



**Working Group Report**  
**on**  
**Development of**  
**Protected Cultivation in Haryana**



**Haryana Kisan Ayog**

CCS HAU Campus, Hisar-125004  
Government of Haryana



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on  
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CCS Haryana Agricultural University Campus  
Hisar 125004  
Government of Haryana

## The Working Group

### Chairman

#### **Dr. Brahma Singh**

Former Director  
Agriculture and Life Sciences  
Defence Research and Development Organization

### Members

#### **Dr. Balraj Singh**

Director  
National Research Centre for Seed Spices  
Tabiji, Ajmer, Rajasthan

#### **Dr. Ramesh Kumar**

Director  
Directorate of Floricultural Research  
ICAR, Pusa Campus, New Delhi-110 012

#### **Dr. S.K. Arora**

Former Head  
Department of Vegetable Science  
CCS HAU, Hisar, Haryana. 125004.

### Nodal Officer

#### **Dr. M.L. Chadha**

Former Director (Africa & South Asia), AVRDC- The World Vegetable Centre  
Consultant, HKA, CCSHAU, Hisar, Haryana



**CHAIRMAN**  
HARYANA KISAN AYOOG  
CCSHAU CAMPUS  
HISAR-125004



## FOREWORD

Haryana is well suited for the promotion of horticulture, especially in view of its vicinity to the National Capital Region and other big cities around, beside having easy access to both domestic and external markets. In this context, technology of Protected Cultivation, to grow low volume high value crops, offers great potential to the farmers engaged in peri-urban agriculture. The technology is also scale neutral as it benefits both the large-scale and small scale farmers and ensures higher productivity as well as income.

Protected cultivation of vegetables and flowers also offers much needed option for agricultural diversification needed to increase farm income. High quality nursery raising of vegetables is a new option in meeting the increasing demand for kitchen gardening by the affluent Urbanites interested in growing their own healthy foods. Similarly, growing of good planting materials of fruits and flowers offers yet other options of increasing farmer's income.

In view of above, Haryana Kisan Ayog took the initiative to form a Working Group on Protected Cultivation under the leadership of Dr. Brahma Singh, with Drs. Balraj Singh, Ramesh Kumar and S.K. Arora as members, and Dr. M. L. Chadha as a nodal officer from the Ayog. I congratulate Dr. Brahma Singh and his team for their sincere efforts in bringing out this useful Report entitled "Protected Cultivation for Haryana" in a record time. It not only contains valuable information relating to this field but would serve as a Road Map for promoting peri-urban horticulture in the State. I am sure the Department of Horticulture, State Agriculture University, the extension workers/officials and the farmers interested in horticulture will benefit from this report and in the process accelerate protected cultivation in the State of Haryana.

It is also our expectation that this publication will be useful especially for the progressive young farmers willing to adopt new entrepreneurial skills to benefit from secondary agriculture, for which protected cultivation is one of the best options.

**(R. S. Paroda)**



**FORMER DIRECTOR  
AGRICULTURE AND LIFE SCIENCES, DRDO &  
CHAIRMAN  
WORKING GROUP ON PROTECTED CULTIVATION  
IN HARYANA**



## **PREFACE**

Ensuring food and employment security to over 1.2 billion population from available resources on a sustainable

basis in the country is a huge task. Besides wheat and rice, Haryana is one of the leading states in the production of certain fruits, vegetables, flowers and mushrooms. Present statistics show that Haryana can boast of its leading position in India in production of cauliflower (5<sup>th</sup>), pea (6<sup>th</sup>), cabbage (7<sup>th</sup>), okra (7<sup>th</sup>), onion (7<sup>th</sup>), tomato (7<sup>th</sup>), brinjal (9<sup>th</sup>) and potato (10<sup>th</sup>). Haryana is also producing sizeable quantity of flowers like marigold, roses and tube rose. Among the modern agro-technologies, protected cultivation technology of horticultural crops and their nursery multiplication is getting added attention due to its distinct advantages such as higher productivity, off-season production and entrepreneurial avenues.

Modern protected cultivation technologies cover climate control greenhouse and poly/net protected structure farming, hi-tech horticulture, naturally ventilated green/polyhouse, soil-less vegetable farming (hydroponics and aeroponics), plasticulture, drip irrigation, fertigation and integrated nutrient, pest, water and weed management. Simple and low cost protected structures such as net houses (shade, insect proof), poly tunnels, plastic mulch etc. are also getting popular among the farmers. Due to shortage of power and its tariff, the provisioning of cooling and/ or heating devices in protected structures is uncommon.

Central Government programmes like National Horticulture Mission, National Committee on Plastic Applications in Horticulture (NCPAH), Rashtrya Krishi Vikas Yojana (RKVY), Vegetable Initiatives in Urban Clusters, and others are laying emphasis on protected cultivation.

Government of Haryana has taken lead in popularization of protected cultivation by establishing two demonstration centres at Gharaunda and Sirsa under Joint Indo-

Israel agriculture promotion programme, establishing clusters for vegetable production, mushroom production and many more to boost horticulture production in the State. Besides, the Government has appointed a separate Working Group on protected cultivation for Haryana under Haryana Kisan Ayog. This step seems to be the first of its kind. The report under reference has been prepared by this Group by interacting with all stakeholders including farmers spread over the State. The Group has brought out the strength of the state in this venture and suggested ways and means to achieve the goal of boosting horticultural production through protected cultivation in the State. It is hoped that all the stakeholders would take advantages of this report in achieving the common goal of boosting not only the horticultural production but also strengthening all the stakeholders by converging their energies in mutually progressive manner.

I would be failing in my duty if I do not acknowledge the help rendered by Dr. R. S. Dalal, Member Secretary Haryana Kisan Ayog, Dr. M. L. Chadha, Consultant, Haryana Kisan Ayog, Dr. Ravi Kant, Research Fellow, Haryana Kisan Ayog; and Dr. Balraj Singh, Member of Working Group on protected cultivation and Director, National Research Centre for Seed Spices, Tabiji, Ajmer, Rajasthan, Dr. Ramesh Kumar, Director, Directorate of Floricultural Research, ICAR, New Delhi and Dr. S. K. Arora, Former Professor and Head, Department of Vegetables Science, CCS HAU, Hisar in providing support, inputs and suggestions for formulating and preparing this report. I profusely thank Dr. Naved Sabir Principal Scientist, NRCIPM, New Delhi, Dr. S.S. Sindhu, Dr. B.S. Tomar and Mrs. Shweta Walia and Ms. Seema Rani from CPCT for their help and valuable suggestions as well as for critically going through the manuscript and preparation of this report. The inputs and supports extended by Dr. A. S. Saini, Dr. Satyinder Yadav and other officers of Department of Horticulture, Government of Haryana are thankfully acknowledged. We are thankful to the Professor and Head, Horticulture, Vegetable Science and Dean, College of Agriculture and Agriculture Engineering, CCSHAU, Hisar for their valuable inputs. The group is thankful to all the experts involved in brainstorming sessions and acknowledges their support and appreciation. The group profusely thanks Dr. R. S. Paroda, Chairman, Haryana Kisan Ayog for providing an opportunity to prepare a holistic report on protected cultivation in Haryana.

  
**Brahma Singh**

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## ABBREVIATIONS

<b>AHRD</b>	Agricultural Human Research Development
<b>APEDA</b>	Agricultural Product Export Development Authority
<b>AVRDC</b>	The World Vegetable Centre
<b>CCM</b>	Cool Chain Management
<b>CCSHAU</b>	Chaudhary Charan Singh Haryana Agriculture University
<b>COE</b>	Centre of Excellence
<b>CPCT</b>	Centre for Protected Cultivation Technology
<b>CSR</b>	Corporate Social Responsibility
<b>DIHAR</b>	Defence Institute of High Altitude Research
<b>DRDO</b>	Defence Research and Development Organization
<b>FAO</b>	Food and Agricultural Organization
<b>FRL</b>	Field Research Laboratory
<b>GAP</b>	Good Agricultural Practices
<b>GI</b>	Galvanized Iron
<b>Govt</b>	Government
<b>HKA</b>	Haryana Kisan Ayog
<b>HRD</b>	Human Resource Development
<b>IARI</b>	Indian Agricultural Research Institute
<b>INM</b>	Integrated Nutrient Management
<b>IPM</b>	Integrated Pest Management
<b>IWM</b>	Integrated Weed Management
<b>KMP</b>	Kundli- Manesar – Palwal Express Highway

<b>LDPE</b>	Low Density Polyethylene
<b>NCPA</b>	National Committee on use of Plastic in Agriculture
<b>NCPAH</b>	National Committee on Plastics Application in Horticulture
<b>NCR</b>	National Capital Region
<b>NGO</b>	Non-Governmental Organization
<b>NHM</b>	National Horticulture Mission
<b>NIFTEM</b>	National Institute of Food Technology Entrepreneurship and Management
<b>NRCIPM</b>	National Research Centre for Integrated Pest Management
<b>NVGH</b>	Naturally Ventilated Greenhouse
<b>NVPH</b>	Naturally Ventilated Polyhouse
<b>PAU</b>	Punjab Agricultural University
<b>PPP</b>	Public Private Partnership
<b>R&amp;D</b>	Research and Development
<b>RKVY</b>	Rashtriya Krishi Vikas Yojna
<b>SAU</b>	State Agriculture University
<b>SEZ</b>	Special Economic Zone
<b>SWOT</b>	Strength Weaknesses Opportunities and Threats
<b>TEAM</b>	Transparent Electronic Auction Management
<b>TERI</b>	Tata Energy Research Institute
<b>UV</b>	Ultra Violet
<b>WGPC</b>	Working Group on Protected Cultivation

## EXECUTIVE SUMMARY

Haryana Kisan Ayog, Government of Haryana, vide letter No. HKA/11/WG-05/6194-6202 dated 15-9-2011 constituted a Working Group on Protected Cultivation (WGPC) in Haryana with ten terms of reference. Accordingly, the Working Group had meetings, field visits with all stakeholders, the farmers, Department of Horticulture, Government of Haryana, Seed Companies, Protected Cultivation input providers, horticulture markets, CCS, Haryana Agricultural University, Hisar, Haryana Kisan Ayog Chairman, Chief Consultants and other concerns. The Group generated information and gave recommendations as per terms of reference.

Protected cultivation is fast emerging as one of the progressive areas in agriculture through various govt. schemes of Haryana, Rashtriya Krishi Vikas Yojana, National Horticulture Mission and National Horticulture Board, due to which the area under protected cultivation has reached to nearly 150 ha within a few years. However, the baseline data, historical development and SWOT analysis of these developmental programmes on protected cultivation were studied by WGPC. The critical analysis revealed several lacunae at policy, research, education, extension, human resource and marketing levels. The WGPC has critically studied all these aspects and tried to sum up each issue with critical gaps and solutions, followed by broad guidelines and recommendations to streamline various components of protected cultivation technology for overall improvement.

First and foremost, the greenhouse structures being promoted at the state level have been studied and the kind of suitable structures for different areas, crops and seasons have been recommended along with the pragmatic cropping sequences for high quality vegetable and cut flower production, as well as the estimated cost of these structures. Among various structures advocated, zero-energy naturally ventilated greenhouses, insect-proof net-houses, high tunnels with top ventilation, temporary walk-in tunnels, and other low cost structures along with their dimensions, have been suggested considering the climate and economic affordability for the state growers. Besides this, an exhaustive treatise on the cropping sequences for both, vegetables and cut-flowers for important structures have been suggested. All suggested structures should be practically demonstrated at

each district. These demonstration facilities should include scope of on-farm value addition of the produce and be linked with Krishi Vigyan Kendras (KVK) wherever possible. Extensive use of plastic mulch coupled with low pressure drip irrigation/fertigation in production of horticultural crops in open fields has been recommended to boost production to the extent of 25% and discourage surface irrigation leading to saving/conservation of water.

Once the greenhouses have been constructed, the prime requirement, thereafter, is successful crop production. Since farmers are hardly provided any technical guidance on production and protection technologies, they suffer acutely on account of poor know-how. Therefore, WGPC has reviewed the research gaps and given critical recommendations for the overall handling of these gaps in the area of protected cultivation through institutional support by opening a School on Protected Cultivation at CCS HAU, Hisar, not only for leading focused research to address these issues but also to conduct training and awareness programmes for the growers interested or engaged in protected cultivation. Apart from this, Industrial Training Institutes (ITIs) in the state in consultation with the school may be introduced with a diploma course on greenhouse construction, repair and maintenance apart from the development of minor tools and equipments enabling youths to take it up on entrepreneurial ventures. Training of local artisans on protected structures at appropriate places has been advocated by the group.

Since peri-urban areas of Haryana have an added geographical advantage, being in proximity of National Capital Region (NCR) of Delhi, thereby giving ample scope to growers for increased income. WGPC has critically analyzed these locational advantages for devising appropriate strategies that can give long-term economic boost to agriculture as a whole to the state, particularly the youth who can take up protected cultivation as entrepreneurial venture. Besides, Working Group has strongly recommended the formation or encouragement to formation of clusters of protected cultivation so that such hubs sustain themselves as units of holistic technological and economic entities in geographical and economic terms. These clusters may additionally be provided with diagnostic laboratories, certification and accreditation, which otherwise is not possible for sporadically located greenhouses across the state.

Other than technical know-how on production and protection technologies, the

major difficulties faced by the farmers include poor marketing support or their access to reliable marketing network. Since protected cultivation growers incur huge initial investments, they often fail to fetch better prices for their produce in spite of higher quality. Therefore, working group has suggested strong marketing support to the clusters of protected cultivation with preferable involvement of the growers at critical junctures of decision making across different stages of the gamut of marketing their produce. One of the path-breaking suggestions is for the creation of electronic auction mechanisms with transparent auctioneering of the produce with the help of cluster farmers themselves not only in auction but also possibly through linking it up with export. The group suggested that the marketing mechanism for horticulture produce adopted may ensure 60 % share of consumer's price to the farmer.

Working Group has suggested strong public-private linkages for holistic development of protected cultivation in the state, the major of them being the use of SEZs for the development of such clusters of protected cultivation. Besides, strong recommendations have also been given on policy issues for the future of the technology for accelerating the production of vegetable crops and flowers using different protected structures.

Subsidies for promotion of protected cultivation need to be partially linked with the produce instead of presently given only on inputs. There should be a centre for development of export linkages and provision of assistance to cluster farmers for the export of certified produce like fresh vegetables, fruits and cut flowers and foliage. Due care should be given to environment and safety measure mechanisms such as safe disposal of plastics and any other harmful chemical or wastage – as per environmental and Global GAP stipulations.

Intensive research, awareness, incentives, training, better sustained return, continuous support to the venture in cluster production mode would constitute appropriate strategy for accelerating production of vegetable crops and flowers using protected cultivation practices in Haryana.

The report has culminated in the major recommendations for strengthening the protected cultivation technology in the State.

## Introduction

Haryana is known as the cereal bowl of the country. Its agriculture is in transition and considerable diversification has already set in, giving ample opportunities for horticulture, with in the state. Horticulture is gradually becoming important agricultural activity in the state, as fruits, vegetables, flowers, medicinal plants, seed spices, mushrooms and others are continuously increasing their contribution in raising the farmer's income and their standard of living besides, being a source of employment opportunity to them. Increased urbanization has put pressure on land for vegetables, flowers and other horticultural crops. Fertile lands under vegetables and fruit crops are being converted into real estates resulting in shortage of farm land and necessitating vertical growth in vegetables and other horticultural crop production. Haryana is bestowed with a diverse agro-climate, which is favorable for growing a large number of horticultural crops. To harness the potential for improving economic conditions of the farmers and provide nutritional security to the state and to the nation, Haryana Government has a vision to make the state as modern horticultural state with a mission to lead in domestic and export markets. To achieve this, different programs have been undertaken in 11<sup>th</sup> plan and have also been proposed and progressed for 12<sup>th</sup> plan Those include formation of two working groups on horticulture under Haryana Kisan Ayog;

1. Working Group on Horticulture in Haryana
2. Working Group on Protected Cultivation in Haryana

This report pertains to second Working Group on protected cultivation of vegetables and flowers in Haryana.

Haryana has made impressive progress in vegetable production over the years as is evident with the data on the subject. The total area under vegetables in Haryana was 11.30 thousand ha with a total production of 1,35.36 thousand tons and with an average productivity of 11.97 tons during 1966-67, which has increased to 346.4 thousand ha with a total production of 4649.28 thousand tons with an average productivity of 13.42 tons per ha by the end of 2010-11 (Agriculture Policy for Haryana document 2012 HKA, Hisar). There was no flower cultivation in the state

during 1966-67 but covered 6.3 thousand ha during 2010-11. More emphasis on protected cultivation has been advocated in Agriculture Policy for Haryana 2012 document.

Climate change and poor water availability will necessitate growing more food with less and less water. Climate change is being experienced in the state which timely cautions for taking appropriate safeguards in the production of vegetables and flowers. Climate change being erratic and unpredictable with available technologies in the state makes it necessary to switch on to a cultivation system which provides protection to the crops against biotic and abiotic stresses envisaged with such changes. The scope of area expansion under cultivation of vegetables and flowers is very little, the only option is vertical expansion through increased productivity and cropping intensity using protected farming with environment control measures, quality seeds, fertilizers and plant protection measures, plastic mulching, protected nursery production, use of green/ polyhouses for off-season production of vegetables and flowers have consistently given good results both at research farms and farmers fields.

The report covers, success stories on protected cultivation, historical background and present scenario of protected cultivation in general, SWOT analysis of protected cultivation of vegetables and flowers in Haryana, present position and appropriate action plan keeping in view the terms of reference of Haryana Kisan Ayog.

## **Success Stories- Protected cultivation**

### **China**

China started Protected cultivation in 1990`s and today the area under protected cultivation in China is more than 2.5 m ha. Out of this 90 % area is under vegetables cultivation in 29 out of total 34 provincial-level administrative areas. In China, low cost protected technology viz; plastic mulches, plastic low tunnels and walk-in-tunnels are being used on large area (80 % of the total area under protected cultivation) and it is perhaps the basic reason that today China is the largest producer of vegetables in the world.

## India

**1. Ladakh (J&K)-** DRDO pioneered research on protected cultivation and made leafy vegetables production possible at subzero ambient during winters which was otherwise considered impossible. During frozen winter ( $-20^{\circ}\text{C}$ ) leafy vegetables are being produced under low cost protected structures like trenches and green/polyhouses. Early vegetable nursery production under protected structures has made possible cultivation of several vegetables hitherto considered impossible. Cucurbits production under plastic mulch in open fields became possible by raising nursery in protected structures. Local structures befitting to the requirement of the place made possible seed production and maintenance breeding of temperate vegetables. Every vegetable farmer practices protected cultivation making Ladakh surplus in vegetable production. Now a wide range of vegetables are grown in the protected structures. Greenhouse grown Local Palak (Mongol) and Coriander are popular. Besides garlic, onion, radish and lettuce are grown in sub-zero winters, in spring the structures are used for growing vegetable seedlings and in autumn these are used for growing different crops like cucumber, tomatoes, brinjal, okra and capsicum. Some families do grow flowers and indoor plants. The technology is spreading to cold deserts of Himachal Pradesh (Lahaul–Spiti) and entire J&K.

**2. Uttarakhand** – At Kainchi (Gerbera), Bhimtal-(liliums, carnation, gladiolus), Bhaktola and Garmpani (Vegetables) protected cultivation mostly under walk-in-tunnels has become commercial activity for the farmers. Impressed with the progress of Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora's experiment at Bhaktola, the state of Uttarakhand has launched Chief Minister's Protected Cultivation Scheme where in 1300 green/polyhouses of 100 and 200 sq m size are to be supported with 80 % subsidy in all the districts of the State.

**3. Tamil Nadu** has emerged as a hub for protected cultivation. Hosur, Ooty, Kodaikanal and Coimbatore have emerged as growth clusters. Protected cultivation ensures controlled atmospheric conditions which are very much conducive for plant growth besides protecting the crop from the vagaries of nature. Drip with fertigation gives a boost to the crop growth and extends the crop harvesting period. This has



emerged as a viable technology for providing farmers with manifold increase in their incomes from small and marginal holdings. Cut flowers like rose, carnation, and vegetables like colored capsicum, tomatoes and cucumbers are being cultivated. The success of protected cultivation is mainly due to the increased income realized by the farmers. On an average farmers earn about Rs. 20,000 to Rs. 30,000 per month from a 1000 sq. m. of polyhouse. About 1700 greenhouses have been established till now in the state at a cost of Rs. 48.08 crores in 152.5 ha.

**4. In Karnataka,** seed multiplication of flowers and vegetables is practiced and popularized by M/S Indo -American Hybrid Seeds, is a well known example. This has been adopted in Karnataka by M/S Namdhari Seeds Pvt. Ltd, other seed companies and a large number of farmers. M/s Namdhari Seeds is exporting fresh vegetables grown under green/ polyhouses by farmers with a contract system of vegetable production.

**5. In Punjab,** net-house vegetable production is becoming popular. Through a systematic economic analysis of net –house, cultivation of vegetables like tomato, brinjal, capsicum, potato, peas, chillies has been found profitable. The gross and net returns were double in net house cultivation than traditional methods of growing of these crops. The life span of net house is 10 years. The farmer gets 50 % of the total cost of the net house as subsidy to install new net houses. (a project of PAU and AVRDC in Punjab). An early crop of Chappan kaddu (*Cucurbita pepo*) is taken under polyhouses in Punjab which give high return to the farmers. At Kharar in Punjab the first project of its kind in the country — a hi-tech greenhouse covering an area of one acre with capacity to produce up to 35 lakh seedlings of fruits and vegetables at one time has been set up by a farmer with technical expertise from Israel.

**6. In Rajasthan,** Mr. Sunil Kumar could succeed to produce 5 tons of high quality cucumber from 1000 sq. m. greenhouse with the first crop and 7.5 tons from the second crop and he marketed the entire produce to Delhi niche markets and attained around rupees 4 lakh as gross income from these two crops.

**7. Haryana** has become a major producer of button mushrooms by adopting black polyethylene protected structures in waste land mainly in Sonipat and Panipat districts. Several spawn production and training centres are being run by NGOs.

**8. Himachal Pradesh,** bestowed with varied agro- climatic conditions, proved a boon to the vegetable growers as natural greenhouse. In 1990-91, the vegetable productivity was hovering around 15.2t/ha. The horizontal expansion in area and introduction of high yielding varieties coupled with refined production technology, enhanced productivity to 18.12t/ha in 2000-01 and 20.00t/ha in 2011-12. Protected cultivation started in 2009 by covering 55ha area, has expanded to 125ha in 2011-12. The overall productivity in polyhouse is 100t/ha, which is the sole factor motivating the farmers for adoption of poly-culture. The flower production has also appeared on State map by covering an area of 860 ha in open and 70 ha under poly houses.

## Historical Background and Present Scenario

The idea of growing plants in a environment-controlled greenhouse goes back to Roman times. The first modern greenhouse, covered with glass was built in Italy in the 13<sup>th</sup> century to house exotic plants that explorers brought from the tropics. The experiment quickly spread to Holland and England, along with plants. These early attempts required a lot of work to close them at night or during the winter and they had serious difficulties to maintain an appropriate heat level. The use of plastic materials such as greenhouse covers is relatively recent. It started in 1948 in the United States with Prof. E.M. Emmert of the University of Kentucky, who had the idea to replace the glass with regenerated cellulose (paper cellophane) to cover a wooden structure. Since then plastic greenhouses have been extended to the five continents and have displaced glass as a material of walls and roof. In the 20<sup>th</sup> century economic development, especially after the Second World War, led to the construction of glass greenhouses and polyhouses.

The protected cultivation technology has been in use since several centuries. Riverbed cucurbits cultivation involving protection of young seedlings from cold winds in winter months by using straw fence is a traditional example in North India. In Europe during winter months underground horse or cow dung hotbeds covered with mica sheets were used for raising leafy vegetables. Commercial production of vegetables and cut flowers started in 19<sup>th</sup> century. In early 19<sup>th</sup> century glasshouses in different designs came up in Europe and Asian countries, mainly in The Netherlands and Japan, respectively. Subsequently, with the development of plastics, several designs of protected structures or greenhouses came up. Polyethylene polymer was first developed in 1930s and in 1950 it came in use in horticulture in the form of plastic films and pipes for making structures and watering, respectively. Several types of plastics like polyvinyl chloride, polypropylene and polyesters were developed later keeping in view the requirement of protected cultivation such as transparent ultra violet (U V) stabilized polyethylene sheets as cladding material for greenhouses. A revolution in plastic technology helped in progress and popularity of protected cultivation.

The Netherland has a long tradition of protected cultivation under glasshouses for growing flowers and vegetables with the most advanced and automated technologies. Around 10,000 ha area is under protected cultivation and most of these are climate control glasshouses with soilless cultivation. Around 20 m ha is under different forms of protected cultivation world over. Among the gulf countries Israel is the largest exporters of cut flowers and vegetables grown under protected conditions coupled with micro irrigation and fertigation. Hi –tech greenhouses are being used for production of export quality cut flowers and vegetables. In Europe, the highest area under greenhouses coverage is in Spain followed by Italy. The countries which are located around Mediterranean region like Morocco, Algeria, Egypt, Greece, Italy, Jordan, Portugal, Spain, Syria, Tunisia etc. cover area of about 2 lakh ha under greenhouses; 20,000 ha under glasshouses; 1.4 lakh ha under low tunnels and over 4 lakh ha under plastic mulches. In Asia, China, started protected cultivation in 1990's, under the largest area under protected cultivation; more than 90% of the greenhouses in China are used for vegetable production. The total area covered in China increased to 2.5 m ha under plastic covered greenhouses (85% of the world wide coverage), 9.6 million ha under plastic mulch and 0.9 m ha under low tunnels and floating covers. More than half of vegetable produce comes out of high tunnel polyhouses in China. China these days has large area under protected cultivation making it largest producer of vegetables in the world. Japan is next leading country producing fruits, vegetables and cut flowers under protected structures covering 52,000 ha. Countries like South Korea, Kuwait, UAE, Korea, Canada, Russia, Kenya, Ethiopia, South Africa, New Zealand and Australia have sizeable area under protected cultivation.

In India, the area under all forms of protected cultivation is reported to be around 25,000 hectares. This area is on the increase due to the efforts made under National Horticulture Mission, Ministry of Agriculture, Government of India. Defence Research and Development Organization (DRDO) has Field Research Laboratory (FRL) now renamed as Defence Institute of High Altitude Research (DIHAR) at Leh (Jammu and Kashmir) at 11,500 ft above mean sea level which successfully attempted protected cultivation in early 1960s for the production of vegetables in

frozen winters for the army personnel stationed there. Indo-American Hybrid Seeds (India), Bangalore is the pioneer in India to make use of greenhouse technology since 1965 for commercial productions of flower seeds, cut flowers and ornamental plants. Indian Petrochemical Corporation Ltd (IPCL) made significant contribution in protected cultivation by commercially producing UV stabilized low density polyethylene (LDPE) cladding and aluminum frames for polyhouses. National committee on use of plastics in agriculture (NCPA) in 1981 under the Ministry of Chemicals and Petrochemicals further boosted protected cultivation. This was transferred to Ministry of Agriculture under Division of Horticulture in 1993 and was entrusted with the task of promoting use of plastics in agriculture projects like irrigation and protected cultivation. The NCPA operated through 22 Plasticulture Development Centres (PDC) spread all over the country promoting protected cultivation (use of hail nets, shade nets, packaging of produce). M/s Namdhari Seeds, near to Bangalore is also producing fresh vegetables for export involving farmers of the area. Similarly several protected units in Maharashtra and Karnataka are producing high quality flowers and exporting the same. In northern India several units are successfully growing gerbera and carnation flowers in tarai region of Uttarakhand and HP. A farmer near Kotputali in Bamanwas has demonstrated growing parthenocarpic cucumber under naturally ventilated greenhouses which showed that protected cultivation can be a success story for arid regions of the country. Mr. Sunil Kumar could succeed to produce 5 tons of high quality cucumber from 1000 sq. m greenhouse with the first crop and 7.5 tons from the second crop and he marketed the entire produce to Delhi niche markets and attained around rupees 4 lakh gross income from these two crops.

In Haryana, protected cultivation in private sector was taken up in Gurgaon for the production of cut flowers for export during 1980's but could not make much headway. Progressive farmers under National Horticulture Mission have taken up production of vegetables like cucumber, capsicum, tomato and gerbera. Under Indo-Israel Projects, two demonstration centres at Gharaunda (Karnal) and Mangiana (Sirsa) are creating interest and awareness among farmers in protected cultivation of vegetables and other horticulture crops.

## **SWOT Analysis on Protected Cultivation in Haryana**

Per capita land availability and size of holdings are continuously decreasing with increasing population, urbanization and industrialization. Hence, cultivation of high value crops in poly or net houses with controlled fertigation has the potential to sustain a family on less than one acre.

Power requirements can be met from solar energy and rain water harvested from green/ polyhouses could also be recycled for production. This will, therefore, be an efficient resource input and social capital use scenario (Report on policy issues and options based on interface with farmers, HKA, 2011-12).

### **Strengths**

1. Haryana has close proximity to large market of vegetables and flowers in the country both for domestic and export (International airport for shipping perishables like flowers and vegetables) requirements.
2. Very good fertile soil and quality of water is available in the districts of Sonipat, Karnal, Panipat, Ambala, Kurukshetra, Yamuna Nagar and Panchkula.
3. The entire state is well linked with canals, therefore, quality water available in some areas may not be a problem where ground water is problematic or not good for agriculture.
4. Big niche markets are available in Delhi and Chandigarh and most of the areas of the district of Gurgaon, Faridabad and Panchkula are posh.
5. Sizeable dairy industry and cattle population are available in Haryana which help in organic protected cultivation.
6. Panchkula has the potential to emerge as a good centre of cut flowers, vegetables and strawberries.
7. Pro-farmer policy of the Government to support such priority areas in Horticulture may catalyze development of the sector. Slight sprucing up of policy matters will give boost to protected cultivation in state.

8. Kundli-Manesar-Palwal (KMP) Express highway (Express way) can be used for fast transportation of the fresh produce to the International Airport for export purposes.
9. Demonstration centres under Indo-Israel project are functional at Gharaunda (Karnal) as Centre of Excellence for Vegetables and Centre for Excellence for Fruits at Mangiana (Sirsa) to demonstrate new technology interventions
10. Presently, a few farmers are growing some of the vegetables following cluster approach in some parts of Haryana like mushroom cultivation in few villages of Sonipat including sweet corn and baby corn; carrot in few villages of Hisar and Bahadurgarh Tehsil, cauliflower in few villages adjoining Najafgarh in a cluster approach. Similarly, protected cultivation can also go in cluster approach in various parts of the state.
11. CCS Haryana Agricultural University, Hisar and National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Kundli are suitable for research and human resource development
12. Protected cultivation of vegetables and flowers under National Horticulture Mission in all the districts of the state is being promoted.
13. Positive attitude and keenness of farmers towards vegetable and flower production has been noticed
14. Being close to Delhi, so availability of all kinds of inputs .
15. Facilities for micro-propagation of vegetables and flowers exists at Bio-technology park, Department of Horticulture, Government of Haryana, Micro-propagation Technology Park, TERI, Gual Pahari, Gurgaon, Haryana and CCS HAU Hisar, Haryana to meet the requirement of micro propagated planting material for protected cultivation
16. Centre for Protected Cultivation Technology, Indian Agriculture Research Institute, Pusa, New Delhi is in close proximity of Haryana from where farmers can avail technical advice and training.

## **Weaknesses**

1. Most of the youths in rural areas of the state are not attracted towards agriculture.
2. There is lack of knowledge and expertise with the state departments and SAU about protected cultivation including availability of inputs and focused research
3. Mindset of the farmers to go with the traditional agricultural system and crops.
4. Uncertainty on return from investment for being uncommon due to handling by untrained farmers.
5. Low risk bearing capacity of majority of farmers in Haryana. Most of the greenhouses are there with farmers having large holdings of land.
6. Marketing fee on fresh vegetables and flowers is prohibition.
7. Non availability of adequate post harvest management related facilities in the state.
8. Knowledge and technological gaps in protected cultivation under certain conditions are prominent.
9. Crop varieties/hybrids for protected cultivation are to be imported as there is almost no research for development of indigenous varieties/ hybrids for protected cultivation.
10. Dust storms make claddings opaque, thereby affecting their efficiency, life and crop yield in South Western districts of the state..
11. There are visible technological gaps on IPM, INM, IWM and other modern technologies under protected cultivation in Haryana.
12. Lack of proper training and availability of quality seeds, tubers and other planting materials in floriculture through Government department.
13. Lack of training in protected cultivation in general.



14. The number of innovative farmers is very very low owing to very few number of viable demonstrative units existing in the state.
15. Mechanized farming in no-where is the sight.
16. The shift of labour from agriculture to less laborious works assigned under MNREGA is the direct adverse effect hampering agriculture in India at the state level.

### **Opportunities**

1. Large population of educated youth is unemployed in rural areas. They can be motivated and trained in the field of protected cultivation in an experimental mode.
2. All kinds of protected cultivation technologies can be adopted in various areas of the state for cultivation of large number of vegetables, flowers, and a few fruits.
3. Adoption of protected cultivation in peri-urban areas of the state near NCR, Delhi in cluster approach holds potential.
4. Big niche markets can be explored in Delhi, Panchkula, Chandigarh, Ambala, Gurgaon, Karnal, Sonipat, and Faridabad districts.
5. On farm value addition of the fresh produce and minimal processing.
6. Institutions located in Rajiv Gandhi Educational City, Sonipat have potential to enter for HRD in the field of protected cultivation.
7. Biotic and abiotic stresses in cultivation of vegetables and flowers can be minimized completely to a great extent through protected cultivation.
8. Protected cultivation technology is known for increased input use efficiency which is a key to successful farming. The farmers in Haryana appear to have an aptitude towards that.
9. Introduction of aeroponics and hydroponics.

## Threats

1. General atmosphere of the state is not favourable to attract industries for investment for the development of basic infrastructure related to Hi-tech horticulture in the state.
2. High population of wild animals like blue-bulls and wild boar even monkeys can be a threat for protected cultivation.
3. Power supply in rural areas is a serious weakness to introduce hi-tech protected cultivation.
4. Lack of insurance for protected cultivation on vegetables and flowers.
5. The entire developmental pattern of protected cultivation is subsidy driven and once the greenhouses are constructed, farmers are left to fend for nothing.
6. Farmers do all the time depend on seed companies for seeds and planting material which at times may misfire.
7. In hi-tech greenhouses, initial high cost and thereafter high running cost do not encourage adoption chances by majority of small and medium farmers.
8. As the greenhouse structures grow older, the incidence of sucking pests like mites, whiteflies, thrips, aphids and of soil-borne pathogens especially nematodes start building up. The dynamics of pest management/IPM technologies for protected cultivation are highly knowledge-intensive and hence without trained manpower and scientific monitoring, it remains a serious threat to protected cultivation not only presently, but also for future.
9. Absence of standard postharvest management practices of produce from protected cultivation.
10. The disposal of high quality produce, through the hands of self centered middle men, earns the lowest premium to the growers. This threat prevails upon from the beginning and hinders the adoption of new technology, besides the loss in remuneration.

## Reviewing the current status of protected cultivation

The terms of reference given to the working group (Annexure I) are discussed below.

### 1. Reviewing the current status of protected cultivation in Haryana.

Protected cultivation was started in early 1990s in Haryana with the establishment of units like Kuber Floritech, Cosco Blossom, German Gardens in Gurgaon; Torbo Floritech, Chandigarh and Mission Flora in Karnal, largely as entrepreneurial ventures by business houses with the financial support from National Horticulture Board as soft loans. Most of these units could not succeed due to different reasons, primarily the unsuitable design of protected structures, operational expenses on climate control, wrong selection of crops, lack of trained manpower and critical inputs. Protected cultivation in Haryana is still in a state of infancy as, at present, around 150 ha is covered under different protected structures in various regions for mainly producing vegetables and a few floricultural crops. The area under protected cultivation in Haryana is likely to increase fast in near future in the wake of several initiatives under schemes from Central and State Governments.

### 2. To examine the existing structure and design for protected cultivation and suggest suitable low cost models for large scale adoption.

Presently, the State Government under National Horticulture Mission is supporting mainly the following protected structures in various regions of Haryana state:

**Table: Various structures being promoted Under NHM in Haryana and their rates of Fabrications:**

Sr. No.	Component	Unit cost inclusive of taxes & charges (Rs/m <sup>2</sup> )
1.	Single span NVPH (5 m height)	700/-
2.	Multi span NVPH (6.5 m height)	935/-
3.	Polyhouse with Fan pad system	1465/-
4.	Insect proof net house/shade net house/ anti bird/anti hail net house with GI pipe perlin/Steel cable perlin	600/-
5.	Walk-in –tunnels- I (2.5-3.0 m height)	450/-
6.	Walk-in –tunnels- II (>3.0-3.5 m height)	550/-
7.	Walk-in –tunnels- III (>3.5 m height)	600/-

### **a. Single Span Green/ Polyhouse**

These are the naturally ventilated green/ polyhouses with single span and with a total central height of 5 m, side ventilation of 3m, without any provision of roof ventilation. These green/ polyhouses can only be used mainly during winter months (Nov. –March) or during low temperature period for vegetables and selected flower production. These green/ polyhouses are not suitable for rest of the period mainly during April – September for cultivation of vegetables and cut flowers in various regions of state of Haryana and more specifically in districts of Gurgaon, Faridabad, Palwal, Rewari, Narnaul, Mahendergarh, Jhajjar, Rohtak, Hisar, Sirsa, etc. due to inner higher temperature inside the structures (3-5° C) as compared to outer ambient temperature.

### **b. Multi Span NVPH:**

These multispan naturally ventilated greenhouses are being fabricated with a central height of 6.5 m, gutter height of 4.25 m., side ventilation of 3.5 m. and roof ventilation of 1.0 – 1.5 m. These are suitable for cultivation of vegetables like tomato, cherry tomato, and capsicum for a period of 8-9 months and three crops of parthenocarpic cucumber can be grown in such structures in 8-10 months in various regions and districts of Haryana.

### **c. Green/ polyhouses with pad and fan system**

Green/ Polyhouses with pad and fan system are also being promoted by the State with gutter height of 4.5 m with common side ventilation and top ventilation. In the promotional scheme, these structures are being clubbed with exhaust fans and cellulose cooling pads of 1.8 m in height with 150 mm thickness for cooling the greenhouse environment. But the cost of fabrication of these structures is very high and lot of running cost in terms of power requirement is also involved. Moreover, power supply in the rural areas in Haryana is a major constraint. Therefore, these structures have a limited use for cultivation of vegetables and cut flowers. Although several vegetables and cut flowers can be grown under such structures if there is a regular power supply and if the basic cost of fabrication is less. But by now only few such structures have been fabricated and existing in the State for protected cultivation.

#### **d. Walk-in-Tunnel - I**

The walk-in-tunnels have been divided into three groups according to their height, i.e. central height and side ventilation although, they are also similar to the single span green/ polyhouse in design and fabrication.

These structures are having a central height of 2.5 to 3.0 m and they are dome shape with a side ventilation of 1.5 m with rolling flap or curtains on both the sides. These structures have the limited use for protected cultivation of vegetables and cut flowers. These structures can mainly be used during the winter period (November-March) for cultivation of various vegetables and few flowers in rest of the period of the year. It is difficult to use such structures as the inside temperature will increase normally 3.0 - 4.0°C as compared to outside temperature.

#### **e. Walk-in-tunnel-II**

These are the structures similar to the single span polyhouse having the central height of 3.0-3.5 m dome shaped having 1.8 m side ventilation. These structures can mainly be used during the winter period (November - March) for cultivation of various vegetables and few flowers. In rest of the months it is difficult to use such structures as the inside temperature will increase normally 3.0 -4.0 °C as compared to ambient temperature.

#### **f. Walk-in-tunnel-III**

These are the structures which are fabricated in dome shaped structure with a central height of 3.5 m along with the side ventilation of 2 m. These structures have the limited use for protected cultivation of vegetables and cut flowers. These structures can mainly be used during winter (November- March.) for cultivation of various vegetables and few flowers. In rest of the period of the year it is difficult to use such structures as the inside temperature will increase normally 2.0 -3.0°C as compared to outside temperature.

#### **g. Net houses:**

Presently, only some farmers are using simple structures of shade nets and rarely the insect-proof net houses in Haryana. But some shade net houses and insect proof

structures have been fabricated at public sector institutions and Government Department, in different locations of the state which have been fabricated in different shapes and designs and have limited use due to various reasons . In some cases side walls have been fabricated with insect-proof net but the roof has been covered with shade nets, which are not fulfilling the requirements of virus-free safe vegetable cultivation. But now under the promotional schemes of NHM, the State government is promoting both the insect proof net houses and shade net houses in tubular shape and these structures are having central height of 4 m and most of the structures are flat in design. In such structures the side wall is 2.5 m and they are dome shaped but such structures have been rarely fabricated in the State but some examples are available. Otherwise, these structures, the insect-proof net houses or the shade-net houses are quite suitable for cultivation of large number of vegetables and also cut flowers in various regions and districts of Haryana state.

In general multi span naturally ventilated greenhouse and shade net house are mainly being used as protected structures for protected cultivation of vegetables and in some cases ornamental crops with and without financial supports from Government. Structures listed above cannot be easily fabricated or erected by the farmers themselves at village level by using the rural artisans. The cost of these structures seems to be high.

### **Low cost models of protected structures for large scale adoption.**

The following low cost models are suggested for large scale adoption in the state for safe and economical production of vegetables, cut-flowers and selected fruit production in various regions and districts of Haryana depending on the season, crop and climatic conditions of that area:

#### **a. Use of Plastic Mulches for Vegetable, Flower and Fruit Production:**

Plastic mulches are mainly used for weed control, to increase soil temperature and to keep soil moist resulting in reduction in the use of irrigation water. The most preferred mulch are transparent (clear) and black, although wide variety of shades and colours are being used for specific purpose. Currently worldwide double colour plastic mulches viz., silver + black, blue + black, yellow + black, white + black and

red + black are being tested in horticultural crops and more specifically for vegetables. The following benefits of plastic mulches for commercial vegetables, flower and fruit production have been observed:

1. Moisture retention by reducing evaporation from the bed surface.
2. Inhibits weeds growth- black, silver + black, yellow + black, blue + black, white + black mulches greatly inhibit lights penetration in the soil. Due to this weed seeds do not germinate under these mulches. Clear or transparent mulch allows light penetration and cause frequent weeds seed germination and growth.
3. Reduces fertigation leaching by rain fall or run off during rainy season.
4. Decreases soil compaction which provides better environment for seedling emergence and its root growth.
5. Protects fruit quality in vegetables by reducing rain-splashed soil deposits on fruit. In addition mulches also reduce fruit rot caused by soil borne organisms, as they work as barrier between the fruits and the organisms.
6. Helpful in fumigation. Mulches increase the effectiveness of soil fumigant chemicals.
7. Help to control pests: Highly reflective mulches assist management of insect pest and diseases,. Basically yellow + black is used if the whitefly is the vector for viruses; silver + black is used in case aphid is the vector and blue + black is used if thrips are the vector for virus.
8. Black mulch (150 to 200 micron thickness) can be used in orchards either in rows or around the plants to control the weeds and conserve moisture. It can be used in all kind of fruit crops along with drip-fertigation system.
9. In contrast to conserving moisture poly mulching avoid water logging in roots zone thus avoiding root rot.
10. The use of following plastic mulches (10-25 micron thickness) is suggested for different horticultural crops in different seasons and areas keeping in view the objective.

## **A. Vegetable Crops**

- **Rainy Season-** Only black, yellow+ black for tomato, chilli, brinjal, okra and cucurbits
- **Early Summer Season-** Clear (Transparent) mulch for advancing the cucurbits 15-20 days ahead to the main season.
- **Winter Season-** Clear (Transparent) mulch for tomato, chilli and brinjal crops.
- **Summer season-** Only black or silver + black for all cucurbits, brinjal, chilli and tomato cultivation.

## **B. Flower Crops**

- **Post Rainy Season –** Black or silver + black for marigold, gladiolus and chrysanthemum.
- **Winter Season-** Clear mulch: gladiolus , lilium, marigold
- **Summer Season-** Black or silver + black for marigold

## **C. Fruit Crops**

Use of black or silver + black for strawberry cultivation (October- March) under open field and under plastic low tunnels is suggested. In orchards black plastic mulch (50 to 200 micron) can be used. Black polythene mulching for papaya cultivation in rainy months can be used.

### **b. Plastic Low Tunnels:**

Plastic low tunnels are the temporary structures erected over the individual rows of the beds by stretching transparent plastic only to protect the crops against extreme low temperature during winter season for their advancement of 25-30 day over normal season of sowing under open fields. These temporary structures can be used for off-season production of vegetables mainly cucurbits through advancing their production over normal season by about one month. Such advancement of crops like cucurbits can give better prices to the producers in niche markets of Delhi, Chandigarh and Gurgaon. The optimum size of plastic low tunnels is 45cm x 60 cm



width/height depending upon the crop and planting time. Individual row of the crops are covered by such structures using transparent plastic film of 20-25 micron thickness stretched over bent GI wires of 8 mm diameter. These wires can be reused for 8-10 years, whereas, the plastic used for making low tunnels can be used only for two years.



**Plastic Low Tunnels**

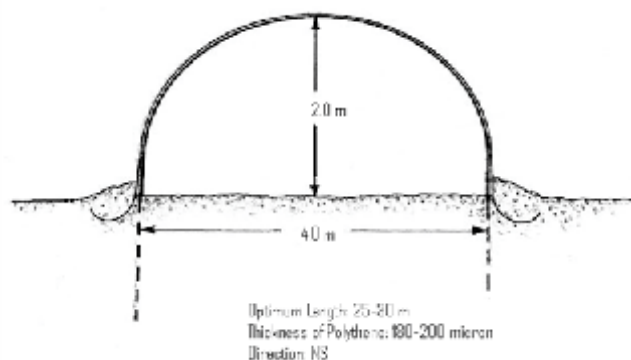
**c. Walk-in-Tunnels:**

Walk-in-tunnels are purely the temporary structures which are made by using GI pipes and transparent plastic of 180-200 micron thickness. Walk-in-tunnels are used for complete off-season cultivation of vegetables like bottle gourd, summer squash, cucumber, French bean, tomato and others during winter season (Dec.–Jan.). The basic objective and utility of walk-in-tunnels is to fetch high price of the off-season produce to earn more profit per unit area. These kind of temporary protected structures are highly suitable and profitable for the vegetable growers in various parts of Haryana State.

Optimized size of the walk in tunnel is 100-120 Sq m, having 4.0 m width and 25 to 30 m length with a 2.0 m central height. The basic advantages of the size of 25-30 m long tunnel is better cross ventilation, size of plastic available and better pollination by honey bees. The cost of fabrication of such 100-120 sq. m. size walk- in- tunnel is Rs 16000-18000/- .

**Basic advantages of the use of walk-in-tunnels are:**

- Off-season cultivation of vegetables for earning more income.
- Walk-in-tunnels are only erected over the crop during the peak winter months of December, January and mid February and thereafter the structure is removed from the crop.
- Since, the plastic is used only for 60 to 75 days (Dec. – mid Feb.); its re-usage life can be for several years.
- These are temporary and low cost structures, which can be fabricated by the farmers themselves at village level by taking help of rural artisans.



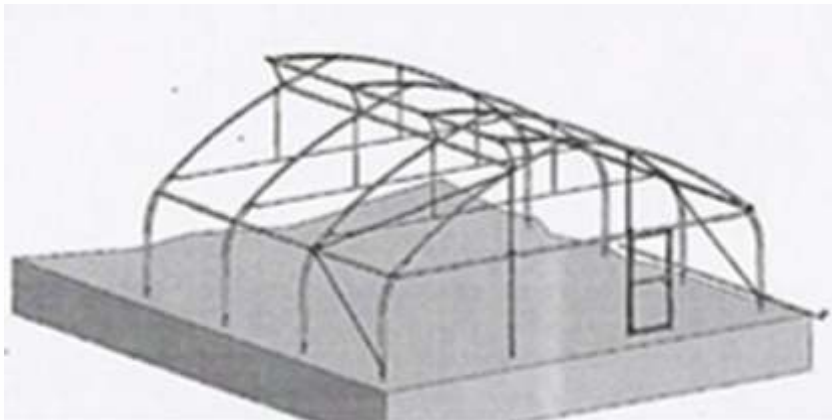
**Walk-in-Tunnel**



**Bottle gourd in December**

**d. High Tunnels With Top Ventilation:**

High tunnels are the permanent structures which can be prefabricated and assembled on site by means of bolts, nuts and washers only. Such structures are made with galvanized steel pipes and profiles for long life of the structure. This enables easy implementation and full adaptation to all related sub systems used in modern greenhouse production. Such structures are provided with 1.0 m of top ventilation along with a central height of 4.7 – 5.0 m and side ventilation of 2.2- 2.5 m. These structures are in fact more suitable for the climatic condition of Haryana state as the state Government is already popularizing these type of permanent walk-in - tunnel structures viz. walk -in- tunnel-I (central height 2.5 – 3.0 m without top vent), walk -in- tunnel-II (central height 3.0 – 3.5 m with top vent), and walk -in- tunnel-III (central height 3.5 m but without top vent ). These structures in present design can be used for crop production only during the winter period (November – March), whereas, the modified walk- in- tunnel structures provided with top ventilation can be used for longer period (August – April) for cultivation of vegetable and flower crops under different regions of Haryana state and the cost of such structures is also at par to walk-in-tunnel III. Similarly, the single span, naturally-ventilated green/ polyhouse should also be modified with top ventilation for their efficient and long duration use in Haryana state.



**High tunnels with 1.0 m top ventilation**

**e. Insect proof net house:**

Insect proof net house can be fabricated as temporary and permanent structures in different designs. Temporary structures can be fabricated in walk-in-tunnel design and shape with double door facility at one end of the structure. The minimum size of insect proof net house in green-house design is 100 sq.m. The basic cost of fabrication for temporary net house is around Rs. 160-180/ m<sup>2</sup>, whereas, it is around Rs 350-400/ m<sup>2</sup> for permanent net house fabricated in design of a greenhouse. The permanent structures can be fabricated in two designs, one as flat roof design and shape with a height of 2.5- 3.0 m. The other permanent insect proof net house can be fabricated in dome shape in greenhouse design.

Usually the farmers are growing vegetable crops like tomato, chilli, sweet pepper, okra and others under open fields. But during rainy and post rainy season it is very difficult to grow these crops successfully in open field due to leaf curl, yellow vein mosaic and other viruses. These viruses spread through insect vectors like whiteflies or aphids. The population of whitefly after the start of monsoons is very high and it remains in the open environment up to end of October depending upon the temperature. The farmers are often using high dosage of insecticides, to control these vectors. Despite repeated use of insecticides virus infestation on tomatoes, chilli and okra still persists. The second most common and most severe problem in tomato, brinjal and okra is the fruit borer against which also the growers are using huge amount of insecticides and they are unable to control this insect. The other way to control the virus and fruit borer is to put a mechanical barrier between the crops and open environment. This is possible with the use of insect proof net of 40 or 50 mesh in the form of net houses or insect proof net covered walk-in-tunnels. By this way the growers can directly reduce the use of insecticides and they can grow virus free crops of tomato, chilli, sweet pepper, brinjal, okra and others during rainy or post-rainy season. For growing virus free healthy seedlings of these crops either in the greenhouse or by covering the nursery beds with insect proof net is a pre-requisite. The farmers can erect these insect proof net houses by using half inch size GI pipes after bending them in half-circle shape. Other insect proof net houses can also be made by covering all sides and top with insect proof net of 40 mesh, but the

net should be UV stabilized. It has been experimentally established that under these double door net houses crops like sweet pepper, tomato, chilli, brinjal, okra and others can be grown successfully without infestation of viruses or insects like fruit and shoot borer etc. Moreover, growers can save the huge amount spent on pesticides to control the insect/pests



**Temporary Insect proof net house in Walk- in -Tunnel Design**



**Rectangular shaped permanent insect proof net house with provision of net on the top**



**Insect proof net house with provision of net on inner side**



**Permanent Insect proof net house in greenhouse design**

**f. Shade Net House:**

Shade net houses are the low cost temporary to semi-permanent structures made by providing 40-60% shade as per crop schedules and requirements. Usually, during April to July, 50-60% shade net is used over the structure at a height of 7-8 feet. Mostly the black colour shade net is preferred as this colour absorbs maximum heat. During the month of August to October, 30-40% shade net is used. The optimized size of shade net house is 100-120 m<sup>2</sup> and the height of the permanent shade net house is 2.5 – 3.0 m. During peak summer months, it is not possible to grow certain vegetables like green coriander, beet leaf (palak) etc. due to very high atmospheric temperature and radiation. The basic objective of shade net is to reduce the temperature and radiation for successful cultivation of crops like green coriander, beet leaf, radish, early cauliflower, early cabbage, early carrot and for advancing the crop like lettuce and broccoli ahead to their normal season of growing for fetching high price in the market. Basic cost of fabrication of such shade net houses is approximately Rs. 100-120/ sq. m. depending upon the design of the shade net houses.

These temporary plastic structures (shade net house) are suitable for off-season vegetable cultivation particularly for south west Haryana.



**Temporary Shade Net Structure**



**Capsicum crop under permanent silver colour shade net house**

**g. Zero-Energy Naturally Ventilated Green/ Polyhouse:**

Naturally ventilated green/ polyhouse is the protected structure where no heating or cooling devices are provided for climate control. These are simple and medium cost greenhouses which can be fabricated with a cost of approximately Rs.700-850/- sq. m. and these greenhouses can be used successfully and efficiently for growing year round parthenocarpic slicing cucumber, off-season muskmelon, tomato and sweet pepper crops for 8-9 months duration. These structures are having a manually operated cross ventilation system for use as and when required. These naturally ventilated green/ polyhouse structures are having a gutter height of 4.5-5.0 m, side ventilation of 3.0- 4.5 m, top ventilation of 1.2 to 1.8 m and are highly suitable for long crop production in various parts of Haryana state. During peak summer months (Mid April to July), roof (top) of these structures can be covered with 30-40% shade nets for cultivation of vegetables during peak summer months by reducing the inside temperature as much as possible. Looking to the year round, increasing demand of high quality parthenocarpic slicing cucumber, tomatoes, capsicum and flowers like chrysanthemum, roses, gerbera and carnation can be

supplied in up markets of the metro and other big cities like Delhi and Chandigarh. This is most suitable low cost structure. Parthenocarpic cucumber is one of the most suitable and profitable crops for cultivation under naturally ventilated green/polyhouses in peri-urban areas of the state round the year. Three successful crops of cucumber can be taken in a naturally ventilated greenhouse in a period of one year. Muskmelon is the second suitable crop, which can be successfully cultivated for its complete off-season (Oct-Jan) availability. Needless to emphasize that these crops fetch very high prices of the off-season produce in the up markets of the metro and other big cities of the northern parts of the country.

Similarly, high value vegetables like regular tomatoes, cherry tomatoes and coloured peppers are the three well tested crops which can be grown for long duration (8-10 months period) under naturally ventilated greenhouse conditions. In metro cities like Delhi there is year round demand of these high quality vegetables in the up markets viz. five star hotels, shops of embassies or high commissions of various countries situated in Delhi. Greenhouse vegetable production is a highly intensive enterprise requiring substantial labour for whole day commitment, which restricts the adoption of this technology. The working group recommends that vegetable and cut flower growers of Haryana should use the naturally ventilated polyhouse technology for cultivation of high quality produce for higher profits.

All the structures are basically dependent upon low pressure drip fertigation system.



**Naturally Ventilated  
Green/ Polyhouse**



**Multi-span Naturally Ventilated  
Green/Polyhouse**



### **3. Reviewing the status of research in the field of protected cultivation and suggest measures to address current gaps and specific needs of the state.**

Protected cultivation is one of the upcoming areas among other disciplines of horticulture. Hitherto, the science of protected cultivation has been viewed rather narrowly. In real sense, protected cultivation is actually a complete science in its own as the entire gamut of agricultural activities are taken up in fairly transformed manner. Most of abiotic and biotic conditions in greenhouses/structures are at variance with multiple factors on all crop growth parameters.

Ample research has been carried out in the area of protected cultivation mainly from the perspective of protection against snow, frost and pests under temperate conditions. Many of these conditions are not relevant to countries like India and hence there are visible gaps not only in technology but its proper implementation on the overall impact and economics. Haryana state does not have temperate areas.

Apart from the research activities taken up at Centre for Protected Cultivation Technology (CPCT), I.A.R.I., NEW DELHI, which has taken up a lead in the research and development in the area of protected cultivation, only sporadic research efforts are being taken up in Indian agriculture research system. In Haryana, CCS Haryana Agricultural University, Hisar has taken up research on protected cultivation at a low and initial level. The University does not have holistic and comprehensive approach to cover the requirement of the state for protected cultivation. Opening of a School of Protected Cultivation at CCS HAU is therefore, being suggested to meet research, trained human resource and associated needs of the state. It is suggested that proposed school may take up R&D activities in the area of protected cultivation in the state of Haryana in view of the following gaps visible currently as well as for future requirement of the State.

i. First and foremost, exhaustive data generation on abiotic parameters under different structures is seriously wanted. This would result in the emergence of recommendations for suitable designs of protected structures under different geographical locations and micro-climate for various crops. R&D initiatives on the

low-cost technologies for soilless and organic production of vegetables and flowers under protected cultivation needs to be taken up for the state.

ii. In general, varieties/hybrids of vegetables and flowers suitable for protected cultivation have not yet been developed in India. There is an ample scope for the development of these varieties/hybrids and R&D activities in public-private partnership model.

iii. Production technology standardization of vegetable crops like capsicum, cucumber, tomato, leafy vegetables, may be carried out. Especially, the crop-specific fertigation scheduling for Haryana condition is very crucial considering the soil, water and climatic conditions. Similarly production management for different crops under various structures also needs to be standardized. R&D initiatives on the development of innovative tools, implements and equipment for protected cultivation may be given a boost in the overall research activities of associated institutions leading to more efficient mechanization of such protected system at large.

iv. Influence of the abiotic variations on different plant growth parameters of various crops under Haryana conditions has a lot of scope of research work in immediate future.

v. Similarly, there are lot of avenues for seed production under protected structures as the entire dynamics of isolation distances so stipulated for open field conditions, do change under protected cultivation. Disease free crops can be raised under protected structures for healthy seed production of certain vegetables and flowers.

vi. There is a need for mapping of key pest problems in different crops in Haryana under protected cultivation. The creation of diagnostic repository for key pests and their natural enemies is an important requirement of this area.

vii. R&D activities on pest management strategies for different crops to develop IPM and organic pest management options in modular and calendar-cum-need based modes are required.

viii. Research on pollination and pollinators under protected conditions for production of vegetables is required to be taken up for various kinds of stakeholders.

ix. Market research starting from produce management, value addition, minimal and industrial processing standardization and economics of entrepreneurial options may be worked out for bringing about holistic developmental opportunities for the state.

x. Extension research on the level of knowledge among protected cultivation growers, level of adoption, constraints, strengths, weaknesses, opportunities and threats need to be worked out for streamlining the lacunae.

**4. To suggest specific crops and their sequences for all the year round production of vegetables/flowers and for raising nurseries using appropriate structures.**

• **Vegetables:**

**Naturally Ventilated Green/ Polyhouse for Year Round Nursery Production**

**A) Vegetable Nursery:** Nursery can be raised in 6 to 8 batches annually.

**1. June-July:**

Virus free, healthy main and off-season nursery can be raised for different crops like tomato, brinjal (for open field), capsicum, cucumber, sweet corn (hybrids) and chilli etc.

**2. July-August:**

The healthy nursery of brinjal, cucumber, tomato, capsicum, lettuce and cole crops can be raised in this time period.

**3. August- September:**

Capsicum, lettuce, parsley, beet root, celery, tomato (winter crop for open field), cucumber (under green/ polyhouse cultivation) and all cole crops.

**4. September-October:**

Virus free healthy nursery of cole crops, lettuce, parsley, beet root, celery, and all cucurbits (for off season cultivation under walk-in-tunnel)

**5. October-November:**

The healthy nursery of summer squash, lettuce, parsley and cole crops

**6. November-December:**

Nursery of tomato (for open field) chilli, brinjal, late cauliflower, cabbage

**7. December-January:**

Tomato (for off-season cultivation under plastic low tunnels), chilli, brinjal and all cucurbits

**8. January-February:**

Nursery of all cucurbits (advancing the crop in open field conditions), sweet corn and cucumber for protected cultivation

In foggy months of December January, sunken nursery for growing seedlings of summer vegetables like tomato, capsicum, brinjal, cucurbits (Poly bags or plugged trays), summer annuals of flowering ornamentals can be successfully grown. This technique is also most suitable for growing virus free nursery in the desert area. Winter crops can be grown in summer in the deserts.

• **Flowers:**

**1. June-July:**

Rooted cutting of early chrysanthemum can be propagated and nursery of other seasonal flowers like balsam, celosia, tithonia, vinca and marigold etc. can also be raised. Cuttings of certain fillers like golden rod, thuja ferns etc can also be undertaken.

**2. July-August:**

Propagation of woody perennials, foliage, fillers shrubs climbers and evergreen shrubs like hibiscus, nerium and bougainvillea can be taken up during this period. At the same time nursery of mid and late linum, jafri, calendula, antirrhinum, clarkia, sweet pea, sweet william clarkia, tithonia, vinca, amaranthus etc. can also be prepared during this period.

### **3. August- September:**

Nursery of Jafri, calendula, clarkia, tithonia, vinca, stock, poppy, sweet sultan, sweet pea, sweet william can be raised and rooted cutting of chrysanthemum along with the propagation of roses and jasmine can also be done during this period.

### **2. September-October:**

Marigold, jafri, linum, chrysanthemum, limonium, petunia, dahlia rooted cuttings, phlox, cornflower, candytuft nursery of mid and late seasonal flowers like petunia, limonium and stasis can also be raised.

### **3. October-November:**

The clumps of gerbera can be separated for further propagation purpose. Nursery of petunia, nasturtium, dahlia, cosmos, linaria, cinraria, salvia can be raised and forcing of various bulbous flowers including raising of poinsettia under short day can be done. Pots of dahlia can be prepared.

### **4. November-December:**

Cuttings of desi roses can be raised while doing pruning.

### **5. December – January:**

In this season fresh planting of roses and off-season early nursery of marigold flower can be taken up.

### **6. January – February:**

Off-season and early nursery of marigold can be raised under protected structure and spring season bulbs can be raised.

### **7. February- March:**

Raising of cutting of indoor foliage plants and division of suckers and bulbs like Amaryllis, football lily, caladium etc, budding in roses, raising of marigold nursery can be taken up.

## **SUITABLE CROP SEQUENCE**

### **A) Naturally Ventilated Green/ polyhouse:**

#### **a. Regular Tomato or Cherry Tomato Sequence I:**

Only indeterminate type of varieties/ hybrids which fulfill all the quality requirements can be grown under such structures for a period of 8 to 9 month in different locations of the state of Haryana depending upon the climatic conditions of that area. The crop can be raised as stated below:

- i) Virus free healthy nursery of such varieties/ hybrids is raised under protection in soil or soilless media.
- ii) 25 – 30 days old seedlings are planted in the green/ polyhouse possibly from mid July to first week of August.
- iii) Around 2400 to 2600 plants can be adjusted in 1000 sq.m. green/ polyhouse area depending upon the design and size of beds.
- iv) Crop transplanted in mid July can continue upto end of April or mid May next year depending upon the crop management and climatic conditions.

#### **b. Standard Tomato and Cherry Tomato Sequence II:**

- i) Crop can be transplanted in the month of mid February to Mid March after raising virus free healthy nursery.
- ii) The crop can continue upto the end of December or January depending upon the crop management and climatic conditions of the area.
- iii) Under this sequence the green/ polyhouse structure is required to be covered on the top of the roof with a 40-50% black color shade net during the months of May-August depending upon the prevailing climatic conditions.

#### **c. Capsicum:**

Suitable varieties/ hybrids of capsicum with green, orange, chocolate, red or yellow or other colour can be grown for a period of 8-9 months depending upon the crop management and climatic conditions of the area as stated below:

- i) Virus free healthy nursery of these varieties is raised under protection in soil or soilless media in the month of July.
- ii) 35 – 38 days old seedlings can be transplanted from first week of August to first week of September.
- iii) Around 3600 to 3800 plants are adjusted in 1000 sq.m. area depending upon the design and size of the beds. The crop transplanted in the first week of August can continue upto end of April in the next year in the green/ polyhouse.

**d. Parthenocarpic Cucumber:**

Firstly suitable parthenocarpic varieties/ hybrids are selected for cultivation under green/ polyhouse conditions. Thereafter, seedlings of the selected variety are/ hybrid raised in soil or soilless media only under protection. Three crops of parthenocarpic cucumber can be grown under such greenhouse conditions as stated below:

**1<sup>st</sup> Crop:**

- i) Seedlings of the selected varieties/hybrids are raised in the month of July.
- ii) 20-22 days old seedlings are transplanted in the first week of August.
- iii) Around 3600-3800 plants are adjusted in 1000 sq. m. Green/ polyhouse area depending upon the design and size of the beds. The crop transplanted in the first week of August will continue mostly up to mid October to third week of October.

**2<sup>nd</sup> Crop:**

- i) The seedlings for the 2<sup>nd</sup> crop are raised from end of September to 1<sup>st</sup> week of October in soil or soilless media under protection.
- ii) 20-25 days old seedlings are transplanted one week after removal of the first crop from mid October to third week of October.
- iii) The mid October transplanted cucumber crop can continue up to end of January.

### **3<sup>rd</sup> Crop:**

- i) Seedlings of the third crop of cucumber are raised in the month of January.
- ii) 25-30 days old seedlings can be transplanted during first to second week of February after removal of the 2<sup>nd</sup> crop.
- iii) This crop will continue up to end of April or first week of May depending upon the crop management.

### **B) Insect Proof Net House:**

**a. Tomato:** Indeterminate type green/ polyhouse varieties/ hybrids of standard and cherry tomato which are normally grown under green/ polyhouse are suitable for cultivation under insect proof net houses for a period of eight months (September to mid April) under different agro climatic conditions of Haryana. But after using a cover of shade net on the roof of the insect proof net house, the duration of tomato crop can be extended up to end of May as stated below:

- i) September to Mid April without cover.
- ii) Mid September to end of May: Covering 40% shade net over the roof of the net house structure.

### **b. Capsicum:**

The capsicum crop can be grown vertically like a green/ polyhouse for a period of 7-8 months in different agro climatic conditions of Haryana which can be further extended by using a shade net over the roof of the insect proof net house in a similar way like tomato for a period of one month. The varieties/ hybrids which are suitable for green/ polyhouse can be grown under insect proof net house as given below:

- i) October to April : Without using shade net on the top of the roof of the insect proof net house (40% shade net intensity)
- ii) October to May: By using 40-50% shade net over the roof of the insect proof net house.



**c. Cucumber:**

The parthenocarpic varieties/ hybrids of cucumber can be grown vertically in insect proof net house like a green/ polyhouse. Two crops can be taken.

- i) September to mid December
- ii) Mid February to April

**C) Walk –In- Tunnel shape insect proof net house:** The following crops can be raised in seasons given below:

**a. Okra :**

- July to October
- September to December
- January to April

**b. Brinjal:**

- July to Mid December
- January to April

**c. Tomato:**

- July to November

**d. Chilli :**

- January to May
- June to November

**e. Summer Squash:**

- January to April
- October to December

**f. French Bean:**

- October to December
- Mid January to mid April

**D) Walk-In-Tunnels:** Crop varieties grown in open field may yield better under such structures.

These structures can be used for cultivation of different vegetables only during peak winter months (December to Mid March) only to protect the crop against low temperature in different parts of Haryana state. These are the temporary and low cost structures which are highly suitable for complete off-season cultivation of crops like bottle gourd, summer squash, bitter gourd, sponge gourd, ridge gourd, melons and others. Some of the crops and their growing period are given below:

**1) Summer squash :**

- December to February

**2) Bottle gourd, Sponge gourd, Ridge gourd :**

- November to March

**3) Muskmelon and Watermelon:**

- January to April
- October to January

**4) Tomato production during peak winter season**

- October to January

**5) Brinjal :**

- October to February

**6) French bean and Cow pea**

- November to February

**E) Shade net house:**

Shade nets are mainly used for cultivation of different vegetables during peak summer months (April to June) to protect the crops against high temperature and radiation. For Haryana conditions following crops are suggested:

**1) Leafy Vegetables ( Leafy Coriander, Palak and Mint)**

- April to July (shade net with 40-60% shading intensity).

**2) Early Cauliflower**

- June to September (shade net with 40% shading intensity).

**3) Early Broccoli and Lettuce**

- August to November (shade net with 40-50% shading intensity).  
Lettuce can be further extended up to January to April

**4) Parsley and Celery**

- September to April (shade net with 40-50% shading intensity)

**5) Tomato**

- March to June (shade net with 40-50% shading intensity).

**6) Chilli**

- February to June (shade net with 30-40% shading intensity).

**7) Capsicum:**

- February to June (shade net with 30-40% shading intensity).

**F) Plastic Low Tunnels:**

Plastic low tunnels are mainly used for advancing the crop mainly cucurbits 20-40 days ahead to their normal season of cultivation. Following crops are suitable for plastic low tunnels.

**1) Summer squash:**

- December to March

**2) Melons:**

- Mid January to April

**3) Bottle gourd, Pumpkin and Cucumber:**

- Mid January to May

## FLOWERS:

Working group deliberated at length production of flowers under protected cultivation in Haryana. Naturally ventilated green/ polyhouse and shade nets are considered suitable, economical and affordable by Haryana farmers. Information on these is given below:

### A) Naturally Ventilated Green/ Polyhouse

**a. Chrysanthemum:** It can be grown for both main season and off-season production in various regions of Haryana state by using blackout (2-3 hrs) during long day conditions and artificial light for 2-3 hrs during short day conditions by making suitable arrangement.

- August to November (after transplanting of rooted cuttings for off -season crop)
- December to April ( for off-season crop)

#### For Main Season:

- October to early December (main season crop)

**b. Gerbera:** This crop can be grown in naturally ventilated green/ polyhouse under climatic conditions of Panchkula, Morni Hills, Ambala, Kurukshetra, Karnal and Panipat in Haryana state. Plantation can be done in October month and crop will continue for a period of 2-3 years.

#### c. Cut Flower Rose:

This Crop can be grown in naturally ventilated green/ polyhouse in few areas of Haryana state like Kalka, Morni Hills and Panchkula. Plantation can be done in October month and flower production can continue for a period of 5-6 years.

**d) Lilium:** A high value flower –Asiatic and Oriental lily can be grown under naturally ventilated green/ polyhouse during winter season from October to February throughout Haryana state. The major advantage of the naturally ventilated polyhouse is that flowering can be obtained early to fetch better price from the markets in Chandigarh and Delhi.

## **B) Shade Net House:**

**a. Fillers and foliage ornamental plants:** Various kinds of foliage plants like asparagus, Boston fern, ornamental lettuce, leather leaf fern etc. can be grown in different season of Haryana state with shading of 40-60% for their year round cultivation.

**b. Indoor Plant Propagation/Ornamental plant Nursery:** Peri-urban areas of Haryana, which are located in National Capital Region, can produce large scale indoor plants and nursery of seasonal flowers for supply to cities like Delhi, Gurgaon and Faridabad. Research on flower/foliage production under protected cultivation needs to be intensified for large scale production.

### **5. Use of protected cultivation in Peri-urban Agriculture for increasing the income of the farmers living around big cities like NCR.**

Peri-urban agriculture has an important component of horticultural production. Horticultural crops have short shelf life and are to be produced close to the consumption center. Their production in peri-urban areas has great potential of providing better returns to the farmers. High priority has been accorded under National Horticulture Mission to promote protected cultivation, particularly for taking up cultivation of vegetables under green/ polyhouses and shade net houses in the peri-urban areas. Haryana being close to National Capital Region (NCR) has advantage of close-by huge potential market of these crops. According to Food and Agriculture Organization of United Nations (FAO), urban poor consumers spend between 60 and 80% of their income on food, making them vulnerable to higher food prices. Vegetables are becoming unaffordable to urban poor during these days. Peri-urban farmers of Haryana near NCR of Delhi may take advantage of it. Since peri-urban areas have a constraint of availability of land for agriculture; protected cultivation (requires less land) of vegetables and flowers is advocated to them. This would provide better productivity and round the year production of leafy vegetables like palak, coriander and others. Under net houses and naturally ventilated green/ polyhouses, poly tunnels and other structures, vegetables like cucumber, tomato, capsicum, brinjal, chillies etc. can be grown for long period which would provide them advantage of high price of early and late crops. Mushroom production needs

to be encouraged in peri-urban areas of Haryana near NCR. Use of plastic mulch and low cost drip irrigation in production of most of the vegetables in peri-urban areas of Haryana near NCR has great scope and paying proposition. Establishment of Hi-tech Greenhouses in Peri-urban Haryana near NCR for the supply of vegetables and flower seedlings, fruit saplings can generate quality employment to agriculture graduates. This would boost horticultural production by providing quality planting material to the growers. Hence, protected cultivation of vegetables, flowers and fruits like strawberry needs to be promoted in peri-urban areas of Haryana. In fact protected cultivation should be taken up in cluster approach in peri-urban areas of NCR for safe and high quality vegetables and flower production and such cluster or farms can be certified under GAP. Similarly, on farm value addition should also be taken up on such farmers or clusters. All kind of protected technologies viz., Naturally ventilated green/ polyhouses, Insect proof net houses, Shade net houses, Walk-in-tunnels, Low tunnels, Plastic mulching should be taken up on large scale for high quality vegetable and flower production.

#### **6. Identify measures required for promoting effective linkages with the markets for increasing farmers' income.**

Marketing is one of the Achilles' heels or a deadly weakness of farmers in their overall constraints in realizing the profitable and reliable buyers/markets. The situation for green/ polyhouse growers is worse than open field growers as the former have much higher initial investments and hence, inspite of better quality they are not able to get higher prices due to small holdings, sporadic location, non-adherence to quality and GAP standards and more than above all, the non-availability of scientific guidance on production technologies including plant protection. Small green/ polyhouses, located at distances from each other sulk for survival – as they lack knowledge of production technology and often do not have any access to organized marketing mechanisms.

Therefore, providing subsidy to the growers for the construction of the green/ polyhouses may prove ornamental only, until there is holistic growth of all the allied sectors of which marketing mechanism and linkages are one of the most crucial components.

It is imperative to work out effective solutions for holistic growth of market sector especially for the horticultural crops and more so for protected cultivation growers. Following measures may help in sprucing up these linkages:

- i. Marketing centres across different districts of Haryana should be established for associations/cluster partners of the protected cultivation so that farmers have a direct role in market price mechanisms. Every district market/mandi should have ample space allotment to various farmer clusters with due care for the representation of all the stake holding farmer groups.
- ii. Cool chain and cold storage facilities should be available on subsidized rates to the farmers so that they are not dependent on prevalent market rates.
- iii. At higher level of technology, the state may develop a transparent electronic auction mechanism that should have cluster leaders as well as representation of marginal growers for effective access to different strata of growers.
- iv. The farmer clusters should be facilitated with certification agencies for diagnostic and GAP standards so that the quality produce of the growers could fetch higher prices through organized and up-markets and preferably for export.
- v. Development of protected cultivation clusters, their intra and inter cluster co-operative group approach has been suggested to have better linkages with markets in NCR region and APEDA, Ministry of Commerce for export of produce.
- vi. Competitive retailing through electronic auctions involving multinational branches at one hand and cluster farmers on other for both pre-production tie-ups and post production auctions may be developed to splice out middle men to achieve transparency for better price realization to growers.
- vii. Some marketing mechanism of horticultural produce has to be developed by agriculture economists to ensure at least 60% of customer price to reach back to the growers.

**7. To assess the current training programmes and facilities in relation to protected cultivation and suggest measures for human resource development, specially the small holding farmers.**

The current training program on protected cultivation and mushroom production is going on at the Horticulture Training Institute, Karnal by Department of Horticulture, Haryana Agro-Industries Corporation Ltd, Integrated Mushroom Research and Development Centre, Sonipat, CCS HAU, Hisar and several NGOs. These centres are helping farmers in this important self employment protected cultivation activity. These efforts are considered inadequate. The working group suggested adding School of Protected Cultivation to CCS HAU which would cater the training needs, besides research needs, of all stakeholders of protected cultivation in Haryana.

Haryana presently has one Horticultural Training Institute at Karnal, which was established with World Bank aid under Agricultural Human Resource Development (AHRD) Scheme in the year 1998 for imparting training on various aspects of horticulture ranging from one week to six months duration.

Recently, two Centers of Excellence (COE) on protected cultivation have been established at Gharaunda (Karnal) and Mangania (Sirsa). The COE for vegetables was established under Indo-Israel collaboration in Gharaunda near Karnal which is fulfilling its objectives of demonstrations of protected cultivation and nursery raising technologies of vegetables and flowers. Other than this CCS HAU, Hisar has some limited facilities for the field demonstration for protected cultivation for the students. Therefore, the current level of infrastructure, facilities and staff are inadequate to meet the emerging requirements of protected cultivation.

Hence the working group strongly recommends establishing a **School of Protected Cultivation** at CCS HAU Hisar as stated earlier and being emphasized here.

Protected cultivation of vegetables and flowers involves technical inputs and technologies from the following

**Expert Vegetable/ Horticulturists-** Thorough knowledge of crops, crop husbandry and post harvest management



**Plant Breeder-** Development of suitable varieties/ hybrids for protected cultivation.

**Agriculture Engineer-**Structure designs, micro-irrigation, claddings, packaging, environment control gadgets, crop handling tools and other engineering inputs

**Plant Protection Specialists-** Biotic stress in protected cultivation is different and their management technology is different from open field cultivation. After three years of protected cultivation insect and pathogen load builds up in the covered spaces necessitating prophylactic and control measures.

**Plant Physiologists-** Under protected environment plant physiology is different than that of open field. To make use of modified environment and manipulate it to better photosynthetic activity, growth, flowering, fruiting etc. inputs from plant physiologist and environment science experts are necessary.

**Agricultural Economists –cum- Social Scientist:** Protected cultivation practices in vegetables and flower production are to be compared with open field cultivation practices which are distinct and different. To ascertain superiority of one practice with another in each vegetable and flower crops economic tools, methodologies, intelligence etc. are to be made use of. Cultivation practice with economic superiority (more input use efficiency and return) is only welcome.

The expertise of above in an appropriate mix is to be used to maximize output with minimum inputs in protected cultivation of crops.

The human resources with expertise of perfect blend of above science and technologies is to be produced continuously to meet the requirements of the state. At present there is no such provision. Few courses with repetitive contents in above mentioned disciplines are now being taught at CCS HAU, Hisar at graduate and postgraduate programs. This requires thorough review and consideration of consolidation of expertise naming it as School of Protected Cultivation. This school, if approved, may be equipped to meet all the requirements of protected cultivation of the state including Human Resource Development, research, training (farmers and staff of Horticulture department of Haryana) and future requirements of the state. Faculty of this school may be trained elsewhere in the country and abroad.

The faculty of the school and that of Department of Horticulture, Government of Haryana be interchanged. The demonstrations/ Centers of Excellence under Indo-Israel collaboration and any other connected collaboration should be wholly associated with the proposed school. Existing sporadic infrastructure connected with protected cultivation should be associated to this school. This aspect has been discussed with CCS Haryana Agricultural University authorities and they were receptive to this suggestion.

**8. To find out the role of public-private partnership in strengthening protected cultivation in the state and suggest appropriate policy measures to provide enabling environment of above role in private sector.**

Private sector can play an important role in the promotion and adoption of protected cultivation in Haryana. Certain global private vendors already operating with considerable success in the country can be roped in for protected cultivation on turn key projects in certain clusters with public funding. Some farmers on their own or partial involvement of Government Department are experimenting with the turn key projects.

Supply of high yielding hybrid/variety seedlings and saplings of horticultural crops under hi-tech greenhouses (created on public expense) can be considered in PPP mode. The private partner can be given the target of supply of particular hybrid seedlings in plug trays instead of seeds dovetailed with farmer's requirement at partially public expense to have better quality nutritive produce for the benefit of consumers and promote export of the produce.

These clusters of horticultural production can work as pockets of excellence not only producing quality vegetables and flowers, but also generating the demand of inputs, thereby creating a multi-layered business hub conducive to all the stakeholders – producers, suppliers, marketers and exporters. By intelligent and transparent handling of marketing possibly on the lines of electronic auctioning of such high quality produce, ultimately ensuring much better profit margins for the growers.

It will be pragmatic to develop clusters of protected cultivation by consolidating entrepreneurial ventures of farmers which will be real empowerment of the marginal

farmers for not only sustainable development but also their economic empowerment and skill development in many ways. This aspect can be discussed at appropriate level enabling harvesting benefits of potential resource.

Through constructive linkage development of public-private partnership such as CSR activities, marketing, processing and export industries can be linked up for progressive empowerment of people and the areas of the state.

Efforts may be taken up by SEZs to develop such clusters of protected cultivation with holistic production system approach. Public and private partnership in protected cultivation of vegetables and flowers must ensure fulfillment of interest of growers, consumers, private partner and the State.

## **9. Review ongoing Government policies and programs for the promotion of protected cultivation in Haryana and suggest best options for promoting the same.**

Government of Haryana is currently promoting protected cultivation in a big way through subsidized financing of such projects under Central Government projects/ programs and its own projects.

There are possibilities of improvement in several ways across financial, technical and marketing components:

i. The subsidy-linked promotion of different components of protected cultivation often finds itself brushing with several suspected levels of corruption; hence there is greater need of transparency. The construction quality of the greenhouses has to be verified by multiple agencies. Besides, there has to be independent panel of experts for linking the payment to construction firm not only with the quality of the construction but also with successful on-farm production system, so that the firms ensure to hire suitable experts for extension of production technology on sustained and regular basis. The crux of the problem is that while greenhouse technology is being promoted, the greenhouse production could not yet be promoted. The purpose of the state government should not be the promotion of greenhouse construction rather it should be promotion of production through protected cultivation. Besides this, the government should recommend low cost and

environment friendly technologies, for example, low cost structures like insect proof structures, walk-in-tunnels and low cost fertigation technologies.

ii. Technical experts should be nominated by an independent body involving farming clusters for approving the technical feasibility of the protected structures. Three monthly seminars of two-days duration of all the clusters be held independently, where in such identified panel of experts handle all the pre- and during crop operations and crop production and protection issues. The subsidy to the growers should be available even if the construction of structures is done by the farmers themselves.

iii. Each cluster can be linked with GAP certification laboratories for sample testing and certification on franchise basis. GAP certification agencies can be linked with each of the state funded laboratories for facilitating entire cluster for credible produce management. This may ultimately lead to promotion of export of high quality produce.

iv. Besides, promoting the protected cultivation technology, the marketing aspect has to be equally promoted. Considering such high level of funding by the state government on protected cultivation, why not approx. 20% of the state funding be diverted for developing marketing and export hubs in the state including Transparent Electronic Auction Management (TEAM) system and Cool Chain Management (CCM) System. In the TEAM system, only cluster approach should be promoted. Each cluster of production system should be connected with the Central Body headed by state officials and farmers themselves. Each decision has to be 'LIVE' recorded on video. Graded produce from various clusters should be subjected to electronic auction, splicing out the middle men from marketing chain. Any mechanism helpful in elimination of middle men in marketing of horticultural produce would be welcomed.

v. Ongoing policies and programs of the Government (both centre and state) are centered on producing support (subsidy) on inputs like structures, drip-fertigation and plastic mulch. This support does not have a binding on undertaking production of vegetables and flowers by growers and resultant return as tonnage of

produce. The purpose of promotion of protected cultivation needs to be measured not by area coverage but the produce obtained.

vi. This support totally or partially should be linked to the actual production of vegetables and flowers. Policy of the Government besides being proactive be result-oriented. If feasible promotional support should be linked to production only.

### **10. To propose most appropriate strategy for accelerating production of vegetable crops and flowers using protected cultivation practices in Haryana.**

An appropriate strategy for accelerating production of vegetable crops and flowers using protected cultivation practices in Haryana should cover the following.

- Large scale motivation and training of educated unemployed youths in the field of protected cultivation in Haryana.
- Government support must be extended for self fabrication mode of temporary low cost structures like insect proof net houses, shade net houses, walk-in-tunnels and plastic low tunnels for the production of vegetables and flowers.
- Government support may also be extended to farmers for self-fabricated low cost protected structures.
- Large scale production and distribution of healthy vegetable and flower seedlings to the large section of growers on nominal price.
- Government should support and promote protected cultivation in cluster approach especially in peri-urban areas near the NCR and in proximity of Kundli Manesar palwal Express Way, Northern as well as Southern Peripheral Express Ways.
- Develop suitable varieties and hybrids suitable for protected cultivation.
- Where ever possible promote organic production under protected structures.
- Government should promote to develop input hubs for protected

cultivation in multi-locations in PPP mode.

- Marketing is the key for success of protected cultivation. Electronic auctioning of produce through cluster representatives may be initiated.
- In all the posh colonies of major city markets, some shops should be mandatorily allotted to farming clusters of protected cultivation.
- Protected cultivation has hitherto been promoted from the view point of more and more construction of greenhouses by providing subsidy.
- However, there is need to link such subsidies with production system, i.e., when the protected cultivation produce is sold/auctioned by the grower some of the subsidy may be realized to him at this level as an incentive. A special cluster club of protected cultivation growers may be established along with a protected cultivation Panchayat at the state level.
- All the protected cultivation clusters must be mandatorily clubbed with rain water harvesting infrastructure and facilities.
- Practical demonstration units at each district level may be established for 5 years, ensuring the demonstrations of all low cost protected structures along with the production and pest management strategies.
- Suggest most suitable crop sequences for different protected structures and seasons based on research data.
- Large scale promotion of low pressure drip irrigation system for low cost small scale protected cultivation in Haryana state should be encouraged.
- Selection and promotion of suitable designs of protected structures for different regions of Haryana such as large scale adoption of naturally ventilated green/ polyhouse for high quality vegetable cultivation in North viz. Sonipat, Panipat, Karnal, Kurukshetra, Ambala and Panchkula districts and large scale adoption of insect proof and shade net houses in South west regions of Haryana for safe vegetable cultivation.
- Large scale use of different colour plastic mulches for different seasons clubbed with raised beds and drip- fertigation system for vegetable and

flower production should be promoted under open field conditions and also to discourage expensive surface irrigation in horticultural crops.

- Promotion of large scale mechanization in vegetable and flower cultivation by using raised bed maker, rotavator, chiseler, plastic laying machine, plastic low tunnel making machine, pipe bending machines for making walk- in – tunnels, drip lateral laying and binding machines
- To establish convergence and synergy among various ongoing and planned government programmes in the field of protected cultivation development.
- To ensure adequate, appropriate, time bound and concurrent attention to all links in production under protected conditions, post production on farm value addition, processing and consumption chain.
- All ITIs in Haryana State should start a diploma course on fabrication of protected structures, repair and their maintenance.
- Use of self driven trolleys for training and pruning in greenhouse vegetables along with the equipments related to aided pollination in vegetables under protected cultivation.
- Use of solar energy for running drip system and up to some extent for running heating and cooling devices of the protected structures.
- Explore introduction of bumble bees as pollinators for improving fruit set in capsicum and tomato.

Awareness, incentives, training, better sustained return, continuous support to the venture in cluster production mode would constitute appropriate strategy for accelerating production of vegetable crops and flowers using protected cultivation practice in Haryana. Being a diverse, infant, full of uncertainty and constraint ridden subject, protected cultivation does not permit to evolve an appropriate strategy with few variables and conditions for the entire state of Haryana for different vegetables and flowers production.

## Major Recommendations

- i. Protected cultivation technology needs to be given a prioritized boost by the State Govt. of Haryana through promotion of greenhouses construction including the low cost structures as per technical and dimensional standards keeping in view the climate, crop and season.
- ii. Self-constructed greenhouses and low cost temporary structures may also be considered for subsidy linked schemes.
- iii. The quality of structures and technical adherence to dimensions and material used, have to be ensured through multiple-agency verification.
- iv. Promotion of protected cultivation in the State should be holistic with a complete package and not merely the construction of greenhouses and protected structures only. It has to rather ensure quality of construction, regime of Global GAP and surety of successful production mechanisms through engagement of experts, particularly production technology, cropping systems and plant protection measures – exclusively for protected cultivation.
- v. Quality seeds/nursery/other planting material suitable for protected structures should be ensured at the time of granting the scheme of funding to the grower.
- vi. Additional/supplementary subsidy/grant may be provided to the growers, if they happen to be in the cluster of within 2 km of other such large number of protected structures, for realizing the ultimate goal of cluster formation through farmers' efforts rather than supporting individual greenhouses in independent and sporadic location without any technical guidance, input availability and market linkage.
- vii. Protected Nursery Hubs should be promoted for supplying healthy and disease-free planting material of horticultural crops particularly vegetables at affordable price (may be subsidized) to the growers of both the protected structures and open field cultivation.



- viii. Research gaps on protected cultivation including plant protection, Global GAP, export requirements and development of human resources should be addressed through opening a School of Protected Cultivation at CCS HAU, Hisar on priority. The existing facilities in public sector like at CEV, Gharaunda and CEF, Mangiana may develop strong collaboration with the proposed school of protected cultivation for uniform handling of demonstrations, education and human resource development. The School should handle future requirements of the State regarding protected cultivation. In continuation of such efforts, ITIs in the State may be introduced with a course on greenhouse construction, repair and maintenance apart from the development of minor tools and equipment, so that the youth could soon take it up on entrepreneurial basis.
- ix. Institutions of agriculture in Haryana and close-by states may be given special funding for development of varieties and hybrids exclusively suitable for greenhouses and other protected structures as no such varieties / hybrids of Indian origin could yet be developed for this region.
- x. Besides this, institutional and stakeholder linkages should be provided on regular basis for the spread of technical know-how and the development of competitive marketing mechanisms for input industry.
- xi. Demonstration centres having each kind of appropriate and affordable protected structures may be created at district level in the State.
- xii. Development of large Protected Model for Vegetable and Flower Farms may be started in the peri-urban areas particularly near Delhi with all diagnostic and Global GAP certification laboratories with accreditation authority.
- xiii. Marketing of high quality, GAP certified produce may be encouraged through Electronic Auction Mechanism both for domestic consumption and export purposes for suitable price realization to the growers who often invest huge amounts of initial capital for the construction of protected structures and other allied facilities. Such market mechanisms should minimize, if not completely eliminate the middlemen. In fact, cluster farmers themselves

- should be involved in critical decision-making of overall transparent marketing system.
- xiv. Besides this, each city market may have provision of allotment of large shops to cluster farmer bodies which should be electronically linked with other such marketing centres or export hubs for suitably and timely diversion of the same in both the scenarios of glut or shortage.
  - xv. Similarly, there should be a centre for development of export linkages and provision of assistance to cluster farmers for the export of certified produce like fresh vegetables, fruits and cut flowers and foliage.
  - xvi. Due care should be given to environment and safety measure mechanisms such as safe disposal of plastics and any other harmful chemical or wastage – as per environmental and Global GAP stipulations.
  - xvii. Subsidies for promotion of protected cultivation need to be partially linked with the produce instead of infrastructure development or inputs (such as seed etc.) alone.
  - xviii. Explore introducing bumble bees as pollinator for improving fruit set and yield in tomato under protected cultivation.
  - xix. Soil and water testing of fields should be mandatory for the green/polyhouse growers.
  - xx. A team of experts from the discipline of vegetable science, entomology, plant pathology, nematology, agricultural engineering and soil science needs to be appointed at every district of the State for the providing expertise at the spot.
  - xxi. Electric fencing of the poly-green house should be encouraged to keep the structures protected against wild animals like Blue-bulls.
  - xxii. Foggers should be fixed on the top of the structures for removing dust from the roof of the structure
  - xxiii. Awareness programs for the consumers should be conducted about the quality and pesticide free vegetable produced under protected cultivation.



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## Meetings held of working group on protected cultivation for Haryana

Sr.N.	Date	Place	Purpose
1	4-Oct-2011	TAAS- New Delhi	First meeting of working group on protected cultivations
2.	29, 30-Oct 2011	Field visits at Karnal, Panipat and Kurukshetra	Field visits of working group on protected cultivation
3.	10-Nov-2011	Field visits at Gurgaon and Faridabad	Field visits of working group on protected cultivation
4.	8-Feb-2012	HKA Camp Office Gurgaon	Meeting of stakeholders on Protected Cultivation for Haryana
5.	17-March-2012	CEV Gharaunda, Karnal	Working group meeting with Dr. A.S. Saini Addl. Director General Horticulture, Department of Horticulture, Haryana
6.	05-May - 2012	Haryana Kisan Ayog, Hisar	Discussion meeting of working group on protected cultivation in Haryana with the Vice-Chancellor and senior staff CCS HAU, Hisar
7.	07-Nov - 2012	PAU, Ludhiana	Working Group Meeting
8.	06-Dec - 2012	NAAS, Delhi	Presentation of final report and brain storming with the stakeholders

## Annexure-I

### Terms of Reference (ToR)

1.	To review the current status of protected cultivation in the State of Haryana.
2.	To examine the existing structures and designs presently used for protected cultivation and suggest suitable low cost models for large scale adoption.
3.	Review the status of research in the field of protected cultivation and measures to address current gaps and specific needs of the State.
4.	To suggest specific crops and their sequences for all the year round production of vegetable and flowers and for raising nurseries using appropriate protected structures.
5.	Use of protected cultivation in peri-urban agriculture for increasing the income of farmers living around big cities like NCR.
6.	Identify measures required for promoting effective linkages with the markets for increasing farmers' income.
7.	To assess the current training programmes and facilities in relation to protected cultivation and suggest measures for human resource development, especially the small holder farmers.
8.	To find out the role of public-private partnership in strengthening protected cultivation in the State and suggest appropriate policy measures to provide enabling environment for active role of private sector.
9.	To review on-going Government policies and programmes for the promotion of protected cultivation in Haryana and suggest best options for promoting the same.
10.	To propose most appropriate strategy for accelerating production of vegetable crops and flowers using protected cultivation practices in Haryana.

## Annexure II

**Present State policies for promotion of protected cultivation of vegetables and flowers being adopted by Dept of Horticulture, Govt. of Haryana.**

### State Policy

1.	Demonstration Centres <ul style="list-style-type: none"><li>• Centre of Excellence for Vegetables at Gharaunda, Karnal: a Rs. 6.00 crore demo Centre.</li><li>• Centre of Excellence for Fruits at Mangiana, Sirsa: a Rs. 9.70 crore demo Centre.</li></ul>
2.	New Project on Waste Treatment and Integration: Rs. 55.00 crore: approved
3.	New Project on Saline Water Treatment and Integration: Rs. 10.00 crore: approved
4.	Front Line Demonstration Centres: 14 FLDC in 14 districts in PPF mode.
5.	Exposure visits of officers, farmers and business personnel/ industries
6.	Arranged visits – budgetary support
7.	Financial support to farmers in installing protected structures:
8.	Uniform rate of structures
9.	Increase in assistance level to 65% from 50 % Central Govt. + 15% from State Govt.
10.	Same assistance to continue during 12 <sup>th</sup> Plan
11.	Assistance available in 17 districts under NHM
12.	Assistance extended to all 21 districts
13.	Extra support on planting material under polyhouses

	<ul style="list-style-type: none"> <li>• For flowers: Rs. 250/sq m</li> <li>• For vegetables: Rs. 52/sq m</li> </ul>
14.	Land-holding with farmers
15.	Weekly calendar of each farmer to visit undergoing protected cultivation
16.	Arrangement of farmers training at HTI for 3-6 days: free of cost
17.	Pre and post installation inspection of polyhouses by Technical team from Directorate: mandatory before completion certificate to Firm
18.	<p>Formulation of uniform specifications</p> <p>Well- defined Specification are formed after visit of various States and in consultation with experts both from industry and Israel for:</p> <ol style="list-style-type: none"> <li>a. Hi- Tech Green house from 1000 to 4000 sq. m. for both Tubular and Channel structures</li> <li>b. Naturally Ventilated Green Houses from 500 sq. m. to 4000 sq. m. for tubular and channel structures</li> <li>c. Walk-in-tunnels/single span structures for 400 sq. m. to 1000 sq. m. for tubular structures</li> <li>d. Insect net houses from 500 sq. m. to 4000 sq. m. for tubular structures</li> </ol>
19.	Sixteen firms are empanelled under protected structures. These firms are bonded with bank guarantee
20.	Rates are at par across the firms in the entire State
21.	Bankable Projects
22.	Projects sent to NABARD for evaluation and finalization.
23.	Training program for Department officers and protected cultivation farmers.

## Annexure III

### Protected Structures' Current Status (2011-12) and Potential (2012-13)

Sr. No.	District	No. of Structure(s)	Approx. Area (sq. m.)
1.	Panchkula	8	12000
2.	Ambala	2	1200
3.	Karnal	4	15000
4.	Panipat	8	19500
5.	Sonipat	6	13000
6.	Rohtak	4	3500
7.	Jhajjar	1	500
8.	Faridabad	1	4000
9.	Gurgaon	6	6000
10.	Fatehabad	1	3000
11.	Hisar	4	3000
12.	Sirsa	1	1000
13.	Kaithal	8	15000
14.	Jind	3	4500
15.	Kurukshetra	3	5500
16.	Bhiwani	2	1000
17.	CEV	-	22000
18.	CEF	-	7000
	TOTAL (2011-12)	62	112000 Sq. m.
	POTENTIAL	-	5,00,000 Sq. m. (2012-13)













**Head Office**

**Haryana Kisan Ayog**

CCSHAU Campus  
Hisar-125004

Tel.: +91-1662-289593

Fax: +91-1662-289511



[www.haryanakisanayog.org](http://www.haryanakisanayog.org)

**Camp Office**

**Haryana Kisan Ayog**

Kisan Bhawan, Khandsa Mandi,  
Gurgaon-122001

Tel.: +91-124+2300784