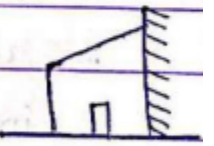
Q) Greenhouse :- A structure covered with Glass or plastic film in which Temperature and humidity is maintained artificially for the protected cultivation of plants is called Greenhouse

Advantages :- - off season production of fruits and vegetables
- Round the year production of most desired crop
- Higher production per unit area is obtained
- Higher value and higher quality crops can be grown
- Efficient use of Irrigation water, fertilizers and pesticides
- cultivation of rare plant species.
- Nursery for all vegetables crops can be grown.
- Suitable for rearing / hardening of tissue culture plants.

Q) Types of Greenhouse :-

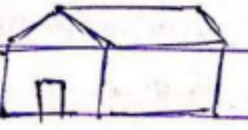
1) Greenhouse type on the Based on utility
2) Greenhouse type on the Based on Construction
3) Greenhouse type on the Based on Covering material
4) Greenhouse type on the Based on cost of Construction
5) Greenhouse type on the Based on shape :-

i) Lean to type Greenhouse :-



- Greenhouse is place against side of existing building
- It is typically facing south side - small type of Greenhouse

ii) Even span type Greenhouse :-



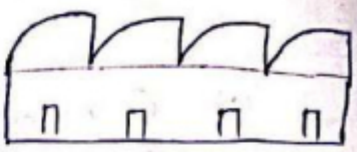
- The two roof slopes are of equal pitch and width
- Small size, constructed on level ground

iii) Uneven Span type Greenhouse —

- constructed on hilly terrain, - The roofs are of unequal width.

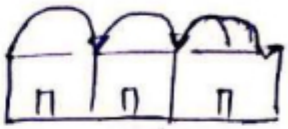
iv) Saw tooth type Greenhouse —

- ridges and furrow type Greenhouse, - Natural ventilation.



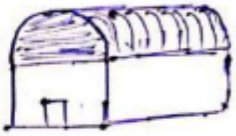
v) Ridges and Furrow type Greenhouse —

- Design of this type use two or more A-Frame greenhouse connected to one another along the length of the eave
- The eave series as furrow or gutter to carry rain and melted snow away



vi) Quonset Greenhouse —

- domeshaped, less expensive
- arches or trasses are supported by pipes.



Q.) Plant response to green house environment —

1) Light — - visible light of the solar radiation is a source of energy for plant
- in photosynthesis, plant growth and reproduction the light is very essential element
- The high and low light intensity also affects on crop growth.
- The light Intensity is measured by International unit 'Lux'
- Greenhouse crops subjected to light intensities varying from 129.6 k lux on clear Summer days to 3.2 klux on cloudy ~~condition~~. winter days
- The visible spectrum of light that is used in photosynthesis. The 'UV' and 'IR' Rays not used
- In the Blue band light (Short wavelength) alone is supplied to plants, The growth is retarded and the plant becomes hard and dark in colour.
- when plant are grown under red light (longer wavelength) growth is soft and internodes are long, resulting in tall plants.

2) Temperature — - Temperature is a measure of level of the heat present
- Greenhouse crops are grown at a day temperature which are 3 to 6°C higher than the night temperature on cloudy days and 8°C higher on clear days.
- The enzymes are biological reaction catalyst and are heat sensitive
- all biochemical reactions in the plant are controlled by the enzymes.

3) Relative humidity :— - As the green house is a closed space the R.H. of the greenhouse air will be more when compared to the ambient air due to the moisture added by the evapotranspiration process.
- The process like Humidification and Dehumidification are occured in maintained R.H. Level
- For most crop. The acceptable range of R.H is between 50-80 %.
- In a Summer season the evaporative cooling pads and fogging systems is implemented for the maintain R.H.

4) Ventilation :— - A green house is ventilated for either reducing the temperature of the green house air or for replenishing carbon dioxide supply or for moderating the R.H. of the air.
- Air Temperature above 35°C are generally not suited for the crops in green house.
- Fan ventilation is essential to have precise control over the air temperature humidity and carbon dioxide levels.

5) Carbon dioxide :— - Carbon is an essential plant nutrient and is present in the plant in greater quantity than any other nutrient about 40 % of the dry matter of the plant is composed of Carbon.
- under normal condition, CO_2 exist as a gas in the atm. slightly above 0.03 % or 345 ppm.
- During the day when photosynthesis occur under natural light the plants in a green house draw down the level of CO_2 to below 200 ppm under these circumstances. infiction of ventilation increases CO_2 level, when the outside air is brought in to maintain the ambient level of CO_2.
- If the CO_2 level less than ambient levels CO_2 may retard the plant growth
- Ideal CO_2 level - 1000 - 1200 ppm.

Q.) Planning and Design of Greenhouse —

1) Site selection and orientation —

- A greenhouse is designed to withstand local wind, snow and crop loads for specific cropping activity
- drainage, Level land, availability of electricity, water, labour, Transportation, Road
- Sites should be away from buildings and trees.

2) Structural designs —

- The most Imp. 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
- The design should have the proper ventilation and light Intensity
- A straight side wall and arched roof is and gable roof is most common and widely used structures.

3) Covering material —

- Glass, acryl sheet, polycarbonate, fiberglass reinforced polyester sheet, polyethylene is the various types of covering material
- The light, temp., weight, Resistant to Impact and durability to Outdoor weathering and thermal stability over wide range of temperature

Q.) material of Construction for Traditional and low cost greenhouse —

1) Wood — - wood and bamboo are generally used for low cost polyhouses.
- The wood is used for making frames, columns, over which the polythene sheet is fixed
- Pine and Casuarina. Teak wood is use for polyhouse
- wood must be treated with protection against decay

2) Galvanised iron (GI), aluminium, Steel and reinforced cement concrete —

- GI pipes, tubular steel and angle iron are generally used for side posts., columns and purlines in Greenhouse structure as wood is becoming scarce and more expensive In galvanising operation the surface of iron or steel is coated with thin layer of zinc to protect it against corrosion. The commonly followed process to protect against corrosion are—

i) Hot dip galvanising (hot process)
ii) Electro galvanising (cold process)

3) Glass :- Glass has been traditional glazing material all over the world
- widely used glass for greenhouse are i) Single drawn or Float glass (Thickness 3-4mm) ii) Hammered and tempered glass (Thickness of 4mm)
- Hammered glass is not transparent but translucent
- Tempered glass is quickly cooled after manufacture

Q. Rules of watering in Greenhouse :-
~~1) Use well drained substrate with good structure~~
1) Focus on the root zone — Remember that it's the roots that need access to water not the leaves. wetting the foliage is a waste of water and can promote the spread of disease
2) water only when needed
3) water deeply and thoroughly —
4) water in the morning
5) use the right tool — for efficient watering at the root zone use a soaker hose or an even more precise drip irrigation system instead of a sprinkler
7) water just before inital moisture stress occur.

8. Types of Irrigation system —

1) **Overhead Sprinklers** — - A pipe is installed along the middle of a bed
- Risers pipes are installed periodically to a height well above the final height of the crop. (For bedding plants 0.6 m and for fresh flowers 1.8 m height is sufficient)
- The Nozzle is installed at the top of each riser and it rotates 360° circ
- Trays are placed under pots to collect water that would otherwise fall on ground and wasted.
- Bedding plants, azalea liners and some green plants are commonly watered from overhead

2) **Drip Irrigation** — - also called trickle irrigation.
- Drip irrigation consist of laying plastic tubes of small diameter on the surface or sub surface of the field or greenhouse. beside or beneath the plants, water is delivered to the plants at frequent intervals through small holes or emitters located along the tube
- water application efficiency is 90-95 %.
- Fertigatation.

3) **Foggers and mist spraying** — - Fog particles size - less than 50 microns (0.002 in) in diameter.
- mist particles size — 50-100 microns.
- The fog and mist is use to reduce the air temperature and increase the humidity within the plant canopy
- It is also used for the foliar feeding, insecticides and ~~pesticides~~ Fungicides feeding. This saves time and gives a uniform application.

4) **Perimeter Irrigation System** - The Nozzles are feeded in a zigzag manner at angle of 180°, 90°, 45° in field.

5) **Hand watering** —

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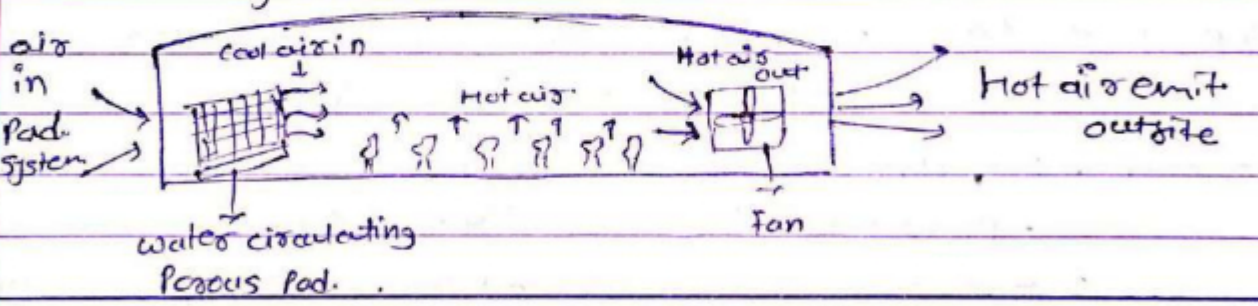
8. Design Criteria of Green house for Cooling purpose —

1) **Natural ventilation** — - In this tropics the sides of greenhouse structure are often left open for natural ventilation.
- The ventilators were located on both roof slopes adjacent to the ridge and also on both side walls of the greenhouse
- During winter cooling Phase, the south roof ventilator was opened in stages to meet cooling needs.

- In summer cooling phase, The south ventilator was opened first followed by the next ventilator.
- This sets up a 'chimney effect' which in turn draws in more air from the side ventilators creating a continuous cycle.
- This system did not adequately cool the greenhouse
- on hot days the interior walls and floor were frequently injected with water to help cooling.

2) Forced Ventilation :- - In Forced or active ventilation, mechanical devices such as fans are used to expel the air.
- This include summer fan-and pad and fog cooling systems and the winter convection tube and horizontal airflow systems.

- Fan pad cooling system :- Fan and pad systems consist of exhaust fans at one end of the greenhouse and a pump circulating water through and over a porous pad installed at the opposite end of the greenhouse.



Q.) Design criteria of Greenhouse For Heating purpose :-

1) Heating System :- - The heating System must provide heat to the greenhouse at the same rate at which it is lost by conduction, Infiltration and radiation.
- The heating system is generally use where The winter season is longer and The climate is very cold.

- These are Three types of heating system of Greenhouse.

i) Heater system. (most common)
ii) Central heating system.
iii) radiation. heating system.

2) Solar heating system :— - solar heating is often used as a partial or total alternative to fossil fuel heating systems.

- The general components of solar heating system are collector, (Flat plate) (copper tube) heat storage facility, exchange to transfer the solar derived heat to the greenhouse air, backup heater to take over when solar heating does not suffice and set of controls

3) water and rock storage :— - water and rocks are the two most common. materials for the storage of heat in the greenhouse

- one kg water can hold 4.23 kJ of heat. For each 1°C rise in Temp.
- Rock store about 0.83 kJ of heat For each 1°C. To store equivalent amount of heat, a rock bed would have to be three times of large as a water tank.

Q. Define Drying → drying is the universal method of conditioning grain by removing moisture to a moisture content level that is in equilibrium with normal atmospheric air in order to preserve its quality and nutritive value of for food and feed and its viability for seed

Define Dehydration— Dehydration means removal of moisture to very low. levels usually to bone dry condition.

Importance →. ↑ storage period of grains.
- prevent from insect and fungus attack.
- The grains germinate when moisture is present The drying stops the germination process of grains
- prevent respiration.

methods— 1) Sun drying

2) mechanical drying
   i) Drying with forced natural air
   ii) Drying with forced artificially heated air
   iii) Drying with desiccants.
   iv) Drying with infrared rays.

* Equilibrium moisture content (EMC)

- The air passes through the dried zone and picks up moisture in the drying zone until it reaches equilibrium moisture content (EMC) in the case of very wet grain.
- Henderson (1952) develops this eqn.

$$1 - RH = \exp\left[-C\, T M_e^n\right]$$

where, RH = equilibrium R.H., decimal

Me = EMC dry basis, percent

T = Temperature °K and °C

n = product constants, varying with material.

* classification of Grain drying —

1) Thin layer drying — Thin layer drying refers to the grain drying process in which all grains are fully exposed to the drying air under constant drying conditions. i.e. at constant temp. and humidity. Generally upto 20 cm. thickness of grain bed is taken as thin layer

2) Deep bed drying — Deep bed drying process refers to the heterogeneous drying of grain in deep layer (more than 20cm deep) where drying is faster at the inlet end of drying chamber than at the exhaust end. The drying of grain in a deep bin can be taken as the sum of several thin layer of grain arranged one above another.

Q) moisture content —

① wet basis → moisture content is usually expressed is percentage by wt. on wet. basis of.

$$m = \frac{W_m}{W_m + W_d} \times 100$$

W_m = weight of moisture

W_d = weight of bone dry material

(2) Dry basis :- The moisture content on dry basis is more simple to use in calculation eg the quantity of moisture present at any time is directly proportional to the moisture content on dry basis.

$$M = \frac{W_n}{W_d} \times 100 = \frac{m}{100 - m} = 100$$

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8) moisture content determination method :-

(1) Direct method —

i) Air oven method — used to determing % moisture content in grain.

ii) Vaccum oven method — The oven door is locked air tight and is connected to vaccum pump to reduce the pressure. The materials to be dried are kept on the trays inside the vacuum dryer and pressure is reduced by means of vacuum pump.

iii) Infrared method — Infrared radiation is used in many moisture analyzers such as halogen moisture analyzers which are used to produce infrared radiation from halogen lamp.

- The weight of the sample is measured and recorded continuously and once it becomes constant the drying is stopped.

(2) Indirect method —

i) Electrical resistance method — This type of moisture meter measures the electrical resistance of measured amount of grain compaction (bulk density) and temp.

- The electrical resistance varies with moisture, Temperature and degree of compaction.
- They take only 30 seconds for the moisture measurement.

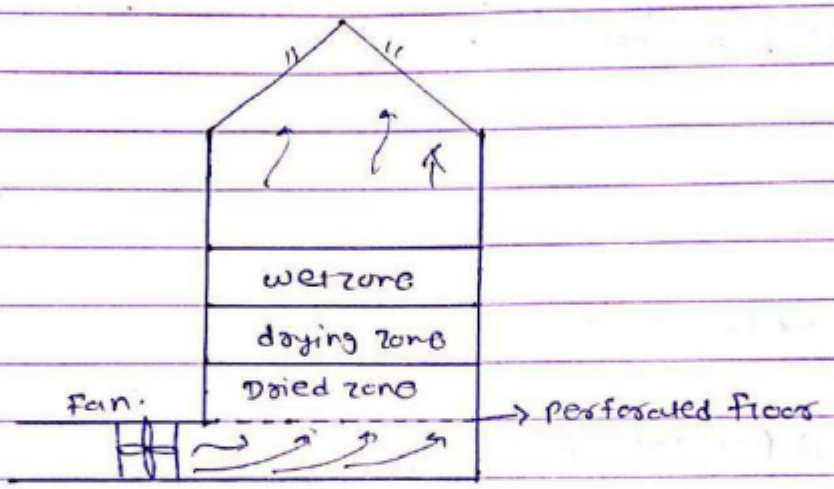
ii) Dielectric method — The dielectric properties of grain depend on its moisture content

- In this type of moisture meter, 200 gm grain sample is placed between the condenser plates and the capacitance is measured
- It takes 1 minute for the 55 e measurement of moisture

Q.) Commercial Grain Dryers :—

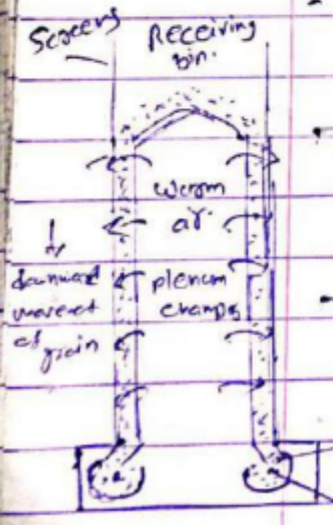
1) Deep Bed dryer :—

- Deep bed drying process refers to the heterogeneous drying of grain in deep layer (more than 20 cm deep) where drying is faster at the inlet end of drying chamber than at the exhaust end.
- The rate of moisture removal is max. for the bottom layer and decreased exponentially for subsequent layers



2) Recirculatory batch dryer (RPEC dryer)

- This is continuous flow non-mixing type dryer
- This dryer was developed at Rice processing engineering Centre (RPEC), IIT, Khargpur
- It consist of two concentric circular cylinders made of perforated sheets of 20 gauge. The cylinders are set about 20 cm apart to move the grain downwards
- RPEC dryer are made for half one and two tones holding capacities



8) Louisiana State University (LSU) dryer :— This is a continuous flow mixing type of grain dryer which is popular in India and the USA It was developed at Louisiana state University Baton Rouge, USA in 1967

- It consist of 1) Rectangular drying chamber fitted with air ports and the holding bin 2) an air blower with duct 3) grain discharging mechanism with a hopper bottom and 4) an air heating system

3) Baffle dryer — This is a continuous flow mixing type of grain dryer The main advantage with the dryer is uniformly dried product is obtained

- Grain is fed at the top receiving bin and allowed to move downward in a zigzag path through the drying chamber where it encounters across flow of hot air. A bucket elevator can recirculate the grain till it is dried to the desired moisture level. This design helps in mixing of dried and undried grains.

5) Tray dryer —

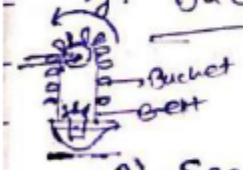
6) Solar dryer —

7.) Material of handling equipment —

1) Conveyor — 1) Belt conveyor

2) Screw Conveyor

2. Bucket Elevator — A Bucket elevator consist of buckets attached to a chain or belt that revolves around two pulleys one at top and the other at bottom



A) Spaced bucket elevator — i) centrifugal discharge elevator
ii) positive discharge elevator
iii) marine leg elevator
iv) high speed elevator

B) continuous bucket elevator — i) super capacity bucket elevator
ii) Internal discharge bucket elevator.