

**Protected Cultivation**



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# Introduction:

Protected cultivation which is also known as controlled environment agriculture (CEA) or partially greenhouse cultivation is a modern-day practice of production of qualitatively and quantitatively superior high value crops under certain controlled environment obtain higher level of yield without sacrificing the soil and water conservation aspect.





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# WHY ?



Because we; Humans can not control climate,  
but can control micro climate



Because we can have our favorite fruits, vegetables  
and herbs on our plate around the year.



Because assured higher yield and high quality production



Because precious water and nutrient can be saved



Because less burden of pesticide



Because farmer with small plot can also go for it.



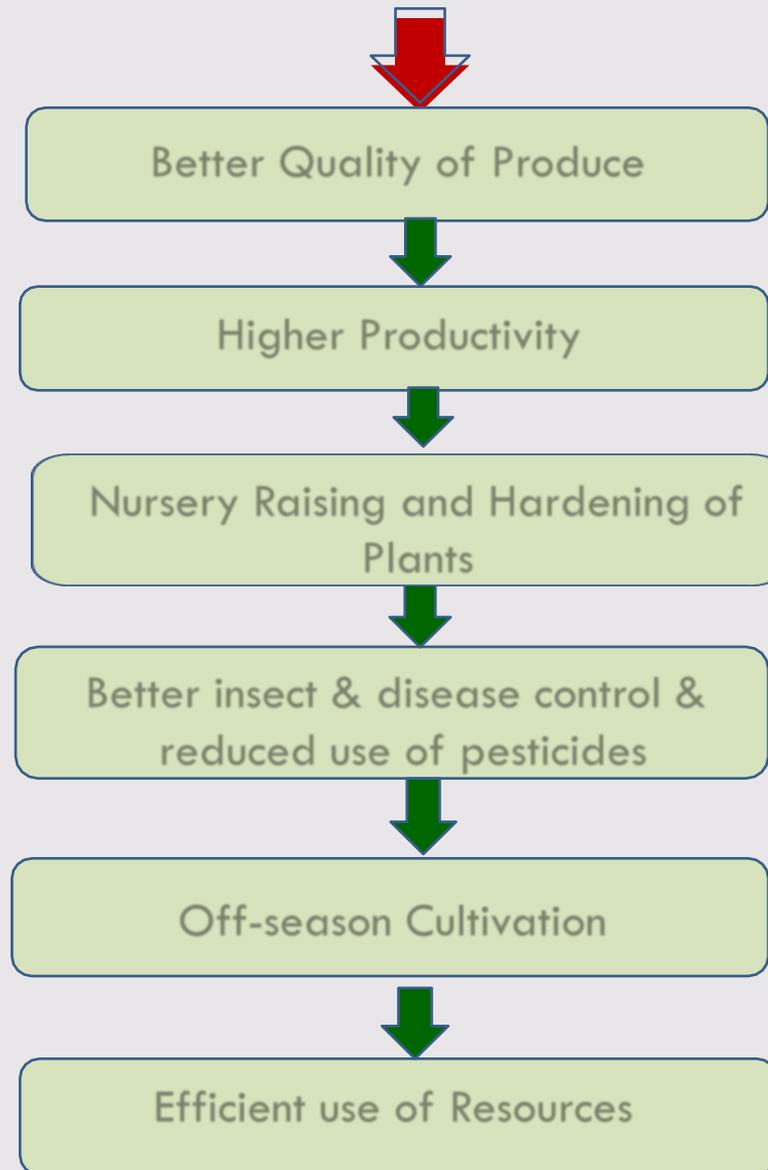
Because farmer can earn premium prices





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# Benefits Protected Cultivation





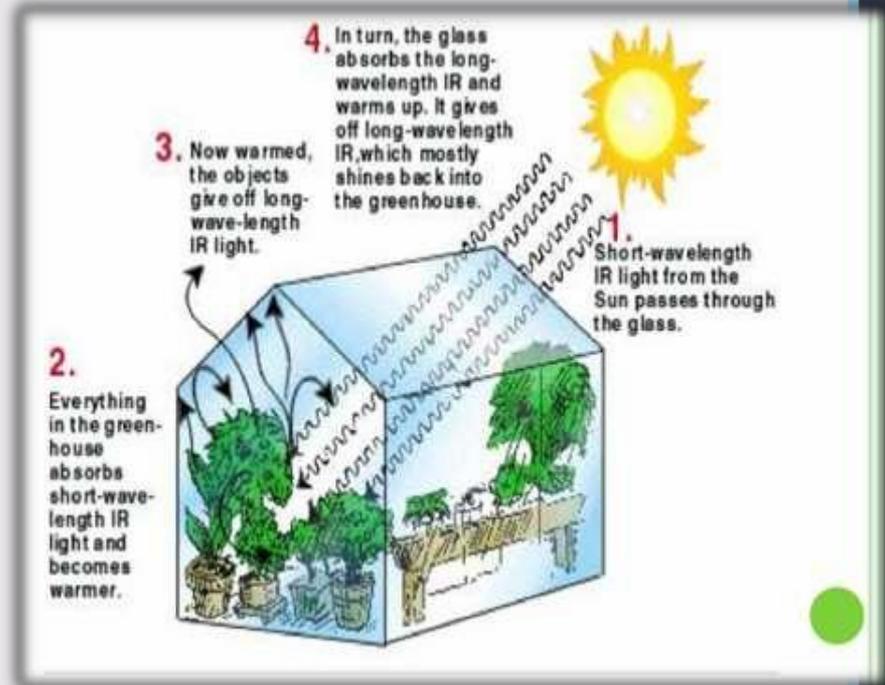
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# Principles of greenhouse cultivation

The greenhouse is covered with a transparent material such as plastic, pvc sheet or glass. Based upon its transparency the greenhouse cover transmits most of the sunlight.

The crop, floor and other objects inside the greenhouse absorb the sunlight admitted inside the greenhouse. These objects in turn emit long wave thermal radiations for which the greenhouse covering material has lower transparency and as a result of this the solar energy is trapped thus leading to increased temperature inside the greenhouse. This is known as "**Greenhouse Effect**".





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# Global & National Scenario

**Total 115 countries**  
**practices**  
**protected**  
**cultivation**

**55 countries practices it on**  
**commercial basis**

**China is the leading producer**

Country	Area (ha)
1. China	2760000
2. South Korea	57445
3. Spain	52170
4. Japan	49059
5. Turkey	33515
6. Italy	26500
7. Mexico	11759
8. Netherland	10370
9. France	9620
10. USA	8425



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Area under greenhouse in India – 50000 ha approx.

States with largest greenhouse area are- Maharashtra, Karnataka, Gujrat, Himachal Pradesh, NE states, Uttarakhand, Tamilnadu, Jammu and Kashmir.

Protected Cultivation started in India as a part of agricultural experiments.

Maharashtra and Gujrat has combined area of 5730 ha under protected cultivation



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# Gable type Greenhouse

. Very first version of greenhouse

. Built perpendicular to sun

. Inclination of roof as per local climatic condition

. polythene sheets used as covering material

. Bed width 6-12 meter

. Can be multispan





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- Frame is made of wood/bamboo
- Can withstand bad weather better than Gable.
- More strong design .
- Can be used in areas with moderate to high snow fall.

# Gambrel





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# Skillion

Constructed on southward part of any fixed building.

Single sloping roof.

flat roof of the skillion design

Transmits the least amount of light over the course of a year. This is because more light is reflected when the sun is low in the sky, however lower light conditions

may be preferable for certain crops.

Passive vents need to be located at the highest point to naturally remove heat.





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# Curved roof raised high arch

- . Semi circular tunnel with good height
- . Polythene sheets used as covering material
- . Light framed curved arch provides strength
- . Higher available head room
- . Easy to construct





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# Saw-tooth

The sawtooth design provides effective, natural venting of hot air. However, light levels can be lower due to the additional structure above the crop. The vertical walls of the gable, skillion and sawtooth designs maximise the useable internal space





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# Plastic low tunnel

Plastics tunnel popularly known as low tunnels are miniature structures producing greenhouse like effect.

These tunnels facilitate the entrapment of carbon dioxide, thereby enhancing the photosynthetic activities of the plant that help to increase yield. These structures also protect the plants from high wind, rain, frost and snow.

Besides being inexpensive, these structures are easy to construct and dismantle.





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# Naturally ventilated greenhouse

- . Most common and popular in India
- . Cheap zero energy model.
- . Whole year round production.
- . Maximum ventilation.
- . Use of cheap covering material





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## Glass

Glass has long been the traditional covering.  
Its favourable properties include:

- high absorption in the photosynthetically active radiation (PAR) bandwidth
- Good heat retention at night
- Low transmission of UV light
- Durability

# Materials Used for Greenhouse





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## Plastic Sheeting

Essentially there are three materials in this category - polycarbonate, acrylic (polymethyl methacrylate) and fibreglass. Plastic sheeting is not used extensively in India but its use is increasing. Sheeting products are more durable than plastic films and have fairly good heat retention, good initial absorption in the PAR range and low UV light transmission.





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## Plastic films

Films are the most common and lowest cost type of covering material. The types of film available are polythene (polyethylene), EVA (ethyl vinyl acetate) and PVC (poly vinyl chloride). With the constant improvements in plastics, these covering materials offer a lot of flexibility and performance options. Coverings can have a variety of additives which are used to give plastic films useful properties. For example, films may be used to exclude ultra violet (UV) light for chemical free pest control or reflect long wave infra red (IR) radiation to improve heat retention at night. As a result, some plastic covering materials are coloured or tinted.

Additives to the plastic determine its:-

- durability
- capacity to reduce heat loss
- capacity to reduce droplet formation
- transmission of particular wavelengths of light
- capacity to reduce the amount of dust sticking to the film.





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## Shade net or Thermal net



- ❖ Thermal net can increase the temperature below the net by up to 3°C compared to external field temperature
- . In trials it has proven to offer protection against larger insects including cabbage root fly and also protects from birds, rabbits and deer
- . Thermal net gives protection from wind, hail, heavy rain and helps prevent capping
- . Easy to use just like normal insect net and has high resistance to tearing Made out of HDPE with UVI inhibitor that can last up to 5 years
- . Whilst it does not offer the same level of protection as our normal insect netting it still has a niche in the market for certain early crops.



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## Additives which can be used -

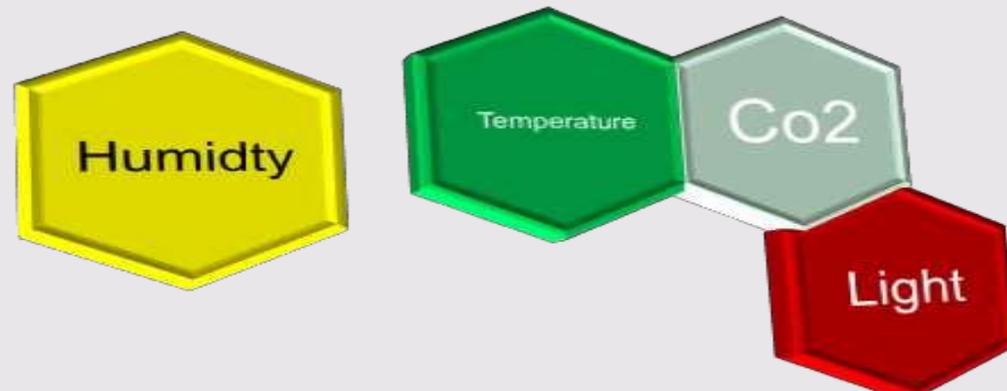
- UV (290-400 nm) absorbers and stabilisers increase durability, reduce the potential damage to biological systems in the greenhouse and may control some plant Pathogens.
- Infrared (700-2500 nm) absorbers reduce long wave radiation and minimise heat loss.
- Long wave radiation (2500-40000 nm) absorbers reduce the loss of heat radiated from materials and objects (including plants) inside the greenhouse
- Light diffusers scatter light entering the greenhouse, reducing the risk of plants getting burnt and improving the amount of light available to the lower parts of the plant
- Surfactants reduce the surface tension of water, dispersing condensation
- Antistatic agents reduce the tendency of dust to accumulate on plastic films.



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# Factors influencing microclimate inside greenhouse

The most important climatic factors influencing the structural design and the quality of the indoor microclimate are the temperature, the global solar radiation, the precipitation and the wind intensity. Thus, local meteorological conditions strongly influence not only the indoor climate control equipment of greenhouses but also their structural design. Harsh weather conditions are the most common cause of failure of greenhouse structures.





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## ■ Light

- . Most important component of greenhouse
- . Although sunlight is the most common source; use of artificial light can be found in high end greenhouses.
- . 1/3<sup>rd</sup> to 1/4<sup>th</sup> part of light in full saturation is used by plants thus shading does not influence photosynthesis but reduced temperature helps on other hand.





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# Climate control inside greenhouse

**The main reason for microclimate control in greenhouses is to achieve maximum plant growth and yield.**

Automatic control system monitors:

- inside the greenhouse (soil and air temperature, relative humidity, carbon dioxide concentrations, electrical conductivity and soil moisture)
- outside the greenhouse (temperature, relative humidity, solar radiation, wind speed, wind direction and rainfall rate)
- equipment (pipe temperature, vents and curtains position)



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## Climate in the greenhouse is controlled by:

- heating system
- ventilation and fogging system
- lighting and shading system
- fertigation system
- CO<sub>2</sub> injection system



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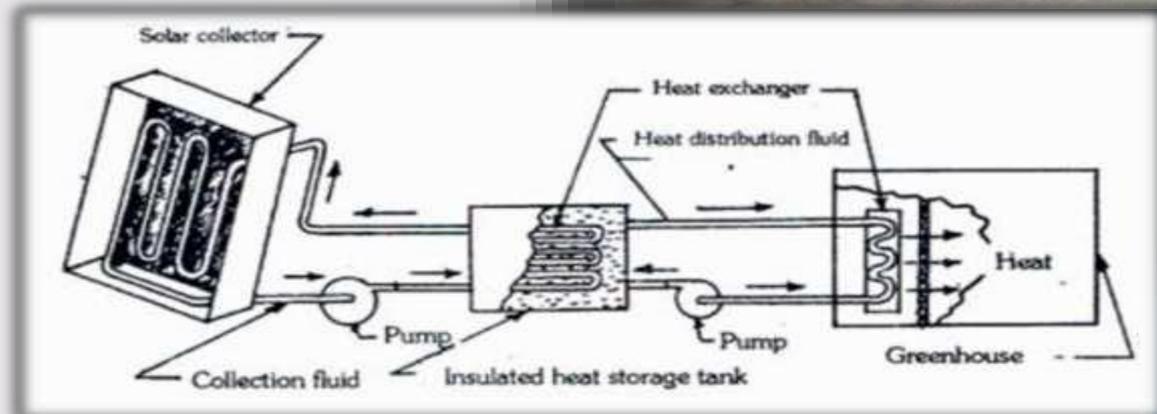
# Heating system in greenhouse

➤ Heating water system could be based upon the perimetric pipelines, under benches, or by overhead fan radiators

A hot water heating system is the best way of provide uniform temperature distribution in the greenhouse.

The hot water heating system includes:-

boiler with  
a burner  
main  
heating  
loop  
secondary  
heating  
loops





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## Ventilation and fogging system

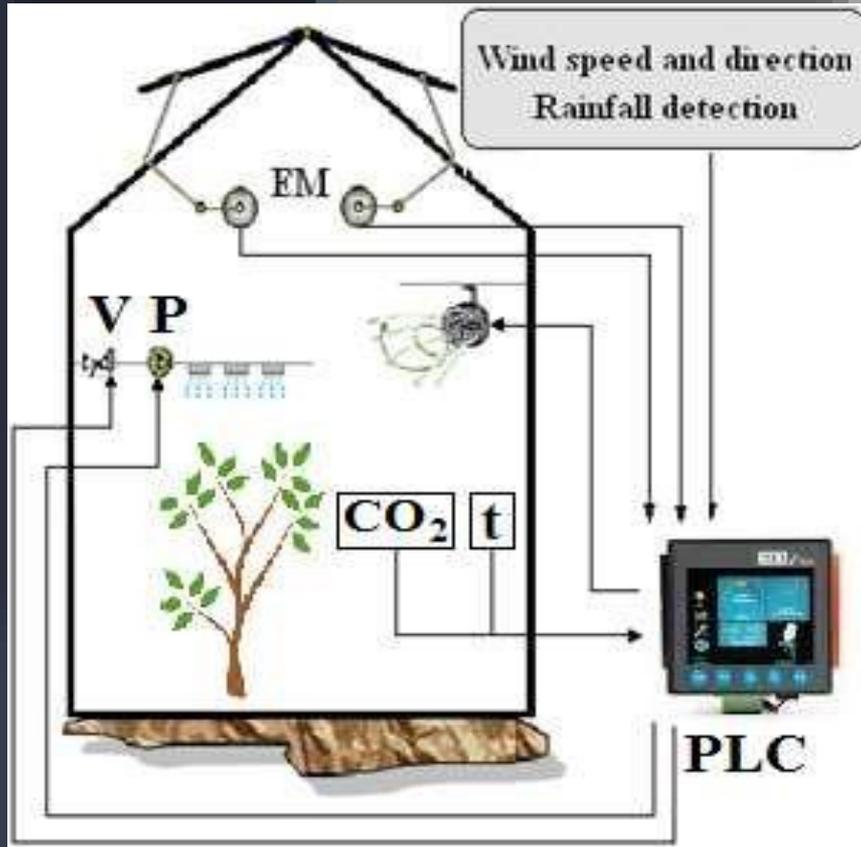
- **Greenhouse** ventilation is most important for controlling the temperature, relative humidity and CO<sub>2</sub> level. A good ventilation in the greenhouse can be achieved with a combination of a roof vent, front doors and fans.
- Plants grow under the influence of the PAR radiation (diurnal conditions), performing the photosynthesis process. Furthermore, temperature influences the speed of sugar production by photosynthesis, and thus radiation and temperature have to be in balance in the way that a higher radiation level corresponds to a higher temperature
- Sensor and processor based systems automatically opens butterfly vents as per the Climatic requirement.



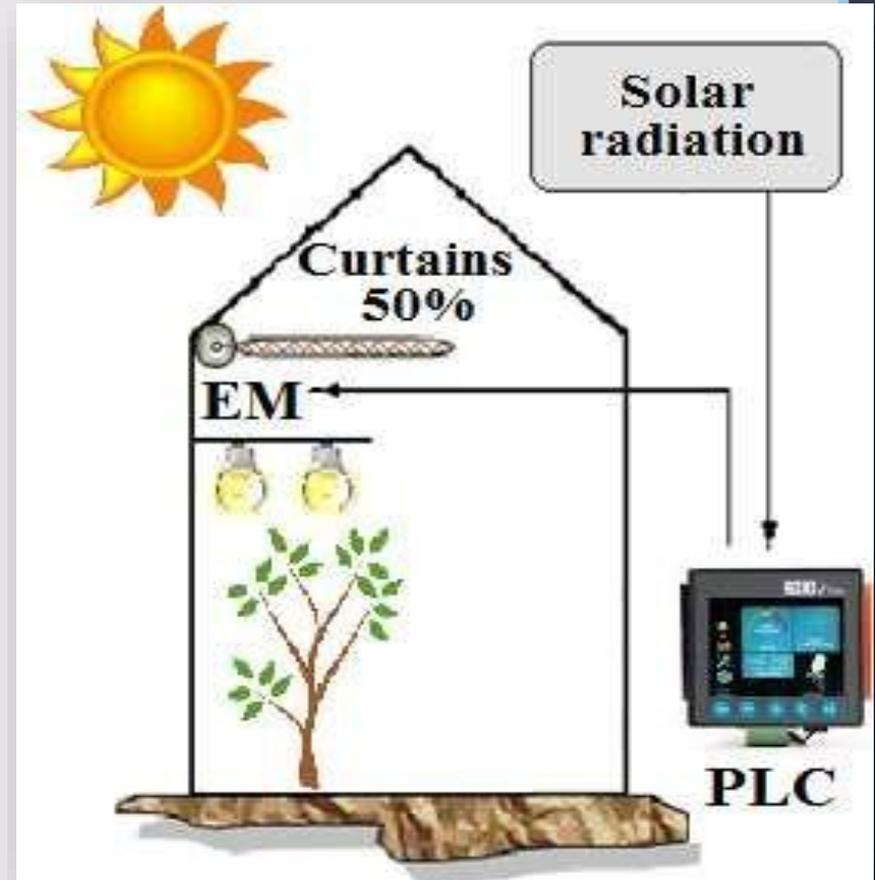


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Ventilation and fogging system



Lighting and shading system



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# The lighting system

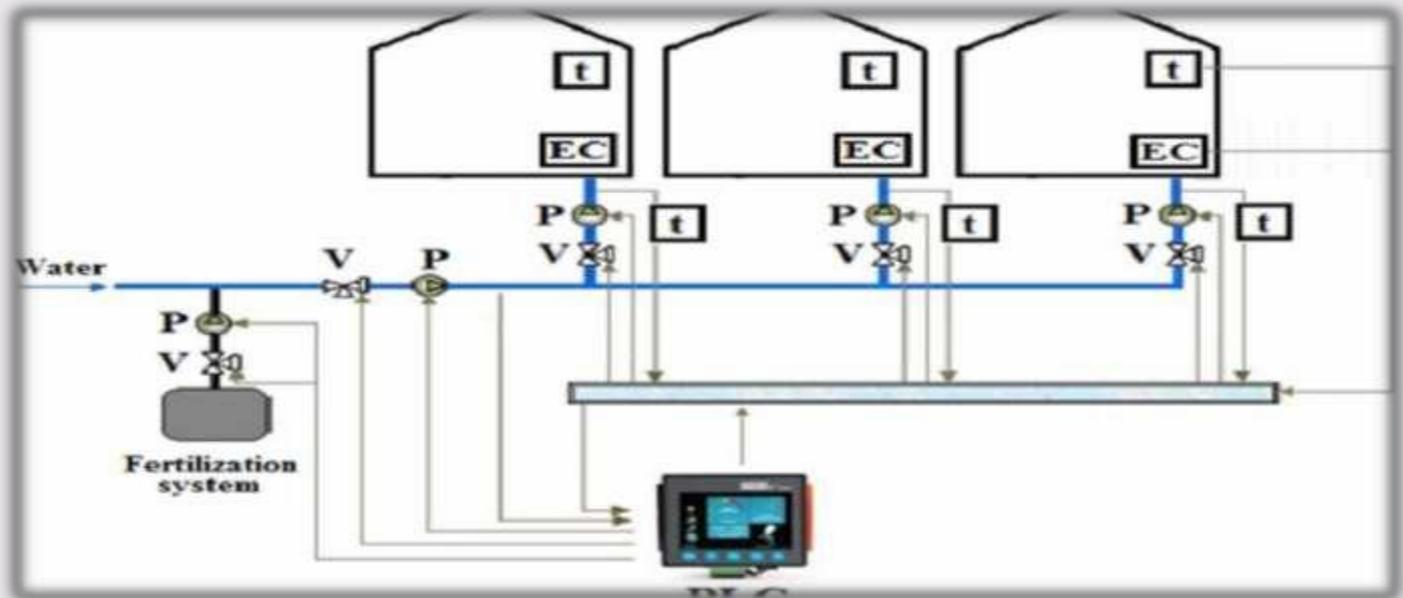
Light intensity significantly influences other climate parameters in the greenhouse. Artificial illumination is applied in the absence of natural light, or when overshadowed. The shading system is installed mostly to prevent heat transfer from excessive light (blocking the direct sun rays). Shade curtains also help to reduce thermal losses at night. If the weather station detects high solar radiation, the PLC activates the electric motors (roll-up system) and curtains move horizontally



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## Irrigation and nutrition system

- To achieve a rational use of water and fertilizer it's best to use a fertigation system (drip irrigation), which involves the pumps, filters, control panel, EC and pH sensor. This system provides the required mixture based on current needs of the crops. The EC sensor measures water conductivity and checks the concentration of respective mixture components.





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# CO<sub>2</sub> injection system

- ❖ CO<sub>2</sub> is added to the room to improve the process of photosynthesis. A special fan pushes CO<sub>2</sub> from the vent, forcing it to mix with outside air in order to cool down (from 200 °C), to the ambient temperature or below it (30 °C) Gas condenser, collects the steam in the gas pipeline and separates it. A certain portion of the condensing heat can additionally warm up the soil.



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# Alternatives of soil based cultivation

The Soils inside the greenhouse is subjected to frequent change due to degradation of fertility, soil borne pathogen etc. As a result, soil less cultivation is becoming popular day by day. Media for soil less cultivation can be either solid (made up of tree bark, rockwool, peat, perlite, vermiculite wood chips etc.) or close circuit liquid media otherwise known as “hydroponics”.

Hydroponic and aeroponics are the latest addition to this. In hydroponics an inert material saturated with nutrients is used of simply nutrient dissolved





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Tomatos grown in rockwool media

Passively ventilated  
seedling raising nursery



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# Govt. Initiatives on Protected Cultivation

- **Water Management**
  - Drip Irrigation System
  - Sprinkler Irrigation System
- **Protected Cultivation**
  - Greenhouse
  - Plastic Tunnel
  - Shadenet House
  - Walk in Tunnels
  - Plant Protection Nets
- **Surface Cover Cultivation**
  - Plastic Mulching
  - Soil Solarisation
- **Water Resource Management**
  - Farm Pond & Reservoir lined with Plastic Films
- **Vermi Bed - Organic Farming**



**Protected Cultivation Offers  
Next Generation Agriculture ...**

# Protected Cultivation – Greenhouse & Shadenet House



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**Greenhouse** is framed structures covered with UV stabilized plastic films in which crops are grown under partially or controlled environment conditions.

## **Type of Structures**

A. Naturally Ventilated – Tubular, Wooden & Bamboo

B. Fad & Pad System



**Shadenet house** are considered as one of the major technologies to provide development of healthy seedlings & hardening for various horticultural crops irrespective of climatic conditions.

## **Advantages**

- Moderates temperature & humidity.
- Plant propagation is effective.
- Helps to improve quality and quantity of produce.
- Reduces infestation of disease / pests.
- Savings in water & fertilizer requirements as compared to open field cultivation.
- Reduces gestation period of the crop.



# Crops covered under protected cultivation



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**Capsicum**

**Tomato**

**Cucumber**

**Cabbage**

**Strawberry**

**Carnation**

**Rose**

**Gerbera**

**Orchid**



# Crops covered under protected cultivation



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**Ridge gourd**



**Bottle gourd**



**Cucumber**



**Gerbera**



**Anthurium**



**Rose**

**Chilli**



**Okra**



**Broccoli**



**Capsicum**

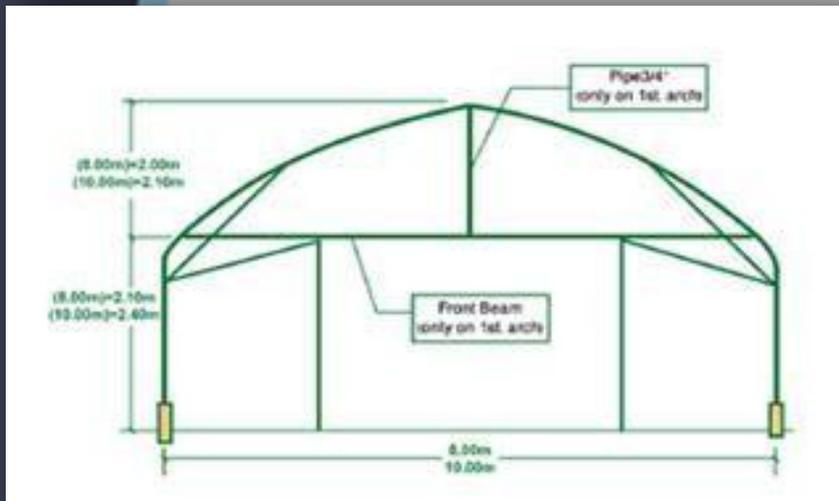


# Walk in Tunnels



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- Walk-in tunnels structure is covers with UV film, suitable for all types of crops; flowers and vegetables.
- Designed to withstand wind up to 120km/hr, and trellising loads up to 25 kg/m<sup>2</sup>.
- Structure gable configuration can be 8 or 10 meters wide.
- Height reaches 4.10m (2" pipe) for 8m, and 4.50m (3" pipe) for 10m.
- Option for vertical curtains (2m long) on tunnels side walls.
- 2 or 3 meter height.





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# Plastic Tunnels

These are miniature structures producing greenhouse like effect. Facilitates the entrapment of carbon dioxide thereby enhancing the photosynthetic activity. It protects plants from harsh climatic conditions such as rain, wind, hail snow etc. These are mainly used for raising nursery.

## Advantages

- Protects from hostile climate.
- Helps in early seed germination.
- Round the year cultivation is possible.
- Healthy saplings can be raised.





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# Plastic Mulching – In-situ Moisture Conservation

Plastic Mulching is covering the soil around the plant with plastic film to conserve the soil moisture that prevents weed growth and regulate soil temperature. Presently there different colour plastic films used as mulches such as black, silver-black, red, yellow, while-black etc.



## Advantages

- Prevents weed growth and acts as barrier to soil pathogens.
- Accelerates uptake of micro nutrients from the soil by the active root zone.
- Conserves soil moisture thereby reduces the irrigation water requirement of the crop.
- Enhances quality of the produce with cleaner crop.





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# Vermi - Bed – Organic Farming

- ✓ The product is chemically treated, UV stabilised and completely stitch-less having ability to withstand extra environmental stress.
- ✓ Dimension of the bed 12' x 4' x 2' ( L x W x H) & Mass 340 gms /sqm ( minimum), having fourteen support pockets (40mm X 120mm) for inserting pegs to keep the bed erect.
- ✓ Three net windows on both sides for ventilation purpose to maintain required humidity to enhanced life span of the earthworms. An reinforced bottom outlets in corner is used for draining vermiwash with drain cover.
- ✓ Requires less space, can be installed anywhere (allows shifting of structure) with proper ventilation.
- ✓ Bed produces annually 100 liters of Vermiwash.
- ✓ **Indian Standard (BIS) formulated in 2010.**



" Get Rid of Chemical Fertilizer Enrich self and soil with  
Vermi fertilizer in lesser Cost"



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# BIS Standards - Protected Cultivation

S. No	Applications	Component Description	IS Code
1	Mulching	Surface covered cultivation - plastics mulching - code of practice	IS 15177:2002
2	Greenhouse	Plastic film for Greenhouses - specifications	IS 15827:2009
		Recommendations for Layout, Design and Construction of Greenhouse Structures.	IS 14462 : 1997
		Recommendations for Heating, Ventilating and cooling of Greenhouses	IS 14485 : 1998
		Steel Tubes for Structural Purposes	IS 1161 : 1998
3	Agro Shadenets	Shadenets for Agriculture & Horticulture Purpose	IS 16008:2012
4	Protection Nets	Plant protection nets	IS 10106:part 1: section 6:1992
5	Vermi-Bed	Agro Textiles- High Density Polyethylene (HDPE) Woven Beds For Vermi-culture-Specification	IS 15907:2010