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Types of Greenhouse and Their Impact on Crop Production

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After the green revolution, India made enormous strides in agricultural production, but productivity is still poor due to climate change and the intrusion of conventional cultivation practices. In order to meet the world's food demand in 2050, global output will have to increase by 70% (FAO, 2020). Man has devised technical means for growing crops all year. In this sense, greenhouse technology may be the sole way to manage the local environment in order to maximize crop productivity per unit area and improve crop production on terms of quantity and quality, which is impossible in open fields. Currently, commercial protected cultivation is being adopted by progressive farmers for the cultivation of high value flowers and vegetables (Maitra *et al.*, 2020).

A greenhouse is a method for controlling and modifying climatic conditions that allows plants to grow in climates that aren't ideal for their growth and development. This greenhouse technology becomes more important as the climate changes, emphasizing high-quality produce and increased productivity through effective resource utilization. The productivity and efficiency of greenhouse technology, on the other hand, are entirely dependent on the types of greenhouse structures utilized for production. The development of creative greenhouse structures is emphasized by the recent trend in human population expansion, as well as the progress of consumption habits. In general, the type and equipment of greenhouse structures used in any place are suited to the local environment, construction materials, and crop. Growers, designers, and researchers in each region examine components such as cover materials, climate-control systems, irrigation, and fertilizing equipment on a regular basis in order to enhance efficiency, cut inputs, and eliminate unfavorable environmental consequences. The type of growth structure employed determines the efficiency and productivity of a greenhouse operation. Because there are so many greenhouse designs to choose from for a certain region, it's critical to understand the benefits and drawbacks of each greenhouse type and structure.

Types of Greenhouse

1. Types of greenhouse based on cost investment

a. Low technology greenhouses

Only a small percentage of farmers employ low-tech infrastructure to produce their crops. The entire height of the low-tech greenhouses is less than 3 meters. Tunnel homes, the most prevalent type of low-tech greenhouse, have poor ventilation due to their lack of vertical walls. Because little or no automation is employed, this style of building is quite affordable.

However, as compared to open field farming, this form of structure offers significant crop productivity benefits. The growing environment still limits crop potential, and crop management is tough.

b. Medium technology greenhouses

Vertical walls are a common feature in medium-technology greenhouses. Medium technology greenhouses are more than 2 meters tall but less than 4 meters tall, with a total height of less than 5.5 meters. For greater ventilation, these greenhouses have either a roof or a side wall. They also offer medium automation and are often covered in single or double-skin plastic film or glass. Medium-level greenhouses represent a fair economic and environmental base for the farming business, since they strike a balance between cost and productivity.

c. High level greenhouses

The height of the high-level greenhouses' walls is at least 4 meters, and the roof peak can reach up to 8 meters above ground level. These buildings provide exceptional agricultural output while still being environmentally friendly. This building has enough roof ventilation as well as side wall vents. Plastic film (single or double), polycarbonate sheeting, or glass are utilized as cladding materials in high-level greenhouses. There are environmental controls that are automated. High-tech structures are often attractive to look at, and they are increasingly being used in agriculture prospects around the world. Despite the fact that these greenhouses are expensive, they provide a highly productive and environmentally sustainable option for a modern fresh produce industry.

2. Greenhouse type based on shape

a. Lean-to type greenhouse

When one or more of the sides of a lean-to greenhouse are put against the side of an existing greenhouse building, it is called a lean-to greenhouse. The current greenhouse structure's roof has been extended with covering material, and the exposed space has been adequately covered. The entire construction should face south, which is the greatest orientation for getting enough sunlight. This form of greenhouse is restricted to single or double-row plant benches with a total width of 7 to 12 feet and a length as long as the structure to which it is attached.

b. Even span type greenhouse

The even span greenhouse is a common form of greenhouse that is built entirely on the ground level and has two roof slopes of equal width and pitch. When the greenhouse is tiny and attached to a home at one gable end, this style of greenhouse building is employed. The cost of an even-span greenhouse structure is higher than that of a lean-to structure. In comparison to a lean-to construction, the design has a superior shape for air movement inside the structure to maintain constant temperatures during the winter season. In different parts of India, numerous types of single and multiple span constructions are available. For single span type the span in general, varies from 5 to 9 m, whereas the length is around 24 m and the height varies from 2.5 to 4.3 m.

c. Uneven span type greenhouse

This uneven span type of greenhouse is suitable for hilly or undulating terrains. The roofs of the structure are differ in width; which resembles the name of the structure and make the structures adaptable to the side slopes of hill. This type of greenhouses is rarely used as it is not adaptable for automation.

d. Ridge and furrow type greenhouse

Two or more A-frame greenhouse structures are joined along the length of the eave in this sort of greenhouse construction. The eave is a gutter or furrow that collects rainwater and snow melt. The side wall between the greenhouses is removed, making the structure appear to

have a single large interior. The interior space in the greenhouse structure reduces labor, lowers automation costs, improves personal management, and reduces fuel consumption because there is less uncovered wall area through which heat escapes.

Fig.1: Saw-tooth greenhouse

e. Saw tooth type green-house

This style of greenhouse is similar to ridge and furrow greenhouses, except that the saw-tooth design of the greenhouse allows for natural ventilation (Fig. 1). The saw tooth vent can be opened to provide continuous airflow to lower the internal temperature or closed to maximize the climate control of the growth space. In addition to the side ventilation, the roof ventilation alone provides 25% of the overall ventilation of the covered area. The arches' shape enables for a lot of light to pass through.

f. Quonset greenhouse

By pipe purling along the length of the quonset type greenhouse, pipe arches are used to give support. Polyethylene is commonly used as a covering material. When compared to gutter-connected greenhouses, this greenhouse is ideal for a small isolated cultural area and is also cost-effective. These houses are joined either in a free-standing manner or in a ridge and furrow pattern. The interlocking kind has truss members that overlap enough to allow a plant bed to grow between the overlapping areas of neighboring dwellings.

3. Type of greenhouse based on utility

a. Active heating system of greenhouses

The air temperature inside the greenhouse drops at night. To keep plants from getting a chilly bite from freezing, some heat must be provided. The amount of energy required to heat a greenhouse is determined by the pace at which heat is lost to the outside environment. To prevent heat losses, many technologies are used, such as double layer polyethylene, thermo pane windows (two layers of factory sealed glass with dead air space), or heating systems such unit heaters, central heat, radiant heat, and solar heating systems.

b. Active cooling system of greenhouses

For optimum crop development throughout the summer, it is preferable to keep greenhouse temperatures lower than ambient temperatures. As a result, modifications to the green house are made to allow enormous volumes of chilled air to be brought into the greenhouse. Evaporative cooling pads with fans or fog cooling are used in this style of greenhouse. This greenhouse is built in such a way that it allows for a roof opening of up to 40%, and in some circumstances up to 100%.

4. Types of greenhouse based on construction

a. Wooden framed structures

In general, timber frame structures are appropriate for greenhouses with spans under 6 meters. Without the use of truss materials, the side posts and columns are made of wood. Pine wood 4 is widely used since it is both affordable and strong. Similarly, locally available lumber can be used for greenhouse construction because it is strong and durable.

b. Pipe framed structures

When the clear span is roughly 12m, pipes are used to construct greenhouses. Pipes are used to make side posts, columns, cross ties, and purlins in general. The trusses aren't employed in this design.

c. Truss framed structures

If the span is more than or equal to 15 meters, green house structures can be built in truss frames. A truss is made up of rafters, chords, and struts that are welded together from flat steel, tubular steel or angular iron. Struts are compression support members, while chords are tension support members. Each truss is fastened to angle iron purlins that run the length of the greenhouse. The majority of glass houses are constructed using truss frames, which are ideal for pre-fabrication.

5. Types of greenhouse based on covering materials

a. Glass greenhouses

In glass greenhouses, glass is employed as a covering material (Fig. 2). It has the advantage of greater interior light intensity, higher air infiltration rate, lower interior humidity, and good disease prevention quality as a covering material. Glass greenhouses are constructed using ridge and furrow, lean-to, and even span designs.

b. Plastic film greenhouses

Flexible plastic sheets, such as polyvinyl chloride, polyethylene, and polyester, are used to cover this sort of greenhouse. Plastics are more common as a greenhouse covering material since they are less expensive and require less heating than glass greenhouses. The biggest downside of using plastic sheets as a covering material is that they have a short lifespan. The best ultraviolet (UV) stabilized film, for example, can only last four years. This covering material is suited for use in both Quonset and gutter-connected designs.

c. Rigid panel greenhouses

Quonset type frame, also known as ridge and furrow type frame, is a greenhouse covering material made of polyvinyl chloride rigid panels, fibre glass-reinforced plastic, acrylic, and polycarbonate rigid panels. These materials, unlike plastic or glass, give a more consistent light intensity throughout the greenhouse and are also more resistant to breakage. High-quality panels have a longer lifespan, up to 20 years. However, the panels move around, collecting dust and harboring algae, which is the principal disadvantage of rigid panel greenhouses, resulting in dimming of the panels and a steady decrease in light transmission.

Fig. 2: Glass greenhouse

Framing Material

Greenhouses are commonly constructed with aluminum, steel, and wood framing materials. Aluminum, on the other hand, is the most durable and cost-effective of the three. They come in a variety of forms and thicknesses. Rafters, side posts, and other structural components can be made using this framing material. Wooden framing is rarely utilized since it deteriorates quickly in the greenhouse's mist facilities. If wood is utilized, pressure treated lumber that "resists" decomposition is recommended.

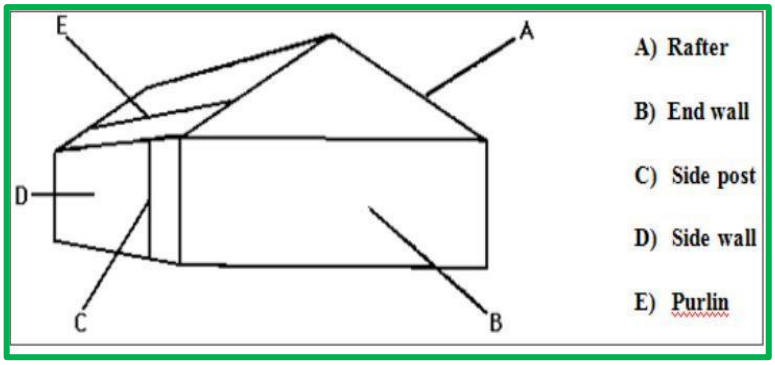

Fig. 3: Primary components of greenhouse

Covering Material

The type of protected covering material and its feature cause alteration in microclimate of the plants (Alsadon *et al.*, 2016; Katsoulas and Kittas, 2008). Greenhouse covering materials should be transparent enough to allow for maximum light transmission, as well as long-lasting and low-cost. Although glass materials provide the finest light transmission for greenhouse crop cultivation, the structural components that support the glass are highly expensive. Another covering material, fibreglass, is more durable and does not require as many structural components as a glass home requires. On a commercial level, it is commonly employed. Unfortunately, fibreglass is more susceptible to ultraviolet (UV) radiation, and as the fibre swells, it enables less light transmission.

Fiberglass has a five-year life span under certain circumstances. One of the most common non-rigid covering materials for commercialised greenhouses is double sheets of polyethylene (PE) film packed with air, which provides the necessary support for normal functioning. Recently available polyethylene (PE) film has a two-year shelf life and must be replaced after that time. In case of poly ethylene type greenhouse, short wave radiation transmitted inside and get trapped while long wave radiation transferred out, thereby increases the inside temperature as compared to shade house (Dwivedi and Dwivedi, 2005).

Although maintaining these covering materials is costly, the lower initial investment as well as the fewer structural components necessary to support these covering materials has made it the most cost-effective for both consumers and producers. A wide range of modern polycarbonate and acrylic greenhouse covering materials are now available.

Conclusion

The design of a greenhouse has a significant impact on its productivity and efficiency. Ridge and furrow greenhouse design provides significant productivity and efficiency in output, and aluminum is the most reliable and widely utilized framing material for trading greenhouse structures. Similarly, for crop production, multiple sheets of polyethylene film are the most cost-effective covering material. However, the facility's initial and long-term expenses, the lack of availability of various structural components, the lack of standardization of region-based greenhouse and other structure design, and a lack of knowledge are all key barriers to its implementation.

References

1. Alsadon, A., Al-Helal, I., Ibrahim, A., Abdel-Ghany, A., Al-Zaharani, S. and Ashour, T. (2016). The effects of plastic greenhouse covering on cucumber (*Cucumis sativus* L.) growth. *Ecological Engineering*, **87**: 305–312.
2. FAO (2020). Food and Agriculture data. FAOSTAT, Rome.
3. Dwivedi, P. and Dwivedi, R. S. eds. (2005). Physiology of abiotic stress in plants. Agrobios Publication, Jodhpur: 35-78.
4. Katsoulas, N. and Kittas, C. (2008). Impact of greenhouse microclimate on plant growth and development with special reference to the Solanaceae. *European Journal of Plant Science and Biotechnology*, **2**: 31–44.
5. Maitra, S., Shankar, T., Sairam, M. and Pine, S. (2020). Evaluation of gerbera (*Gerbera jamesonii* L.) cultivars for growth, yield and flower quality under protected cultivation. *Indian Journal of Natural Sciences*, **10**(60): 20271-20276.

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