

Management of Low-Cost Greenhouse Structures for Northeast Region

In Northeast region of India, the resources or inputs like soil, water climate, etc., are very much favourable for the rare crops to be grown. However, topography of land is a limited factor for large greenhouses and farmers have to construct small greenhouses suitable to sloppy lands available. Big markets are far distant with transport infrastructure not being proper, low-cost structures and overall low investments are more beneficial for the farmers in this region. Study in different Northeast regions on greenhouse cultivation has shown that quality vegetables, flowers can be grown in low-cost protected structures that can fetch good returns in markets. Flowers like orchids, Anthuriums can be successfully grown in walk in tunnels, wooden polyhouses, etc., to improve financial status of local farmers boosting economy of the region.

A GREENHOUSE is a house covered with transparent material under which the plants can be grown in a partially controlled or fully controlled climatic conditions for achieving best quality and maximum yield round the year.

Based on use of cladding or covering materials, greenhouses can be called as polyhouses when covering material is polythene, glass houses when the cladding material is glass. The modern greenhouses normally are built on a steel frame and are covered with plastic, which is fixed to the frame with aluminum grippers.

In general, flowers, vegetables, and fruits are produced in a greenhouse. It creates a microclimate surrounding the crop that helps the crop in its maximum growth. Greenhouses also provide higher concentrations of CO₂ to increase the production to its maximum level. The greenhouse consists of steel structure, covering material, gutters and ventilation systems as well as climate control systems.

Land Selection

While selecting the site for construction of a polyhouse, the following points should be considered:

- The soil should have a pH of 5.5-6.5 and EC of 0.5-0.7. Ms/cm.
- Availability of continuous source of quality water.
- The pH of the irrigation water should be 5.5-7.0 and an EC between 0.1-0.3 ms/cm.
- The site of construction should be higher than the surrounding land.
- The selected site should be pollution free.
- Sufficient land should be available considering future expansion.
- Easy and cheap availability of laborers.
- Communication facilities should be available at the site.

Different types of low-cost structures suitable in Northeast Region



Open vent walk in tunnel



Closed vent walking tunnel



Walk in tunnels on hills in Sikkim for *Cymbidium* Orchids

Walk in tunnels

Since most of the Northeast region is hilly area, walk in tunnels with a width of 6–10 m with desired length are most suitable structures. Based on local temperature and altitude, the structures can have a permanent open vent at the top or permanently closed at top.

If the temperatures are very low and need to maintain more temperature in the structure, one should go with closed vent walk in tunnels. Similarly, if inside temperature need to be reduced, open vent walk in tunnel should be selected.

General specifications are as follows:

1. Center height of structure 2.5–4m

2. Width of structure 6–10 m based on availability
3. Length of structure as per availability but min 12 m and max 100 m
4. Other structural parts specifications as per state SHM/ NHB

Bamboo polyhouses/shade net house structures

Availability of ample quantity quality Bamboo in Northeast region makes farmers use of Bamboo for erecting greenhouses. If treated well, these Bamboo structures can sustain 8 to 10 years and make the farmers earn good profits from such low-cost structures.





In this type of green house, frame structure is made up of locally available wood materials like Bamboo. Before erecting the structure, bamboo poles are treated with turpentine and tar. Wooden battens are used for poly fitting. Gutter in the structure is used of it's a multispans structure. In multi span structure, the height at top is maintained 4.5-5.5 m and gutter height is maintained at 3.5-4 m. Grid is taken as 6×4 m or 8×4 m. UV stabilized multilayered polyfilm or shade net is used as a covering material. Such structures are commonly used in entire Northeast to produce vegetables and flowers like Anthuriums, Orchids, gerbera, etc. The detailed specifications of materials can be used from state SHM/NHB.

Shade net house

When shade net is used as a covering material, such structure is called as shade net house. Rains cannot be controlled in such structures. However, being cheap, these are popular not only in Northeast but entire country.

Wooden, GI or MS steel pipes, angles, etc., are used for making frame on which shade net is fitted with fitting accessories. Shade nets are available in 35%, 50%, 75% and 90% shades. Similarly, shade nets are available in red, white, green, black, blue and grey colors. In general, in India, 50% white or 50% red shade net is suggested for vegetables and flowers cultivation.

These structures are available in flat as well as in dome shaped roofs as shown in above images. Height varies from 3–5 m and grid varies from 4×4 to 8×4 m.

The specifications for structural components can be used from state SHM/NHB guidelines.

Climate control in protected structures

The growing of plants in the optimum conditions

by controlling the climate is one of the most important aspects of protected cultivation.

The microclimate of a plant is specified in terms of temperature, light, air composition and the nature of root medium. Crop growth has also recently been concerned with Ultra-Violet (UV) content of light.

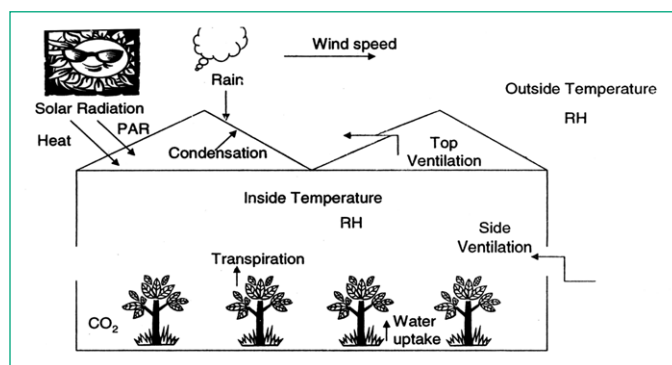
Climatic parameters affecting the plant growth under greenhouse

1. Light
2. Temperature
3. Humidity
4. CO_2
5. Air circulation

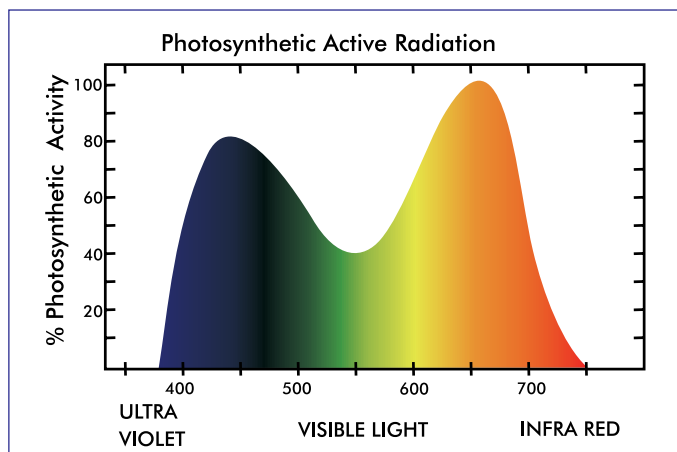
Light: The light is the most important factor that influences the plant growth and development.

Quantity of the light: Intensity of the light is measured in lux. The photosynthetic activity strongly increases with the increase of light intensity. For most of the crops 50,000-60,000 lux standard light intensity is required.

Quality of the light: The solar radiation filtered by the atmosphere is composed of rays of different wave



Protected cultivation concept



PAR influence on photosynthesis
*PAR- photosynthetic active radiation

lengths as below:

UV rays (00-400 nm wave length)

Visible rays (400-700nm)

NIR (Near Infra-Red) rays (700-3000 nm).

The visible radiation (400-700 nm) also called as photo synthetically active radiation (PAR) is used by the plants to drive photosynthesis. It has two main bands for photosynthesis.

Influence on photo morphogenetic activity within the range 480-650 nm is significant.

The near infrared radiation (700-3000nm) is supposed to have only a heating effect on the plants.

Far infra-red radiation (3000-14000 nm) reflected by the soil, increases the temperature inside the greenhouse.

Duration of the light: It is the time that a plant is exposed to light. A critical duration of light or day length is required for growth and flowering in some plants. On the basis of day length requirement for flowering plants are classified as short day (Chrysanthemum, Poinsettia), long day (Spinach, Lettuce) and day neutral (Rose, Gerbera) plants.

Temperature: The temperature plays an important role on the vegetative and photosynthetic activity of the plants. It affects the plant growth either by increasing or decreasing the rate of different plant processes as photosynthesis, respiration and transpiration. The maximum activity is obtained in a defined range of temperature. Below and above the range the activity slows down.

Humidity: The moisture content in the atmosphere is called atmospheric humidity. The humidity is induced by plants transpiration and by evaporation from the irrigation water. Relative humidity is the ratio of the actual moisture content

(g/kg) to the saturated moisture content (Maximum amount of water vapour) of air at the same temperature. RH is expressed in percentage (%). The control of the RH inside a green house is of most importance, as an excess or less can lead to viruses, diseases and mites to plants. Standard Relative Humidity (RH) for most of the crops is 60-75 %.

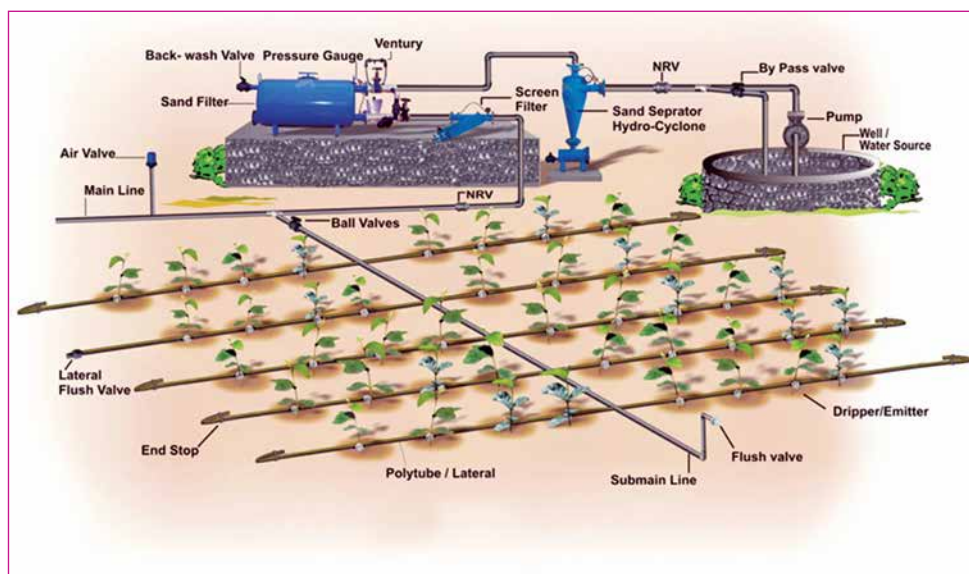
CO₂ and plant growth: Plant growth depends upon the balance between the formation of carbohydrate from CO₂ and water and degradation of those compounds in the energy yielding process of respiration. When a plant is supplied with adequate CO₂ and moderate to high levels of light the rate of photosynthesis exceeds the rate of breakdown of carbohydrate and plant is said to have positive carbon balance. During darkness, the rate of respiration exceeds the rate of photosynthesis and the plant has negative carbon balance. For proper growth to occur, the positive carbon balance must predominate. Any increase in photosynthesis will enhance the carbon balance and thus, plant growth rate.

Air Circulation: The air circulation in the greenhouse is very important, as it removes extra heat, humidity from inside and also replaces it with cool outside air. It is also very helpful to maintain at least 60-75 % humidity inside the greenhouse. It also influences the CO₂ level in the greenhouse.

Climatic requirement for various crops

Name of the crop	Day (° C)	Night (° C)	Humidity (%)	Light intensity (LUX)
Gerbera	20-24	18-21	60-65	40000-50000
Rose	24-28	18.5-20	65-70	60000-70000
Tomato	22-27	15.5-19	60-65	50000-60000
Cucumber	24-27	18-19	60-65	50000-60000
Capsicum	21-24	18-20	60-65	50000-60000

Source: PTC +, The Netherlands



Components of drip irrigation system



Drip Irrigation & Mist irrigation systems in greenhouses for crops

Water Management systems in protected structures

Drip irrigation: Drip irrigation method is an application of small amount of water near the root zone of the plants at frequent intervals in a fashion drop by drop through emitting devices via a network of PVC mainline, sub-main line, filtration unit, controls valves, laterals and drippers. This system minimizes the water losses in the conventional irrigation methods such as deep percolation, runoff and evaporation.

General tentative water requirement of greenhouse crops

Name of the crop	Water requirement in lit/day/sqm
Roses	5 to 7
Gerbera	4 to 6
Carnation	4 to 6
Capsicum	5 to 7
Tomatoes	5 to 7

Fogging and misting system: Fogging systems are fairly effective and uniform methods of greenhouse cooling that provide a reasonable increase in relative humidity in a greenhouse. Foggers are connected to lateral with micro-tube and it is hanging over iron wire in green house (3m above). Misters are attached on Stake in beds. Fogger and misters produce very small droplets (about 70 micron) of water in the air and evaporated before falling onto the crop canopy. Foggers and misters are equipped with an anti-leak device which does not allow flow of

water droplets to fall down after the system is switched off. Foggers/Misters have low discharge rate with smaller area coverage. The operating pressure of fogger/ mister is varying in between 3.0 kg/cm² to 5.5 kg/cm². Generally, the time of operation of foggers and misters is 0.30 sec. to 60 sec. three to four times in an hour at some specific time interval. The frequency of fogging/misting depends upon the temperature and humidity inside the green house. Generally, foggers and misters are used more frequently in summers as compared to winters.

Specifications of Irrigation systems for various crops in Greenhouses

Roses in Greenhouses

- 1 Spacing between 2 laterals on one bed – 45 cm.
- 2 Spacing between 2 drippers – 30 cm.
- 3 Discharge of 1 dripper – 1.2 lph.
- 4 Diameter of lateral – 16 mm.

Gerbera in Greenhouses

- 1 Spacing between 2 laterals on one bed – 30 cm.
- 2 Spacing between 2 drippers – 30 cm.
- 3 Discharge of 1 dripper – 1.2 lph.
- 4 Diameter of lateral – 16 mm.

Capsicums in Greenhouses

- 1 Spacing between 2 laterals on one bed – 45 cm.
- 2 Spacing between 2 drippers – 30 cm.
- 3 Discharge of 1 dripper – 1.2 lph.
- 4 Diameter of lateral – 16 mm.

Carnation in Greenhouses

1. Spacing between 3 laterals on one bed – 30 cm.
2. Spacing between 2 drippers – 30 cm.
3. Discharge of 1 dripper – 1.2 lph.
4. Diameter of lateral – 16 mm.

However, Installation of foggers/misters depends on the relative humidity and temperature in the selected locations.

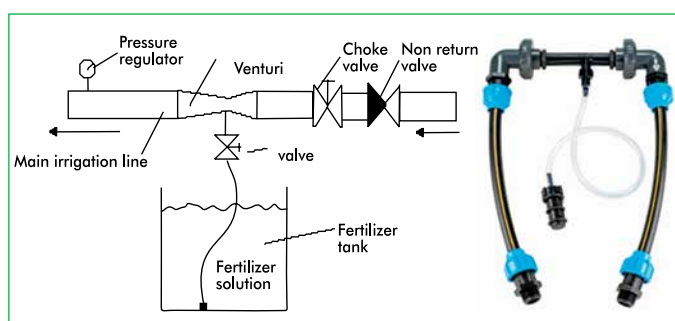
Fertigation Equipments

Application of nutrient through irrigation water is generally referred as fertigation. The main advantages are control of timing, concentration, location and proportion of nutrients.

Various types of fertilizer injection equipments available in market are as follows:

1. Venturi
2. Pressure differential injection
3. Pump injection

Venturi: It operates on the principle, where a flow constriction with specific entrance & exit design installed on pipeline creates a vacuum due to increased velocity of flow through the constriction. The injection rate depends on pressure differential



Venturi system

across it. This pressure differential is between 5% to 75% according to the injector's design. The inlet pressure required for the operation ranges from 1.4 bars to 9.8 bars (with suction hoses 12 mm in diameter) depending upon the model.

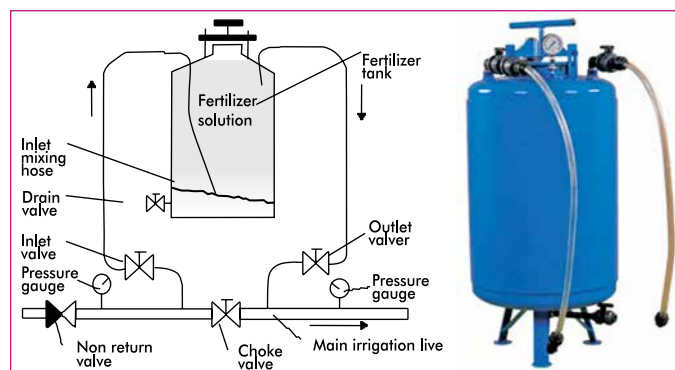
Advantages

1. Simple in design with no moving parts.
2. Easy to install, requiring little maintenance.
3. Fertilizer rates can be controlled with some accuracy.
4. Suitable for very low injection rates.
5. Injection can be controlled with a metering valve.
6. Low cost.

Disadvantages

1. Quantitative fertigation is difficult.
2. Requires pressure loss in main irrigation line (can be 33%).
3. Automation is difficult.

Pressure differential injection (Fertilizer tank with flow by pass): The principle of operation includes a throttling valve, which force some of the mainline flow through a batch tank, which is connected to mainline. Flow diversion



Fertilizer tank with flow by pass

from the main line is accomplished by a pressure gradient of 0.1 to 0.2 atmospheres. Irrigation water enters the tank through 1/2" to 3/8" pipe and water with fertilizer solution flows into the mainline. The injection rate depends upon the pressure gradient.

When pressure gradient increases (0.1-0.7) injection rate increases & it varies from 300 l/hr to 1000 l/hr.

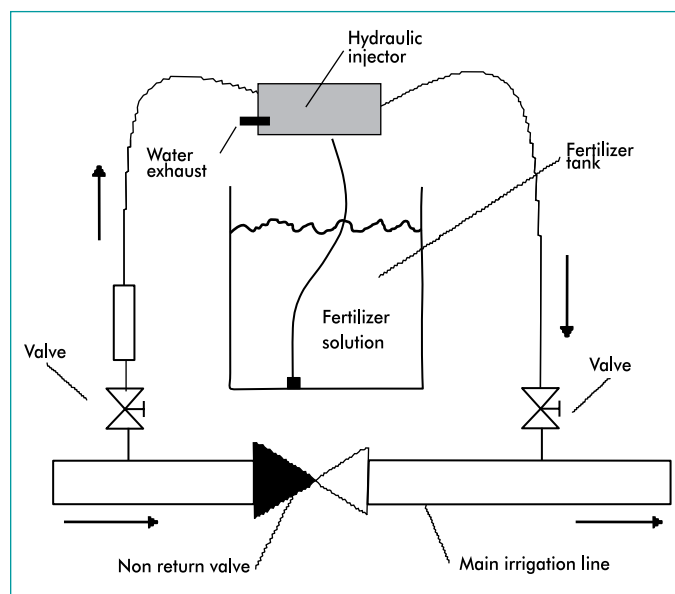
Advantages

1. Very simple to operate. A stock solution does not have to be premixed.
2. Easy to install and requires little maintenance. Changing fertilizer is easy.
3. Ideal for dry formulations.

Disadvantages

1. Concentration of solution decreases as fertilizer dissolves, leading to poor placement of nutrients.
2. Requires pressure loss in main irrigation line.
3. Tank must be able to withstand irrigation line pressure.
4. Proportional fertigation not possible.
5. Limited capacity.
6. Accuracy of application is limited and determined by volume rather than by proportion.

Pump injection: This is the most common method of injection of fertilizer into irrigation systems. Injection



Pump injection

energy is provided by electric motors, impeller-driven power units and water-driven hydraulic motors. The pumps are usually rotary, gear, piston or diaphragm-type which deliver fertilizer solution from the supply tank into the pressurized mainline. This method can be very accurate.

Maintenance of Greenhouses

Greasing should be done to the following parts of a polyhouses.

Doors: The wheels of the doors and the ridge, on which the wheels move from one side to other, should be greased properly once a month.

Racks: In case of an automatic opening and closing of vents of a greenhouse, the racks should be greased completely once a month. Adopters, in which the racks are moving, should be greased. This will result in easy movement of racks. Pipes on which the racks are mounted, joints of the pipe and racks should be greased.

Handles of side vents: In case of side vents, the handle of side vents should be greased properly once a month. This will allow less force to operate the vents up and down.

Wheels of shade nets: The wheels on which the string of shade net is moving, should be greased once in 15 days to achieve easy movement of shade net.

Cleaning of top plastic: Accumulation of dust particles on the top of plastic reduces the light transmissions in the polyhouses up to 15%. In order to achieve maximum light transmission in the polyhouses, it is necessary to clean the top plastic. We can achieve this by washing the top plastic with clean water every month particularly in a peak season. Such washing also helps removal of algae if it is collected on top plastic.

Application of Distemper/chalk: Application of distemper/chalk helps in reducing light intensity and temperature in the greenhouse, especially in summer and hot seasons.

Way of application: Lime or calcium carbonate

[CaCO₃] is used for coating on top plastic. White coating of lime reduces the temperature inside the greenhouse by 3–4°C, it also reduces the lux intensity by 20–25 Klux. For a polyhouses of 500 sqm area, 20 Kg of lime is mixed in 150 lit of water and is sprayed on top plastic with the help of foot pump or knapsack sprayer. The lime should be thoroughly mixed in water and it should be properly filtered with the use of clean cloth, otherwise there may be chances of chocking of nozzles of spray gun. For the lime to stick properly on the plastic, a gum or sticker [fevicol-ddl] is used in lime solution. Before using lime, the top plastic should be washed with clean water. Two labors can finish washing and lime coating in 4 hours for a polyhouses of an area 500 sqm. Procedure of application of distemper is same, only the quantity required is 15 Kg of distemper.

Painting: In case of mild steel polyhouses, one should paint the structure with silver paint once in every two years. It will avoid rusting of the structure.

CONCLUSION

In the last 10–15 years, farmers from Northeast region have successfully grown Anthuriums and orchids those are in demand all over India and are also exported to Dubai and other countries. Vegetables cultivation under such structures is now common in Northeast. However, more efforts are required to promote such technology by using local available inputs like Bamboo, etc., to reduce the initial costs thereby increasing profits to the farmers. Organizing proper trainings, forming of FPOs of farmers, introduction of markets can help Northeast farmers in improving financial status and sustainability.

For further interaction, please write to:

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