Greenhouse Technology

Chapter two

INTRODUCTION

What is Greenhouse Technology?

- Today about 92% of plants, raised by man, are grown in the open field.
- Since the beginning of agriculture, farmers have had to cope with the growing conditions given to them by Mother Nature.
- In some of the temperate regions where the climatic conditions are extremely adverse and no crops can be grown, man has developed technological methods of growing some high value crops by providing protection from the excessive cold and excessive heat.
- This is called Greenhouse Technology. **"Greenhouse Technology is the science of providing favourable environment conditions to the plants".** It also protects the plants from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, extreme temperature, insects and diseases. An ideal micro climate can be created around the plants.
- Greenhouses are framed or inflated structures covered with transparent or translucent material large enough to grow crops under partial or full controlled environmental conditions to get optimum growth and productivity.

FUNCTIONS OF GREENHOUSE:

Greenhouses are framed or inflated structures covered with transparent or translucent material large enough to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity.

- The yield may be 10-12 times higher than that of outdoor cultivation depending upon the type of greenhouse, type of crop, environmental control facilities.
- Reliability of crop increases under greenhouse cultivation.
- Ideally suited for vegetables and flower crops.
- Year round production of floricultural crops.

- Off-season production of vegetable and fruit crops.
- Disease-free and genetically superior transplants can be produced continuously.
- Efficient utilization of chemicals, pesticides to control pest and diseases.
- 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
- Production of quality produce free of blemishes.
- Most useful in monitoring and controlling the instability of various ecological system.
- Modern techniques of Hydroponic (Soil less culture), Aeroponics and Nutrient film techniques are possible only under greenhouse cultivation.

According to the cover: Greenhouse types are

- Plastic greenhouse
- Glass Material Greenhouses
- Polycarbonate greenhouse

Polycarbonate greenhouse

- It provides up to 60% better thermal insulation than greenhouse glass and is nearly impossible to break.
- Its flexibility is builder-friendly, where you can design any shape or size imaginable with a Polycarbonate greenhouse
- Polycarbonate Greenhouse Insulates Better عزل
- Polycarbonate Greenhouse Outlasts Glass and plastic يدوم
- Polycarbonate Greenhouses are Shatter-Resistant
- Polycarbonate Greenhouse Requires Less Maintenance
- Polycarbonate Greenhouse Means a Longer Growing Season
- Polycarbonate Greenhouse Diffuses better Light From the Sun

Polycarbonate advantages

- **Strength:** Polycarbonate is a strong material. In fact, it is 290x times stronger than the glass usually found in greenhouses. Footballs, tennis balls, birds & all manner of objects flying through the air will not break through the polycarbonate.
- **Safety:** Seeing as we've already mentioned children, it's worth noting that polycarbonate is safer for the little ones. As polycarbonate will resist shattering when pelted with balls, the risk of nasty cuts from broken glass is a thing of the past.
- **UV & Lighting:** Polycarbonate is pretty UV resistant, meaning it will filter out a lot of the harmful UV rays that glass will not. This will provide the plants with the protection that they need. Sunlight (minus the UV) coming through the polycarbonate will also reach nearly every corner of the greenhouse.
- **Insulation:** Polycarbonate is a much more efficient insulator than glass, as it retains the heat for much longer. This will keep the greenhouse at a higher temperature. This in turn, will lengthen the seasons.
- **Cost:** Polycarbonate is not so cheap but it will be cheaper in the long run as it will not need replacing as often as glass.

Glass Material Greenhouses

A glass-paneled greenhouse can be a quite expensive investment, but its durability and aesthetic value are factors that make them the best option. If budget is not the issue and if the greenhouse design is appropriate for glass, the following evaluation should be considered:

- Risks of shipping glass panels

Glasses need to be freighted firmly inside its case to stop any movement and sudden breakage. One more thing to worry about is moisture damage particularly if the shipping is scheduled during humid or rainy seasons.

There is a portion of uncertainty with glass greenhouses because even the most cautious gardeners may unintentionally crack a glass

- **Maintaining the glass panels**

Condensation inside the glass panels can be prevented when they are properly sealed. This holds for both double-paned and triple-paned glass. Maintaining the glass becomes easier when they get glass coatings.

Advantages:

- Durability
- Increased house valuation
- High light transmission
- Well ventilated and insulated

Plastic greenhouse

When it comes to greenhouse covering options, plastic sheets are a popular choice among gardeners and horticulturists. These versatile materials offer a range of benefits that make them an ideal choice for greenhouse applications.

Advantages:

1. **Durability and Longevity**
Plastic sheets, offered by reputable suppliers such as Simply Plastics, are known for their exceptional durability and longevity. Unlike traditional materials like glass, plastic sheets are resistant to impact, breakage, and harsh weather conditions. This makes them an excellent choice for greenhouses, where protection from external elements is crucial. Plastic sheets can withstand hail, heavy rain, and high winds, ensuring the safety of your plants and the longevity of your greenhouse structure.

- **2. Light Transmission**
  One of the key factors for successful greenhouse gardening is providing optimal light conditions for plants. Plastic sheets excel in this aspect as they offer excellent light transmission. These sheets allow sunlight to penetrate evenly, ensuring that plants receive the necessary amount of sunlight for photosynthesis and growth. With high-quality plastic sheets you can create an environment that maximizes plant productivity and health.
- **3. Thermal Insulation**
  Plastic sheets also provide effective thermal insulation for greenhouses. They have insulating properties that help retain heat during colder months, creating a stable and controlled environment for plants. This is especially beneficial for regions with extreme temperatures, as plastic sheets can help regulate the internal temperature of the greenhouse. By preventing heat loss, these sheets enable year-round cultivation and protect delicate plants from frost damage.
- **4. UV Protection**
  Excessive exposure to ultraviolet (UV) radiation can be detrimental to plant health. Plastic sheets designed for greenhouse covering are often treated with UV inhibitors to protect plants from harmful rays. These inhibitors shield plants from UV damage, such as leaf burning or reduced productivity. With plastic sheets you can ensure that your greenhouse provides a safe and UV-protected environment for your plants.

- **5. Cost-Effectiveness**
  Compared to traditional covering materials like glass, plastic sheets are more cost-effective. They are typically less expensive to purchase, install, and maintain. Additionally, plastic sheets are lightweight, reducing the structural requirements of the greenhouse. This cost-saving advantage allows gardeners to allocate their budget to other important aspects of greenhouse gardening, such as plant varieties, fertilizers, or irrigation systems.
- **6. Versatility**
  Plastic sheets offer a wide range of options to suit different greenhouse needs. They are available in various thicknesses, colours, and sizes, allowing gardeners to customize their greenhouse design. For instance, corrugated plastic sheets provide added rigidity and strength, making them suitable for areas with high wind or snow loads. Additionally, different types of plastic sheets can be used for specific purposes, such as diffusing light or reducing heat transmission.

Typical greenhouses

Polyethylene (P E) Cover & Nets on Walls

TYLCV
In tomatoes

The virus
Transmitted by
Bemisia tabaci
(whitefly)

High Construction
with roof ventilation,
Large greenhouse,
no limit of length or width

High Construction 5m.

Double Doors to Avoid Entrance of Insects

White wash to reduce Radiation in summer

Cooling the plants By Micro sprinklers, suitable for hot & dry season for establishing new crop

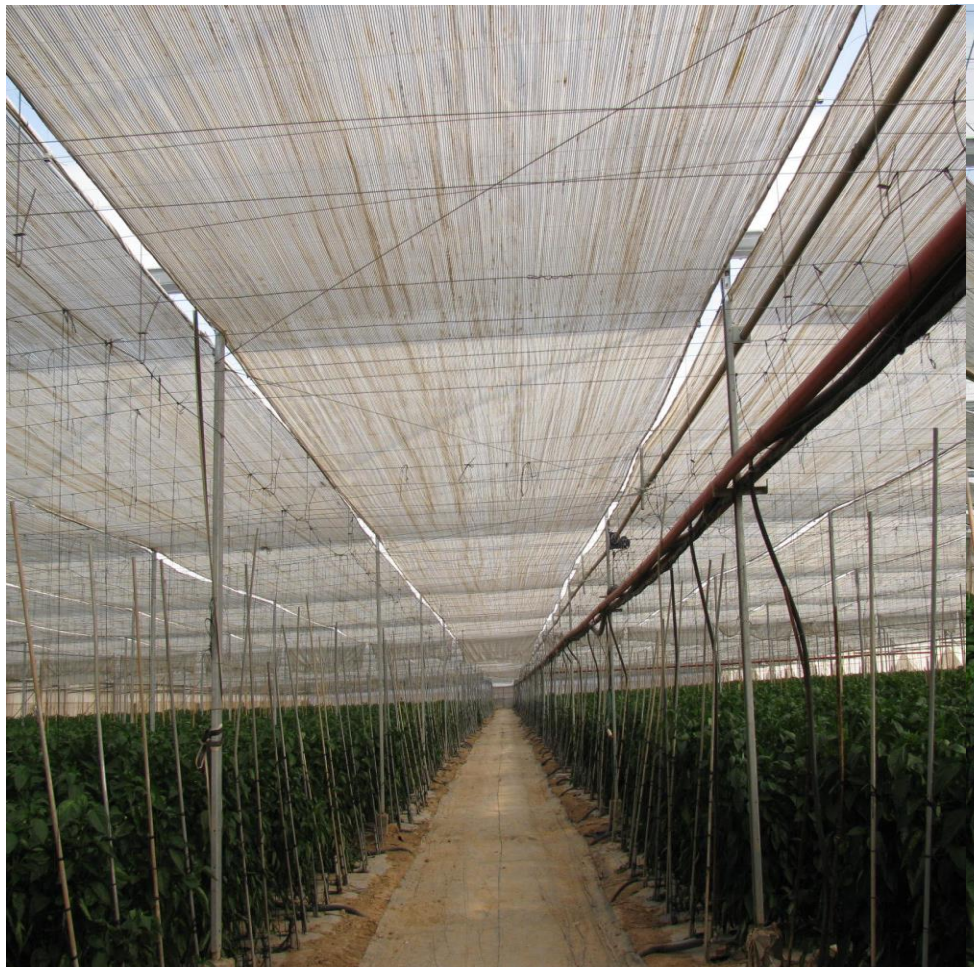
Active Ventilation by fans

Cooling By Pad & Fan - suitable for hot and dried climate condition

Circulators, used in high temperature & high humidity

Small vent in the entrance of greenhouses to stop insects

Moveable screen for shading & energy saving by heat retention in non heated greenhouses



Water sleeves for daily energy storage
Basil growing after 25 days-winter 2010

With water sleeves

Control without

Growing cucumber in greenhouses 2-3 crops per year, use Hybrid & parthinocarpc varieties

Cucumber Biet-Alpha type

High productivity of tomato varieties

The Basic Principle of the Greenhouse Function

- At the heart of the functioning of the **greenhouse** lies simple principles of physics – thermal radiation and heat exchange.
- The greenhouse collects the incoming heat from the outside, turns it into heat, and keeps the warm air. That allows gardeners to keep a certain stable temperature level inside the greenhouse, creating the most favorable environment for the growth and livelihoods of horticultural crops.
- In addition, the greenhouse protects both from the effects of the external environment – for example, weather conditions such as wind, hail, or snow, and from pests like beetles, locusts, and domestic and wild animals that could eat or damage your plants.

- **How Does Greenhouse Work?**

Plants need enough warm temperature, light, water, air, and important nutrients to grow and survive. There are different requirements for different plants. A greenhouse functions by providing the light, warm temperature, and air that is critical for the plant's survival. The rest of the elements such as water, nutrients, and additional necessities to support the plant's growth are up to you.

These are the 5 Basic Steps on How Does a Greenhouse Work.

Step 1: The Sunlight is Trapped

- In order to trap the light, greenhouses use many materials that are made mostly from transparent or translucent materials, like glass or plastic polycarbonate sheets. The trapped light provides the plants with enough access to sunlight.

Step 2: Sunlight is Converted into Energy

- The plants and other elements in the greenhouse absorb the light and convert it to infrared energy (heat). Dark elements tend to absorb more energy and increase the greenhouse temperature. This is why the black surface gets really hot in the summer because it absorbs a lot of heat.

Step 3: The Heat Gets Trapped

- Trapping the heat is one of the primary functions of the greenhouse called the "Greenhouse effect". When the light is converted into infrared energy (heat), it takes a different form (wavelength). The transformation of the energy into a different wavelength makes it difficult for the heat to escape the greenhouse's walls easily.

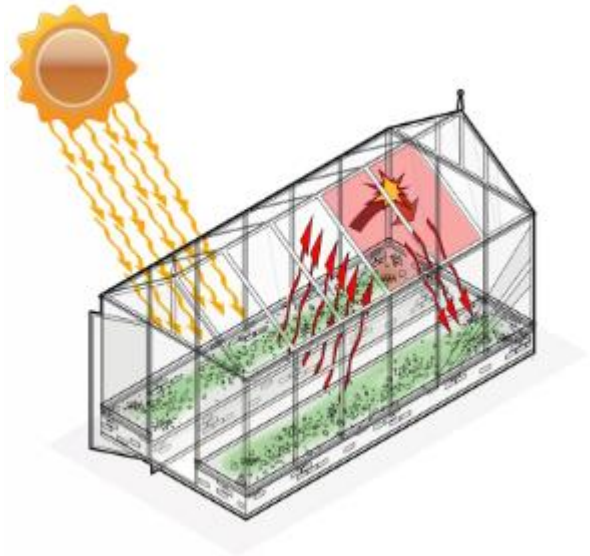
Step 4: Warming the Greenhouse

- When the heat is trapped inside the greenhouse, it warms up the air inside. The warm air causes the temperature to increase inside the greenhouse. Since the greenhouse is relatively air-tight, the warmer air stays inside, and the temperature sustains for a longer period of time. No doubt you've experienced the same effect when you get into a car that is parked directly under the sun for a few hours.

Step 5: Supporting Photosynthesis

- Sufficient light and enough warm temperatures provide ample conditions for the plants to grow. A sufficient amount of light and temperature allows photosynthesis to occur.
- Photosynthesis is the process by which plants synthesize nutrients (mainly sugar) from carbon dioxide from the air, energy from the sunlight, and water, which the plant then uses as food. Photosynthesis generally involves the green pigment in the plants called “chlorophyll” and produces oxygen as a by-product.

It is important to place your greenhouse where there is enough sunlight all day long to ensure that the plants inside get enough light. The plants averagely require about six hours of sunlight every day, although the sunlight requirements may vary depending on the type of plant you grow.



GREENHOUSE FEATURES

- Although greenhouses look like simple structures, there's more to them than meets the eye. A reliable frame, covering, flooring and ventilation are all necessary for basic operation. To sustain the environment, a heating system and some automated processes, like irrigation via a dedicated water supply, may also be necessary.

The Frame:

A sturdy frame is necessary to maintain the plastic or glass panels that let in precious light and capture heat in the greenhouse. Larger greenhouses also need a foundation. The frame can be made of any number of materials, the most common of which are aluminum, wood, rigid PVC and galvanized steel. Aluminum lets in more light and can also support clip-on panels, making it the most common choice.

The Coverings:

Often referred to as glazing, the panels that cover greenhouses are specially designed to let in as much of the sun's radiation as possible. Ideally, they also provide insulation, are impervious to deterioration from ultraviolet radiation and are shatterproof.

The panels can be made of heavy glass or any of a number of synthetic materials designed to maximize light exposure and help reduce heat loss. Glass lets in about 90 percent of the sun's radiation, helping to retain heat and hold up to ultraviolet light. Synthetics, while cheaper and sometimes stronger than glass, let in less of the sun's rays.

The Flooring:

Greenhouse floors need to have excellent drainage. Floors can be made of concrete, stone slabs, brick, sand or even dirt. Gravel floors provide excellent drainage and can be used in conjunction with a weed barrier to keep weeds from growing up through the rocks.

Greenhouse ventilation:

- Ventilation is one of the most important components in a successful greenhouse. If there is no proper ventilation, greenhouses and their plants can become prone to problems. The main purpose of ventilation is to regulate the temperature to the optimal level, and to ensure movement of air and thus prevent build-up of plant pathogens (such as *Botrytis cinerea*) that prefer still air conditions.
- Ventilation also ensures a supply of fresh air for photosynthesis and plant respiration, and may enable important pollinators to access the greenhouse crop.
- Ventilation can be achieved via use of vents - often controlled automatically - and recirculation fans.

Greenhouse heating:

- Heating is one of the most considerable factors in the operation of greenhouses across the globe, especially in colder climates. The main problem with heating a greenhouse as opposed to a building that has solid opaque walls is the amount of heat lost through the greenhouse covering. Since the coverings need to allow light to filter into the structure, they conversely cannot insulate very well. With traditional plastic greenhouse coverings having an R-Value of around 2, a great amount of money is therefore spent to continually replace the heat lost. Most greenhouses, when supplemental heat is needed use natural gas or electrical furnaces.
- Passive heating methods exist which seek heat using low energy input. Solar energy can be captured from periods of relative abundance (day time/ summer), and released boost the temperature during cooler periods (night time/winter). Waste heat from livestock can also be used to heat greenhouses; e.g. placing a chicken coop inside a greenhouse recovers the heat generated by the chickens, which would otherwise be wasted.
- Electronic controllers are often used to monitor the temperature and adjust the furnace operation to the conditions. This can be as simple as a basic thermostat, but can be more complicated in larger greenhouse operations.

UV Absorber

- Greenhouses which are covered with plastic film which contain UV blocking additives reduce the activity of the whitefly and insects which are vector of TYLCV in tomato and other viruses.

- Under UV free environment insects become less active and disoriented.

The whitefly and other insects refrain from entering a greenhouse which is covered with a film which blocks the U V radiation.

Site Selection

- The criteria for site selection in case of protected cultivation structures like shade net houses and greenhouses are as follows:
- (i) Exposure to ample sunlight: The site should not be near tall trees, buildings or by the leeward side of hills.
- (ii) Appropriate distance from a low-lying area: The site should not be in an area prone to waterlogging.
- (iii) Levelled ground surface: A slope of 0–2 per cent is recommended. Levelling is required to be done in case the slope is beyond the recommended range. For steep terrains, it is recommended to build several separate greenhouses with axes parallel to contour lines.
- (iv) pH and electrical conductivity of soil: It should have a pH of 6.0–6.5 and electrical conductivity should be less than 0.5 dS/m.

- v) Availability of continuous source of good quality water in sufficient volume: The approximate water requirement is 1–2 l/m2/day, which can be adjusted based on the season and the stage of cultivation.
- (vi) pH and electrical conductivity of water: The pH and electrical conductivity of irrigation water should be in the range 6.5–7.0 and less than 0.7 dS/m respectively.
- (vii) Continuous supply of electricity: This is particularly necessary during the day time.
- (viii) Good transportation facilities: This is important to enable the transportation of greenhouse produce to nearby markets in time.

- (ix) Availability of sufficient land for future expansion: A gap of 10–15 m should be maintained between two greenhouses, considering the possibility of expansion in future.
- (x) Easy availability of labourers in surrounding area: This should also be kept into consideration. Usually, four labourers are required for flower cultivation in a one-acre greenhouse.
- (xi) Good communication facilities: These should be available at the site.
- (xii) Plantation of windbreaks: The plants that breaks the flow of the wind from a particular direction. These plants are tall and have strong root base. These include poplar, silver oak, casuarina, etc., which are planted on the western side about 20 m away from the greenhouse because west winds are the strongest.
- (xiii) Awareness of relevant occupational safety and health standards.

Greenhouse Orientation

- In a single span or multi-span naturally ventilated polyhouse, the orientation of the structure is in the North–South direction and all roof vents face East, except the last bay, which is in the opposite direction.
- Also, in a naturally ventilated polyhouse or shade net house, 40:60 ratio, i.e., 40 per cent width (East to West) and 60 per cent length (North to South) is kept for better ventilation, though this ratio is based on the wind load on the North–South wall, in high speed wind zones.
- If the wind speed is high in an area, the length of the structure is restricted within 55 m in the North–South direction.
- However, in single or multi-span shade net houses, the longest dimension should be in the East– West direction.
- In this context, the direction of planting beds is also important and has to be done perpendicular to the arc of the Sun movement through the day

Thank you