PROPAGATION STRUCTURES

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INTRODUCTION

- 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.
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GREENHOUSE EFFECT

- In general, the percentage of carbon dioxide in the atmosphere is 0.035% (345 ppm). But, due to the emission of pollutants and exhaust gases into the atmosphere, the percentage of carbon dioxide increases which forms a blanket in the outer atmosphere.
- This causes the entrapping of the reflected solar radiation from the earth surface. Due to this, the atmospheric temperature increases, causing global warming, melting of ice caps and rise in the ocean levels which result in the submergence of coastal lines. This phenomenon of increase in the ambient temperature, due to the formation of the blanket of carbon dioxide is known as **greenhouse effect.**
- The greenhouse covering material acts in a similar way, as it is transparent to shorter wave radiation and opaque to long wave radiation



Earth is about 60°F. Without the atmosphere it would be 0°F.

ADVANTAGES

- Throughout the year four to five crops can be grown in a green house due to availability of required plant environmental conditions.
- The productivity of the crop is increased considerably.
- Superior quality produce can be obtained as they are grown under suitably controlled environment.
- Gadgets for efficient use of various inputs like water, fertilizers, seeds and plant protection chemicals can be well maintained in a green house.
- Effective control of pests and diseases is possible as the growing area is enclosed.

- High Percentage of seed germination.
- The acclimatization of plantlets of tissue culture technique can be carried out in a green house.
- Agricultural and horticultural crop production schedules can be planned to take advantage of the market needs.
- Different types of growing medium like peat mass, vermiculate, rice hulls and compost that are used in intensive agriculture can be effectively utilized in the greenhouse.
- Export quality produce of international standards can be produced in a green house.

- When the crops are not grown, drying and related operations of the harvested produce can be taken up utilizing the entrapped heat.
- Greenhouses are suitable for automation of irrigation, application of other inputs and environmental controls by using computers and artificial intelligence techniques.
- Self-employment for educated youth on farm can be increased



Production of high value crops (Yubari king melon)



Production of quality planting material

TYPES OF PROPAGATION STRUCTURE

BASED ON SHAPE



LEAN TO TYPE GREENHOUSE



SAW TOOTH TYPE GREENHOUSE

EVAN SPAN TYPE GREENHOUSE

QUONSET TYPE GREENHOUSE

UNEVEN SPAN TYPE GREENHOUSE

RIDGE AND FURROW TYPE GREENHOUSE

BASED ON CONSTRUCTION

WOODEN FRAME GREEN HOUSE

BASED ON COVERING MATERIAL

PLASTIC FILM GREENHOUSE

RIGID PANEL GREENHOUSE

CLASSIFICATION OF GREENHOUSES BASED ON COST

A. Low-cost Greenhouse

• Constructed mainly using local and low-cost available material like wooden logs or bamboos. The approximate cost of establishing : Rs. 450–620 per sq m.

Disadvantages

- The protection of wooden structures from insects and termites is a major challenge.
- These structures are small in size and have short life-span.
- Since the height of the structure is lesser as compared to those with steel frames, maintaining proper temperatures in summer becomes difficult. Therefore, they are recommended mostly in cold climatic zones and low wind speed regions.

B. Medium-cost Greenhouse

- Fabricated using galvanised iron (GI) square or rectangular or round pipes or lipped channel or their combinations.
- Withstand high speed (140 km/hr). Suitable for dry and composite climatic zones.
- The normal height of these structures ranges between 6.5–7 m.
- The climate inside the structure is regulated by opening and closing of side curtains Thus, air circulation can be regulated.
- Humidity- foggers/ misters. Light intensity internal collapsible shading nets.
- The approximate cost of establishing such naturally ventilated poly-house unit ranges between Rs. 900–1000 per sq. m depending upon the size of the structure.

Medium cost green house

C. High-cost Greenhouse

- For the production of sensitive, off-season, exotic or quality crops, sometimes mediumcost greenhouses cannot deliver the requisite quality.
- The greenhouse climate parameters are regulated through passive cooling by operating fan and pad systems and sensor-based controlled systems.
- The approximate cost of establishing such greenhouse units ranges between Rs.1500– 2500 per sq m depending upon the size of the structure.

INSECT-PROOF NET HOUSE

- Covered with UV-stabilized insect-proof net of 40–50 mesh for effective control of pests and diseases.
- The minimum size of insect-proof net house is 100 sq m.
- Usually, the quality production as well as growing seedlings are possible under these net houses with proper selection of varieties without application of harmful chemicals

Advantages

- 1. Off-season cultivation
- 2. Production of quality seedlings is possible.
- 3. Restrict the growth of pests and diseases.

SHADE NET HOUSE

- It is primarily constructed to protect plants from highly intense solar radiation.
- The structure is made of wood, stone, bamboo or GI pipes.
- When wood or bamboo are used, the poles are treated with turpentine and tar on one side before inserting them in the ground. Cladding material used on the top and sides of the structure is generally a shade net.
- For hardening of fruit orchard planting material raised under greenhouses.

Advantages

- 1. They control high intensity solar radiation.
- 2. They protect plants from frost.
- 3. They also protect plants from large insects

NET HOUSE

Humid region: Rain Shelter

Rain shelter tomato with reduced incidence of Blight during Monsoon

LATH HOUSE

- Raising seedlings, rooted cuttings, and young plants prior
- to setting them out in the garden
- protection from hot, drying summer winds, reducing the intensity of the sunlight, lowering temperatures, and by maintaining a higher humidity
- _•During December, January and February, the sides may be covered by plastic sheeting, which will furnish additional protection from the winter cold .
- •Protect plants which are sensitive from high light intensity
- •Hardening of vegetable seedlings
- •Low rate of seedling death

HOT BEDS

COLD FRAMES

Hot Bed	Cold Frame
 A hot bed is generally a mass of well- 	1. A cold frame is an outdoor growing "area"
prepared manure placed out doors with a	built without a bottom but with a solid-sided
glass or polythene frame placed on top to	frame of wood, cement or brick, and a
it.	removable hinged top, glazed with glass,
	Fiberglas, or plastic.
2. Hot beds are used for starting the	Cold frames are used for tempering or
plants.	hardening plants to outdoor conditions before
	transplanting.
Hot beds have a heat source.	Cold frame has no heat source.
4. Hotbeds are heated with electric soil	Cold frames receive all of their heat directly
cables, stable manure or steam, or hot	from the sun.
water heated with flues.	
5. Present-day hot beds are built even	5. Present-day frames are often completely
with or slightly below ground level and	above ground and plastic covered.
covered by glass sash.	
6. Hotbed can be used earlier in the spring	Cold frame used later in the spring and
and later in fall and early winter than the	earlier in fall and later winter than the hot
cold frame.	beds.

MIST CHAMBER

- Enclosed structure in which artificially mist is generated for the propagation of Plants or seedlings.
- Relative humidity is maintained at high level (95 %) with the help of mister's, which spray water under high pressure.
- Size of mist partials lies between 50 to $100 \ \mu m$.

Advantages of mist chamber

- This method results in faster rooting of the cuttings. High relative humidity facilitate better root initiation and cooling effect prevents the cutting from drying out
 Create optimum Microclimate for better root initiation and development.
- •Higher success rate found in propagation of hard wood cuttings

Thermo-hygrometer

Lux meter

FACTORS AFFECTING CUTIVATION UNDER PROTECTED STRUCTURES

- Temperature
- ✤ Photosynthetic activity is maximum between 15-27 °c
- Humidity
- (Hygrometer-Used for measuring relative humidity)
- Fruits develop tip burn and calyx burn during hours of ow humidity.
- Overhead high pressure foggers are recommended.
- Light intensity
- Co₂ concentration

Component of protected structures

- Ventilation
- Screening
- Cooling system (Fan and pad system, foggers)
- Heating system(centralized boilers, unit heaters, solar heating system)
- Watering system (drip irrigation)
- Fertigation (fertilizer with drip/sprinkler irrigation)

FAN AND PAD COOLING SYSTEM

HEATING SYSTEM

DRIP IRRIGATION SYSTEM

Fan and pad system

HYDROPONICS SYSTEM

What's Hydroponics?

Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, coconut fibre, etc. to provide mechanical support.

The term Hydroponics was derived from the Greek words hydro' means water and ponos' means labour and literally means water work.

Why opt for hydroponics?

•Due to rapid urbanization and industrialization not only the cultivable land is decreasing

•but also conventional agricultural practices causing a wide range of negative impacts on the environment.

•In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, crops or vegetables.

Hydroponic structures and their operation

- Hydroponic system are customised and modified according to recycling and reuse of nutrient solution and supporting media.
- Commonly used systems are
- 1. Wick
- 2. Drip
- 3. ebb-flow
- 4. deep water culture
- 5. nutrient film technique (NFT)

1.Wick system

- This is simplest hydroponic system requiring no electricity, pump and aerators .
- Plants are placed in an absorbent medium like coco coir. Water or nutrient solution supplied to plants through capillary action.
- This system works well for small plants, herbs and spice and doesn't work
 effectively that needs lot of water.

2.Ebb and Flow system

•This is first commercial hydroponic system which works on the principle of flood and drain.

•Nutrient solution and water from reservoir flooded through a water pump to grow bed until it reaches a certain level and stay there for certain period of time so that it provide nutrients and moisture to plants.

3.Drip system

- The drip hydroponic system is widely used method among both home and commercial growers.
- Water or nutrient solution from the reservoir is provided to individual plant roots in appropriate proportion with the help of pump.
- Plants are usually placed in moderately absorbent growing medium so that the nutrient solution drips slowly. Various crops can be grown systematically with more conservation of water.

4. Deep water culture system

- In deep water culture, roots of plants are suspended in nutrient rich water and air is provided directly to the roots by an air stone.
- Plants are placed in net pots and roots are suspended in nutrient solution where they grow quickly in a large mass. It is mandatory to monitor the oxygen and nutrient concentrations, salinity and as algae and moulds can grow rapidly in the reservoir.
 - This system work well for larger

Deep water culture hydroponic system

plants that produce fruits especially cucumber and tomato, grow well in this system.

5.Nutrient film system (NFT)

- NFT was developed in the mid 1960s to overcome the shortcomings of ebb and flow system. In this system, water or a nutrient solution circulates throughout the entire system; and enters the growth tray via a water pump without a time control.
- The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir.
- Plants are placed in channel or tube with roots dangling in a hydroponic solution.
- Although, roots are susceptible to fungal infection because they are constantly immersed in water or nutrient. In this system, many leafy green can easily be grown and commercially most widely used for lettuce production.

6.Aeroponics

- In an Aeroponics system, plants are grown in troughs, tubes or other types of chambers.
- Their roots are not in any kind of solid material such as Rockwool or soil.
- Instead, roots hang in space and are periodically bathed in nutrient mist. This means that roots can get larger and more easily absorb nutrients and oxygen.

Six types of hydroponic systems

AQUAPONICS

System that combines conventional aquaculture (raising aquatic animals such as snails, fish, crayfish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment.

<u>Materials required for professional hydroponics</u> <u>farm setup</u>

- plant clips.
- 50-gallon nutrient tank.
- PVC pipe.
- plastic tubing.
- expanded clay pebbles.
- water.
- planting cups.

plant clips.

50-gallon nutrient tank.

PVC pipe. plastic tubing.

expanded clay pebbles.

planting cups

Crops	EC (dSm ⁻¹)	pН
Asparagus	1.4 to 1.8	6.0 to 6.8
African Violet	1.2 to 1.5	6.0 to 7.0
Basil	1.0 to 1.6	5.5 to 6.0
Bean	2.0 to 4.0	6.0
Banana	1.8 to 2.2	5.5 to 6.5
Broccoli	2.8 to 3.5	6.0 to 6.8
Cabbage	2.5 to 3.0	6.5 to 7.0
Celery	1.8 to 2.4	6.5
Carnation	2.0 to 3.5	6.0
Courgettes	1.8 to 2.4	6.0
Cucumber	1.7 to 2.0	5.0 to 5.5
Egg plant	2.5 to 3.5	6.0
Ficus	1.6 to 2.4	5.5 to 6.0
Leek	1.4 to 1.8	6.5 to 7.0
Lettuce	1.2 to 1.8	6.0 to 7.0
Pak Choi	1.5 to 2.0	7.0
Peppers	0.8 to 1.8	5.5 to 6.0
Parsley	1.8 to 2.2	6.0 to 6.5
Rhubarb	1.6 to 2.0	5.5 to 6.0
Rose	1.5 to 2.5	5.5 to 6.0
Spinach	1.8 to 2.3	6.0 to 7.0
Strawberry	1.8 to 2.2	6.0
Sage	1.0 to 1.6	5.5 to 6.5
Tomato	2.0 to 4.0	6.0 to 6.5

Table 1. Optimum range of EC and pH values for hydroponic crops

Hoagland solution & its composition

The Hoagland solution provides every nutrient necessary for plant growth and is appropriate for supporting growth of a large variety of plant species. The solution described by Hoagland in 1933 has been modified several times

The Hoagland solution has high concentrations of N and K so it is very well suited for the development of large plants like tomato and bell paper.

Concentration of	Grams of	Volume of stock solution per
stock solution (mM)	compound used (g)	liter (ml) for full strength
Macronutrients		
1,000	101.10	6.0
1,000	236.16	4.0
1,000	115.08	2.0
1,000	246.48	1.0
Micronutrients		
25	1.864	2.0
12.5	0.773	2.0
1.0	0.169	2.0
1.0	0.288	2.0
0.25	0.062	2.0
0.25	0.040	2.0
53.7	30.0	0.3-1
	Concentration of stock solution (mM) Macronutrients 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 0 25 12.5 1.0 1.0 0.25 0.25 53.7	Concentration of Grams of stock solution (mM) compound used (g) Macronutrients 101.10 1,000 101.10 1,000 236.16 1,000 115.08 1,000 246.48 Micronutrients 1 25 1.864 12.5 0.773 1.0 0.169 1.0 0.288 0.25 0.062 0.25 0.040

Composition of Hoagland's solution

<u>ph and electrical conductivity (ec)</u> <u>Management</u>

- Plant nutrients used in hydroponics are dissolved in water and are mostly in inorganic and ionic forms.
- All 17 elements essential for plant growth are supplied using different chemical combinations.
- <u>Hoagland's solution</u> is used as most common nutrient solutions for hydroponic systems.

Various species of plants grown under soil less hydroponic system

Type of crops	Name of the crops
Cereals	Rice, Maize
Fruits	Strawberry
Vegetables	Tomato, Chilli, Brinjal, Green bean, Beet, Winged bean, Bell pepper, Cucumbers, Melons, green Onion
Leafy vegetables	Lettuce, Spinach, Celery, Swiss chard, Atriplex
Condiments	Coriander leaves, Methi, Parsley, Mint, Sweet basil, Oregano
Flower / Ornamental crops	Marigold, Roses, Carnations, Chrysanthemum
Medicinal crops	Indian Aloe, Coleus
Fodder crops	Sorghum, Alfa alfa, Bermuda grass, Carpet grass

Hydroponic research on lettuce, spinach and other leafy vegetables

- Life cycle of hydroponic lettuce is very short compared to traditionally grown lettuce.
- Hydroponic lettuce can be harvested after 35 to 40 days of production.
- Lettuce can be successfully grown in NFT system and more than 8 crops per year can be grown efficiently in this system.
- It was found that there is significant difference in productivity and nitrate content of lettuce in both soil less (floating system and substrate culture) and soil culture however, other traits like leaf area, dry weight and ascorbic acid content were remain unaffected.

Hydroponic lettuce

Tomato grown under hydroponics system

•Many hydroponic systems can be used for growing tomatoes but NFT and deep flow technique (DFT) are commonly used system for successful tomato production.

•Growing of tomato in NFT system with regular recycling of nutrient solutions improved growth, productivity and mineral composition

•Open and closed hydroponic systems were evaluated for performance of various cultivars of tomato and in closed system higher marketable yield was obtained as because of fruit cracking, yield was reduced in open system

Hydroponic tomato

WATER CONSERVATION IN HYDROPONIC vs. SOIL FARMING

As water becomes scarce and important as a resource, the use of hydroponics and other water saving technologies for crop production is needed now and is poised to popularize in time.

Hydroponics

- Hydroponics uses substantially less water as compared to the soil farming
- in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished.
- Water is not wasted in this process, as it gets recovered, filtered, replenished and recycled. Waste nutrient solution can be used as an alternate water resource for crop cultivation under hydroponic system

Traditional Soil farming

- In soil farming, most of the water that we supply to the plants gets leached deep into the soil and is unavailable to the plants roots,
- Water sources from groundwater or dam/river water commonly contain factors that can influence plant yield and affect plant condition, including salinity, dissolved solids and pathogens.
- Savings in irrigation water, fertilizer and increase in vegetable and water productivity under this system isl ess.

Benefits of Hydroponics..

- hydroponic technique is becoming popular because this is clean and relatively easy method
- There is no chance of soil-borne disease, to the crops thereby eliminating use of pesticides and their toxicity.
- plants require less growing time as compared to crop grown in field as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants.
- This technique is very useful for the area where environmental stress (cold, heat, dessert etc) is a major problem.

- Crops not influenced by climate change therefore, can be cultivated year-round and considered as off season .
- commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling.
- Higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture.

Limitations of hydroponics

- Technical knowledge and higher initial cost is fundamental requirement for commercial scale cultivation .
- Plant in a hydroponics system is sharing the exact same nutrient, and water borne diseases can easily spread from one plant to another.
- Hot weather and limited oxygenation may limit production and can result in loss of crops.
- Maintenance of pH, EC and proper concentration of the nutrient solution is of prime importance.
- Finally, light and energy supply is required to run the system under protected structure.

four largest hydroponic start-ups in INDIA

1.Letcetra Agritech

•Letcetra Agritech is Goa's first, indoor hydroponics farm, growing good quality, pesticide-free vegetables.

•The farm in Goa's Mapusa is an unused shed and currently, produces over 1.5 to 2 tons of leafy vegetables like various varieties of lettuce and herbs in its 150 sq metre area.

•The start-up is founded by Ajay Naik, a software engineer-turnedhydroponics farmer. He gave up his IT job to help farmers in the country.

2.BitMantis Innovations

•Bangalore-based IoT and data analytics start-up **Bit Mantis Innovation** with its IoT solution **Green SAGE** enables individuals and commercial growers to conveniently grow fresh herbs throughout the year.

- •The "Green SAGE" is a micro-edition kit that uses hydroponics methods for efficient use of water and nutrients.
- •It is equipped with two trays to grow micro-greens at one's own convenience.

Junga FreshnGreen

- Agri-tech start-up **Junga FreshnGreen** has joined hands with InfraCo Asia Development Pte. Ltd. (IAD) this year to develop hydroponics farming methods in India.
- The project started with the development of a 9.3-hectare hydroponics-based agricultural facility at Junga in Himachal Pradesh's Shimla district.

Future Farms

•Chennai-based **Future Farms** develops effective and accessible farming kits to facilitate Hydroponics that preserve environment while growing cleaner, fresher and healthier produce.

•It focuses on being environment friendly through rooftop farming and precision agriculture.

•The company develops indigenous systems and solutions, made from premium, food grade materials that are efficient and affordable.

Best hydroponic crops

beans

strawberry

cucumber

spinach

radish

blueberry