover marketing tries to market by not revealing its inherent characteristics. Internet marketing is marketing through online platform by creating customized applications.

Brand image development is significant step for successful marketing. For improving brand image is to create brand awareness, influence customer, establishing or maintaining brand recognition. Establishing perfect distribution channels, etc.

Learning 8

Lead Speaker : **Er. A. K. Senapati,** Professor of ACHF, NAU, Navsari.

Topic : **Post-Harvest Management & Processing of Vegetable crops**

YouTube link : https://youtu.be/Zxez7a1lvP4

Brief Summary: On this day, the Honourable professor of Aspee college of Horticulture & Forestry, NAU, Navsari has taught us through Google meet on the

various topics related to post harvest management, processing & value addition of vegetable crops.

For the topic of Post-harvest management, respected sir has told us about the topics of **PHT subunits, PHP (post-harvest physiology) control, Maturity indices, Methods of harvesting, pre-harvest treatments, Post-harvest treatments, Sorting, Grading, Packaging, Storage, Post-harvest loss, Reason why PHM is necessary & also current status of Post-harvest losses.**

For the topic regarding to Processing of Vegetable crops, respected sir has discussed about **various types of processing like (1) Primary (i.e., Sorting, Grading), (2) Secondary (i.e., slicing, preservation) & (3) Tertiary (i.e., preparation of Ketchup, jam, juices, etc.) & also talked about the Objectives of Preservations & various Preservation methods (physical, chemical, biological, hurdle).**

Topics related to Value addition of vegetable crops, He has taught us about **Preparation of Tomato Ketchup, freeze fresh Tomato slices & Potato sticks, Fortified Pasta, Drying of Green peas, Mixed Vegetable Pickles, Dehydration of Onion flakes & Okra slices & also taught us about Preparation of Ginger Powder & Water melon Candy.**

Learning 9

Lead Speaker : **Mrs. Asha Naik**, Entrepreneur, Belgaum.
Topic : Value Addition in Flowers
YouTube Link : https://youtu.be/P0p_afNIbYE
Brief Summary: It was 9th lecture of webinar series under Student Ready Experiential Learning Program on the topic **"Value Addition in Flowers"**, in which **Mrs. Asha Naik**, the speaker explained about her journey in the line of floriculture and also shared many ways of floral value addition.

She said that priorly she was in textile business but due to some reasons she left her business and floriculture and sericulture which was her side business becomes main stream of business. She started growing of flowers and their selling and jumped in floral business. Now she is doing event management and stage decoration work and well established in business and becomes flori entrepreneur.

Earlier when people in their area grows gerbera in greenhouse, she with her husband decided to grow carnation which are relatively difficult to grow, and it was

their hard work that they succeed and able to produce number of carnation blooms. But as they were not getting good price of their product, they decided to run their own flori shop after taking some basic training on management of flowers and their use. In Sep.2006 she organized a flower show to aware the local people about the different outsider flowers, and from here she got 1st opportunity in her business. Then after she never been left behind and made lots of progress and won many awards for these. She got honors of decorating stage for honorable**Prime Minister Shri Narendra Modi Sir** when they visited Belgaum.

She started to make different flower arrangements, dry flower arrangements, prepared bouquets and used combination of different colours of flowers and foliage to decorate the stage. She started to use petals of different flowers like Rose, Marigold to make **"Rangolis"** and **"Designs"** on the floors. She used rose petals in garland preparation with combination of other flower petals so that they become more colourful and attractive. She also used to make **"Tiara" (Venis)** using flowers and foliage in marriage and other occasions. She suggested to use flowers for oils extraction (in perfume industry) and for food purpose (**"Gulkand"** from rose petals).

She shared a clip in which it is suggested that the flowers used in temples or churches which are mostly dumped in garbage should use for the preparation *of Agarbatties* which really is a good idea.

Really, it was very informative session and more than that very inspiring session.

Learning 10

Lead Speaker : **Dr Alka Singh**, Professor & Head of Flori. Department, ACHF, NAU, Navsari.
Topic : Scope of Floriculture for entrepreneurship
YouTube Link : https://youtu.be/P0p_afNIbYE
Brief Summary: On this day, the Honourable professor of Aspee college of Horticulture & Forestry, NAU, Navsari has taught us through Google meet on the various topics related to scope in Floriculture for entrepreneurship.

In the webinar session professor taught about the meaning of Floriculture, the present scenario of pollution, Urbanization and Deforestation problems, Value of Floriculture on (environment, Health and Social life), Urban heat Island effect, how the indoor air pollution occurs. (2.6 million people died due to household pollution).

Other topics covered by professor is as below:

- Solution for all these problems is Growing more and more plants.
- Some holly books also mentioned by professor like – Rigveda, Atharvaveda, Mahabharat, Purana. A book named 'Last child in the wood' by Richard Louv.
- The historical value of Floriculture related with flowering plants and huge trees.
- Emotional and Psychological Impact of plants on humans because of their texture, fragrance, colour, appearance etc. (Japanese Garden)
- Plants can also put in Hospitals and classrooms.

- Floriculture scenario – Production and Area.

Bright Opportunities for Entrepreneurship

1) Greenhouse technology – for production of different cut flower specially Rose, Gerbera and orchid
2)Pot plant business – for indoor and outdoor plants pot.
3)Mechanical methods and robotics adopted in different areas.
4)landscaping: A promising scope
In small home garden, Societies, Industrial garden, living area, outdoor living garden, road side plantation, traffic islands. Landscaping on Airport, Railway, Bud depot, Public park, Eco-tourism etc. (Delhi Airport)
5)New concepts – Rooftop garden, vertical garden, Farmhouse development, balcony garden etc.
6) Succulents & Cactus – have high demand
7)Ornamental plant nursery
8)shipment of pot plants business

- Mr. Nirmal shah, Plant unlimited, Kalamazoo, USA – a successful man who develops many plants & contribute to the whole country.
- Adenium variety developed by Gujarat. – Gujarat Adenium – 1, Gujarat Adenium – 2

Value addition-based opportunities in Floriculture:

1) Dry flowers
2) Essential oil
3) Natural dyes
4) Flower arrangements
5) Pot pouri
6) Aromatherapy
7) Home decor and home fragrance
8) Export value

- Dry flower export industries
  1)Ramesh flower Pvt. Ltd
  2)Fauna International
  3)Salema spices pvt. Ltd, Salem, Tamilnadu.
- Different plants for dry flowers: Exotica, cones, curls, leaves
- **Performance of seniors in the ELP**
  1)The vertical wall in ACHF
  2)Products from dry flowers
  3)Training and flower arrangements
  4) Flower Exhibition

Learning 11

Lead Speaker : Dr. H.P. Shah (Flori), ACHF, NAU, Navsari.

Topic : Orchids in Greenhouse.

YouTube Link : https://youtu.be/UsUuSIEXOCE

Brief Summary: The Orchidaceae are a diverse and widespread family of flowering plants with blooms that are often colourful and fragrant. It is one of the largest families. They have about 25000-30000 species and 600-800 genera. Species which are grown in India are around 1600.It can be found anywhere around the globe; therefore, it is said to be omnipresent. Most commonly cultivated (commercially) orchids are Arachnis, Phalaenopsis, Ascocenda, Oncidium, and Cymbidium and Dendrobium.

Out of these Dendrobium is the most used and highly imported orchid genus in India. Dendrobium can be grown in any climate. It is a sympodial epiphytic plant. Major producing countries of Dendrobium are Singapore, Thailand, Malaysia, Indonesia, Netherlands, Japan, Kenya and Australia. Major producing states of India are Goa, Maharashtra, Kerala and Sikkim. It is excellent for growing in pots since it has lifespan of around 60-70 days. Its cut flower has the highest value. Other uses include indoor plant, making glues, bracelets, medicine etc. A spike contains 10-12 florets. A floret is made up of sepals, petals and labellum.

Orchids can be classified on the basis of Growth habit, Vegetative structure and Temperature requirement. According to

Growth Habit – Terrestrial, Epiphyte and Lithophyte

Vegetative Structure – Monopodial (Single Stem), Sympodial (Multiple Stem)

Temperature Requirement – Warm, Intermediate and Cool

Propagation methods include Division (Keikis), Cuttings, Back bulbs and Tissue Culture (Most rapid method).

Media should have good water retention capacity, high porosity, good aeration, good anchorage etc. E.g., brick pieces, charcoal pieces, peat moss etc.

Spacing should be around 25-30 cm between the plants. Width of the bed is around 1 metre in which 4 rows are made. Another great method of planting is Block Planting.

Cultural practices include Staking, Irrigation and Nutrition.

Tinting can be practiced to have desirable colour in flowers.

Various disorders found in Orchids are Dry sepal injury, deformed flower and browning of throat. Pests include snail and slug, orchid beetle.

Learning 12

Lead Speaker : **Dr. Desh Raj** (Professor Floriculture, COA, CSKHPKV, Palampur)

Topic : Production of quality planting material in indoor ornamental plants

YouTube Link : https://youtu.be/UsUuSIEXOCE

Brief Summary:

- **Why indoor gardening**
  - The pleasure and thrill of growing house plants/ indoor plants are immense.
  - Indoor gardening brings an intimate and natural association of the man and the plants.
  - Indoor gardening is never out of season.
  - indoor plants add charm to the architectural beauty of the house and complement the interior setting.

- **Purpose of indoor plants**
  - Remove indoor pollutants.
  - Exceptional value in interior decoration.
  - Primitive ways to cultivate ornamentals.
  - Cultivation for desired satisfaction.
  - Sense of interest for recreation.

- **Global Floriculture Industry**
  - Biggest International flower market is at Aalsmeer owned by Flora Holland in the Netherlands.
  - Countries involved in floriculture trade: 191
  - Total value flower trade: 21020 million US $
  - Value at whole sale level: Over 50 billion US$
  - Estimated global area under flowers: 2m ha.

- **Quality of indoor plants**
  - Robust (ability to tolerate hot, cold or dryer conditions indoor).
  - Evergreen.
  - Attractiveness.

- **Potting media**
  - Soil(Loam/ sandy loam): Sand: Leaf mould (one part each).
  - Peat moss: Perlite: Vermiculite (one part each).
- **Light**
  - Sunny plants: Direct sun in winter is required for over 5 hours and no direct sun in summer i.e., Flowering and coloured foliage plants.
  - Shady plants: Dim light i.e., Aglaonema and dark green to blue green foliage plants
- **Ideal Temperature**
  - Optimum temperature range in air for indoor plants is 21-32• C
  - Optimum soil/ growing medium temperature is 18- 21•C
- **Relative Humidity**
  - Relative humidity of around 50-60 per cent is most ideal for indoor plants.
  - For ferns and orchids relative humidity of 80-100 per cent is requirement.
- **Fertilizer**
  - Optimum level of major nutrients is N: 150-200 ppm, P: 50-70 ppm and K: 100- 150 ppm.
  - Fertigation is also very useful for indoor plants.
- **Propagation**
  - Sexual method
  - Asexual method
- **Propagation through seeds**

  1)Araucaria 2) Aralia 3) Begonia 4) Coleus 5) Cyclamen
- **Vegetative propagation**
  - Cutting: - Philodendron, Peperomia, Dracaena, Begonia etc.
  - Air layering: Aglaonema, Croton etc.
  - Offshoot: agave, aloe etc.
  - Runners: geranium, fern etc.
  - Suckers: Hydechium, Cana etc.
  - Tissue culture and micro propagation
- **Insect and pest**

1) aphids 2) Mealy bugs 3) Red spider mites 4) Scales 5) Thrips

- **Disease and viruses**

1) Alternaria 2) Botrytis 3) Cercospora 4) Colletotrichum 5) Fusarium 6) Phytophthora
7) Dasheen Mosaic Virus 8) Cucumber Mosaic Virus 9) Bidens Mottle Virus

Learning 13

Lead Speaker : **Dr. I. B. Maurya**, Dean, College of Horticulture & Forestry, Jhalawar.

Topic : High Tech nursery for entrepreneurship

YouTube Link : Not available

- **Brief Summary:** Nursery is Defined as an area where plants are raised for eventual planting out.
- High tech nursery is growing plants in greenhouse, building of glass to or a plastic Tunnel, designed to protect young plants from harsh weather, while allowing access to light and ventilation. for example: tissue cultured banana, gerbera and carnation etc.
- An Japanese quote says **"Seedlings determines half of the yield "**
- **Method of nursery raising:** Flat or raised bed
  Poly bag of cup
  Portray/plug tray
- Tomato, brinjal, chilli, capsicum, cucurbits, all flower Annual, Strawberry, banana, Seedling for rootstock requires nursery.
  - **Advantages:** Zero mortality.
    - Easy insect pest control.
    - Growing disease free seedlings during off season.
    - Reduce seed rate.
    - Pro-tray technology enhances 20% yield.
    -
- **Media:**

Media use for high tech nursery only pure soil less media: 3-part cocopeat + 1

Part of perlite + 1 part of Vermiculite.

- **Materials for high-tech nursery**:
  - Pro-trays with thermoscope base.
  - Boom irrigation of fogger system.
  - All devices for creating micro climate in polyhouse.
  - Media mixture machine.
  - Robotic grafting machine.
  - Power sprayer.
- **Components of high-tech nursery:** Protected structures
  - Seedlings trays
  - Media
  - Irrigation & nutrients
  - Tools / machines

nursery structures: **Shade net:** to give different amount of shade to plants. Available in different colors and mesh size.

Poly-tunnel: Nursery covered with a plastic film or sheet to form a tunnel; it is miniature structure.

Green house or polyhouse: structure covered by poly-film the plant can grow under partially or fully controlled climatic condition.

- **Tools for high tech nursery management:** Nursery calendar. plant **High tech** development register, nursery inventories, Records of nursery experiment.
  - Grafted vegetable seedlings also known as **robot grafting.**
  - The plants of **Cucumber** are grafted on rootstock of **bottle gourd.**

- **Most important Disease of nursery is Damping-off** occur in two stage pre- and post-emergences. **Control by seed treatment with 4g Trichoderma/kg of seed + 3ml apron/kg of seed.**
- **Use yellow and blue sticky trap for pest control**.
- **Seedling Packaging & Transportation:** for long distance packed in

corrugated boxes. And properly sealed.

Do not stake more than 5-6 boxes.

Transplant seedling in evening.

Learning 14

Lead Speaker : Dr. S.K Jain
Topic : Safe handling of vegetable crops for self-life extension
YouTube Link : Not available
Brief Summary: On this day, the honorable Dr. S.K. Jain (Director Extension Education Agriculture University, Kota, Rajasthan) has taught us through Google meet on the various topic related to safe handling of vegetable crops for self-life extension.

Safe handling of vegetable including three treatment:

1. **Chemical treatment**
2. **Gaseous treatment**
3. **Physical treatment**

- **Chemical Treatment** used to increase the self-life.

A. **Anti-microbial and anti-browning agents**
B. **Nitric oxide** (NO) No has been combined with cold storage condition and Modified atmosphere condition to improve the self-life like green beans, broccoli.
C. **Calcium chloride**

- **Gaseous Treatment: ozone** is generally used in Gaseous treatment.

- **MAP** (Modified Atmosphere packaging) by sealing them in polymeric film to modify the oxygen and carbon dioxide concentration levels within the Package atmosphere.

Physical Treatment:
A) Heat treatment – Heat treatment have shown beneficial effects for insect control, prevention on fungal development, post-harvest storage disorders including chilling injury.
B) Edible coating- Edible coating are thin layer of material which provides a barrier to moisture, oxygen and solute movement for the food.
C) Irradiation- Irradiation is a process of exposing the produce to speed particles or rays for improving the shelf life.

2. Motivation of ELP students for participation in competition and success

Ashly's Experience about microgreens

As a part of our ELP, Dr. Sanjeev Kumar sir instructed our batch to grow microgreens at our home. Under his instructions and guidance, I grew microgreens. I prepared and enjoyed many dishes out of it. Later, **sir encouraged me to participate in "Grow Microgreens at Our Home" contest organized by IFTR, Chennai as part of World Science Day Celebration**. **In the contest, I was selected as one of the best entries.** I am very thankful to Dr. Sanjeev sir for encouraging and motivating me to participate in the contest and achieve success. It was a new and nice experience.

Jyotsna's Experience about microgreens

Due to corona pandemic, we were unable to carry out the hands-on-training under ELP that was supposed to be held at our college. So as a part of ELP, microgreens were cultivated at our home under the guidance of Dr. Sanjeev Kumar sir. We also prepared few dishes out of it and it was a good experience to enjoy the dish prepared from what we have cultivated on our own. With this knowledge I was also able to participate in a competition "Grow microgreen at our home" organized by IFTR Chennai as a part of World Science Day. I am very thankful to Dr. Sanjeev Kumar sir for motivating me to come forward and participate in the competition and achieve success.


Indigenous and Frontier Technology Research Centre
Chennai 600 064, Tamilnadu, India.

Certificate of Recognition

This certificate is awarded to

Ms. Ashly Jossy

For presenting one of the Best entries in the
Grow Microgreens At Home Contest held on November 10, 2020
to commemorate the "World Science Day 2020"

Dr. Bhavani L.G
Coordinator

Dr. Shanmitha Tatha
Coordinator

Dr. C. Lakshmanachichar
President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