

# Protected cultivation of high value vegetable crops for sustainable production in north eastern hill region

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*Due to increasing population, urbanization and rapid industrialization, achieving food security has become a major challenge in our country. It is estimated that by the year 2050 about 342 million tonnes of vegetables will be required to meet the consumers demand. Keeping in view the scenario, protected cultivation of vegetable crops especially the high value ones would be promising technology for improved productivity and cropping intensity. This technology may be promising for north eastern hill region due to unpredictable weather and prevalence of more congenial natural environment requiring minimal or no cooling as compared to other northern plains of India. Protected cultivation is carried out under protected structures like net house, shade house, polytunnel, polyhouse, etc. which are given different names depending on the cladding and other materials used during construction.*

**Keywords:** Cropping intensity, Industrialization, Protected structures

**T**HE basic concept of protected cultivation implies to the growing of high value crops under protected structure providing ideal microclimate for obtaining maximum growth with minimal or least stress. Thus, this technology provide substantial opportunity to obtain maximum benefit of growing the low volume and potential vegetable crops irrespective of environmental factor and to get off-season vegetables. Scattered and small land holdings, difficult terrain, fluctuating and unpredictable weather, prevalence of extended monsoon during rainy season especially in Meghalaya affecting the produce in terms of both quality and yield, thereby, reducing profit margin of northeast hill regions'farmers in cultivation under open environment. Protected cultivation technologies are commercially adopted in some of states of India like Maharashtra, Andhra Pradesh, Chhattisgarh, Madhya Pradesh, etc. The area under protected cultivation is likely to increase in hilly regions due to unpredictable weather and prevalence of more favourable natural environment which requires lesser or no cooling as compared to adjoining northern and southern plains. Commonly used protected structure for cultivation of vegetables are fully automated climate controlled or high tech greenhouses, partial climate controlled or modified naturally ventilated greenhouses, walk in

tunnels, insect proof net houses and plastic low tunnels. There is a vast potential for increasing the area under low cost polyhouses manifold in north eastern hill regions for production of high value vegetables during off-season to harness the benefit of the premium price of the produce and also early and delay harvest period.

Protected cultivation has a tremendous scope in north eastern hill regions, considering the increase in consumer preference for off-season and high quality produce of vegetable crops. This technology promise higher production not only in commercially grown high value vegetable crops but also in some vegetables such king chilli, bird eye chilli, dale chilli as which are endemic to north eastern region even under adverse agro-climatic conditions.

## **Selection of crop, varieties and crop calendar**

For cultivation under protected structure, high value low volume crops such as capsicum, tomato, parthenocarpic cucumber, cherry tomato, etc. are the most suited and hence, widely cultivated to secure maximum yield per unit area. Some of the private sectors hybrids promising for protected cultivation are tomato: Naveen 2000 Plus, Avtar; capsicum: Indra, Bharat, Mahabharat, california Wonder, Orobelle, Tanvi Plus; parthenocarpic cucumber: Kian, Nun-9729 and

Nun 3019. Besides these private sector hybrids, recently many hybrids/varieties are developed and released by research organizations under public sector, such as Pusa Seedless Cucumber-6, Him Palam Khira-1 in cucumber; Arka Basant and Arka Gaurav in capsicum; and Pusa Rakshit, Arka Meghali, Arka Saurav in tomato. These cultivars are reported to be promising for protected cultivation.

For the north eastern hill region where the farmers are mostly marginal with poor income, low cost naturally ventilated polyhouses or partially controlled polyhouses would be the most feasible structure. Under such protected structure, the climatic conditions of the cultivation area are the most important determinant for the crop cycle or harvest duration. The time of sowing

and transplanting could be made flexible. Citing tomato as example, its transplanting under north eastern hill region could be done from mid-August to first week of September and achieve harvesting till March to April. Similar harvest duration could also be achieved in off season. Capsicum being more climate sensitive, its transplanting should be done earlier by mid of July till early August so that the plant attain proper vegetative stage before the prevalence of low winter temperature. Likewise, king chilli, one of the potential chilli species endemic to the region is mostly cultivated during spring summer in open conditions but under naturally ventilated polyhouse, its year round cultivation is possible. With 40% shade net intensity on the roof during peak summer, reduce

**Table 1.** Production technology of high value vegetable crops under protected conditions

Vegetable	Variety	Planting time	Seed rate	Spacing	Inter-culture operation	Fertigation	Plant Protection	Crop duration (months)	Yield
Tomato	Big fruited tomatoes: Naveen 2000 Plus, Avtar 7711, Arka Vardan, Arka Vishal, BSS 366 Cherry tomatoes: Cherry 1, Cherry 2, BR-124 and H A-118	Jan and Feb May and June	150–200 g/ha	70 × 30 cm	Training, Pruning, Mulching, Topping, Cluster thinning of fruits to attain proper sizes	Fertigation @5–8 L/m <sup>2</sup> (5: 3: 6 ratio of N: P: K) according to growth and season of the crop.	Whitefly, Thrips, Aphids: Yellow and blue traps; metasystox spray @1.5 ml/L water 10 days after transplanting Mite: Spray dicofol @2.0 ml/L	8–9	Big fruited tomato: 250–300 t/ha Cherry tomatoes: 100–150 t/ha
Capsicum	Red: Bharat, Mahabharat, Indira, Tanvi Plus, Mekong Yellow: Orobelle, Tanvi and US 26 Green: Mekong and California Wonder (OP)	Jan-Feb and July-Aug for two crops in a year; March for raising single crop	50 g/1008 m <sup>2</sup>	45–60 × 30 cm	Topping after 1 month; Training for keeping 2 leader or 4 leader system; Thinning of fruits to attain proper sizes	Fertigation with Polyfeed (19:19:19) or application of any water soluble fertilizer @2.22 g/m <sup>2</sup> by dissolving 7g/10 litres of water, two times from 3 <sup>rd</sup> week post-transplanting and terminating 15 days before harvesting.	Use of sticky yellow traps or yellow water traps and regulation of humidity through fogging to minimize the incidence of insect vectors; Integrated management for powdery mildew and collar rot diseases	9–12	8–10 kg/m <sup>2</sup>
Cucumber	Parthenocarpic: Kian, Akameer, Nun-9729 (Summer), Saintis (Winter) Others: Japanesh Long Green, Poinsett, Malin, Pusa Sanyog	Feb, June, Oct	60 g seed/1000m <sup>2</sup>	70–150 × 30–60 cm	Training, Trellising avoid fruits upto 1.5 to 2.0 feet above the ground removing dry leaves	A basal application of 50–100 kg NPK/ha with The polyhouse soils should be analyzed for the nutritional status for ensuring judicious and economic use of liquid fertilizers, water soluble fertilizers like Samadhan or polyfeed (19:19:19) with the irrigation water	Use of sticky yellow traps or yellow water traps and regulation of humidity through fogging to minimize the incidence of insect; Integrated management for powdery mildew and downey mildew	3–3.5	4–5 kg/m <sup>2</sup>
Lettuce	Butter head: Boston, Butter crunch, Dark Green Boston, Red Butter head Crisp head: Garishma, Dublin and Salinas Loose Leaf: Oak leaf, Revolution, Dark Ruby Red	Nov–March	375–500 g/ha	45×30 cm	Weeding, earthing up and mulching	Fertigation @2 g/L of water twice a week.	Use of sticky yellow traps or yellow water traps and regulation of humidity through fogging to minimize the incidence of insect; Integrated management for powdery mildew and downey mildew	3–3.5	30–40 kg/m <sup>2</sup>

blossom and fruit drop, a major issue in this chilli species, is also observed. The cultivation of other crops such as parthenocarpic cucumber, gherkins, zucchini, and cherry tomatoes under protected cultivation needs to be introduced amongst the farmers of north eastern region for crop diversification.

### Design and dimension of protected structure

Efficient designing and construction of location specific polyhouses is the pre-requisite for success of protected cultivation technology by making use of appropriate and need based cladding material that combines the desirable characteristics of various materials. An ideal polyhouse may be standardized as per agro-ecological situation for harnessing the real potential of greenhouse technology. There are three types of polyhouses, viz. low cost polyhouse, medium cost polyhouse and high tech polyhouse.

**High tech or fully automated or high cost greenhouse:** In this type of polyhouse, there is higher automation for getting maximum climate control so as to extend the cropping season. This protected structure is provided with heaters and fan-pad cooling system to maintain ideal temperature in winter and summer, respectively. An operator, comparator and sensor form the basic part for running the structure. Cultivation of bell pepper and tomato with extended harvest duration is possible under this type of structure. It is constructed with plastic in normal places but glass houses or rigid plastic are used for construction under colder climate.

**Medium cost greenhouses:** This type of protected structure is similar with fully automated greenhouse but here the temperature and humidity control is achieved by exhaust fans with evaporative cooling pads. In northern India mostly the mid and low hills this type of protected structure offer promises for cultivation of many vegetable crops. The main advantage of this type of polyhouse is its cost effectiveness as compare to the fully automated one.

**Naturally ventilated low cost polyhouse:** The main advantage of this type of protected structure is the involvement of low initial investment. This type of polyhouse structure is constructed with GI pipe or steel pipe, logs or bamboo or any material which are available locally. There is no provision of heating or cooling pads in this polyhouse structure. A UV stabilized plastic is used to cover the roof and insect proof nets with proper mesh or thickness form the sidewall. This type of polyhouse require about half of the initial cost for construction of semi-automated polyhouse. Modified naturally ventilated polyhouses offer great scope not only for cultivation of high value vegetables crops but also raising of disease free pro-tray seedlings. Since climate in north eastern hill region is mild, low cost polyhouse can be successfully used for production of both off season vegetables and round the year production providing opportunity for the farmers to earn premium prices. Farmers of this region use polyhouse with bamboo frame to meet both the demand of local market and also for domestic

consumption.

**Plastic low tunnels:** Plastic low tunnels or row covers are simple and cost effective structures that provide protection from climatic variation. This type of portable structure is often used for vegetable crops during off season in open field. This type of structure can be installed over one or many rows of vegetable crops to provide ideal microclimate during cool and rainy season. The plastic covering not only provide protection from abiotic factors such as rain, hail and storm but also raises the soil temperature for optimum plant growth. Provided with the location specific modification, this type of protected structure are promising for vegetable cultivation in hilly regions and cold deserts.

### System of production based on growing media under protected cultivation

**Soil cultivation:** This is the traditional method of cultivation where plants are cultivated in soil. This is the most widely adopted system in the current time in north eastern hill region though there are disadvantages of soil borne pest and pathogens.

**Cultivation in growing media/substrate (Hydroponics/Aeroponics):** Soilless cultivation where vegetables are cultivated in growing media under protected conditions is gaining popularity amongst the farmers and agri-entrepreneurs in the country. For such type of cultivation, growing media such as cocopeat, rock wool, vermicompost, perlite, vermiculite, etc. are utilized, thus keeping the crop free from soil borne infections. This type of cultivation system is still very new to the farmers of north eastern hill region and needs popularization by creating awareness and skill development by expertise. In this regards, ICAR Research Complex for NEH Region, Umiam, Meghalaya has imparted awareness amongst the hill farmers and human resource development through demonstrations and training programme in its demonstration units of hydroponics. Other research institute in the region such as Central Potato Research Institute, Upper Shillong Centre, Meghalaya is working on soilless cultivation of potato through aeroponics. However, limited resources such as power supply, heavy initial investment, growing media, quality seedlings, mechanization, etc. are some of the lacuna in wide scale adoption of such type of cultivation system in the region.

### Healthy nursery production under protected condition

Most of the farmers of the region prepare seedlings in soil under open field conditions where biotic and abiotic stresses are major constraints in raising healthy and time bound seedlings. Among the biotic stresses, soil borne fungi, nematodes and different viruses are the major limiting factors in growing healthy seedlings of vegetables like tomato, chilli, sweet pepper, etc. Among abiotic factors, unfavourable microclimate, especially temperature restricts raising off-season nursery under open field conditions. Most of the farmers cultivate vegetables in the normal growing season by raising seedlings in open fields. At the time of harvest, the



Production of King-chillies under naturally ventilated polyhouse



Soil less cultivation of lettuce under hydroponic system

market become oversupplied with these vegetables resulting in poor returns or losses. However, the same vegetable can fetch higher or premium prices when produced in off season through soil or growing media. Raising nursery inside protected conditions not only offer promise for production of healthy, disease free and off-season vegetable nursery but also provide scope for vertical space utilization.

#### Protected cultivation and vegetables' grafting

Grafting of vegetable crops is becoming popular in recent times to combat biotic and abiotic stresses in addition to modifying growth and yield characteristics. As the grafted plants are more sensitive to biotic and abiotic stress in particulars, it requires proper protection in the initial phase. So, protected cultivation offers promise in providing optimum growing environment for grafted vegetable plants. In north eastern region, grafting of fruit crops is practise by farmers but grafting of vegetables is a new technology and need to be introduced. Some of the research institute such as ICAR-IIHR, Bengaluru, ICAR-CAZRI, Jodhpur, ICAR-IIVR, Varanasi, CSKHPKV, Palampur, etc. are working in grafting of solanaceous and cucurbitaceous vegetables.

#### Benefits of protected cultivation technology

Some of the benefits obtained through protected cultivation technology are summarised below:

- Environment control allows raising vegetables throughout the year independent of climatic factor

which otherwise is not possible under the open field conditions.

- Protected cultivation provide optimum yield per unit area/input.
- The production of chemical, insect-pest and disease free premium products.
- Production of export quality crops.
- Provide opportunity to farmers with small and the marginal land holdings to enhance their income by cultivating vegetable crops targeted for the international markets.
- Provide employment generation for the educated youth of rural areas in agriculture.

#### SUMMARY

Indigenous technological database need to be developed to make adoption of protected cultivation sustainable in north eastern hill region. Cost effective and location specific design of the protected structure needs to be developed. Systematic efforts are needed for development of suitable hybrid/varieties for protected cultivation; package of practices including fertigation specific to north eastern region need to be worked out. Protected cultivation has huge initial investment and labour intensive. Therefore, locally available suitable design of tools, devices and equipments are required to reduce the cost of cultivation.

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Plant trees, Conserve water,  
Protect environment.

