

Off-Season Vegetable Cultivation Under Protected Structures: A Promising Technology For Doubling Farmers Income

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ABSTRACT

The demand for fresh vegetable prevails round the year but supply is restricted to cultivation season. The performance of the different vegetable crops is highly influenced by changes in climatic vagaries like fluctuation in temperature, light, humidity, wind velocity etc. that adversely affect the growth, physiological process, flowering, fruit setting and finally yield and economic return. The unpleasant climate drastically reduced the total production or even result in total crop failure. To increase the availability of the fresh vegetables beyond normal season, promotion of off-season cultivation is the need of the hour. Summer crop of winter season vegetables under open field condition is not possible as scorching sun and higher day and night temperature adversely affects the vegetative growth, prompted flower and fruit drop. Again cultivation of summer crop during winter months in open field suffers from low temperature, cold waves and freezing injury. By adopting proper protection technologies and providing favourable environment, the crops can be raised during off season. With the introduction of shade net which partially control the temperature and light and creates a favourable environment for crop growth that enables raise the crop under intense summer months with desirable yield and quality. Again poly house maintained higher temperature and light intensity compared to outside during winter months which favours the growth and yield of summer season vegetables. The full paper discussed the different aspects of off-season vegetable cultivation to make the production system economically viable and remunerative.

Key words: Off-season vegetable cultivation, agro shade net, poly house, temperature and light.

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INTRODUCTION

Vegetable crops are cheaper source of natural protective nutrients namely carbohydrates (cassava, sweet potato, potato, colocasia), protein (peas, beans, drum stick, agathi flower, fenugreek leaves), fat (taro leaves, drum stick leaves), minerals (palak, amaranth, fenugreek, coriander) and vitamins (carrot, beet, cabbage, tomato, chilli). They are good source of essential amino acids that are lacking in cereals and pulses. Crops like amaranthus, okra, ridge gourd and sponge gourd are valuable source of roughages in the form of dietary fiber and neutralizes the acid formed during the digestion of protein and fatty foods. Coloured vegetables like orange carrot, purple cabbage/cauliflower, red tomato and watermelon are rich source of antioxidants and possessed anti-cancerous properties.

India is the second largest producer of vegetable crops in the world just after China. The present production of vegetables, 138.00 million tonnes (NHB-2011) is to be raised to 250 million tonnes by 2024-2025 [16]. 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 [25, 26]. Protected cultivation is 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 [18]. It is a method where plants are getting protected from adverse conditions like rains, freezing temperature, hailstorm, sun burn, insect and disease pest etc. The main purpose of protected cultivation is to create a favourable environment for the sustained growth of crop so as to realize its maximum potential even in adverse climatic conditions. Protected cultivation offers several advantages like production risk is comparatively less than open field condition, 10-12 times higher yield than that of outdoor cultivation, proper nourishment of the crop, opportunity for year round production of high-value vegetable crops, disease free quality planting material production, efficient utilization of land and resources. This economic return can increase manifolds if high value vegetables are selected for cultivation under protected conditions, like poly houses, net houses, poly tunnels, rain shelter etc. The productivity of off-season vegetables can be increased many fold through protected cultivation technologies by growing the crops throughout the year. Singh and Sirohi [25] reported that protected cultivation of vegetables offers distinct advantages of quality, productivity and favourable market price to the vegetable growers. Proper selection of crops and adoption of appropriate protected structures will lead to better productivity and profit maximization. The system will also help to create employment for the local youths particularly farm women.

Utilization of Protected Structures for off-Season Vegetable Production

Growing of summer vegetables in winter months

Use of Poly house

The demand for fresh summer vegetable like okra, bitter gourd, bottle gourd, cucumber etc. increased many fold during winter months for increasing diversity in diet. Open field cultivation of summer vegetables during winter months will not be possible due to temperature fluctuations. The summer vegetables can be successfully cultivated in the poly house as the temperature inside poly house remain higher compared to outside environment. Again the adverse effect of cold wind can be overcome during crop cultivation. Poly house are the structures made of polyethylene. The size of structure can differ from small shacks to big-size buildings as per the need of the grower. In present condition, poly house cultivation of off-season vegetables is emerging as a specialized production technology to overcome abiotic stresses for year round production. Poly house gives the optimum environmental facilities to the crops. It can be utilized for organic cultivation of high value vegetables. Poly house also protect the crop from the attack of pest and diseases. Apart from crop cultivation, raising of seedlings of different summer season vegetable can also be practised for advancing the crop period and for better remuneration. Several researchers have observed that poly house cultivation can offer several benefits to small farmers which can help in doubling their farm income. Singh *et al.*, [27] reported that low-cost, naturally ventilated poly houses were the most suitable and economical for year-round cultivation of cucumber in the northern plains of India. Isaac [15] observed that coriander plants establishes and grows well with higher biomass production in naturally ventilated poly house. Sweet pepper can be successfully grown under zero energy naturally ventilated poly house condition and produced higher returns [3]. With the development of parthenocarpic hybrids in brinjal, now it is possible to grow brinjal under the protected conditions [16]. Dixit [8] studied the performance of leafy vegetables under protected environment and open field condition. Protected structure offers an opportunity for extended period of leafy vegetable cultivation under frost free and comparatively higher night temperature conditions.

Table No 1: Performance of tomato varieties under poly house and open field conditions in Barapani, Meghalaya.

Varieties	Poly house yield (q/ha)	Open field yield (q/ha)	Varieties	Poly house yield (q/ha)	Open field yield (q/ha)
BT-117-5-3-1	342.00	115.00	Selection-2	233.00	73.83
KT-10	283.60	117.40	Selection-1	200.98	84.03
BT-10	294.00	111.65	KT-15	211.60	51.65
Arka Alok	260.00	57.90	H-24	243.17	58.75
BT-12	302.40	101.00	Arka Abha	193.50	70.33

(Source: Singh, [26])

Table No 2: Suitable vegetable varieties for year round cultivation under low cost poly house

Crops	Varieties	Season
I-Year		
Tomato	Naveen, Karnataka	May- Aug
French bean	Kentucky Wonder, Contender	Sept- Nov
Cauliflower	White Marble, Indam	Dec- Feb
Coriander	CO-1, Mehak	May- April
Green manure	<i>Sesbania spp.</i>	May
II-Year		
Tomato	Naveen, Karnataka	June- Sept
French bean	Kentucky Wonder, Contender	Oct- Dec
Chilli	KA-2, Arka Lohit	Jan- April
Cowpea	Arka Suman	May- June
Other crops		
Okra	Arka Anamika	May- June
Palak	All Green, Pusa Jyoti	June- July

[Source: Phookan and Saikia, [20]

Table No 3: Economics of crop cultivation under poly house

Sl No.	Crop	Month of planting	Area under crop (m ²)	Yield (kg)	Productivity (ton/ ha)
Crops in terrace					
1.	Capsicum	May	32.31	26	8.05
2.	Tomato	April	32.31	24	7.43
3.	Brinjal	May	35.0	38	10.86
4.	French Bean	June(1st week)	19.38	12	6.19
5.	Cabbage	July	62.70	63	10.05
6.	Cauliflower	August	32.31	22	6.81
7.	Pea	December	32.31	23	7.12
8.	French Bean	January	35.0	25	7.14
9.	Tomato	March	62.70	35	5.58
Crops on riser					
10.	Bitter Gourd	June	10.16	9.2	9.06
11.	Bottle Gourd	June	20.23	35	17.30
12.	Cucumber	July	10.16	12	11.81
13.	Bitter Gourd	November	10.16	4.6	4.53
14.	Cucumber	February	30.31	26	8.58

[Source: Anonymous, [1]

Low tunnel/ Row cover

Cultivation of crops like tomato, summer squash, melons, capsicum are very difficult in open field during winter month under north Indian condition due to prevalence of cold wind. In such situation these crops are grown in low tunnels/ row cover. The structure protects the crop from wind damage. It also helps to retain the heat. Crop inside the row cover matures early and produce reasonable yield having higher market price. Row cover can increase the fruit yield up to the extent of 25% in many cucurbits namely summer squash, cucumbers, melons etc respond over open field condition during adverse climatic

condition [13]. Earlier production and yield increment in cool season crops like spinach and leaf lettuce under row covers was reported by Dickerson, [7].

Table No 4: Performance of vegetable crops under low tunnel

S. No.	Crop	Transplanting time	Harvesting time	Crop advancement	Expected cost benefit ratio
1.	Summer squash	First week of December	First week of February	60 days	1:3 to 1:4
2.	Muskmelon	Third week of January to first week of February	Second week of April to Last week of April	30-40 days	1:2.5 to 1:3.5
3.	Bottle gourd	Third week of January to first week of February	Second week of April to Last week of April	30-40 days	1:2.5 to 1:3.5
4.	Bitter gourd	Third week of January to first week of February	Second week of April to Last week of april	30-40 days	1:3 to 1:4
5.	Water Melon	Third week of January to first week of February	Second week of April to Last week of April	30-40 days	1:2 to 1:2.5
6.	Cucumber	Third week of January to first week of February	First week of February	30 days	1:3 to 1:4

(Source: Singh *et al.*, [28])

Growing winter vegetables in summer months

Use of Shade net

Supply of winter vegetables like cabbage, cauliflower, carrot radish, turnip etc become restricted during summer months. The price of these vegetables remain very high due to restricted production and long distance transportation. Cultivation of winter vegetables like cabbage, cauliflower, carrot radish, turnip etc during summer month is possible through adoption of agro shade net house cultivation. A Shade house is a structure enclosed by shade nets or any other woven material to allow required sunlight, moisture and air to pass through the gaps. It creates an appropriate micro climate conducive to the plant growth. A shade house structure composed of two basic components i.e. frame and cladding material. The shade house frame provides support for cladding material and designed to protect against wind, rain and crop load. The life span of shade house can be up to 5 years depending on the climatic condition and the structural material utilized. Shade nets are available in wide range of shade percentages viz. 25%, 30%, 35%, 50%, 60%, 75% and 90%. The partial shade and ventilation reduce the temperature inside the structure and provide favourable environment for crop production. The structures also protect the crop against pest attack and natural weather disturbances. The structures can also be utilized for raising seedlings of different winter vegetable for early season open field cultivation. Negi *et al.*, [19] reported that under higher altitude shade net can help to increase yield of many vegetables. They found that the percentage of yield increase was maximum for pea (286%) followed by capsicum (70%) and tomato (58.66%). Similarly, under low altitudes situation the maximum fruit yield was found for brinjal (169.33%) followed by capsicum (136%). Apart from yield quality of fruit can be enhanced under shade net condition. Cheema *et al.*, 2004 observed that cultivation of off-season vegetable crops under shade net can produce higher yield, advance the maturity and reduce the incidence of insect pest attack. Singh and Asrey [29] also reported that cultivation of tomato in a greenhouse would help obtain high productivity and better return. Study on performance of cucumber inside the shade net house revealed that fruit yield and quality was better compared to the crop grown in open condition and nearly 3½ times higher fruit yield of cucumber was recorded under shade net house [9, 10]. Zoran *et al.*, [31] also stated that fruit yield of cucumber can be increased by 113 to 131% under shade net condition over the open field cultivation.

Table No 5: Performance of vegetable crops inside agro shade net

Tomato						Capsicum	
Net house	Fruit weight (g)	Yield kg/pt	TSS (0 Brix)	Vit.C (mg/100g)	Acidity (%)	Fruit weight (g)	Yield Kg/pt
NH-1	54.0	3.62	5.8	32.76	0.78	45.7	2.7
NH-2	57.9	3.83	6.3	34.02	0.78	57.4	2.5
NH-3	48.8	3.97	6.1	34.74	0.92	77.6	2.6
NH-4	45.6	3.71	7.0	36.18	1.03	62.5	2.7
Open field	42.0	2.17	5.6	32.72	0.72	35.8	1.3

Cloches:

During summer month potted plants and small group plants are protected from high temperature and hot wind during initial growth stage by using cloches. When the adverse climatic condition is over, the cloches are removed. Cloches are generally employed to provide protection to young transplants in vegetable gardens during hot summer. Cloches are easy to transport, hence preferred over using a permanent structure. The structure also helps to mature crops early in the season. Low density polyethylene and poly vinyl films are common used as glazing materials for cloches.

Growing winter vegetables in rainy season**Rain shelter**

The price of the vegetable crops remain very high during rainy season due to prolonged shower and high soil moisture. The attack of disease and pest increases during rainy season which drastically reduce the crop yield and quality. Vegetable cultivation faces severe challenges in north-eastern part of India due to extended rainy season. Rain shelter can provide an opportunity to grow different types of vegetable inside the structure which is not possible in the open field. Rain shelter houses are roofed with plastic film and other waterproof materials to shelter crops from rain. The houses are effective in reducing crop damage caused by diseases and insect pests, in promoting crop growth, and in achieving stable production of high quality vegetables [29-33]. The structures are mostly made up of GI pipes or bamboo poles with roofs made up of transparent UV-stabilised low density polyethylene film. The structures are naturally ventilated and protect from direct shower. The use of rain shelter is highly effective in vegetable production, particularly in heavy rain areas. Success cultivation of crops like cabbage, cauliflower, French bean, radish, palak, coriander have been achieved through rain shelter. The structure can also be used for growing seedlings of winter vegetable to catch the early season [5, 6, 11, 12].

Poly tunnel

Poly tunnels are widely used during rainy season for cultivation of low heights vegetable crops like cabbage, cauliflower, onion, radish, palak, coriander etc. It protects the crop from direct sunshine and heavy rains. The tunnels are elongated semi circular shaped low height structures made up of polyethylene. These are the temporary structures which can be moved to another places easily if required so. Nowadays, different types of micro greens are cultivated inside poly tunnel to catch off-season markets of herbs and salads. Ranjan *et al.*, [23] enlisted the poly tunnels benefits in musk melon cultivation such as frost protection, earliness in planting and harvesting, and season extension. They observed that muskmelon cultivation under low poly tunnel produced highest fruit yield/plant (9.07 kg), number of fruits/plant (18.36), fruit diameter (98.37cm), number of branches (7.05), vine length (159.24 cm) and number of leaves/plant (144.08) which was much better than unprotected condition. They opined that the better growth and development of all yield contributing parameters of muskmelon under low poly tunnel was due to increases in net photosynthesis and production of more assimilates available for individual to grow [17, 18].

Challenges in off-season vegetable production under protected structures

Farmers are facing a lot of challenges during cultivation of vegetable crops inside protected structures. High initial cost for establishment of structures like poly-house, shade net, rain shelter etc discourage for wider adaptation. Again non-availability of various construction materials like GI pipes, polyethylene sheet etc are not generally available in local market and need to be imported at high costs including freight and custom duty. Sometimes for installation, monitoring and supervision, skilled workers are required which are not easily available in the village areas. The package of practices of different vegetable crops for round

the year cultivation have not been standardised, hence the recommendation of one region may not work for other region. Lack of awareness among farmers about the potentials of protected vegetable production hampering the large scale cultivation. Very limited research work have been initiated on protected vegetable farming of different commercial crops.

CONCLUSION

The growing population and rapid industrialization and urbanization is gradually decreasing the cultivated land. The demand of fresh vegetable under shrinking land area forces the policy maker to think beyond open field cultivation. For maximum utilization of available land and to enhance the productivity as well as to minimize the use of harmful pesticides, protected structures offers immense scope for the farming community of India. To fulfil the dream of doubling farmers income, adoption of protected structure for year round cultivation of the different vegetable crop is the need of the hour. Effort should be made to minimise the initial investment of establishment of protected structures. Promotion of low cost protected structures with natural ventilation should be encouraged. The market should be linked with the availability of crop in the protected structure for maximum monetary return. Government support as well as intervention of NGOs for financial help and arrangement for skill development programme on protected cultivation will help to increase the area under protected cultivation. Supply of improved package of practices for protected cultivation through leaflets, farmers training will help to create more awareness about the protected cultivation among the farmers.

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