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RESEARCH ARTICLE

PROTECTED CULTIVATION OF VEGETABLES-SUSTAINABLE VEGETABLE PRODUCTION THROUGH USE OF GREENHOUSE CULTIVATION

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ABSTRACT

Adoption of horticulture, both by small and marginal farmers has brought prosperity in many regions of the country as India is endowed with a wide variety of agro-climatic conditions & enjoys an enviable position in the horticulture map of the world. In spite of its great importance, it facing a lot of constraints like photo-stress, moisture stress, temperature stress, weed growth, deficiencies in soil nutrients, excessive wind velocities and atmospheric carbon-dioxide. These constraints can be alleviated by adopting a unique, specialized hi-technology known as protected cultivation. The intent is to grow crops where the extreme conditions are existed and plant could not survive by modifying the natural environment. Protected cultivation of vegetable offers distinct advantage of quality, productivity and favorable market price to the growers. With the increase in population of our country and improvement in the dietary habits, the consumption of vegetable has improved. People realize the importance of vegetables in their diet as vegetables have high nutritive values which are the vital for the body. Since, vegetables are treated as high value crops and their regular supply in the market as in fresh condition is essentiality. It increases their income in off- season as compared to normal's season. Off season cultivation is one of the most profitable technologies under Northern Plains of India. Virus free cultivation of Tomato, Chilli, Sweet pepper, cucumber, Bitter Gourd and other vegetables mainly during rainy season.

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INTRODUCTION

Protected cultivation

Protective cultivation practices can be defined as cropping techniques wherein the micro climate surrounding the plant body is controlled partially/fully, as per the requirement of the plant species grown, during their period of growth. With the advancement in agriculture, various types of protective cultivation practices suitable for a specific type of agro climatic zone have emerged. Among these protective cultivation practices, greenhouse/ polyhouse are extremely useful for round-the-year vegetable cultivation. The worldwide production of vegetables has tremendously gone up during the last two decades and the value of global trade in vegetables now exceeds that of cereals. The worldwide production of vegetables has doubled over the past quarter century and the value of global trade in vegetables now exceeds that of cereals. Vegetables are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are the major causes of low yields and will be further magnified by climate change. India is the second largest producer of vegetables in the world, next to China. It produces 162.18 millions tonnes of vegetables from an area of 9.2 million hectares (NHB, 2014). The utility of protected cultivation has been found maximum with respect to the crop need. Presently in India, around 25,000ha area is under all forms of protected cultivation, and this technology is suitable for different parts of the country. In spite of all these achievements, per capita consumption of vegetables in India is very low against WHO standards (180 g/day/capita against 300 g/day capita recommended by FAO). There are different ways and means to achieve this target, e.g., bringing additional area under vegetable crops using hybrid seeds, use of improved agro techniques. Another potential approach is perfection and promotion of protected cultivation of vegetables. In natural season local vegetables flood the markets substantially bringing down the prices. In the absence of storage infrastructure and vegetable processing industry in the country, off-season vegetables farming is the only viable option that can add value to the farmer produce. Vegetables can be cultivated in off-season, with the induction of an artificial technique like

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greenhouse technology, in which temperature and moisture is controlled for specific growth of vegetables. The green house is generally covered by transparent or translucent material such as glass or plastic. The green house covered with simple plastic sheet is termed as poly house. The green house generally reflects back about 43% of the net solar radiation incident upon it allowing the transmittance of the "photo synthetically active solar radiation" in the range of 400-700 Nm wave length. The sunlight admitted to the protected environment is absorbed by the crops, floor, and other objects. These objects in turn emit long wave thermal radiation in the infra red region for which the glazing material has lower transparency. As a result the solar energy remains trapped in the protected environment, thus raising its temperature. This phenomenon is called the "Green house Effect".

- Protected cultivation can be defined as a cropping technique where the micro climate surrounding the plant body is controlled partially/ fully as per the requirement of the plant species grown during their period of growth**.**
- Greenhouse technology is the most practical way of achieving the goal of protected cultivation.

Worldwide Total Area in Major Greenhouse Production Countries

S.No.	Country name	Greenhouse area in (Ha.)
01	China	2,760,000
02	Korea	57,444
03	Spain	52,170
04	Japan	49,049
05	Turkey	33,515
06	Italy	26,500
07	India	25,000
08	Mexico	11,759
09	Netherland	10,370
10	France	9,620
11	US	8,425

Source: Kacira (2011) and Paroda (2013)

Advantages of protected cultivation

- Poly house give 5-6 times higher production compared to open field for round the year
- High input use efficiencies are achieved.
- Grown under unfavorable agro climatic condition.
- Protection from excess rainfall, wind, extreme cold, birds, Animals, human activity AND Minimum space maximum production per unit area.
- Minimum use of water and fertilizers
- Diseases and pests can be controlled easily
- Quality of product is superior
- PS are ideally for suited for production of genetically engineered and micro propagated veg. varieties and Hybrids.

Components of Green house

Protected cultivation has two major components of technology. One is the infrastructure involving frames, cladding materials, irrigation system, tools, implements, other engineering inputs and another is crop production technology.

Basic requirements: The Technology of producing horticultural crops in greenhouses has been around for decades. Greenhouse production provides growers with the ability to achieve significantly higher yields than open field production. P^H meter, EC meter, Thermometer, Electronic Scale – 5 lbs. capacity, Measuring Cylinder, Relative Humidity meter.

Growing Mediums

These are presently in use here, Soil [direct], Soil with gravel in bags, Coir, Perlite.

Water

Availability and quality of water should be checked. Access to good quality water is one of the most important inputs for greenhouse production. At their early stage, crops require at least 0.75 to 1 liter per plant, per day and this increases at the blooming, fruiting, and harvesting stages. High yielding indeterminate tomatoes before harvest may require up to 2.5 to 3.00 liters per plant per day.

Growing in the Soil

The soil should be properly prepared to allow for excellent development of the root system. It is best to use Raised Beds which ensures less compaction and room for workers to manoeuvre. Beds should be 1.7 meters from centre to centre of beds. The suggested planting distance is 3 two rows per bed, 40 centimeters between plants along the bed and 50 centimeters between rows staggered for tomato and sweet pepper.

Drip Irrigation System

The Components are. Water Tanks, Water Pumps – electric or gas, Elevated stand of about 5 feet to support tanks for gravity feed, Filter Systems, Pipes, Drip lines or Spaghetti system [Micro Tube 5/3]

Irrigation

The quantity of water used is dependent on the soil, the weather condition, growth stage of the plant and the pressure. The recommended pressure is between 8 – 12 psi. For the spaghetti system [Micro Tube 5/3] an electric pump is used, giving a pressure of 15 psi at the dripper. Also when using bags e.g. 6 x 11 x 14 two drippers are used per bag, with a dripper on either side of the plant.

Fertilization Program

Plants are fertilized every time water is added except once per week when the system is cleaned. It is best to use individual soluble fertilizers when available to make your mixture. This is after a chemical analysis of the soil is done. Attached are general fertilization programs for Tomato and Sweet Pepper, changes will have to be made depending on the location.

Plant Support System

This can be made from any affordable material available e.g. bamboo, wood and metal. The wire at the top of the system should be about 2.5 meters above ground.

Trellising or Plant Training

The cord and wires should be in place immediately after transplanting. White is the recommended color of the cord.

Plant training is done as required, possibly weekly. Sweet Pepper Pruning and trellising.

Tomato pruning involves three operations

a. Suckers – To be removed twice weekly. b.Fruits-To be removed weekly (done during (a) developmental stage (b) to facilitate marketable fruit size). c. Leaves – Five days before harvest remove the lower leaves up to the lowest fruit bearing cluster.

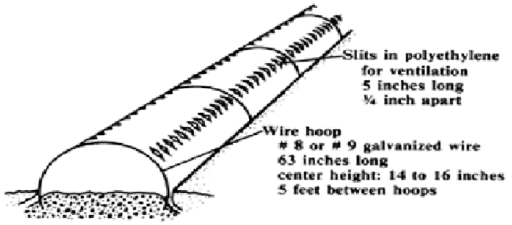
Limitations of Protected Cultivations

- High cost of initial installation (Capital cost).
- Needs a special postharvest facility.
- All the operations are very intensive.
- Close supervision and monitoring.
- Require ensure marketing.
- Manual or hand pollination in cross pollinated vegetables like cucurbits or development of their parthenocarpic hybrids/ varieties.
- Expensive, short life and non-availability of cladding materials.
- Lack of appropriate tools and machinery.
- Structure cost initially looks unaffordable. Farmers with zero risk affordability do not come forward to adopt it.

Kind of Protected cultivation

- Glass House.
- Poly House.
- Shade Net House.
- Poly tunnel.

There are five different types of environmental parameters maintained in a protected area. These are:

Glass House (High-tech.): Evaporative cooling and heaters are used to maintain required temperature inside glass house. Popular for Netherland. Maintained *the water and nutrient supply* by the mist and drip irrigation system with fertigation. High value blemish free crops of Tomato, Cauliflower, Cherry tomato, Sweet pepper, musk melon and Cucumber for long period.	
Poly House: Naturally Ventilated Poly houses Maintained the water and nutrient supply by the drip irrigation system with *fustigation* provided to maintain a favorable temperature and humidity during summer. Mainly being used in Turkey and Japan.	
Shade Net (Greenhouse): The greenhouse is covered Top with side walls have insect proof nets from gro*und to height of 5-6 feet with* manually rolable net cover. Mainly used for production of cucumber, muskmelon, tomato. In Japan Israel and Turkey**.**	
Low tunnels*:* Low tunnels and small walk-in tunnels are actually miniature greenhouses. Row Cover materials, clear (non-perforated) – too hot, clear (perforated) – hot, white (perforated) – warm, green (perforated) – warm, woven – warm.	 Slitted Row Cover

Environment of Green House

Light

Light is a most critical factor for poly house. PAR (Photosynthetically active radiation)-400-700 nm Important for photosynthesis, production & crop development. UVR -A-315-400nm (influence stem & leaf devp.) NIR – wavelength 700-3000nm (responbl. For Heating) FIR- wavelength 3,000-100,000nm (its causes the green house effect) we can reduce sunlight 30%, 50%, 75%. The 50% shed net are common in India.

Temperature

For vegetables healthy and maximum growth, the temp requirement is between 26'C to 30'C during day time and 15'C to 18'C in night. To control the temp inside the poly house, the ventilation as well as cooling pads and fans are used. Because of this we can have continuous quality production of vegetable throughout the year.

Carbon–di-oxide

In our surrounding atmosphere CO2 conc. Plants use this CO2 for photosynthesis. In poly house, during night time there is no photosynthesis but CO2 is given out by respiration. It has been proved that if poly house having 1000-2000 ppm of CO2, then vegetables production increases to 4 to 5 times more compare to normal conditions.

Relative humidity

For vegetables, we should have proper humidity. Requirement for vegetables it is 60% to 65%. Because of controlled humidity plant growth remain continue, their shelf life also increases. Humidity helps in color combination of vegetable.

Wind movement

If humidity is more in polyhouse, then chances of diseases and pest increases. Under such condition, side vents of polyhouse are opened to promote wind movement in polyhouse. Because of wind movement the humidity decreases and chances of diseases also reduced.

Improved Varieties suitable for polyhouse

Crops	Varieties'	Specific Type
Tomato	Pusa Hybrid-1, Daniela, FA-179,189, BR-124, HA-818,T-56, Arka Vardan, Arka Vishal, Naveen 2000 plush, VL Tamater -4, Pant poly house brad tomato-2, Pant poly house brad tomato-3	Indeterminate type High, TSS-6.8-7.0%, Fruit Wt. 120-200g,
	Indira, Pusa Deepti	Red fruits
Capsicum	VL-3, Orobellee, Golden Summer	Green Yellow fruits
Cucumber	Hasan, Sarig, Dinar Satis, Almir ,Pant Parthenocarpic Cucumber.-2, and 3	Parthenocarpic And Slicing type
Musk melon	Arava	High yield under polyhouse
Summer squash	Australian Green, Pusa Alankar, Goldy	High yield Low Tunnels

Comparative study between open field condition and protected condition

S.No.	Protected	Open
01	High yield 5-6 times	Less yield
02	Good fruit appearance	less
03	All most all marketable produce	50-80 %, 30% during rainy season
04	Easily control insect and pest	Difficult
05	Duration is fixed	Not fixed
06	No threat of damage	Doubt

Estimation cost for 500 M^2 areas of different Polyhouses

S.No.	Type of green house	Cost/$M^{2(Rs)}$	Ceiling Area	Ceiling Amount (Rs.)
01	Low cost	125	500	31,250
02	Medium cost	500	500	1,50,000
03	High cost	2000	500	9,00,000

Conclusion

The greenhouse technology is still in its preliminary stage in India and concerted efforts are required from all concerned agencies to bring it at par with the global standards. Economically viable and technologically feasible greenhouse technology suitable for the Indian agro-climatic and geographical conditions is needed at the earliest. Globalization coupled with economic liberalization will help in achieving the desired results. Efforts should be made to synthesize energy conservation principle along with environmental safety on a broader perspective. The future need for improving this technology is: Standardizing proper design of construction of polyhouses including cost effective and indigenously available cladding and glazing material. Computerized Control System maximize returns it includes time base/volume base/sensor based irrigation system, opening and closing of ventilators and side wall roll up curtains, CO2 Generator, Climate Control, Temperature, Humidity, Heat Radiation, Control of EC, pH, ppm level of elements in irrigation water etc. as required to the plant. Developing cost effective agro-techniques for growing of different vegetable crops in the different types of

polyhouses and lowering energy costs of the green house environment management.

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