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Greenhouse Cultivation

Introduction:

The principle of controlling the crop's microenvironment is essentially what the phrase "green house" refers to. Usually shaped like a house, it may be adjusted to provide the right amount of natural light, humidity, temperature and even greenhouse gas concentrations to suit the needs of a specific crop. The most intensive type of commercial farming, known as "food factories," is greenhouse technology. Greenhouse vegetable production leverages technological advancements to optimize crop yield and elevate the quality of vegetable products by controlling the environment. Greenhouses are the most effective way to overcome climatic diversity. Small growers may find that protected cultivation meets their needs since it can greatly boost productivity while also improving crop quality.

Principle: The basic ideas of protected agriculture are ventilation for cooling and air CO_2 management and the greenhouse effect for heating planted space utilizing sunrays. The planted area is sealed off and coated with glass or plastic film that traps heat by being partially opaque to long-wave infrared radiation emerging from the soil, plants and structural surfaces but transparent to incoming short-wave radiation from the sun impinging on the outside surface. Enclosed spaces so maintain a temperature that is higher than the surrounding air. Trapped heat, however, eventually escapes through radiation, convection/ventilation, and conduction. Heat sinks, decreased airflow, and the use of radiation shielding either slow down the rate of cooling or add another heat source within.

Important considerations for successful protected cultivation

The expanding greenhouse horticulture subsector offers marginal land usage, appealing financial options and chances to preserve the environment. Compared to current open-field cropping, the technology is far more advanced, necessitating a great deal more care and precision as well as greater start-up and operating expenditures. A number of greenhouse horticultural considerations need to be taken into account when determining how much time, money, and effort to invest. These include:

1. Economics
2. Ecology
3. Technology
4. Physical infrastructure
5. Labour

Important aspects to be kept in mind before undertaking protected cultivation of Horticultural crops:

- Climate of the place.
- The crop to be grown.
- Resources to undertake protected cultivation.
- Knowledge of government support schemes of protected cultivation.
- Market for selling of quality produce

Selection of vegetables:

The size of the structure, crop production economics and profit margin all influence the vegetable crop that is grown in a greenhouse. In an expensive greenhouse, any crop can be cultivated at any time; in a typical low-cost greenhouse, the selection of crops is more important. The practice of growing high-value vegetable crops including tomatoes, cucumbers, chillies and capsicums in greenhouses is gaining popularity. Compared to an open field, a greenhouse requires more labor and other inputs per unit area. Fresh vegetables are in high demand all year round in big cities. Tomatoes grow rather well in protected environments.

1. Economics:

1.1 Cost: Greenhouse horticulture involves huge start-up costs, due to the structures presently used. However, attempts have been made by farmers having less resources, to find more affordable yet effective structures, including the use of local timber/ bamboos.

1.2 Capital: Lot of initiatives have been taken up by Government of India to promote protected cultivation through various schemes like National Horticulture Mission, *Rashtriya Krishi Vikas Yojna*. Under these schemes, farmers are provided with 50% subsidy and even more at State level e.g. 65 to 75% in Gujarat.

1.3 Market: Most markets require a steady supply of high-quality produce, which greenhouse horticulture provides. A thorough marketing policy needs to be put into place in order to lower transportation costs, stable prices and provide the market in particular, the large supermarket chains that are becoming more and more common in metropolitan areas with products that are labelled and quality-certified. Large retail groups are increasingly included precise growing standards for the environmentally sound development of healthy commodities in their contracts with large producer organizations

2. Ecology

Greenhouse horticulture was developed in the temperate countries to conserve heat for growing plants during cold periods. In the Tropics, this feature limits the use of the technology, giving tropical protected horticulture some markedly differing needs. Key ecological factors involved include solar radiation/ temperature, water, wind, relative humidity, flooding and pests.

2.1 Solar radiation: The mean daily total of solar radiation energy for each month is crucial for crop output and plant growth. This will give the required details regarding the variation in the average daily total solar radiation over any two-month period. With the use of this information, appropriate greenhouse equipment can be planned to regulate solar radiation in a way that benefits crops grown beneath it by adjusting the amount, length, and quality of light. The lowest daily radiation required for a plant to grow sufficiently is 500–1000 Wh/m2/day. In order to properly

utilize the high mean daily radiation in tropical regions, cultivars appropriate for shorter day lengths must be selected.

2.2 Temperature: For greenhouse technology the temperature should be considered in two different ways. First, the outside temperature on which the structural design of a greenhouse depends. Second is the inside temperature, which is modified in favour of the crop grown under the greenhouse.

2.3 Water: Greenhouses keep out rainfall, thus requiring a consistent supply of adequate quality water for efficient crop production. This water should be free of excessive solid particles (e.g. soil, algae) and a pH level of 6.5 to 7.2. For instance, tomato and sweet pepper plants use an average of 1.5 -2 litres water per day. Sufficient volumes must therefore be calculated for the duration of drought periods and appropriately-sized storage facility constructed. Significant volumes of rainfall can be harvested from the roof of greenhouses.

2.4 Relative humidity: The importance of air humidity for designing greenhouse for crop production is frequently underestimated. Both the humidity of air outside and inside of a greenhouse shall be meticulously evaluated and considered while planning a greenhouse. Furthermore, both absolute humidity and relative humidity has to be properly measured and shall be considered with due importance. Plant growth and production will slow down or stop when the humidity in air is lower than 30% or higher than 90%.

3. Technology:

3.1 Selection of variety: There are three aspects for crop selection for farming under greenhouse. These aspects are guided by combined output of some information.

1. The market, growing habit (vine or indeterminate), differential capacity to improve yield in comparison to open field, off-season production, greenhouse status and climate control system all influence the choice of crop.
2. The selection of crop groupings depends on the climate and the crop's physiological potential for increased output.
3. The choice of crop type is determined by practical viability, consumer desire and genetic capacity.

3.2 Selection of growing media:

Soil-based root media: Most of the greenhouses for crop production use soil-based media. Traditionally, the soil-based medium is composed of equal parts by volume of loam field soil, coarse sand, rice husk and well-decomposed organic matter adjusted to proper pH level.

Soil-less root media: In initial stages of greenhouse cultivation, particularly in crop specific greenhouse, soilless root medium is popular for the following reasons:

1. Proper field soil is not available, and transportation of soil is not feasible.
2. Maximization of production through highest possible supply of nutrient, air and water to the media.
3. Reduce the weight of the medium (for potted plant) to suite the pot for long distance market and
4. Perfect application of automation in the greenhouse.

3.3 Pasteurization or fumigation of growing media: It is now a must-have procedure for all greenhouses. Nonetheless, there is a greater

potential for the formation of disease-causing organisms in warm climates where the greenhouse's interior environment does not freeze, the humidity is high and the temperature is higher. In a greenhouse, the continuous culture of a single crop or a cycle of several crops offers a constant host for the growth of disease-causing organisms. The previously mentioned factors further exacerbate the nematode problem. Soil solarization, any appropriate chemical or steam injection can all be used to achieve pasteurization.

3.4 Drip Irrigation: It is the most effective way to cultivate any type of horticulture crop in a greenhouse or an open field. One of the main issues with drip irrigation systems is clogging, which may be prevented with careful monitoring throughout system installation and operation. In addition, the following has to be attended to. Water analysis not only provides information about how well a crop can use it, but it also provides insight into potential clogging issues in drip irrigation systems. Therefore, it is imperative to assess the water quality prior to planning the construction of a drip irrigation system.

3.5 Fertilizer application and fertigation in greenhouse (Constant feed, Intermittent feed): Maximizing the benefits of fertilizer in terms of plant growth or output is essential in a greenhouse. The ideal approach to provide plant nutrients—naturally or with chemicals—so that the plants can utilize them is called fertilization. Using a drip irrigation system, there are two primary ways to administer liquid fertilizers containing specific plant nutrients to greenhouse plants.

3.6 Crop Protection: Maintenance of crop health is essential for successful farming for both yield and quality of produce. Pest Monitoring measures such as sticky traps should always be in place for timely action. Unwanted visitors should be discouraged from entering the greenhouse. GAP (Good Agricultural Practices) should be adopted to protect the crops from pests.

3.7 Canopy management: It is the procedure whereby a plant is regularly pruned to provide it with a certain, enduring structural framework. In reality, a plant's direction and spacing of some branches or its main stem are controlled by pruning or other means so that they form a suitable framework that lets in more light and airflow. In order to allow for high density planting, this lowers the land area covered by the plant canopy and boosts biomass efficiency.

3.8 Tools and equipment: Much higher levels of efficiency will be possible with the usage of specialized tools and equipment. The condition of the greenhouse environment can be determined by using items like meters to measure temperature, relative humidity, light, pH, electrical conductivity, and plant nutrients. These meters can also be used to advise management decisions that will better suit the plants. The ultimate form of computerization is completely automated systems that enable effective control of larger facilities even from a distance through satellite or telecommunications technologies.

4. **Physical infrastructure:** 1. Roads 2. Energy 3. Engineering facilities

5. Labour: The competencies required for conventional open field operations are very different from those required for greenhouse horticulture. This has to do with how often, when, and how detailed operations are. Additional tasks

(such as more thorough pruning, trellising, pollination, measuring PH and electrical conductivity (EC), and taking care when utilizing double doors) as well as more technical abilities are required. Numeracy and literacy are essential for maximum productivity. Due to their devotion and superior attention to detail, women are typically better suited for the majority of operations. The viability of relevant and suitable buildings for the production of vegetables is primarily dependent on the local climate. Despite this, selecting these structures also depends on a number of other considerations, such as a farmer's financial situation, the availability of a guaranteed market and electricity.

The following are the major protected cultivation methods in vogue:

1. Mulching
2. Floating Covers
3. Low tunnels / Row Covers
4. Cloches
5. Polyhouses / Greenhouses

Mulching: Covering the soil around cultivated plants is a common method to improve the growing environment for plants. This includes preserving soil moisture, keeping the soil temperature higher, weed control, and maintaining a more friable root zone that promotes soil aeration and root growth. Depending on the intended effects and climatic conditions, covering materials can be synthetic (polyethylene and PVC) in various colors (usually black) and thicknesses, or natural (leaf, straw, sawdust, peat moss, gravel, etc.).

Plastic mulches have several advantages,

- Soil moisture is better conserved.
- Weeds are effectively controlled by blocking sun light.
- Soil fumigation is more effective.
- CO_2 enrichment around plant root zone.
- Permits cleaner crop produce.
- Early crops, higher yields and more income.

Floating Row Covers: A plastic film cloth known as a "Floating Row Cover" is used to shield crops from sucking pests, hoppers, beetles, and insect vectors without the need for any mechanical support. Floating coverings consist of non-woven or spun-bonded cloth with a density ranging from 10 to 50 g/m2. Single rows or multiple rows at once are covered. The main purpose of heavier covers with densities greater than 30 g/m2 is to protect against frost and freeze. Burying in the ground secures the edges. The floating covers can be used for the full growing season of leafy vegetables, which are self-pollinating crops. Under floating covers, the crops of watermelon, squash, radish, musk melon, tomato, pea, carrot, cabbage, leafy vegetables, lettuce, green beans, and cucumbers are cultivated.

Low Tunnels / Row Covers: Rows of plants in a field are sometimes covered by low tunnels that offer protection from wind, insects, and freezing temperatures. Over low (up to 1.0 m high) hoops composed of cane, bamboo strips, or steel wires, clear plastic films or nets are stretched. Films of polyethylene with venting holes (4% of surface area) and a thickness of around 50 microns are employed. PVC films are also utilized occasionally. Lately, non-woven spun-bonded porous lighter films have also been used. The low tunnel allows the plant microenvironment to be passively controlled. Low tunnels work well when combined with drip irrigation and plastic

mulches. Low tunnels enable the production of melons, cucumbers, tomatoes, strawberries, capsicums, beans, summer squash, and other crops earlier and with substantially higher yields.

Cloches: A cloche is a kind of protective enclosure used in kitchen gardens, orchards, and woodlands. It is made up of a structural frame and transparent or translucent glazing material for individual plants. Cloches are eliminated once the plant has established itself well. In clear, sunny weather, the provision of natural ventilation is necessary to prevent excessively high temperatures.

Poly-house/Greenhouse: It is a large enough structure that can accommodate a person to operate within, and it is framed or inflated with a transparent or translucent cover that generates a greenhouse effect, providing at least some control over crop microclimate. In a polyhouse or greenhouse, the wintertime air temperature rise is used to grow crops, planting materials, and nurseries without the need for additional heating. The controlled ventilation of the enclosed enclosure allows for the enrichment of the air inside with a higher concentration of carbon dioxide, hence improving crop productivity. By using air conditioning, evaporative cooling, and shade, one can modify the ambient temperature and relative humidity.

Classification of greenhouse based on suitability and cost

a) Low cost or low tech greenhouse: Simple materials that can be found locally, such bamboo and stone pillars, can be used to build an inexpensive greenhouse. Materials for cladding are made from ultra violet (UV) film. Unlike traditional or high-tech greenhouses, this type of greenhouse does not come with a dedicated control unit for controlling environmental factors. On the other hand, straightforward methods are used to control the humidity and temperature. By using shade materials like nets, even the intensity of the light can be decreased. By opening the side walls in the summer, you can lower the temperature. In addition to providing protection from the elements for agricultural production, such a structure serves as a rain shelter. If not, the interior temperature rises when plastic film is applied to all sidewalls. The cold climate zones are the primary locations for this kind of greenhouse.

b) Medium-tech greenhouse: Due of the low initial expenditure, greenhouse users prefer manually or semi-automatically operated controls. Pipes made of galvanized iron (G.I.) are used to build this kind of greenhouse. With the aid of screws, the canopy cover is secured to the structure. To endure wind disturbance, the entire construction is securely fastened to the earth. To regulate the temperature, there are exhaust fans equipped with thermostats. To keep the greenhouse's interior humidity at a desirable level, misting systems and evaporative cooling pads are also installed. Maintaining a consistent climate during the cropping period is particularly challenging and time-consuming because these systems are semi-automatic, which means they need a lot of attention and maintenance. Dry and mixed climate zones are appropriate for these greenhouses.

c) Hi-tech greenhouse: In order to address some of the challenges found in medium-tech greenhouses, a high-tech greenhouse is designed with all of its components, including environmental parameter control, supported by

automatic operation. High-value, low-volume vegetables can now be grown using computer-based advanced technology that fully automates temperature, humidity, and irrigation control for both local and long-distance supply.

References:

- AVRDC (2006). Vegetable Matter. AVRDC-The World Vegetable Center, Shanhua, Taiwan.
- Bailie, A. (2001). Water management in soilless cultivation in relation to inside and outside climatic conditions and type of substrate.Talus Hortus 8:16-22.
- Bakker, N.; Dubbeling, M.; Gundel, S.; U, Sabel-Koschella,; & de Zeeuw, H. (2000). Growing cities, growing food. Urban agriculture on the policy agenda. Feldafing, Germany, Zentralstelle für Ernahrung und Landwirtschaft (ZEL), Food and Agriculture Development Centre.
- Bhardwaj, M. L.; Bhardwaj, R. K.; Kansal, S.; Thakur, K.;Sharma, H. D. and Kumar, M. (2011). Off Season Vegetable Production Technologies, Dept. of Vegetable Science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni-173 230 Solan(HP), pp. 52-62.
- Mathura Rai. (2013) Protected Cultivation of Vegetables. In Off-season Vegetable Production Technologies, Centre of Advanced Faculty Training Horticulture (Vegetables). Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni-173 230 Solan (HP), pp. 258-278.
- Mishra, G.P.; Narendra Singh, Hitesh Kumar and Shashi Bala Singh. (2010). Protected Cultivation for Food and Nutritional Security at Ladakh. Defence Science Journal. 61 (2): 219-225.