



Working Group Report
on

Development of Horticulture
in Haryana



Haryana Kisan Ayog

CCS HAU Campus, Hisar-125004
Government of Haryana



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Government of Haryana

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FOREWORD

Haryana, having excellent geographical location with climate ranging from dry sub-humid to arid, is ideally suited for cultivation of a wide range of horticultural crops. While the State has made significant progress in the field of crop production, its growth in horticultural has to be accelerated to ensure much needed agricultural diversification as well as increased income for the farmers. The present area under horticulture is around 4.23 lakh ha (6.34 %), which can easily be increased to cover at least 10 per cent of cultivated area. Although in recent past, much faster progress has been made, yet there is an urgency to harness the benefits of advances in horticultural research for inclusive development.

Increased production of horticultural crops can help in improving both food and nutrition security, enhancing rural employment, alleviating poverty and promoting agricultural exports. Also in view of increased urbanization and living standards, and considering the convenience needs of dual income families, much greater thrust is needed to exploit the market potential of horticultural crops, both as fresh and processed products.

Dr. K.L. Chadha, as Chairman, Dr. O.P. Pareek and Dr. P.C. Gupta as members, beside Dr M.L. Chadha as Nodal Officer, of the Working Group deserve all appreciation for their sincere efforts in finalisation of this expert group report entitled "Working Group Report on Horticulture Development in Haryana". I congratulate them for their sincere efforts in this regard. I am quite confident that this report will provide a 'Way Forward' for the State to achieve Horticultural Revolution in Haryana.

I am sure this valuable publication will be highly useful to the organizations/institutions involved in horticultural research and development. It will also be equally useful for the administrators, researchers, policy planners, farmers and the entrepreneurs.

(R. S. Paroda)

**FORMER DDG (Hort) ICAR &
CHAIRMAN**
WORKING GROUP ON DEVELOPMENT
OF HORTICULTURE IN HARYANA



PREFACE

The Haryana Kissan Ayog, Government of Haryana under the Chairmanship of Dr. R.S. Paroda assigned me the responsibility of preparing a Roadmap for the Development of Horticulture in Haryana State. I am grateful to the Ayog for providing me an opportunity as the Chairman of an Empowered Committee to be associated with this endeavour. The Empowered committee comprised of eminent colleagues namely Dr. O.P.Pareek, Former Director, Central Institute for Arid Horticulture, Dr. P.C.Gupta, Former Director, Horticulture & Executive Director, HDB, Prof. P. Das, Chairman, The Science Foundation for Tribal & Rural Resource Development, Odisha and Dr. M.L.Chadha, Consultant, Haryana Farmers Commission. However, Dr. Das could not lend his services to the committee due to his other pre-occupations.

The endeavour of preparing the roadmap has been both rewarding as well as challenging. It has been rewarding for the reason that it has given the committee an insight into the progress the state has achieved and the potential it holds in Horticulture. It has been challenging due to the very comprehensive and exhaustive Terms of References (ToR) assigned to the committee which are as under:

- To identify the potential of agricultural diversification through promotion of horticulture so as to improve farmers' income and state revenue substantially.
- To review the current status of horticulture sector (crop varieties, production and productivity, quality, post harvest management etc.,) in the State and

recommend improvements keeping in view the agroclimatic conditions and economic potential through value addition and export.

- To review the infrastructure and programmes of R&D, their impact and identify gaps for future improvement.
- To find out the requirement/need of different horticultural crops especially the availability of quality planting material.
- To Explore the opportunities for promoting urban and peri-urban horticulture
- To assess the potential for protected cultivation of vegetable crops and flowers
- To assess the processing facilities available in the State and indicate future opportunities for rural based primary processing and value addition activities.
- To find out the current status of Public Private Partnership in horti-business and identify the future areas of collaboration.
- To assess the present marketing system available infrastructure and policies for horticulture development and suggest measures for further improvement
- To analyze the adequacy of available human resources for the transfer of technology and suggest future training and manpower needs.

In order to address the issues flagged in the TORs, the committee met three times on August 30, 2011 for the introductory meeting, December 16-17, 2011 for the stakeholders' workshop and May 28-30, for finalisation of the draft report. Dr. K. L. Chadha, Chairman & Dr. M. L. Chadha, Consultant, Haryana Kisan Ayog also discussed with the Director General (Hort.) & other staff of the State twice on March 12-14, 2012 & April 11, 2012. The Chairman also made a field visit to Centre of Excellence of Vegetable at Gharaunda, Horticulture Training Institute & Horticulture Biotechnology Centre at Karnal and modern mandi and field plantation & polyhouses near Rohtak on April 10, 2012.

A number of useful inputs emerged from the visits and the interactions the committee had with various stakeholders. The first draft report was prepared and circulated to about 40 experts. The experts also provided inputs based on the draft report circulated as also presented at New Delhi on December 6, 2012. The present report

captures the essence of impressions gained by the committee since its constitution.

The report is divided into four Sections each devoted to i) Horticulture Research & Development, ii) Strategy for Horticulture Development, iii) Strategy for Post-Harvest Management and iv) Summary & Recommendations. The issues identified have been addressed in 14 chapters. I thankfully acknowledge the support and cooperation extended by all the committee members of the working group and all the experts who have participated in the discussion and contributed useful inputs in preparation of this report. Thanks are also due to Dr. R S Dalal, Member Secretary, Dr. M. L. Chadha, Nodal Officer, & Dr. Ravikant, Research Fellow, Haryana Kisan Ayog, Dr. S. K. Singh, Principal Scientist, & Dr. K. V. Prasad, Sr. Scientist, IARI, New Delhi, Mr. Santosh Kumar Atre, Co-ordinator, The Horticultural Society of India, New Delhi and Ms. Shashikala Sivasakthi (Technical Assistant) for their support in finalization of the report. I place on record my sincere gratitude to Dr.R.S.Paroda, Chairman, Haryana Kisan Ayog for the opportunity provided & guidance given to me.

K.L. Chadha
(K.L.Chadha)

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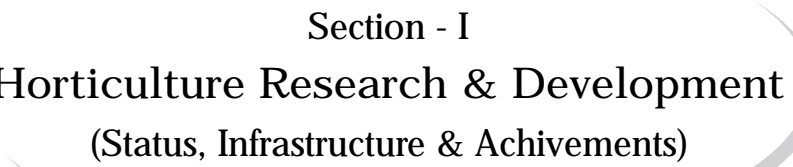
ABBREVIATIONS

AICRP	:	All India Coordinated Research Project
AICVIP	:	All India Coordinated Vegetables Improvement Project
APC	:	Agriculture Project Officer
APEDA	:	Agricultural Processed Food Export Development Agency
APMC	:	Agriculture Produce Market Committee
BCIL	:	Biotech Consortium of India
CA	:	Conservation Agriculture
CCS HAU	:	Chaudhary Charan Singh Haryana Agricultural University
CDFD	:	Centre for DNA Fingerprinting and Diagnostics
CEV	:	Centre for Excellence
CIAE	:	Central Institute of Agricultural Engineering
CIPHET	:	Central Institute of Post Harvest Engineering & Technology
CISH	:	Central Institute of sub-Tropical Horticulture
CMV	:	Cucumber Mosaic Virus
CPRI	:	Central Potato Research Institute
CSIR	:	Council of Scientific and Industrial Research
CSSRI	:	Central Soil Salinity Research Institute
CSWCRTI	:	Central Soil & Water Conservation Research & Training Institute
DHO	:	District Horticulture Officer
DMR	:	Directorate of Mushroom Research
ECS	:	Evaporative Cooling System
FLDC	:	Front Line Demonstration Centre
FUE	:	Fertiliser Use Efficiency
FYM	:	Farm Yard Manure
GAP	:	Good Agricultural Practices
GAU	:	Gujarat Agriculture University
GBPUA&T	:	Gobind Ballabh Pant University Agriculture & Technology

GDP	:	Gross Domestic Product
GoI	:	Government of India
HAFED	:	The Haryana State Cooperative Supply & Marketing Federation Ltd.
HDP	:	High Density Planting
HSHAD	:	Haryana State Horticulture Development Agency
HTI	:	Horticulture Training Institute
IARI	:	Indian Agriculture Research Institute
ICAR	:	Indian Council of Agriculture Research
ICCOA	:	International Competence Centre for Organic Agriculture
IIHR	:	Indian Institute of Horticulture Research
IIP	:	Indian Institute of Packaging
IIVR	:	Indian Institute of Vegetable Research
INM	:	Integrated Nutrient Management
IPM	:	Integrated Pest Management
JAU	:	Junagadh Agriculture University
KVK	:	Krishi Vigyan Kendra
LLDPE	:	Linear Low Density Polyethylene
MAP	:	Modified Atmospheric Packaging
MAS	:	Marker Assisted Selection
MDFVL	:	Mother Dairy Fruits and Vegetable Ltd.
MDH	:	Mahashian Di Hatti
MGNREGA	:	Mahatama Gandhi National Rural Employment Guarantee Act
MPKVV	:	Mahatma Phule Krishi Viswa Vidyalaya
NAIC	:	National Agriculture Insurance Corporation
NARP	:	National Agriculture Research Project
NBPGR	:	National Bureau of Plant Genetic Resources
NCR	:	National Capital Region
NDRI	:	National Dairy Research Institute
NDUA&T	:	Narendra Dev University of Agriculture & Technology

NHM	:	National Horticulture Mission
NHRDF	:	National Horticultural Research and Development Foundation
NMMI	:	National Mission on Micro Irrigation
NMPB	:	National Medicinal Plants Board
NPOP	:	National Programme for Organic Production
NRCC	:	National Research Centre of Citrus
NRCM	:	National Research Centre on Mushroom
NUE	:	Nutrient Use Efficiency
OP	:	Open Pollinated
PALCVD	:	Potato Apical Leaf Curl Viral Disease
PAU	:	Punjab Agriculture University
PPP	:	Public Private Partnership
PSB	:	Phosphorus Solublizing Bacteria
PVC	:	Poly Vinyl Chloride
R & D	:	Research and Development
RH	:	Relative Humidity
SASA	:	State Agriculture Statistics Authority
SAU	:	State Agriculture University
SLM	:	Sustainable Land Management
SWOT	:	Strengths, Weaknesses, Opportunities and Threats
TMV	:	Tobacco Mosaic Virus
TOR	:	Terms of Reference
VHT	:	Vapour Heat Treatment
VIUC	:	Vegetable Initiative in Urban Clusters
WUE	:	Water Use Efficiency
YVMV	:	Yellow Vein Mosaic Virus

Section - I
Horticulture Research & Development
(Status, Infrastructure & Achievements)



EXECUTIVE SUMMARY

CHAPTER 1 : AGRICULTURE SCENARIO

Haryana State Came into existence on November 1, 1966 as a result of re-organization of erstwhile Punjab state. It is divided into 4 Divisions, 21 Districts, 54 Sub-divisions, 74 Tehsils, 44 Sub-tehsils, 119 Blocks, 10 towns and 6,955 villages. The State has a natural geographical boundary with the Shivalik hills in the North, the river Yamuna in the East and the river Ghaggar in the West. The South-west of the state is bounded by the Aravali hills which run through Southern Delhi and Gurgaon district up to Alwar in Rajasthan. The State lies in the Trans-Gangetic Plains Region (Agro-Climatic Zone VI) as per classification by the National Agriculture Research Project (NARP) of ICAR and is divided into two regions.

- A. Eastern region (two sub-units)
 - i. Shivalik hill region with semi-arid to dry sub-humid conditions: It has recent alluvial calcareous soils and high rainfall (890 mm) area that covers parts of Ambala, Kalka, Karnal, Panchkula, Panipat and Yamunanagar districts along the Himachal border.
 - ii. Alluvial plains with semi-arid conditions: It has recent alluvial calcareous soils, medium rainfall area that covers parts of Ballabhgarh, Faridabad, Gurgaon, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak and Sonipat districts.
- B. Western region (two sub-units)
 - i. Alluvial plains with semi-arid conditions: It has recent alluvial calcareous soils, medium to low rainfall (561 mm) covers parts of Bhiwani, Hisar, Rohtak, Sirsa and whole of Mahendragarh districts.
 - ii. Sand dune region with arid conditions: It has calcareous sierozemic recent alluvial soils, desert and low rainfall (360 mm). It is spread in south-western parts of Bhiwani, Fatehabad, Hisar, Rewari, Sirsa and Mahendragarh (Narnaul) districts adjoining Rajasthan.

The state has mainly 4 types of soils with pH varying from 6.5 to 9.0. The soils are mostly deficient in nitrogen and zinc, lower to medium in phosphorus and normal in potash. The climatic conditions in the State range from dry sub-humid to arid along North-East, and South-West transects, respectively. The State experiences extreme temperatures ranging from 0-48°C in winter to summer, respectively. The winter season lasts from November to March, while April to June are the hottest summer months. In southern districts, due to high temperature and wind velocity, dust storms are very common. The annual rainfall varies from less than 300 mm in the western and south-western parts along Rajasthan border to over 900 mm in north east zone. The monsoon season commences on the end of June and lasts till the end of September. Irrigation canals form the lifeline of Agriculture. The western Yamuna canal irrigates the districts of Kurukshetra, Karnal, Jind, Sonapat, and Rohtak, while the Gurgaon Canal irrigates parts of Gurgaon and Faridabad districts. Bhiwani and Mahendragarh districts are fed by Juhi, Bhiwani and Jawaharlal Nehru canals. About 75% of the cultivated area in the State is irrigated. The contribution of tube wells and pump sets is about 50%.

1. Present Agriculture Status

Haryana State has a geographical area of 4.45 m ha with 1.37% of the land and less than 2% of India's population. The cropping intensity in the State is around 180 per cent. Agriculture is the mainstay of the economy of the State and continues to be the main source of livelihood for 70% of population. From being a deficit state since its inception in November 1966, food grain production increased over six times to about 16.6 million tonnes in 2010-11. Various factors responsible for this included thrust on improving irrigation system and diversification in agriculture using superior varieties, biotechnology, organic farming, post-harvest management, contract farming and marketing coupled with transmission of latest technical know-how to farmers. Currently, Haryana is not only self-sufficient in food production but is the second largest contributor to India's central pool of food grains also.

The state has 3.8 m ha cultivable area of which 3.55 m ha (98.4%) is cultivated. Of the 15.28 lakh farming families, 2.94 lakh are small farmers occupying 12 % of land, while 7.04 lakh are marginal farmers occupying 3.17 lakh ha of area. Over 43 lakh farmers

and farm workers are engaged in agriculture in the State. Thus, measures for enhancing income opportunities for rural areas are one of the prime concerns of the state. The State Govt. has accorded highest priority to the agriculture sector. Because of the farmer friendly policies of the State Govt., it has made rapid progress in agriculture. The funding of agriculture programmes increased from Rs. 59.67 crores during 2004-05 to Rs.222 crores during 2009-10. Similarly, non-plan outlay of Rs. 72.74 crores during 2004-05 increased to more than 158 crores during 2009-10.

2. Need For Diversification

After self-sufficiency in food grain production, there has been an increasing awareness in India for need to achieve food, nutrition and environment security for the people along with income security for the farmers. Conservation of biophysical resources during human activities while utilizing these for livelihood, has assumed greater importance now than ever before. At the same time, the adopted farm techniques must provide sustained economic benefits to the farmer and food and nutrition security to the community. These guiding principles necessitate diversification. Diversification in agriculture for small holding farmers is important for minimizing the risk in agriculture by integrating it with livestock, poultry, fisheries and horticulture.

The share of agriculture, one of the components of primary sector is only 0.7% out of the overall growth of 9.9% in the economy of the State which accounts for about 15.3% (Rs. 23,208.85 crore) of GDP of Haryana. Of the total GDP from agriculture, 64% comes from crop-husbandry, 30% from animal husbandry, while 6% is contributed by the horticulture sector in spite of the enormous possibilities of much higher returns and employment opportunities as a result of better land use by growing high value horticultural crops. This has been amply demonstrated from the horticulture during the last two decades. Horticulture development has assumed greater importance all over the country in general and Haryana State in achieving food and nutrition security. Moving from rural confines, horticulture has become a profitable commercial enterprise. During the last two decades it has attracted private sector investment in production system management. The economic importance of horticultural produce and products has been increasing over the years due to increasing domestic and international demand. Investments made in horticulture

have been rewarding in terms of increased production and productivity to ensure nutritional security, employment opportunities and gender equity, reversing the declining profitability. It has thus been identified for inclusive growth of agriculture sector in the country. The overall development in farming infrastructure, primarily irrigation and communication networks in Haryana, have provided the needed assurance for this and for profitability and viability of horticulture enterprises.

3. Scope For Diversification

The geographical location of Haryana is uniquely favourable and offers strengths and opportunities for horticultural development as per analysis presented below:

A) Strengths

- State's agro-climatic conditions are suited for growing of a large number of horticulture crops, e.g., fruits, vegetables, spices, flowers, medicinal and aromatic plants and mushroom.
- The State has good cultivable land with high cropping intensity, progressive farming community and rich traditional knowledge and hard working women farmers.
- Assured irrigation in 2/3rd of the State.
- Proximity to National Capital Region (NCRs) with access to a wide range of national and international markets.
- Good infrastructure and several development programmes with good funding both from central sector schemes and State programmes.

B) Weaknesses

- Declining soil health, poor recycling of organic matter, sizeable area under salinity, alkalinity and water logging.
- Water scarcity and declining water quality (water mostly brackish, water table rising up in canal command areas).
- Poor post-harvest and marketing facilities like grading and packaging, cold storage, pre-cooling, waxing centres and processing units.

- Relatively low investment in horticulture.
- Inadequate research support.
- Poor staffing pattern for horticulture development and lack of skilled manpower and framers' training in horticulture technologies.
- Inadequate availability and lack of quality control on seed and planting material.
- Uncertain and short supply of electricity during the day for agriculture.
- Shortage of labour.
- Non adoption of APMC Act.

C) Opportunities

- Scope exists for further area expansion in horticulture to cover at least 10% of cultivated area.
- Considerable scope exists for expanding area under citrus (Kinnow), guava and arid fruits among fruits and potato, onion, chillies, cauliflower, tomato among vegetables.
- Good potential for expanding cultivation of mushroom, honey production and production of speciality crops like baby corn, cherry tomato, strawberry etc.
- Scope for expansion of protected cultivation of good quality vegetables and flowers.
- Fast growing domestic demand due to changing food habits, health conscious and fast expanding middle income group.
- Good export opportunities for some horticulture crops grown in the State.

D) Threats

- Rising salinity and water table in some arid areas; fast depleting ground water and degrading soil fertility.
- Risks from natural disasters not adequately covered by insurance.

- Rapid urbanisation, fragmentation of holdings and deterioration of environment (climate change).
- Relatively poor post-harvest management and weaker marketing system.
- Increasing domestic and international competition due to rising cost of production.
- Lack of interest among young generation to adopt agriculture/horticulture as a profession.

CHAPTER II : HORTICULTURE RESEARCH

(Infrastructure, Programmes and Technologies)

Research on horticulture crops is being carried out in Haryana State by the following organizations:

CCS Haryana Agricultural University at Hisar: Research on horticultural crops is being carried out in various departments of the university namely Horticulture (fruits, flowers) and Vegetable Science (vegetable, potato and spices), Genetics and Plant Breeding (Medicinal and Aromatic crops) and Plant Pathology (Mushroom). The University also has the responsibility of higher education and extension education. The National Horticulture Research and Development Foundation: is working on various aspects of onion & garlic at its Regional Station at Salaru (Karnal), Haryana. IARI Regional Station, Karnal: An outreach station of IARI engaged particularly in supplying of planting material and quality vegetable seeds. KVKs: There are 18 KVKs in the state of Haryana in different districts, 14 of which are under the administrative control of the university while one each is linked to IARI, NDRI and a society named Creation of Heaven on Earth.

1. Fruit Crops

A) Research Infrastructure

Research work on fruit crops is being carried out by the Department of Horticulture CCS HAU, Hisar. It has two Regional Stations- one in the south-western part of the state at Bawal and the other in north-eastern part located at Buria. The department has 7 laboratories besides an experimental orchard in an area of about 100 acres. A Tissue Culture laboratory has also been set up for standardization of micro-propagation protocols. Under Precision Farming Development Centre and Experiential Learning Programme, hi-tech greenhouses and naturally ventilated polyhouses are also being installed. The department has a well developed nursery at the experimental orchard for multiplying true-to-the-type disease free plants of certain fruit species. Besides, the University also has AICRP centre on Arid Fruit at Bawal.

B) Areas of Research : The focus areas of research are:

Crop Improvement – Collection, improvement and evaluation of fruit crops, promotion of indigenous fruit plants and low chilling required crops like pear, peach, plum in northern Haryana in districts of Yamunanagar, Panchkula, Kurushetra and Karnal districts.

Crop Production – Drip irrigation in orchards, intercropping systems in different horticultural crops, standardization of organic farming technology for fruit crops, rejuvenation of old and senile orchards and high density plantation in mango, guava, citrus, pomegranate and sapota.

Plant protection – Control of mango malformation, guava wilt, citrus decline etc.

Post Harvest Management – Reduction in post harvest losses of the produce.

C) Focus Crops

- Hisar : Aonla, ber, guava, citrus (sweet orange and Kinnow), mango, sapota and strawberry.
- Bawal : Aonla, ber, bael, jamun and phalsa.
- Buria : Litchi, loquat, mango and low chilling varieties of peach, plum and pear.

D) Technologies Developed

Crop Improvement – Two varieties of guava namely, Hisar Safeda and Hisar Surkha; Safed Rohtak BS 75-1 and BS 75-3 ber varieties have been registered with NBPGR, New Delhi as resistant against powdery mildew and fruit fly, respectively.

Crop Production – Pruning in ber, grape and phalsa, leaf sampling technique for ber, grape and guava, critical limits of soil salinity levels in ber, grape, lemon and pomegranate, and control of fruit drop in citrus.

Input – Efficient propagation techniques, e.g., patch budding standardised in aonla, bael, guava, and jamun. Rootstocks Troyer citrange and Cleopatra recommended for mandarins and sweet orange, respectively.

Post Harvest Management – Modified atmosphere packages for citrus, guava and mango.

E) Constraints

Infrastructure – Most of the equipments in the department are old or obsolete and require replacement. Farm equipments /implements, tractors, tillers, hydraulic lifting devices, pruners, grading, sorting and packaging facilities, are not provided. Contingency per scientist is insufficient to carry out effective research. Exposure visits of faculty members to other institutions within and outside India are not adequate.

2. Vegetable crops

A) Research Infrastructure

Research in vegetable crops is being carried out at the Department of Vegetable Science, CCS HAU, Hisar. To cater to the regional need, the department has three research stations in different agro-climatic regions of the state where the department is also the centre under the All India Co-ordinated Research Project for Vegetable Improvement of the ICAR. Work on onion & garlic improvement is also being carried out by the National Horticultural Research and Development Foundation (NHRDF) at its Regional Research Station, Salaru, Karnal which was established during 1980.

B) Areas of Research

Crop Improvement – Genetic resources enhancement and management, development of varieties/hybrids according to the changing climate and resistance to biotic and abiotic stresses. Development of varieties for kharif onion,. Development of technology for the depleting natural resources like less land, water, energy, etc., and standardisation of agro-technique for outdoor Hi-Tech. vegetable production using micro-irrigation, fertigation, protected/green house cultivation, soil and leaf nutrient based fertilizer management, mulching for in situ moisture conservation, micro propagation, biotechnology, genetically modified crops, use of bio-fertilizers, vermiculture, biological control, etc., and development of organic vegetable production technology.

Input – Production of quality seed and planting material with seed chain so as to reach the vegetable growers and production and distribution of seeds of onion and garlic.

Post Harvest Management - Standardization of post harvest technology to minimize storage and transportation losses.

C) Focus Crops

- Bulb crops : Garlic, Onion.
- Cole Crops : Cabbage, Cauliflower.
- Cucurbits : Ash gourd, Bitter gourd, Bottle gourd, Cucumber.
- Leaf vegetables : Amaranth, Beet leaf (Palak), Vegetable mustard (saag).
- Legume vegetables : Cowpea, Garden pea, Indian bean (Sem).
- Rhizomatous vegetables : Amorphophalous, Ginger, Turmeric.
- Root Crops : Beet root, Carrot, Radish, Sweet potato, Turnip.
- Solanaceous : Tomato, Brinjal.

D) Technologies Developed:

Crop Improvement – Released 45 varieties of important vegetable crops (see Table 1), five varieties of onion, viz. Agrifound Dark Red (Kharif season), Agrifound Light Red, NHRDF Red, NHRDF Red-2 and Agrifound White (Rabi season) were notified through the Central Variety Release Committee of the Govt. of India, six high yielding garlic varieties Agrifound White, Yamuna Safed, Yamuna Safed-2, Yamuna Safed-3, Yamuna Safed-4 and Yamuna Safed-5 were released for cultivation in all over the country.

Crop Production – Development of production technology of vegetable crops for different regions of the State through its three regional research stations.

Input – Package of practices for seed production, breeder's seed of improved varieties in different vegetable crops for seed multiplying agencies and for vegetable growers of Haryana and other states (indented through central government). Also truthfully labelled seed is produced for vegetable growers of the state, short and long term trainings to vegetable growers and extension functionaries of the department of horticulture in seed production, nursery sowing and management, Vegetable production technology, use of plant growth regulators, use of bio-fertilizers, salinity

management, weed management etc., and quality seed production and distribution of notified onion and garlic varieties in Haryana and other parts of the country.

E) Constraints

Crop Improvement – Non replacement of old garlic varieties by varieties and technologies developed by NHRDF and other institutes.

Infrastructure – Inadequate scientific, technical supporting staff, extension staff at district level, lack of equipments namely tractor, thresher, laser planters, etc., lack of insect proof houses for work on crop improvement and production of nucleus seed/hybrid seeds, lack of underground irrigation facilities for vegetable research farm, fencing of research area, absence of suitable roads in vegetable research farm, inadequate transport facilities for conduct of field trials and lack of facilities for bio-technology and post-harvest management research.

Post Harvest Management – Popularisation of technology for proper curing, neck cutting, sorting, grading and packaging of onion and garlic.

2.1 Potato

A) Research Infrastructure

While voluntary testing of potato germplasm and standardisation of agro-techniques were started in 1973 at Kharindwa District, Kurukshetra and Hisar. Systematic research on potato has being going on at the Department of Vegetable Science of CCS HAU at Hisar under the AICRIP on Potato since 1975.

Hisar centre was declared the Best Potato Centre during 2009 by AICRP on potato (ICAR).

B) Areas of Research

Crop Improvement – To evolve varieties which are regionally adapted and are resistant to PALCVD and late blight.

Crop Production – To develop package of practices for increasing yield and identify major diseases and pests in different regions.

Input – To locate seed producing areas and to decrease rate of degeneration of commercial and pre-release varieties.

Table 1. Vegetable varieties released by CCS HAU, Hisar, Haryana

Vegetable Crops	No. Varieties	Varieties at different levels			
		National	State	AICVIP	University
Indian Bean	1		Hisar Kirti		
Bottle Gourd	3				GH-22 HBGH-35 (Hybrid)
Brinjal	7	BR-112 Hisar Shyamal PH-4	Hisar Pragati HLB-25	Hisar Jamuni	HLB-12
Carrot	3		Hisar Gairic		HCB-1, HCP-1
Cauliflower	1	Hisar - 1			
Chilli	2	Hisar - 1	Hisar Shakti Hisar Vijay		
Long Melon	1	Karnal Selection			
Musk Melon	2				Hisar Madur Hisar Saras
Okera	6	HBH-142, (F ₁ Hybrid) Hisar Naveen, Hisar Unnat, Varsha Uphar			HRB 108-2 HB-0-32
Onion	3	Hisar-2	Hisar Onion-3		Hisar Onion-4
Pears	1			Hisar Harit	
Radish	1		Hisar Sel-1		
Ridge Gourd	1		Hisar Kalitori		
Round Melon	1		Hisar Tinda (HT-10)		
Tomato	10	Hisar Arun Hisar Lalit HS-101, HS-102	HS-110	H-24, H-86 Hisar Gaurav Hisar Lalima	HTH-2-2 (Hybrid)
Watermelon	2				HW-1 Fuken
	45	14	11	6	14

Table 2 Seed spices varieties released by CCS HAU Hisar, Haryana

Spice Crops	Varieties at different levels			
	National	Total	State	Total
Fenugreek	Hisar Sonali, Hisar Mukta, Hisar Suvarna, HM-219	4	Hisar Manohar, Hisar Madhavi	2
Coriander	Hisar Anand, Hisar Sugandh, Hisar Surabhi, DH-206	4	Hisar Bhoomit, Narnaul Selection	2
Fennel			Hisar Swarup	1
Total		8		5

Post Harvest Management – To study storage behaviour of potato.

C) Focus Crop

- Potato

D) Technologies Developed

Crop Improvement – Based on trials at Hisar Centre, Kufri Badshah, Kufri Bahar, Kufri Chipsona, Kufri Jawahar, Kufri Khyati, Kufri Pukhraj, Kufri Pushkar, Kufri Sindhuri, and Kufri Sutlej were recommended for cultivation in the state of Haryana. During 2006-10 three new cultivars namely Kufri Khyati, Kufri Frysona and Kufri Garima were released and recommended for commercial cultivation in Haryana. Of these, the most commonly grown varieties are Kufri Badshah, Kufri Bahar, Kufri Pukhraj and Kufri Sutlej.

Crop Production – A complete package of technologies for potato cultivation has been developed covering optimum size and spacing, potato-based cropping systems and plant protection measures. Many of the agro-techniques have already been adopted by the farmers resulting in several fold increase in production. The nutrient needs of potato-bottle gourd cropping system were standardised. Kufri Pushkar followed by Kufri Badshah varieties were nitrogen efficient cultivars, i.e., while, Kufri Bahar and Kufri Pushkar produced the highest yield at recommended dose of 150% of N and 100% P and K, while, Kufri Khyati at 125% N + 100% P and K, respectively, recommendations have been made on irrigation, mulching and frequency of micro-irrigation in potato production. Various potato-based cropping systems, namely green manuring-potato-cucurbit, potato-tomato-okra, paddy-potato-cucurbits, potato-okra system and potato-onion-guar system have been recommended.

Plant Protection – Delayed planting in association with tuber treatment effectively controlled whitefly and PALCVD. Tuber treatment with boric acid (0.3%) (15% adoption in black scurf infected areas) or *Trichoderma viride* @ 8 g/kg was found to be effective in controlling black scurf disease of potato.

a) Constraints

Crop Improvement – Non-availability of resistant varieties to potato apical leaf curl disease.

Crop Production – Lack of studies on use of drip/micro sprinkler system in Haryana and status of diseases and pests of potato in different regions of Haryana and their relationship with meteorological conditions.

Crop Protected - Production of disease-free seed of potato (tuber) through tissue culture for distribution to farmers and identification of seed producing areas and reducing the frequency of seed renewal.

Post Harvest Management – Storage behaviour of different varieties in country stores and cold stores as well as during long distant travel.

3. Spice crops

A) Research Infrastructure

Research on spice crops is being carried out at the Department of Vegetable Science, CCS HAU, Hisar under the All India Coordinated Research Improvement Project (AICRP) on Spices Improvement. Some funding is also being received from the Spices Board under a Central Sector Scheme on Spices and Medicinal Plants.

B) Areas of Research

Crop Improvement – Development of high yielding varieties.

Crop Production – Development of technologies for production of spice crops.

C) Focus Crops

- Coriander, Fennel, and Fenugreek.

D) Technologies Developed

Crop Improvement - 10 varieties have been released in seed spices, of these 8 namely, Hisar Sonali, Hisar Mukta, Hisar Suvarna, HM- 219, Hisar Anand, Hisar Sugandh, Hisar Surbhi and DH-206 at National level while 2 Hisar Bhoomit and Hisar Swarup at State level.

Crop Production – Use of plant growth regulators, inorganic and bio-fertilizers and for different crops.

Input – Effect of bio-fertilizers on seed yield of fenugreek and fennel has been studied.

Plant Protection – Epidemiological studies on stem gall and weed control in coriander have also been conducted.

E) Constraints:

Plant Protection – High incidence of diseases, e.g., late blight in coriander and gummosis in fennel and downy mildew in fenugreek.

General – Cultivation of crops on marginal land with low productivity and lower market price realization.

4. Flower Crops

A) Research Infrastructure

- Work on flower crops is being carried out at the CCS HAU, Hisar in the Dept. of Horticulture.

B) Focus Crops

- Gerbera, Gladiolus, Marigold, Rose, Tuberose.

C) Areas of Research:

- Crop improvement and Technology of open cultivation in important crops.

D) Technologies Developed

Crop Improvement – Two varieties in marigold namely, Hisar Beauty and Hisar Jaffri were released.

Crop Production – Technology for open cultivation of rose, gladiolus, tuberose and marigold has been developed.

E) Constraints

Infrastructure – Inadequate staff for research on flower crops. Lack of facilities for production of quality planting material and work on protected cultivation and value addition.

5. Medicinal and Aromatic Plants

A) Research Infrastructure

- Work on Medicinal and Aromatic Plants is being carried out at Medicinal and Aromatic Plant Unit of the CCS HAU in the Department of Genetic and Plant Breeding. Besides, the unit is the main centre for production and generating quality planting materials of these crops.
- Area of Research
- Development of superior varieties.
- Standardisation of agro-technology.

C) Focus Crops

- Aloe, Giloe, Isabgol, Kalmegh, Khus, Lemon grass, Mulhatti, Palmarosa, Sarpagandha, etc.

D) Technologies Developed

- Medicinal and aromatic plant varieties were released in Isabgol (HI-5), Mulhatti (HM-1), Roshagrass/Palmarosa (RH-49), Periwinkle (Prabhat).

E) Constraints:

Crop Improvement – Non availability on high yielding varieties and inadequate package of practices for medicinal and aromatic plants cultivation.

Infrastructure – Inadequate facilities for marketing of produce

Policy – Rate of assistance given for medicinal plant promotion by NMPB lesser than other schemes like NHM.

6. Mushroom

A) Research Infrastructure

- Work on Mushroom is being carried out at the Department of Plant Pathology, CCS HAU, Hisar. Strong R & D facilities exist both at the University at Hisar and NAIC R&D Centre at Murthal (Haryana) with technical guidance from Directorate of Mushroom Research, Solan (Himachal Pradesh).

B) Areas of Research

Crop Production – Production technology of mushroom.

Input – Production of spawn.

Transfer of Technology – Organising training programmes for farmers and farmers visits of SAUs and NRCM- Solan.

C) Focus Crops

- Button mushroom, Oyster mushroom, also need diversification to promote other mushrooms for round the year production.

D) Technologies Developed

- Production of mushroom spawn, compost technology and package of practices for better mushroom, Standardization of spawn at district and block level, low cost tunnel or mobile tunnel for pasteurization of compost.

E) Constraints:

Crop Improvement – Lack of emphasis on commercial cultivation of oyster and milky mushroom.

Inputs – Non availability of quality spawn on time and lack of enforcement of quality standards, lack of adequate compost mother units for supply of quality compost to small growers in potential urban and semi urban areas and non-availability of sub-strate for urban and peri-urban areas. Provision of subsidy on poly-ethane used for mushroom huts, chemical free or minimal use of agrochemicals in compost preparation. Gypsum requirement for compost making need to be available for mushroom growers.

CHAPTER III : HORTICULTURE DEVELOPMENT

(Infrastructure, Programmes and Achievements)

The Horticulture Department in Haryana, bifurcated from the Agriculture Department during September 1990, is now located in Panchkula. There are 21 district offices and 25 Government Gardens and Nurseries across the state. While the nurseries produce quality planting material of horticulture crops, the Department provides extension services in the field. Prior to 2005-06, the horticultural programmes in Haryana were implemented with the staff strength of around 99 personnel. However, for the proper implementation of new schemes including National Horticulture Mission and National Mission on Micro-irrigation, the State Govt. sanctioned 48 new technical posts, viz. one Joint Director Horticulture, two Deputy Directors, five Specialists at head quarters and an Assistant Project Officers (APO) in each district. The APO assists the District Horticulture Officer (DHO) for proper implementation and follow up of schemes.

1. Vision and Objectives

Keeping in view the emerging challenges in the field of horticulture and to provide nutritional security to the masses, the department has a vision “to make Haryana modern fruit and vegetable cultivation state to lead in domestic and export market”. To achieve this, it has earmarked the following objectives:

- Diversification from agriculture to horticulture.
- Doubling of horticulture production in the 11th Five Year Plan.
- Optimal use of basic natural resources.
- Establishment of convergence and synergy among stakeholders.
- Improvement in production, yield and quality of horticultural produce.
- Increase in economic status and thereby increase the income per unit area.
- Dissemination of latest technology to farmers.
- Nutritional security to people.
- Creation of export potential and earning foreign exchange.

2. Budget

The funding position of horticulture programmes in Haryana has received a big boost in recent years. Non Plan budget rose from Rs. 35.50 crores to Rs. 73.58 crore between 2005-06 and 2010-11, respectively showing an increase of 107.28%. Since the launching of NHM the budget allocation of the State including both State Govt and Govt. of India share has increased significantly during 11th Plan to Rs. 449 crores.

3. Development Programmes

A number of development programmes are being carried out in the State under the State Plan, Central Government & Centrally sponsored schemes. One of the flagship programme titled, "National Horticulture Mission" has being implemented in the State since 2005-06. Thrust of this mission is on area based regionally differentiated cluster approach for holistic development of horticulture crops having comparative advantage, to create infrastructure at one place on the basis of soil and climate requirements duly ensuring horizontal and vertical linkages with active participation of all stakeholders. The programme is implemented by the Haryana State Horticulture Development Agency (HSHAD) in seventeen districts through different Mission Committees involving farmers, societies and NGOs. Though vegetable cultivation is not covered under NHM, the State Govt. has integrated various components of NHM like IPM, protected cultivation and vegetable seed production to increase production and productivity of vegetable crops.

The following major programmes have been implemented since 2005-2006:

- a) 2005-06 : National Horticulture Mission (February, 2006).
- b) 2006-07: Micro irrigation scheme (August, 2006), re-launched as National Mission on Micro Irrigation (NMMI) in 2010-11 (July, 2010).
- c) 2008-09: Weather Based Crop Insurance for Horticulture Crops (February,2009).
- d) 2009-10: Small Farmers Agri-Business Consortium scheme for Venture Capital Assistance (July, 2009).
- e) 2009-10: National Mission on Medicinal Plants (July, 2009).

- f) 2011-12: National Vegetable Initiative in Urban Clusters (VIUC), (June, 2011).
- g) Front Line Demonstration Centres (FLDC) (14) on the pattern of Indo-Israel Project (July, 2011)

During 2005-06 to 2011-12 a total of 17 schemes were implemented out of which 15 are in the State Plan, 4 in Central Plan Scheme (sharing basis) and 2 centrally sponsored schemes. A list of schemes along with the scope of work is given in Table 3.

4. Policy initiatives

The State Department has taken several initiatives which include:

- Conversion of Horticulture into Agriculture Category.
- Increasing subsidy assistance for micro-irrigation scheme from 50 to 90% and for plastic culture from 50 to 65%.
- Development of an integrated model by integrating components, namely, orchard plantation, construction of water pond and drip irrigation.
- New Industrial Policy – 2011 Announced to boost Processing of Fruits and Vegetables

5. Infrastructure Development

With its headquarters at Panchkula, the Department of Horticulture has undertaken several initiatives for creating a sound infrastructure in the State. These include:

A) Centre of Excellence for Fruits at Mangiana (Sirsa): This Centre has been set up under an agreement between Government of India and Government of Israel at Sirsa (subsequently at Shamgarh) to demonstrate new technologies in fruit crop production with Israeli expertise. The interventions being emphasised in this centre are adoption of new varieties, intensive cultivation practices, micro-irrigation and mechanisation.

B) Indo Israel Centre of Excellence for Vegetables at Gharaunda, Karnal : This Centre has been set up under NHM in collaboration with Israel at Gharaunda near Karnal to provide good quality vegetable seedlings throughout the

Table 3. List of Schemes under operation in Haryana State

S.No.	Name of Scheme	Scope of work
A	State Plan Schemes	
i.	Schemes for Agricultural Human Resource Development (92)	Relates Horticulture Training Institute (HTI), (Uchani) Karnal.
ii.	Setting up of Directorate of Horticulture in Haryana (94)	Staff Scheme.
iii.	Scheme for Popularization and Extension of Latest Technology in Haryana (76)	Covers frontline demonstrations, shows, seminars, etc.
iv.	Scheme for Mushroom Development in Haryana (96)	To boost mushroom production in the state.
v.	Scheme for Development and Promotion of Organic Farming (71)	For construction of Vermi Compost Units at Govt. Farms for in house compost production.
vi.	Scheme for integrated horticulture development in Haryana State (65)	For non-NHM districts (3 Nos.) with incentives on the pattern of NHM.
vii.	Scheme for Demonstration-cum-Food Processing technology in Haryana (70)	For training on household processed products at district level.
viii.	Scheme for Horticulture Bio-technology Centre (66)	For production of Tissue Culture Plants with focus on mini tuber production in potato and to production of breeder seed enmass.
ix.	Scheme for Potato Development and Quality Production (67)	For field demonstration and cultivation of potato.
x.	Scheme for Maintenance of Official and Residential Building (64)	For maintenance of official and residential buildings.
xi.	Scheme for Information and Technology in Haryana (New Scheme)	For e-governance and horticulture information.
xii.	For Good Agricultural Practices and effect of Pesticide Residue on Fruits and Vegetables (61) (New Plan Scheme)	For assessment of pesticide residue and education to the farmers of its ill effects. (New scheme proposed during 2011-12).
xiii.	For strengthening of Horticulture (59) (New Plan Scheme)	Strengthening of Horticulture Department to implement new scheme.
xiv.	Scheme for Integrated Horticulture Development for SC Families (68) (Plan Scheme)	For the direct benefit of SC families in the State, assistance is provided ranging from 75 to 100% on horticulture components.
xv.	789 Special component plan for schedule castes (98) integrated horticulture development plan scheme for schedule caste families	
B.	Central Plan Scheme (Sharing Basis)	
i.	Scheme for Micro-irrigation (72)	For promotion of drip and sprinkler irrigation system in horticultural crops.
ii.	Scheme for National Horticulture Mission (69)	For holistic development of horticulture sector with backward and forward integration.
iii.	Scheme for Horticulture Crop Insurance (63)	To cover horticulture crops against vagaries of weather
iv.	Sericulture Development Haryana (CDP)	For promotion of sericulture in semi-hill areas in Panchkula.
C	Centrally Sponsored Schemes (100%)	
i.	Scheme for improvement of Agriculture Statistics (CS on fruit, veg. crops, 73)	Staff Scheme.
ii.	Scheme for Development and Promotion of Organic Farming (71)	For construction of Vermi Compost Units at Govt. Farms in house compost production.

year and to promote various types of vegetable crops through green house and poly house farming.

Additional centre of excellence for bee-keeping and floriculture with the budget of INR 50 crores are being established. Two more centres of excellence have been proposed on guava at Fatehabad and on banana at Panipat.

C) Horticulture Training Institute, Karnal : The institute is involved in human resource development and is running three courses in horticulture namely one year Diploma besides six and three month courses in the field of horticulture.

D) Horticulture Bio-technology Centre, Karnal (State intervention) : A tissue culture lab was strengthened in 2008-09 under NHM for micro propagation of potato and banana. The lab has been converted into Horticulture Biotech Centre and is located near HTI Karnal. An area of 42 acres is being added for production of potato seed tubers at this place.

E) Potato Development Centre, Shamgarh, Karnal (State intervention):

F) Mushroom Integrated Centre at Murthal : HAIC has set up a Mushroom Research & Development Project at Murthal (Sonipat) in Haryana under the HAIC Agro Research & Development Centre, which executes and implements agro based projects which are directly useful for farmers and entrepreneurs of Haryana.

G) Establishment of a Pesticide Residue Analysis lab with staff (State intervention).

H) I.T. Scheme of Department to link with State Data Centre.

CHAPTER IV : PRESENT STATUS OF HORTICULTURE INDUSTRY

This chapter quantifies status of horticultural development in the Haryana State:

1. Area Expansion

A wide range of horticulture crops are being cultivated in Haryana State including major fruits, vegetables, flowers, spices, medicinal and aromatic plants and mushroom. There has been significant increase in area and production of these crops. As a result horticulture crops which occupied 0.42% (19170 ha) of cropped (45, 99,000 ha) in 1966-67 now occupy 6.4% (4,15,930 ha). Of this fruits cover 11.1%, Vegetables area 83.2%, Flowers 1.5%, Spices 3.8% and Medicinal and Aromatic Plants 3.8% (Table 4).

Table 4: Area under horticulture crops and % of cropped area. (Area in 000'ha)

Year	Geographical Area	Cropped Area	Area under Horticultural crops	% of horticulture area over cropped area
1966-67	4374	4,599	19.17	0.42
2005-06	4,374	6,509	277.50	4.30
2010-11	4,371	6,500	415.93	6.40

Similar trend has been observed for production also, the production of fruits and vegetable in 1966-67 was 1, 62,887 MT which rose to 3,29,19,66 MT in 2005-06 (192.0% increase) to 5,141,271 MT in 2010-2011 (56.1% increase). The average productivity which was 8.49 MT/ha in 1966-67, rose to 11.88 MT/ha in 2005-06 to 12.3 MT/ha in 2010-11.

1.1. Fruit Crops

A number of fruit crops are grown in different districts of Haryana. The major fruit crops include citrus, mango, guava, aonla, ber, litchi and sapota. While the area, production and productivity under fruit crops has been increasing (Table 5), their contribution to the total horticulture basket has been diminishing. The current contribution of fruits is 1.05% of the total area and 7.0% of the total production with several recently planted areas yet to come to bearing.

Table 5: Area, Production & Productivity of different fruit crops in Haryana.

Fruit Crops	2005-06			2010-11			% Increase	
	Area (ha)	Production (MT)	Productivity (MT/ha)	Area (ha)	Production (MT)	Productivity (MT/ha)	Area	Prod
Aonla	1,816	8,130	7.1	1,969	11,035	9.1	8.4	35.7
Ber	3,076	30,219	11.2	4,330	37,942	12.3	40.7	25.5
Citrus	5,041	69,558	17.5	17,151	1,29,996	20.4	240.2	86.8
Grapes	110	3,342	24.0	50	1,061	21.2	-54.5	-68.2
Guava	4,622	34,878	9.7	9,339	71,612	12.1	102.0	105.3
Litchi	199	734	4.7	195	1,100	8.3	-0.2	49.8
Mango	8,224	60,661	8.3	8,704	72,831	9.6	5.8	20.0
Sapota	549	3,735	12.8	1,286	6,336	13.6	134.2	69.6
Others	3,466	24,943	7.2	3,226	24,707	7.6	-6.9	-0.9
Total	27,103	2,36,200	10.6	46,250	3,56,620	13.0	70.6	50.9

The area under fruit crops increased from 27,103 ha in 2005-06 to 46,250 ha in 2010-11 (70.6%). Among various fruits maximum area expansion took place in citrus 5,041 ha (240%), followed by sapota (134%) and in guava (100%). Area increase in Ber, Aonla, and mango was 40.7%, 8.4% and 5.8%, respectively. Similar trend has been observed in production of fruits, which registered an increase of 50% between 2005-06 and 2010-11. The production increase was highest in guava (105.3%) probably due to its precocity in bearing followed by citrus (86.8%), sapota (69.6%), litchi (49.8%) and aonla 35.7%.

There was significant increase in productivity in citrus (20%) and sapota (10%). The productivity reported for the state was higher than the national average in several fruit crops. There was decline in grape production due to uprooting of large areas and virtually no takers for its commercial cultivation. The major fruit producing districts of Haryana are given in Table 6.

Table 6: Major Fruit Producing Districts of Haryana

Crop	District(s)
Aonla	Bhiwani, Gurgaon, Mewat, Yamunanagar, Hisar and Sirsa
Ber	Mewat, Sonipat, Hisar, Sirsa, Rohtak, Jhajjar and Jind
Guava	Hisar, Karnal, Sonipat, Mewat and Gurgaon
Litchi	Yamunanagar, Mango Yamunanagar, Ambala, Panchkula, Karnal and Kurukshetra
Sapota	Sirsa, Fatehabad, Hisar, Bhiwani, Mahendragarh and Jhajjar

1.1. Vegetable Crops

Vegetables contribute 7.9% of the total area and 91.3% of production of horticultural crops in the State. Almost all vegetable crops are grown in the State. The area, production and productivity of vegetable crops in Haryana between 2005-06 and 2010-11 are given in Table 7.

There has been a significant increase in area under vegetable (48.8%) which rose from 2,32,660 ha to 3,46,400 ha (48.8%) during 2005-06 to 2010-11, respectively. Major increase in area and production has been reported in cucurbits, cauliflower, tomato, radish, chillies, okra and brinjal. Maximum area expansion has been in cucurbits where it increased by 120.70% followed by tomato (60%), chillies (52%), radish (51.35%), cauliflower (44.2%) and leafy vegetables was less than 50%.

Table 7: Area, Production and Productivity of vegetable crops in Haryana 2005-06

Vegetable Crops	2005-06			2010-11			% increase	
	Area (ha)	Prod. (MT)	Productivity (MT/ha)	Area (ha)	Prod. (MT)	Productivity (MT/ha)	Area	Prod.
Arum	589	5,982	10.2	626	3,445	5.5	6.3	-42.4
Brinjal	11,462	1,48,709	14.0	14,645	2,55,228	17.4	27.8	71.6
Cabbage	12,341	1,72,233	14.0	13,783	2,62,381	19.0	11.7	52.3
Carrot	15,292	2,49,985	16.4	19,527	3,14,840	16.1	27.7	25.9
Cauliflower	20,995	3,02,759	14.4	30,276	5,31,920	17.6	44.2	75.7
Chillies	9,308	67,958	7.3	14,155	1,29,166	9.1	52.1	90.1
Cucurbits	34,315	3,47,577	10.1	75,732	7,34,882	9.7	120.7	111.4
Leafy Veg	20,607	1,86,039	9.0	28,516	2,35,249	8.2	38.4	26.5
Okra	13,958	93,726	6.7	18,202	1,45,284	8.0	30.4	55.0
Onion	15,494	3,17,699	20.5	22,160	4,53,862	20.5	43.0	42.9
Peas	11,059	84,920	7.7	12,735	78,977	6.2	15.2	-7.0
Potato	18,959	3,74,435	19.8	26,780	5,98,164	22.3	41.3	59.8
Radish	17,154	2,61,120	15.2	25,963	3,79,766	14.6	51.4	45.4
Tomato	17,116	2,57,282	15.0	27,225	3,92,362	14.4	59.1	52.5
Others	14,011	1,14,376	8.2	16,075	1,33,754	8.3	14.7	16.9
Total	2,32,660	29,84,800	12.8	3,46,400	46,49,280	13.4	48.9	55.8

Production of vegetables increased from 29,84,800 to 46,49,280 MT recording a 55.7% growth between 2005-06 and 2010-11. The growth was maximum in cucurbits (111.4%), followed by okra and chillies (90%), cauliflower (75%), brinjal (71%) and cabbage and tomato both registered an increase in production of 52%.

Productivity in cabbage increased from 13.9 to 19MT/ha, brinjal from 13.9 to 17.4 MT/ha, cauliflower from 14.4 to 17.5 MT/ha, okra from 6.7 to 7.9 MT/ha and chillies from 7.3 to 9.1 MT/ha. The productivity in onion however did not increase significantly.

The Haryana State was earlier growing only one onion crop i.e. in rabi season but with the efforts made by NHRDE, the kharif onion cultivation got momentum especially in Mewat region. Now farmers are taking kharif crop on a large scale during the rainy season. However garlic is grown in Rabi season only. Onion has expanded its area from 15,494 ha to 26,780 ha registering an increase of 43.02%. Production in onion also registered almost a matched increase of 42.8%.

Haryana is suitable for raising both early as well as main season crop of potato. The area under potato has increased from 18,959 to 26,780 ha (41%) from 2005-06 to 2010-11 while, production showed an increase of 60%. Major districts for cultivation of different vegetable crops potato are listed in Table 8.

Table 8: Major Vegetable Growing Districts of Haryana

Vegetable	Districts
Brinjal	Gurgaon, Panipat, Mewat, Sonipat and Karnal
Carrot	Sonipat, Mewat, Ambala, Gurgaon, Fatehabad and Bhiwani
Cauliflower	Sonipat, Yamunanagar, Karnal, Ambala, Gurgaon, Kurukshetra, Hisar Jind, Fatehabad and Faridabad
Chillies	Gurgaon, Karnal, Ambala, Jind and Panipat
Cucurbits	Gurgaon, Sonipat, Karnal, Panipat and Bhiwani
Onion Kharif	Mewat, Yamunanagar, Ambala, Karnal and Jhajjar
Onion Rabi	Panipat, Kurushetra, Ambala, Karnal, Bhiwani and Bahadurgarh.
Leafy vegetables	Yamunanagar, Karnal, Kurukshetra, Ambala and Sonipat.
Okra	Sonipat, Gurgaon, Karnal, Yamunanagar and Ambala.
Potato	Kurukshetra, Ambala, Yamunanagar, Sonipat, Panipat and Karnal.
Radish	Sonipat, Karnal, Yamunanagar, Ambala and Fatehabad
Tomato	Karnal, Yamunanagar, Mewat, Gurgaon and Kurukshetra.

1.1. Flower Crops

The commercial cultivation of flowers in Haryana is a recent phenomenon. It started during 9th plan with a modest area of 3,214 ha which increased by 5.66 times by the end of the 11th plan. A number of flowers are grown in Haryana both outdoor and under protected cultivation. These include marigold, rose, gladiolus and chrysanthemum. Area, production and productivity is given in Table 9.

Table 9: Area, Production of Flowers during 2005-06 and 2010-11.

Flowers	2005-06			2010-11		
	Area (ha)	Production (Lakh cut)	Production (MT)	Area (ha)	Production (Lakh cut)	Production (MT)
Chrysanthemum	140.4	0.0	576	108	104.10	260
Gladiolus	432.0	276.0	0	952	1,009.05	0
Marigold	4,448.0	0.0	24,377	4,835	0.00	60,571
Rose	113.0	13.8	720	229	0.00	163
Tuberose	60.0	331.0	0	95	119.66	12
Others	225.0	1.9	558	81	0.24	314
Total	5,418.4	622.7	26,231	6,300	1,233.05	61,320
% increase				(16.2)	(98)	(133.7)

Though the area expansion in flowers has not been much (16.2%). Yet, the production increased manifold in both cut flowers (98%) and the loose flowers (133.7%). The expansion has been highest in marigold followed by tuberose. This auger well for the future of floriculture industry in Haryana State. The major flower growing districts in Haryana as listed in Table 10.

Table 10: Major Flowers Growing Districts of Haryana

Flower	Districts
Chrysanthemum	Rohtak, Gurgaon, Faridabad, Sonipat, Hisar and Karnal
Gladiolus	Faridabad, Panipat, Gurgaon, Sonipat, Mewat, Palwal and Karnal
Marigold	Gurgaon, Sonipat, Jhajjar, Mewat, Karnal and Faridabad
Rose	Sonipat, Mewat, Panipat, Gurgaon and Palwal
Tuberose	Faridabad, Gurgaon, Sonipat and Palwal.

1.1. Spice Crops

Haryana State grows a number of spices namely fennel, coriander and fenugreek and has potential to increase the production of spices. The area, production and productivity of various seed spices grown in the State are as under (Table 11).

Table 11: Area, Production and Productivity of Seed Spices in Haryana
2005-06 to 2010-11

Spice	2005-06			2010-11			% increase	
	Area (ha)	Prod. (MT)	Productivity (MT/ha)	Area (ha)	Prod. (MT)	Productivity (MT/ha)	Area	Prod.
Chillies(Dry)	460	477	1.0	1,896	3,080	1.6	312.2	545.7
Coriander	1,718	2,893	1.6	2,408	3,845	1.6	40.2	32.9
Fennel	91	353	3.8	111	127	1.1	22.0	-64.0
Fenugreek	4,165	6,467	1.5	5,291	9,739	1.8	27.0	50.6
Garlic	2,888	22,547	7.8	3,538	30,316	8.57	22.5	34.5
Ginger	199	2,127	10.6	720	6,765	9.4	261.8	218.1
Turmeric	673	9,572	14.2	1,996	19,588	9.8	196.6	104.6
Total	10,194	44,436	4.4	15,960	73,460	4.6	56.6	65.3

There has been an increase in area under spices from 10,194 ha to 15,960 ha recording an increase of 56.6% between 2005-06 and 2010-11. Area under dry chillies has increased considerably from 460 to 1,896 ha, (312.2%), followed by ginger (261.8%). Turmeric is fast picking up in area expansion. There was modest area increase in other crops during this period. Similar trend was noticed in case of production of dry chilli which increased by 545.7%, followed by ginger 261.8%, turmeric 104.6% increase, fenugreek 50.6% and coriander 32.9%. Major spice growing districts of Haryana are listed in Table 12.

Table 12: Major Spice Growing Districts of Haryana

Crop	Districts
Chillies	Yamunanagar, Fatehabad, Karnal, Rohtak, Panipat and Mewat
Coriander	Sonipat, Yamunanagar, Kurukshetra, Gurgaon, Rohtak and Ambala
Fennel	Jind, Faridabad, Mewat, Panchkula, Kaithal, Mahendragarh and Karnal
Fenugreek	Sonipat, Yamunanagar, Hisar, Ambala, Kurukshetra and Karnal
Garlic	Karnal, Yamunanagar, Sirsa, Fatehabad, Panchkula, Bhiwani, Gurgaon and Kurukshetra
Ginger	Panchkula, Yamunanagar, Ambala
Turmeric	Yamunanagar, Panchkula, Ambala, Panipat, Karnal and Kurukshetra

1.5. Medicinal and Aromatic Crops

Haryana has varying edaphic and climatic conditions which harbour several kinds of native medicinal plants ranging from herbs to perennial trees having nutraceutical values. Medicinal and aromatic plants have a great importance in the state. There are many pharmaceutical and herbal industries which have a vast requirement of medicinal and aromatic plants.

In spite of having potential, farmers, Haryana has not shown much interest in cultivation of medicinal plants. The area coverage under various crops has range between 10-372 ha. Medicinal plant cultivation has been on decline during 2005-06 to 2010-11. Some of the important medicinal and aromatic plant species which can be grown in south west region of Haryana with low rainfall, dry climate and light soils are isabgol, senna, mulathi, ashwagandha, satawar, aloevera and guggal. On the other hand, crops which require high irrigation facility, fertile and medium to heavy clay soils are brahmi, kalihari, gilie, kaunch, kalmegh, satawar, akarkara, sarpagandha, tulsi, mentha etc. This calls for state sponsored promotion of these plants by providing creating suitable market infrastructure and encouragement of entrepreneurs.

1.6. Mushroom

Haryana has been in the forefront in edible mushroom cultivation on a commercial scale in the country from 1972 when first seasonal mushroom growing was taken up by a school teacher, Master Jagdev Singh, in village Barota (Dist- Sonipat). Since then there has been no looking back. In 1980 a State financed Mushroom Research and Training Scheme was started at Department of Plant Pathology, CCS HAU Hisar. Regular training on Mushroom cultivation was started at main campus as well as KGKs/KVKs from 1992. In 1996, a cultivation unit HAIC was established at Murthal (Sonipat). Large commercial mushroom farms with air conditioning facility in tropical conditions also came up in Haryana in early nineties for the first time in the country. The first such farm Mandeep Mushroom Limited, at Khudsa, Gurgaon was started in 1996.

In Haryana, Mushroom has gained the status of a cottage industry and is being grown in the state in clusters. Farmers have taken the crop as a challenge. There is a need of organized marketing, refrigerated vans, packing materials and processing units.

Table 13 sums up the area & production of different group of horticulture crops between 2005-06 to 2010-11.

Table 13: Area & Production of different horticulture crops in Haryana*

Crops	2005-06			2010-11			% inc. area	% inc. prod.
	Area (ha)	Production (MT)	Productivity (MT/ha)	Area (ha)	Production (MT)	Productivity (MT/ha)		
Fruits	27,103	2,36,200	10.6	46,250	3,56,620	13.0	70.6	50.90
Vegetables	2,32,660	29,84,800	12.8	3,46,400	46,49,280	13.4	48.8	55.70
Flowers	5,418	623 (cut) 26,231 (loose)	--	6,300	1,233 (cut) 61,321 (loose)	---	16.2	98.00 133.70
Spices	10,194	44,436	4.4	15,960	73,460	4.6	56.5	65.30
Medical & Aromatic Plants	1,829	299	0.2	1,020	590	0.5	-44.2	97.50
Mushroom	1,22,8760 (tray)	6	4.9 kg/tray	13,21,070	8	6.0 kg/tray	7.5	32.69
Total	2,77,204	32,91,966		4,15,930	51,41,271		50.0	54.50

* Haryana bench mark data, NHM AAP, 2012-13

Under NHM, the State has established 3 clusters. Their details are as follows:

2. Cluster Development

- i) Cluster 1: Mango, Sapota, Stone fruit. (North Haryana)
- ii) Cluster 2: Citrus (Kinnow), guava, aonla. (South Haryana)
- iii) Cluster 3: Vegetables, Mushroom, Flowers

3. Water conservation (Drip Irrigation) and Resources (Community Tanks)

- An area of 26,000 ha has been covered till 2011-12 under Micro-irrigation.
- Number of water tanks constructed during the XI plan was 23248 while, area under drip and sprinkler irrigation systems increased from 4,554 ha. (2006-07) to 29,304 ha (2011-12) (543.48%).

4. Plant Health Clinics

- 17 PHC are under construction in the state. Fourteen are already constructed.
- Till date the total area covered under organic farming is 10,181 ha.

5. Rejuvenation

The targets and area coverage under rejuvenation programmes is given below:

Table 14: Area covered (ha) under rejuvenation

Year	Target (ha)	Covered (ha)
2005-06	200	60.00
2006-07	939	377.00
2007-08	477	305.19
2008-09	3002	27.20
2009-10	110	88.80
2010-11	500	75.0 upto Aug. 2010)

6. Post Harvest Management Infrastructure

6.1. Pack House : There is a plan to construct 53 integrated pack houses in the districts of Rohtak, Hisar, Rewari, Gurgaon, Jhajjar, Panipat, Karnal, Kurukshetra, Panchkula, Sonipat and Sirsa. Each pack house will have fruit and vegetable grading unit/machine, 3-5 cold storage units with 25-100 MT capacity, pre-coolers of 5-10 MT with add on facility of replacing chambers 2-5 (5-10 MT each). The pack house at Rohtak is in operation and has been given on lease to a private player. Each pack house and markets are to be linked with collection centre (at block level).

6.2. Grading : Establishment and commissioning of Kinnow centre with ultra modern machinery imported from France (5 MT/hour capacity) is a major initiative by the Government recently. Farmers get their produce waxed & graded at a nominal price of Rs. 1.10/kg. One potato grading and cold storage unit with a grading capacity of 10 MT/hr or storage capacity of 1750 MT established in identified cluster.

6.3. Marketing : One modern fruit and vegetable market is being established in district Mewat, one terminal market has also been proposed. Five numbers of Agro-

Malls are under construction in Karnal, Kurukshetra, Sonipat and Jhajjar from where all the required facilities like seed, consultancy and retail market shall be operated under one roof.

6.4. Processing Units

- a) One potato processing unit is in operation at Karnal in Private Sector for marketing potato chips (Cluster iii).
- b) One turmeric processing unit has been established in district Yamunanagar by HAFED for facilitation of turmeric processing in the nearby areas or further marketing under brand HAFED.
- c) One seed processing Unit in private sector has been established with NHM support under Cluster (iii).
- d) One processing unit has been established at Sirsa.

6.5. Farmers Information Centres

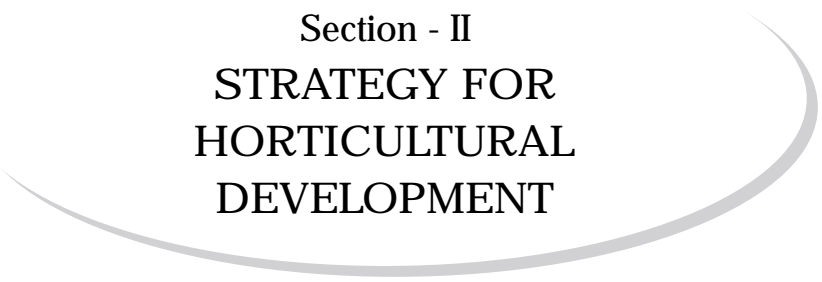
- Two Farmers Information Centres have been established each at Sirsa and Rohtak for farmers seminars, conferences and market information system. These have been established in existing mandies.

7. Constraints

The following constraints are being felt by the Department of Horticulture, Haryana towards developing horticulture industry in the State.

- Insufficient staff and lack of trained manpower
- Reliable statistical data
- Quality water availability
- Pesticide residues in vegetables
- Processing and value addition
- Market information scheme
- Price stability
- Insurance in Horticulture sector- crops, protected structures.

Section - II
**STRATEGY FOR
HORTICULTURAL
DEVELOPMENT**



CHAPTER V : PLANTING MATERIAL

Success of horticultural crop production depends mainly on the availability of the right type of planting material, which also governs productivity and quality. Any improvement in technology base and other strategies will not have the desired impact on productivity unless quality planting material is made available. If proper measures are not adopted in selection of the planting material, it can cause permanent damage to the productivity and the income of the farmers. Over a period of time, there has been a continuous increase in demand for horticultural plants due to a number of Missions and Programmes launched by the Government of India. The massive increase in demand in certain cases has adversely affected the quality of plant material. Since there is limited land /area available for expansion, the increased availability of horticulture produce, has to come through increasing productivity through the use of quality planting material. The strategies for improving availability of quality planting material in different groups of horticultural crops are discussed.

1. Fruit Crops

Being the back bone of horticulture industry, fruit plant material should be true-to-the-type in respect of genuineness of the cultivars and should be produced and propagated from trees giving high yield of quality fruits and should be free from viral, bacterial and fungal diseases. Fruit plants are propagated both through vegetative methods and seeds. Citrus, mango, papaya, litchi, sapota and guava are grafted on rootstocks; strawberry is multiplied by runners and grape by cuttings. It is necessary that these are propagated from elite trees using latest propagation techniques and compatible rootstocks.

1.1 Establishment of Model nurseries

- a) Demand for true-to-the-type propagating material of fruit crops has risen in Haryana for planting new area (area expansion), replacement planting (replacement of old and senile orchards) and for harnessing genetic potential of the crop. The current capacity of production of fruit plants in public and private sector in Haryana is 9.0 and 4.5 lakh plants/year, respectively.

- b) During 2010-11, there were 25 Government gardens and nurseries being run by the Department for production of quality planting material. There is however need for critical review of planting material requirement during the next two plans to provide need-based support of new nurseries.
- c) Nursery activity should be concentrated in the fruit belts to avoid distant transportation.
- d) While the planting material is in excess in case of mango, sapota, peach and bael, there is short fall of plants of citrus (Kinnow) and guava.
- e) While establishing new nurseries, it should be ensured that plants are raised in suitable containers (root trainers) using only sterilised potting mixture. These nurseries should have modern facilities to follow standard nursery practices for plant propagation along with rootstock and scion blocks and facilities for maintenance and sale of plants. Seed trays must be kept above the ground to avoid soil-borne diseases.
- f) Wherever available, use of nucellar seedlings for budding and grafting should be encouraged. Nursery floor should be covered with stones/pebbles to avoid contamination from the soil.
- g) There is need for advance planning in assessing the requirement and accordingly placement of indents to the source organisations.
- h) Developing website linking all certified nurseries will be therefore desirable.
- i) Nurseries should be given definite targets for meeting the requirement of plant material of crops and varieties required under various programmes.

1.2. Use of latest propagation techniques

In recent years, technologies for propagating almost all fruit plants have been developed. Commonly recommended are budding/ grafting methods. Old propagation techniques including inarching, wedge grafting and patch budding are however still being followed resulting in inefficient multiplication of planting material. Nurseries should be encouraged to adopt optimum time and latest techniques for propagating different fruit plants.

1.3. Micro propagation

- a) Plant propagation through tissue culture is one of the powerful tools in horticulture for rapid multiplication and ensuring health and quality of planting material on a commercial scale. In spite of being in practice for over three decades, it has not made much impact except in banana and a few ornamental crops in India.
- b) This technology must be exploited to the fullest for fast multiplication of fruits and vegetables such as strawberry, banana, pineapple and vegetable like potato.
- c) Need based tissue culture laboratories should be strengthened to ensure supply of good planting materials especially of cut flowers and vegetables. The following strategies are suggested for raising true-to-the-type, disease-free plant material of fruit crops.
- d) The shoot tip grafting technology for propagating citrus plants followed at NRC for Citrus Nagpur, which has yielded high quality disease-free planting material, should be adopted for production of planting material.

2. Ensuring Quality Planting Material

There are a number of constraints in ensuring the quality of plant material available in several public and private nurseries. These include absence of scion banks and rootstock blocks of elite trees. Plants are being multiplied in the field directly in the soil and not in polybags/ containers resulting in diseases and pests being carried along with earth balls. Distant transport with earth balls is tedious expensive and less efficient. There is also lack of proper rotation in nurseries. Accordingly, the following strategies are suggested for raising true-to-the-type plant material of fruit crops.

2.1 Establishment of Scion blocks

In the absence of scion blocks, scion is often sourced out which may be from disease infected trees or from old and senile orchards. Therefore, there is an urgent need to identify elite mother plants and establish mother plant blocks of the varieties required in different regions of Haryana; to obtain scion material from true-to-the-

type, healthy, precocious and prolific bearer trees of known pedigree record, free from diseases, pest infestations and physiological disorders; to identify and mark elite mother plants of fruit crops such as Kinnow, ber (Gola and Umran) and guava (Sardar or Lucknow 49) which now occupy considerable area in Haryana by conducting systematic surveys in the production areas/clusters using suitable score cards and to establish blocks of elite mother plants in all public or private nurseries in the State.

2.2 Establishment of Rootstock Blocks

The available recommendations for citrus rootstocks are still not followed by most of the nurseries in Haryana. In many cases seeds are procured from processing factories where seeds of several species get mixed up resulting in incompatibility or virus infestation leading decline of plants. In mango a rootstock 13/1 has recently been imported under the Indo-Israel Project at the Centre of Excellence for Fruit Crops, Mangiana (Sirsa). It is therefore important that blocks of recommended rootstocks are established by public and private nurseries along with scion. More information should be generated on true-to-the-type, compatible rootstocks for fruits like mango, sapota, litchi and guava by the CCS HAU, Haryana.

2.3 Nursery Practices to raise Virus-Free Plants

Several technologies are now available to raise disease free plants. These include use of containerised nursery system, using sterilised potting mixture in place of the current practice of raising plants in field beds and lifting them with earth balls. The current practice is not only cumbersome and expensive but also results in high mortality and spread of diseases carried with earth ball; use of shade nets or polyhouses; Diagnosing of virus disease status of citrus mother plants by testing for viruses namely tristeza, mosaic, ring spot, exocortis and viroid and greening bacterium. This can be done by use of indicator plants and meristem culture.

2.4 Bud wood Certification

Bud wood certification programmes are followed in citrus all over the world to safeguard plants in the nursery from infection of viruses. This has also been successfully followed for citrus at National Research Centre, for Citrus Nagpur and

at the Regional Station of IIHR at Chettali in Coorg. It involves selection of superior mother plants, raising them in protected foundation blocks to supply virus-free scion, raising of desirable rootstocks in vector-free net houses and conducting all propagation under a net house using micro budding.

2.5. Ensuring Accreditation of Nurseries

A Nursery Registration Act is now in force under the aegis of NHB. As per this act, every commercial nursery should be registered under the Fruit Nursery Registration Act and it should comply with uniform norms. There is punishment and compensation for cases of cheating and supply of spurious plant material. There is also a system for accreditation of nurseries through visits and regular monitoring by a Central Agency/ Regulatory body. However, this process is slow in Haryana as only a few nurseries in Haryana are accredited under this Act so far. Accreditation of all nurseries must be got done as per Nursery Registration and Certification Act being implemented by NHB to ensure production of quality planting material. The process of accreditation seems to be slow and should be expedited. List of accredited nurseries should be made available on the public domain. Procurement of planting materials from only identified sources should be made compulsory to avail financial assistance from the government department/ certified agencies under various development programmes.

2.6 National Certification System of Tissue Culture Plants

In recent years, use of tissue culture plants in certain fruit crops particularly in banana has become very common. Therefore, it is necessary that these are bought from certified tissue culture labs. The responsibility of certification of tissue culture and plant material rests with Department of Biotechnology. The accreditation certification is carried out by Biotech Consortium of India, New Delhi (BCIL). The referral laboratory for virus diagnosis is located at IARI, New Delhi, while for genetic fidelity at CDFD.

2.7 Banning of purchase on quotation

It was noticed that plants sourced from outside public nurseries and state are sometimes purchased on quotation basis. It is recommended that purchase of

planting material on quotation must be discouraged at any cost to avoid compromise on the quality of the planting material.

2.8 Traceability record

A procedure should be put in place to maintain traceability record to enable efficient recall in case the plants get contaminated or mixed during the movement of planting material through specified stages of production and distribution.

3. Vegetables

3.1 Pure line Selection

Most of vegetable crops are propagated by seeds except a few tuber crops which are propagated vegetatively. Currently, seed of notified varieties of vegetables (particularly of pure line selections) is produced by public and private sector organisations as also by some progressive farmers themselves. There is limited control on the production and marketing of such seed in the private sector because of multiplicity of seed traders, mushrooming of small seed companies and inadequate profits. ICAR and SAUs are the main agencies that undertake nucleus and breeder seed production. National Seed Corporation reaches most of the farmers with their seeds.

There are several constraints in the production and supply of seeds of pureline selections. Firstly, the seed supplied by public sector organisations is often not adequate, while that supplied by the private sector is not always reliable, often has poor germination resulting in loss of productivity. Such seeds produced by the farmers themselves without any technical help and knowledge also cause decline in quality with time and thus adversely affect productivity. Low market price, poor quality and unattractive packaging of open-pollinated varieties in comparison to hybrids is also becoming a constraint in generating interest in the seed production. In case of pure line selections it must be ensured that seeds are produced from authentic sources, i.e., institutions producing foundation and certified seeds. These must be properly tagged and stored.

Seed village concept should be encouraged to avoid contamination, which would

be helpful in dealing with the problem of maintaining recommended isolation distances for purity of seed, which may not be possible at the level of individual farmers producing seed.

3.2 Hybrid Seed Production

In recent years, the area under hybrid varieties has been increasing considerably in several crops namely tomato, cabbage, capsicum, cauliflower, brinjal etc. These varieties have been released both by public and private sector and are characterised by low seed rate, high yield and quality besides in some cases resistance to some diseases and pests. Hybrids of vegetable crop have been released both by public and private sector. However, private companies have outperformed the public research system in the technology and have impacted the variety and quality of vegetables in the market. While the farmers are finding these hybrids rewarding, the high price of seed is the major constraint. Since in hybrid varieties, seed replacement rate is 100%, they have to be procured from the organisations involved in their development every year. High cost of hybrid seed is a constraint in their adoption by small and marginal farmers. Further, hybrids developed mostly by private sector do not come under the national seed production chain and there is no control over their prices. This makes them beyond the reach of most of the small and marginal farmers and there is reluctance by the farmers to use these seeds as many of them cannot afford them.

A number of hybrids have been developed by the public system as a result of work done at several institutes and universities. However, their seeds are not available except in few cases. It is recommended that seeds of these hybrids which give good yield and high cost benefit ratio may be produced for supply to farmers at a reasonable rate either by a public sector organisation or in PPP mode. This will not only make the hybrids within reach of even small and marginal farmers but will also help in reducing the price of hybrids in the private sector and improved productivity for the small and marginal farmers hybrid seed production should be undertaken only by technically trained manpower and not by ordinary farmers.

3.3 Vegetable Nursery Production

In recent years, there has been a spurt in vegetable nurseries providing seedling plants in various parts of the country. Healthy nursery raising is a crucial step and

determines the production and productivity of all vegetable crops. So far, nursery raising has been done by each farmer under open field conditions. However, with changing climate and increasing vagaries of weather nursery production in protected structures has become common. Individual nursery raising is not only cost intensive but also suffers from shortage of skilled labour.

Lot of progress has been made in modernisation of nursery production for raising 100% healthy transplants. Major vegetable crops which are usually cultivated through transplanting are broccoli, brussels sprout, cabbage, capsicum, cauliflower, cucurbits, knol-khol and tomato. To reduce the cost of production and early establishment, seedlings are raised in trays using artificial media and good quality seed under controlled conditions round the year. In this method there is less competition among plants and greater uniformity. Plug transplants establish better in the field because roots of environmentally controlled raised seedlings are damaged while pulling. In Haryana, several vegetables growers have already made transition to greenhouse produced transplants. Such plants are being produced at the Centre of Excellence for Vegetables, Gharaunda (Karnal) near Panipat. However, with the increasing popularity of such seedlings, 2-3 more such centres are recommended in vegetable growing districts located away from Panipat in areas where vegetables are extensively cultivated or future vegetable clusters are proposed to be established.

NHRDF, Karnal in Haryana is involved in production and distribution of seeds of notified onion and garlic varieties. However, it is only able to produce only about 1.5% of the total requirement of garlic seeds and rest is done by farmers without proper training. The State Department should make arrangement for the procurement and supply of these seeds to the farmers.

3.4 Potato Seed Production

Seed requirements in potato crop is very high due to high seed rates, i.e., > 2.5 tonnes/ha. Breeder seed of potato is exclusively produced by CPRI, Shimla and supplied to State Departments of Agriculture/Horticulture. Production of seed potato is one of the major activities under which certified seed are being produced from breeder seed at Government gardens and nurseries for further distribution to

the farmers. Due to lack of monitoring, the multiplication schedule is not reportedly adhered to by various states. This is also true for Haryana state. Many farmers have thus to delay replacement or are left with purchasing seed from the farmers engaged in seed production often compromising either the variety or the quality. To get economic yields, farmers are advised to replace their seed stocks once in every 4-5 years. It is thus necessary that the state should try to achieve self-sufficiency in potato seed production.

Initiatives have been taken to produce potato micro-tubers at the Horticultural Biotechnology Centre, Karnal. The programme which was started in 2006-07 is now at G-3 stage in the fifth year and 52.5 qtl. of seed produced at this centre has been supplied during 2010-11. This programme needs to be strengthened through technical and other infrastructure support.

4. Flower Crops

In recent years, area under flower crop both outdoors and under protected structures has been increasing in the State of Haryana. While seeds/ plants of flowers like rose, carnation, chrysanthemum and gerbera grown under protected cultivation are imported from outside; seeds/plants of flowers cultivated outdoors are produced within the country. Haryana state has enormous potential to produce open- pollinated seeds of annual summer, winter and autumn flowers. The neighbouring state of Punjab has already taken a lead in flower seed production and their exports. Farmers in the state may be encouraged to identify and exploit similar opportunities.

5. Medicinal and Aromatic Plants

In any strategy to promote cultivation of medicinal and aromatic plants, the importance of making available quality planting material in adequate quantities cannot be over emphasised. The supply of such material needs to be ensured by SAU/ Department of Horticulture. An indent system for these plants needs to be introduced as some of the plants are perennial in nature and require notice well in advance. At present, CCS HAU is the main centre for production and generating of planting material in the state. Five small medicinal plant nurseries with an area of

one ha each have also been established during 2010-11 by Horticulture Department under NMPB at Cheeka in Kaithal, Saat Road, Hisar, village China in Sonipat and village Barola in Karnal. Some of these have already started production of planting material.

6. Mushroom

Haryana has been in the forefront of edible mushroom cultivation on a commercial scale. Accordingly, spawn is available both in public and several private sector establishments. However, there is need to pay attention to the timely availability of quality spawn, monitoring the establishment of spawn units in public and private sectors, enforcing spawn standards and ensuring supply of spawn run substrate in urban and peri-urban areas for cultivation of mushroom at fair price. There is a need for production and supply of spawn for species other than button mushroom before they are introduced for commercial cultivation in Haryana.

CHAPTER V : IMPROVING AVAILABILITY OF HORTICULTURAL PRODUCE

Change in life style and health consciousness of the people have resulted in several folds increase in the use of horticultural produce and products in the country. The requirement is on the rise. Therefore, availability of horticultural produce has to be improved to meet the increasing human needs not only for fresh consumption but also for processing and export. It is also imperative that the produce availability should be consistent and ensured in required quantities for extended periods through the year to meet the diverse needs. This would also ensure nutritional security and generate employment opportunities besides facilitating the domestic trade and export and utilization of processing industries.

Over the last two decades (1990–2010), both area and production under horticultural crops has increased significantly in Haryana, i.e. from 68,050 ha to 4, 15,930 ha (511%), and from 9, 02,040 MT to 51,41,271 MT (470%). However, to meet the increasing demand, the area coverage has to be stepped up from present 6.4% to 10% by the end of the next two plans. The Haryana Government envisages to increase the area under fruits to 80,000 ha and productivity to 17 MT/ha and that of vegetables to 3,45,000 ha and 18.5 MT/ha by the end of 12th Plan. This projected growth is proposed to be achieved by area expansion in non-traditional areas and by adopting intensive cropping systems and cluster approach. Although such efforts are in progress in the State under NHM, but still more focus needs to be given in selected crops by incorporating the following approaches:

1 Emphasis on Focus Crops

Instead of growing a large number of crops, time has come that the state must focus on few fruit crops, in which it has strength and which are bound to show impact in near future and positively benefit the farmers. There could be surveys to identify suitable pockets for different crops, Further development should be concentrated in these areas to achieve maximum yield and higher returns. The following specific suggestions are made:

1.1 Fruits:

Mango – Marketing of mango is not at all a problem because of proximity to NCR.

Area can be expanded in suitable pockets.

Kinnow – It is the major fruit of Haryana and its cultivation should continue to be promoted.

Guava – Area under guava has grown at a fast pace. High density plantation, red pulped varieties suitable for juice extraction need further promotion.

Ber – Area increase has been good, but keeping quality of ber is very poor. Further expansion should be based on availability of remunerative prices in the market.

Aonla – There has been significant increase in area and production resulting in problems in marketing. Further area expansion should be done carefully.

Sapota – Area can be expanded in identified pockets.

Lime – It is used all the year round by all households. It can also be promoted in the kitchen garden.

Strawberry – Fresh fruit has excellent market in NCR. Small scale primary processing units need to be encouraged near growing belts of area increase planned.

Litchi – Suitable pockets for litchi cultivation should be expanded as there is a very low litchi production in India vis a vis demand.

1.2 Vegetables

All the major vegetable crops are being grown in Haryana. There is good scope of expanding area on selective basis. Area under Kharif onion needs to be increased to help overcome shortages.

1.3 Spices

There is further scope of increasing area especially under coriander, cumin and fennel.

1.4 Flowers

More emphasis needs to be given to cultivation of marigold for fresh flower as well as extraction of pigments. Ornamental crops like gladiolus, tuberose etc and foliage

plants need to be promoted in a big way. Essential oils from rose, tuberose, jasmine also have a great scope.

1.5 Medicinal and Aromatic Plants

Tulsi, Aloe vera, citronella, mint have considerable potential in Haryana State.

1.6 Mushroom

Besides oyster mushrooms other mushrooms could be promoted.

2. Identifying New Clusters

The Cluster Development scheme under NHM is in operation in Haryana and one cluster each has been developed for mango, citrus and mushroom in Haryana. This has already given good results. It will be useful to further strengthen the programme and extend this approach for other remunerative fruits, vegetables and flower crops. The clusters should be strengthened on priority by creating the required infrastructure facilities such as cold chain, processing and storage along with provision of information and guidance system by deploying crop specialists as well as crop insurance support. Though vegetable cultivation is not covered under NHM programmes, however, to boost vegetable and flower production in the State and promote their export, components like IPM, protected cultivation and vegetable seed production have been integrated with NHM.

New clusters should be developed in areas which are unutilized, barren and undulating in south Haryana for citrus, guava and ber. The State's integrated model that encompasses orchard plantation, micro-irrigation (drip irrigation) and farm ponds is quite praiseworthy.

While three clusters have been established in Haryana. It has been observed that each cluster covers several diverse crops and extends over several districts located wide across the state and thus defies the objective with which the cluster approach was conceived. The clusters should ensure integrated development of horticulture by provision of common facilities and for plant material supply, production and post harvest management. All future horticulture development should be cluster-based instead of encouraging small plantations scattered throughout the State along with all supporting facilities.

3. Greening of Arid areas

Some selected horticultural crops can be successfully grown under arid agro-climate and in neglected or marginal areas. Such hardy fruits and vegetables can not only be valuable additions to our produce basket but also can generate income and employment opportunities for the people. These crops also provide nutritional security to the local communities. In Haryana, some initiatives have been taken in NHM in adopted districts but considerable area still remains unattended and should be covered under the mission. Potential horticultural crops and their ideal growing regions are listed in Table 15.

Table 15: Some of the Potential Horticultural Crops suitable for Arid regions in Haryana.

Climate zone	Districts	Potential crops
Arid	Rohtak, Jhajjar, Mewat, Bhiwani, Fatehabad, Sirsa	Lasoda, Ber, Ker, Khejri, Phalsa, Pillu, Karonda, date palm, Aonla, Custard apple, phoot, kachari.
Dry Sub-humid	Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal	Loquat, cape gooseberry, cow pea, cluster bean, round melon
Moist Sub-humid	Panchkula, Ambala, Yamunanagar	Loquat, cape gooseberry, jamun, dolichos bean, cow pea
Semi Arid	Panipat, Sonipat, Palwal, Kaithal, Jind, Hisar	Bael, Jamun, Mahua, wood apple, pomegranate, aonla, custard apple, drumstick, Indian almond, Khirni, guar, faba bean

The following suggestions are also made:

- i. Annual crops should be selected based on the available ideal season and their suitability to endure the dry period efficiently. Only short duration varieties requiring less irrigation should be promoted.
- ii. Facility for life saving irrigation should be provided by strengthening the scheme on construction of community ponds in dry and drought prone areas.
- iii. In perennial fruit crops, where feasible, in situ grafting should be encouraged.

2. Reclamation of Wastelands

Expanding horticulture in non-traditional areas including wasteland and saline areas will help in increasing area and making available the produce for diverse uses. The wasteland categories occupy 2.34 lakh ha which is 5.3% of the geographical area in Haryana. These lands are not being used to their optimum potential owing to adverse conditions like salinity, alkalinity, water logging, sand deposits, mining and industrial dumps. The districts of Mahendragarh, Jhajjar, Bhiwani and Hisar have sandy area of about 41 km² besides about 1.8 km² in Karnal, Palwal and Sonapat under riverine sands. About 72 km² area is under marshy and waterlogged lands in Jhajjar, Mewat, Bhiwani, Sonapat and Rohtak districts, 93 sq. km area is under rocky wastelands in Mahendragarh, Rewari, Bhiwani and Mewat districts.

Instead of traditional varieties which are best suited for ideal conditions, several improved varieties which are genetically tolerant to biotic and abiotic stresses and are capable of giving optimum yields even under stress situations need to be introduced and promoted. These marginal areas can be put to productive use by appropriate policy framework followed by suitable adaptive conservation and planting of selected hardy species/ cultivars suiting different categories of wastelands. These marginal areas can be best used by planting salt and moisture stress tolerant varieties and adopting land reclamation practices so as to achieve good yields and appreciable quality (Table 16).

However to make proper use of these lands:

The growers should be trained in land reclamation practices and choice of crops to be grown in the region. Pocket planting should be adopted for perennial fruit crops. Only early maturing summer dormant fruit plants need to be selected for extreme environmental conditions. Subsidies should be provided to farmers growing horticultural crops in marginal areas. There should be provision for replanting and gap filling so as to have a proper plant population in a three to four year package instead of one time subsidy as practiced under NHM. Research institutes like CSSRI, Karnal, CWSR&TI, Panchkula and CCS HAU, Hisar should involve themselves to develop technologies to mitigate edaphic problems and develop crop varieties suited for such areas. Department should make provision for

Table 16. Choice of different horticultural crops which are best suited to grow under marginal and wastelands after reclamation.

Wasteland category	Fruits	Vegetables	Others
Sandy lands	Guava, tamarind, Manila, tamarind khejri	Onion, garlic, chilli, cowpea	Aloevera, aswagandha, Vitex regundo
Salt affected lands	Bael, aonla, drumstick, ber	Okra, beet, chilli, carrot, spinach, methi	Fennel, henna (<i>Lawsonia inermis</i>), <i>Calotropis</i>
Gullied & riverine land	Drumstick, khejri, Phoenix sp.	Chilli, cluster bean, dolichos bean, cowpea	<i>Ailanthus excelsa</i> , <i>Boswellia serrata</i> , <i>Bursera panicillata</i> , licorice, <i>Cassia fistula</i> , <i>C. siamea</i> , sheesham, kusum
Undulating uplands	Olive, peach, guava, ber	Bell pepper (<i>Capsicum annum</i>), watermelon, muskmelon, cucumber, cluster bean, French bean, parwal	Henna, <i>Swertiachirata</i> , poplar
Mined & industrial wastelands	Aonla, bael, ber	Cucurbits	<i>Aloe sisalana</i>
Waterlogged areas	Lotus, jamun, tamarind, water chestnut	Leafy vegetables	Khas khas
Strip lands	Karonda, jamun, ber		Neem, <i>Simarouba glauca</i>

procuring soil reclamation material and supplying to growers at subsidized rates. More emphasis should be given on on-farm rapid preparation of compost using effective microbial consortia developed at IARI, New Delhi and CCSHAU, Hisar.

4. Promoting Round-the-year Vegetable Cultivation

Development of a number of varieties with wide adaptability has made it possible for some vegetables like carrot, radish and cauliflower to be available round the year. In Haryana, these crops can be successfully grown using appropriate time of planting and making the crop available fresh for a major part of the year. The varieties in different crops with their sowing and harvesting time are given in Table 17.

Table 17. Sowing and Harvest time in round the year vegetable growing.

Cultivar	Period of sowing	Period of harvesting
Radish		
Pusa Chetaki	First week of April to mid-August	First fortnight of May to 2nd fortnight of September
Pusa Desi	Mid-August to mid-October	Mid-September to mid-December
Pusa Reshmi	First fortnight of September to Mid-November	2nd fortnight of October to 1st fortnight of January
Japanese White	Mid-October to 2nd fortnight of December	Mid-December to 1st fortnight of March
Pusa Himani	2nd fortnight of December to end of February	Mid-February to 3rd week of April
Carrot		
Pusa Vrishiti	March to April	May to June
Pusa Rudhira and Pusa Asita	September to October	November to January
Pusa Yamdagini and Pusa Nayanjyoti	September to March	November to April
Cauliflower		
Pusa Meghna, Pusa Kartik Shankar	End of May	End of August-October
Pusa Deepali	June	October-November
Pusa Sharad, Pusa Hybrid-2	End of July-August	November-December
Pusa Paushja, Pusa Shukti	End of August-September	December-January
Pusa Snowball K-1, Pusa Snowball	October-December	January-March

5. Cultivation of Off-Season Crops

Off-season production of Vegetable Crops can also yield higher income per unit area if followed systematically with suitable crops and varieties. River bed method of cultivation of vegetables is an indigenous technique to provide early supply of

cucurbitaceous crops. Irrespective of the crop, off-season production always fetches premium price to the farmers. To achieve this objective some of the suggestions are:

Off-season vegetable seedling production to catch early or lean season of availability needs to be promoted. This approach will not only help in higher price realization for produce but also longer season of availability. In several peri-urban areas, use of low cost protected structures is recommended to grow off-season vegetables.

Off-season growing of herbs like green coriander, mint, palak etc. fetches good price in lean or off season. In cultivation of ornamental crops, following technologies may be adopted for maximizing their availability and returns.

Cultivation of Chrysanthemum variety- Pusa Anmol (a photo- and thermo-insensitive variety) that flowers thrice in year needs to be promoted for off season production. Cultivation of Marigold during summer, winter and rainy seasons to get year round production needs to be promoted, so that a pigment extraction industry can also develop and sustained.

Off-season cultivation of gladiolus by planting from July to January at monthly interval gives spikes from September end to April. Further, Sylvia, Royal Jubilee, Australian Fair and Psittacinus hybrids of gladiolus are temperature insensitive and can be grown throughout the year except during May and June. Selected pockets in the state may be encouraged to produce the seedlings of annual seasonal flowers during summer, winter and autumn in plug trays for meeting the demand in the cities and the NCR.

6. Inter- and Mixed-Cropping

Inter-cropping with some short duration crops is recommended in widely spaced perennial fruit trees as it would ensure optimum use of space, increase production per unit area and provide additional income. Besides this system can also improve the water use efficiency and yields of crops being grown at present in different regions as mentioned below:

- i) Methi and palak can be taken as ratoon crop in sugarcane.
- ii) Cauliflower and cabbage planting in October sown sugarcane to fetch good price in market.

- iii) Okra, cowpea, round melon, cucumber in March sown sugarcane, snap melon and cabbage in kharif season maize crop is profitable.
 - iv) Intercropping onion/garlic in sugarcane to improve profitability.
 - v) Vegetable mustard can be raised in wheat after sowing to successfully use the space.
 - vi) Radish, turnip, carrot and beet root can be sown on the bunds of potato, cauliflower and cabbage.
 - vii) Relay cropping of vegetable crops such as planting of early cucurbits (end of Jan-Feb) in late potato crop and cow pea and cluster bean (June-July) in spring-summer okra gives early income to the farmers.
 - viii) Turmeric and ginger as intercrop could be a good option in irrigated regions.
- Some of the vegetable and flower crops recommended for mixed cropping are:
- i) Annual chrysanthemum and radish or annual chrysanthemum and carrot.
 - ii) Marigold and radish, marigold and carrot, marigold and leafy vegetables and marigold and beet root.
 - iii) Fruit orchards can be effectively utilised for intercropping with the above combination during the initial years.
 - iv) There is need to develop location-specific viable integrated farming system models in Haryana.

7. Horticulture-Based Cropping Systems

Since land is a limited resource and the holdings of majority of farmers in Haryana are small, one of the effective ways to increase the production of horticultural crops is to follow horticultural based cropping systems. The system would also help to mitigate risk in crop failures as well as result in full utilisation of the land and input resources. Suitable cropping system models for different eco-regions of the state will have to be developed, e.g., suitable fillers and intercrops for fruit and tree systems as well as suitable fruit species for the existing cropping systems. To illustrate this some of the potato-based cropping systems are given below:

- i) Green manuring-potato-cucurbit and potato-tomato-okra.
- ii) Paddy-potato-wheat system, where potato crop is given 90 days instead of 80 days and recommended dose of NPK is applied to each crop.
- iii) Paddy-potato-cucurbit/ okra (adopted by 20% farmers) need to be replicated.
- iv) Potato-okra system with the application of 20 t/ha FYM.

CHAPTER VII : IMPROVING PRODUCTIVITY AND QUALITY

The Haryana Government has targeted to improve the productivity of fruits and vegetables from the present level of 13.04 and 13.42 MT/ha (2010-11) to 17.03 and 18.5 MT/ha respectively by the end of XII plan. These levels have to be further improved during XIII plan. To achieve this it will be necessary to initiate strategies aimed at improving both productivity and quality in view of their concerns in both profitability and trade.

1. Promotion of High Yielding Varieties

As a result of efforts made in ICAR Institutes and State Agricultural Universities in the country, a large number of improved and high-yielding varieties of several horticultural crops are now available. Over 70 varieties of fruits (aonla, acid lime, apple, banana, custard-apple, grape, guava, litchi, mango, papaya, pomegranate and sapota) and in vegetables about 230 open-pollinated and 60 F1 hybrids besides 5 synthetics of a large number of crops are available. These include large-fruited Aonla; early maturing grape for juice and table purpose, less/ soft-seeded and pink pulped guava, early bearing and crack tolerant litchi, regular-bearing semi-dwarf mango, high yielding papaya, disease resistant varieties in brinjal (Phomopsis and bacterial wilt), cabbage (black spot), capsicum (bacterial wilt), cauliflower (black

Table 18. Some improved varieties of different fruit crops recommended for introduction and evaluation in Haryana.

Fruits	Varieties(s)
Mango	Dashehari 51, Ambika, Pusa Arunima, Pusa Surya, Pusa Lalima
Papaya	Co7, Coorg Honey Dew, Pink Flesh Sweet, Surya, Pant Papaya 1, Punjab Sweet
Guava	Lalit, Shweta, Arka Kiran, Pant Prabhat, MPUAT S-1 & S-4
Lime	Jai Devi, Sai Sharbati, Rasraj, Vikram, Pramalini
Lemon	Pant Lemon 1
Annona	Arka Sahan
Ber	Goma Kirti, Thar Sevika, Thar Bhubraj
Aonla	Goma Aishwarya
Karonda	Pant Manohar, Pant Sudarshan, Pant Suvarna
Litchi	Rajendra Hybrid-235, Rajendra Sabour Bedana, Swarna Roopa, CHES 2, Sabour Madhu, Sabour Priya, Saharanpur Selection
Pear	Pant Pear 1, Pant Pear 17, Pant Pear 18, Punjab Nectar, Punjab Gold, Punjab Soft
Peach	Pant Peach 1
Plum	Pant Plum 1, Fla 12
Khejri	Thar Shobha

rot), cowpea (bacterial blight), chilli (leaf curl), okra (yellow vein mosaic), onion (purple blotch), French bean (bacterial wilt), pea (powdery mildew and rust), tomato (bacterial wilt and root-knot nematode) and multiple disease resistance in watermelon and musk melon and several varieties of spices, potato, medicinal and aromatic plants. These should be tested for their potential for commercial cultivation in Haryana.

In vegetables, heterosis in the form of F1 hybrids in economically important self and

Table 19. Improved F1 hybrids in different vegetable crops

Crop	Hybrid	Developing Centre
Bitter gourd	Pusa Hybrid 2	IARI, New Delhi
Bottle gourd	NDBH-4, NDBH-1	NDUA&T, Faizabad
Brinjal	ARBH-201, ARBH-541	Ankur Seeds, Nagpur
	ABH-1, MHB-39	Mahyco, Jalana
	ABH-1	GAU, Anand
	Pusa Hybrid-9	IARI, New Delhi
	PBH-6	Pandey Seeds, Faizabad
	JBH-1	JAU, Junagadh
Cabbage	Nath-401	Nath Seeds, Aurangabad
Chilli	ARCH-228	Ankur Seeds, Nagpur
	CCH-2	IIVR, Varanasi
Cucumber	PCUCH-1	GBPUA&T, Pantnagar
Garlic	HG-17, HG-27	CCS HAU, Hisar
Onion	Hisar Onion-3	CCS HAU, Hisar
Garlic	HG-17, HG-27 (Selection)	CCS HAU, Hisar
Okra	DVR-2, DVR-3	IIVR Varanasi
Onion	Hisar Onion-3	CCS HAU, Hisar
	JNDOH2-2, JOH-05-9	JAU, Junagadh
Sweet Pepper	KTCPH-3	IARI (RS), Katrain
Tomato	Pusa Hybrid-2	IARI, New Delhi
	NA-601	Nath Seeds
	Avinash-2	Novartis, Mumbai

cross-pollinated vegetables is available in both public and private sector hybrids. These hybrids have yield advantage varying from 20 to 100% resulting in appreciable growth in the development of hybrids in several vegetable crops. While hybrid seeds of tomato, chilli, cucumber and muskmelon are being produced at several places in India, imported seeds of most of the Cole crops are available through private sector only. AICVIP of ICAR and National Seeds Corporation have been producing several of the vegetable hybrids for commercial cultivation. It is high time that maximum area under vegetables is brought under F1 hybrids to improve the productivity. Some hybrids recommended in different vegetable crops for Haryana State are given in Table 19.

In flower crops also newly developed high yielding varieties need to be introduced if not already available. Some of the recommended varieties have been listed in Table 20.

Table 20 : Recommended varieties of different flower crops

Crop	Variety	Developing Centre
Chrysanthemum	Pusa Anmol, Pusa Centenary	IARI, New Delhi
	Anmol, Punjab Anuradha	PAU, Ludhiana
Gladiolus	Pusa Shubam, Pusa Kiran	IARI, New Delhi
Marigold	Hisar Beauty, Hisar Jaffri	HAU, Hisar
	Pusa Narangi Gainda, Pusa Basanti Gainda, Pusa Arpita	IARI, New Delhi
Rose	Pusa Priya, Raktima, Raktagandha, Pusa Mansij, Pusa Abhishek	IARI, New Delhi
	Rose Sherbet, Pusa Baramasi	IARI, New Delhi
Tuberose	Prajwal, Vaibhav	IIHR, Bengaluru

The following spice crop varieties (Table 21) developed by CCSHAU also need to be promoted in the state

Table 21 . Recommended varieties of different spices

Crop	Variety	Special characteristics
Fenugreek	Hisar Sonal	Quick growing dual purpose
	Hisar Mukta	Resistant to downy mildew
	Hisar Suvarna	Resistant to Cercospora leaf spot
	HM-219	High yielding, resistant to powdery mildew
Coriander	Hisar Anand	Dual purpose, bold seeded
	Hisar Sugandh	High yielding, resistant to wilt, powdery mildew
	Hisar Bhoomit	Small seeded, high oil content, resistant to stem gall disease
	Hisar Surbhi	Medium sized seed, less susceptible to aphids & powdery mildew
Fennel	Hisar Swarup	High yielding
Chilli	Hisar Shakti	Fruits upright in clusters, pointed thin, highly pungent
	Hisar Vijay	
Turmeric	CSTH-9	High yield long fingers

2. High Density Planting (HDP)

The continued decline in the availability of cultivable land, rising energy and land costs have left little scope for horizontal expansion to meet the mounting demand for horticultural produce. This has necessitated adoption of High Density Planting (HDP) by use of genetically dwarf cultivars or use of dwarfing rootstock/ inter-stock. The HDP system involves adoption of management practices such as training and regular pruning to control growth and tree form. In fruit crops HDP has been successful in mango, guava and citrus. However, under close spacing for high density planting efficient and intensive input management relating to water, nutrients and plant protection need to be standardised. The technology is especially useful for small and marginal growers as high density planting is easily manageable and gives early and higher yield of better quality fruits and thus higher returns/unit area. But being an intensive system, it requires more capital to establish and is simultaneously more productive and profitable, if followed scientifically. In Haryana a good beginning has been made under NHM to plant fruits under high density planting. It is however, recommend that

- i) Moderate spacing of 5-6 m should be used for effective management and extremely close spacing (2.5 m x 2.5 m) in mango should be avoided.
- ii) Wherever dwarfing rootstocks are available these should be procured and tested for their adaptability to climate and their compatibility with commercial varieties grown in Haryana.
- iii) As a matter of policy all new plantations in the State should be established under HDP. This would enhance productivity from 30 to over 300%.
- iv) In vegetable crops, even under traditional planting system, staking in indeterminate varieties of tomato and capsicum and trailing in cucurbitaceous crops can increase productivity.

3. Canopy Management

Proper management of tree and vine canopies optimizes fruit production. Manipulation of tree canopy is done through training systems, pruning practices and use of growth retardants.

- It ensures sufficient light and ventilation into the canopy and its interception by adequate number of fruiting units and foliage.
- It nurtures and protects the fruits from sun burn.
- Avoids overlapping of branches to minimise parasitic and pest infestation.
- Allows effective coverage of sprays and ease in harvesting.

Canopy management helps to optimize carbon allocation in fruit sinks without disturbing growth and development of other parts of the tree. Better light penetration and interception are critical to achieve high tree productivity as it influences canopy temperature and humidity and thus tree vigour, productivity and quality of fruit. It prolongs orchard life without compromising the productivity and quality of fruits. Developing plants with manageable height and spread also reduces wastage of resources. However, more systematic research is required to develop proper canopy management practices in different crop varieties. Training needs to be imparted on canopy management to the farmers.

There are some special operations which help in improving yield and quality in some horticultural crops. These are:

- i) Staking of cucurbits give good fruiting.
- ii) Some ornamental plants require regular pruning and pinching for proper growth and development.
- iii) Pruning of roses for cut flower production.
- iv) Deshooting of sprouts from rootstocks in ornamental and fruit trees.
- v) Pinching and disbudding in marigold and chrysanthemum; staking in chrysanthemum to prevent lodging in protected structures.
- vi) Earthing up in different flowers to prevent lodging.

4. Rejuvenation of Old and Senile Orchards

Old and senile orchards having over-aged fruit trees with poor efficiency are now a common phenomenon in fruit and plantation crops in different climatic conditions, e.g., temperate fruits (apple, pear, peach) and sub-tropical fruits (mango, guava, and litchi). Closely planted or poorly managed plantations invariably attain such situations in the early years of their establishment. Senile plantations develop over-crowded shoots that get intermingled and have poor photosynthetic efficiency. Some such old orchards that cannot be rejuvenated have to be uprooted for replanting. Many of these plantations can be rejuvenated in such a way that that they develop satisfactory vigour and productivity. It is estimated that in Haryana about 25 to 35 per cent orchards / plantations are senile and have become uneconomical, as per a rough estimate, Rejuvenation is an important component of the programme of National Horticulture Mission in Haryana. An area of over 500 ha area under fruits has been rejuvenated. However, the following suggestions are made to improve the usefulness of the programme.

- i) Gap filling should be done in young and productive orchards where some plants have died due to disease or other reasons to enhance the productivity.
- ii) Almost all the trees of traditional and old varieties should be top-worked and

replaced with new varieties that are superior and can fetch higher market price by procuring scion from genuine sources.

- iii) Suitable pesticide schedule should be recommended for rejuvenation of plants damaged by pests and diseases. Suitable package of practices need to be developed for those rendered unproductive due to poor vigour.
- iv) CCS HAU should standardize suitable rejuvenation techniques for different fruit crops for different regions of Haryana.
- v) The available rejuvenation techniques should be adopted for orchards of mango, guava, aonla, sapota, peach, etc. which have dense canopy and intermingling branches showing loss of productivity.
- vi) Old senile orchards which are over grown and over lived should be removed and replanted.

2. Pollination Enhancement Through Bee-Keeping

Honey bee is an important pollinator in most of fruit and vegetable crops. Fruit set and production has been shown to increase by 15-30% if honey bee hives are kept in orchards. It also gives additional income through honey production. The technology including maintenance of a definite number of bee hives/ per unit area in fruit orchards has been worked out. Under NHM, bee keeping is being promoted in orchards to enhance fruits. This intervention gives hope to even landless farmers who with little training and skill development can earn their livelihood by providing services to make orchards more productive. Over 6,000 hives have been distributed under NHM in Haryana. It should however be ensured that these are being used both for pollination and honey production purposes. More hives and other related gadgets should be made available at cheaper rates

Dedicated centres should be established for promoting bee keeping for enhancing production of horticultural crop. These centres should provide training to the interested farmers. Farmers should also be encouraged to have small processing centres in a cluster of villages so that production, processing, packaging and sale could be integrated.

3. Nutrient Management

Addition of inorganic fertilizer constitutes one of the most expensive inputs in agriculture. However, their excessive and indiscriminate use in commercial horticultural crops has resulted in several problems. Heavy application of nitrogenous fertilizers has resulted in high quantities of nitrates in water bodies in Punjab, Maharashtra and Karnataka states making it unfit for cultivation and also for human consumption. Therefore, it is essential that such approaches be followed, which do not adversely affect yield and quality and are simultaneously cost-effective and eco-friendly. Another important aspect in nutrient use is enhancing the fertilizer use efficiency (FUE) by proper placement of fertilizer in close proximity to the rhizosphere of the highest root activity. Placement of fertilizers in active root zone and at optimum time of application has been known to give best results in several perennial fruit crops. In mango, the highest root activity has been found at a depth of 30-60 cm and at a lateral distance of 120 to 240 cm. In citrus it is 60 -75 cm up to 15-20 cm distances. These simple interventions can effectively improve the fertilizer or nutrient use efficiency (FUE/NUE). Location-specific nutrient guides need to be made available for different fruit crops which would reduce nutrient wastage and enhance production, productivity and quality of the produce. Therefore, use of diagnostic tools for nutrient management in horticultural crops is considered important in the use of optimum qualities of fertilizer. Further all micronutrient deficiency based disorders should be managed using their spray or soil application so that there is no compromise on productivity and quality. Some suggestions in this regards are:

- i) Techniques like green manuring, soil reclamation, organic matter enrichment should be encouraged for cultivation of horticultural crops.
- ii) Tissue nutrient guides need to be developed in different crops to economize on manures and fertilizer doses and ensure precision in time of application.
- iii) Large scale promotion of bio-fertilizers, like Rhizobium, Azotobacter, Azospirillum, arbuscular mycorrhizal fungi, phosphorus solublizing bacteria (PSB), will enhance production and quality of the produce.
- iv) Promotion of neem coated and other slow release fertilizers to avoid

nutrient loss through leaching and fixing in soils is called for.

- v) Multiple micro-nutrient mixes be procured for effective use of micro nutrient deficiencies.

4. Mulching

Mulching has been helpful not only in preventing moisture loss through evaporation from the soil and lowering the temperature but also reducing nutrient loss by leaching and weed control where chemical fertilizers and weedicides are used. Mulching also reduces run-off (20-30%), increases penetration of rainwater, controls erosion, corrects the chemical balance of the soil and reduces damage done by pests and diseases, thus increasing the yield (10-30%). In tomato, mulching with straw, hay, sawdust, asphalt paper and black polyethylene plastic can be used in districts where shortage of water is a problem. Mulching also reduces the extent of blossom end rot and infection by soil-borne diseases. Straw mulching and paper mulching has proved beneficial for brinjal and bell peppers. It has given very consistent increase in yield, earliness and prevented fungal infection in both. Sawdust, straw mulching and light coloured paper mulch improve seed emergence and increase yields of root crops like carrot, beet, potato and lettuce in dry regions. Extensive use of this practice is recommended by farmers. Several disease causing micro-flora and fauna could also be minimized using mulches. Apart from the above the following general recommendation are made.

- i) Plastic mulch material of standard quality suitable for annual/ perennial horticulture crops should be used.
- ii) Use of linear low density polyethylene (LLDPE) and PP non woven black sheets of different thickness as mulch material should be promoted to maintain better hydrothermal conditions and structure of soil besides effective weed control.
- iii) Use of organic wastes/ compost/ straw or hay should be promoted as mulches for all horticultural crops.
- iv) Use of biological mulch i.e., rice husk abundantly available in Haryana may be exploited.

- v) In order to minimize the weed growth and conserve soil moisture mulching be promoted in flower crops like rose, marigold and gladiolus.

5. Water Management

Micro-irrigation is well known for its water saving ability. Under this, water saving to a tune of 30-70% (in orchards) with yields increases up to 20 to 100% have been recorded. It also increases fertilizer use efficiency, limits weed growth and reduces incidence of pests and diseases. In Haryana, 54% of the ground water is brackish, which can be profitably used by micro-irrigation. Adoption of this system should be promoted particularly in regions where facility for micro-irrigation already exists. The programme of development of micro-irrigation in Haryana is under implementation under an NHM integrated orchard plantation model and 15000 ha area has already been covered. Under an integrated model, orchard plantation along with micro-irrigation and farm water pond launched under NHM, 1,600 ponds have also been constructed to store water in different fruit belts in Haryana.

The following aspects need attention:

- i) The initiative taken under State Government programme on micro-irrigation and NHM should be continued and strengthened to ensure high Water Use Efficiency (WUE).
- ii) There is need to increase awareness about the usefulness of micro-irrigation and fertigation through strengthening information system and holding regular training and skill development programmes.
- iii) At present recommendations on micro irrigation are based on recommendation of firms supplying the micro irrigation units. These need to be validated through continued research. Also, presently the systems, their spares and liquid fertilizers are marketed only by private companies. There is need to make provision of public distribution networks to ensure availability of the systems and their spares, maintenance and also the liquid fertilizers for fertigation.
- iv) The CCS HAU, Hisar and CEV, Gharaunda, (Karnal) should be funded for finding cheaper alternatives and combinations of inorganic fertilizers and

liquid fertilizers to economize on the cost of production. Work is required on economic use of water and nutrients on per plant per day basis to improve water productivity and Water Use Efficiency (WUE).

- v) In regions where ground water is highly saline, either provision should be made for mixing soft water or for setting up low cost desalinization to make the micro-irrigation units functional for longer period.
- vi) At present micro-irrigation facility under NHM scheme is available only for new orchards. Efforts should be made to extend it to old established orchards also. In fact it should be provided for all annual and perennial horticultural crops.
- vii) Small and marginal farmers should be encouraged to install low cost zero energy drip irrigation systems.

6. Use of Chemicals

Micro-nutrients are rendered unavailable in annual and perennial crops due to different reasons like developing salinity and alkalinity, inappropriate application of NPK, etc. These problems are very serious in fruit crops like citrus and vegetable crops like cauliflower and potato. Common Micro-nutrients deficiencies in respect of Zn, Mn, Cu, Fe, B have been reported and need to be controlled. The CCS HAU should make specific recommendations to control deficiencies of various micronutrients in important horticultural crops including developing a schedule for time of application and at appropriate crop growth stage.

Interventions with some plant growth regulators have also proved effective in improving yield and quality as a result of their effect on flower induction, enhancing fruit set, reducing fruit drop, causing fruit thinning, fruit set and fruit quality. Several of the physiological disorders in different crops can also be effectively managed by use of chemicals.

7. Promotion of Nutritionally Rich Varieties For Value Addition

Growing of nutritionally rich vegetable varieties/ hybrids also needs to be promoted. These varieties are superior for nutritional traits hence favoured by the processing industries and are also required for ensuring better nutritional security.

Table 22. Suggested varieties/ hybrids for value addition

Crop	Variety/ hybrid	Nutrient(s)
Fruit Crops		
Mango	Amrapali	Dwarf and high in pro-vitamin rich
Guava	Lalit, Hisar Surkha	Anthocyanin rich
Karonda	Pant Manohar, Pant Sudarshan, Pant Suvarna	Iron rich
Vegetable Crops		
Tomato	Pusa Rohini, Pusa Uphar, Pusa Hybrid 2	Vitamin C, lycopene, TSS Vit C
Carrot	Pusa Rudhira Pusa Asita Pusa Nayanjyoti	Lycopene Anthocyanin B-carotene
Amaranth	Pusa Kiran, Pusa Kirti Pusa Lal Chaulai	Pro-Vitamin A, Vitamin C, iron Calcium, Anthocyanin
Bitter gourd	Pusa Hybrid 1, Pusa Hybrid 2	Vit. C, calcium, iron
Chenopodium	Pusa Bathua-1	Pro-vitamin A, vit. C, iron, calcium
Beet leaf (Black)	Pusa Bharti	Pro-vitamin A, Vit C, iron, calcium
Pumpkin	Pusa Vikas, Pusa Hybrid1	Pro-vitamin A
Vegetable mustard	Pusa Sag 1	Pro-vitamin A, Vitamin C
French bean	Pusa Parvati	Protein
Lablab bean	Pusa Sem 2	Protein
Broad bean	Pusa Sumeet	Protein
Garden pea	Arkel	Protein
Flower Crops		
Marigold	Pusa Narangi Gainda, Pusa Arpita	Luetin

CHAPTER VIII : REDUCING COST OF CULTIVATION

Cost of cultivation of crops has been increasing at a very fast pace primarily because of increase in the cost of various inputs like planting material, fertiliser, pesticides and labour. The high cost of production is causing negative impact in the domestic and international markets as our products are losing competitive advantage in export market. Therefore, it is important to ensure that the cost of production is kept at the minimum by economizing on various inputs without sacrificing the produce quality. The following strategy is recommended:

1. Economising in cost of planting material

Planting material is one of the most important investments. However, most of the improved varieties/ hybrids particularly of vegetables and flowers are released by private sector and are costly making these beyond the reach of small and marginal farmers. The cost is still higher in crops like banana where micro propagated plant material is now in commercial use in our country. Similarly in vegetable crops, very costly seeds of high yielding F1 hybrids marketed by private seed companies are used in most of the areas.

While a number of F1 hybrids have been developed by the public sector these are not being commercially produced in most of the cases. These need to be popularised and promoted in a massive way by keeping the price within the reach of the small farmers. Therefore, emphasis on large scale multiplication and marketing of planting material through suitable organisations in PPP mode of public system hybrids which match private sector hybrids in their performance with respect to yield, quality, pests and disease resistance. There is need to ensure that the seeds of these hybrids are available at comparatively lower cost to enable small and marginal farmers of the State to take advantage.

2. Economizing cost of Fertilizers

The emphasis on use of increased doses of fertilisers in recent years has not given the matching yields. In Haryana, the use of nitrogenous fertilizers has been more than the recommended ratio of NPK. Also there is imbalance in the use of phosphatic and potassic fertilisers. These have become major problems in attaining optimal yields

and maintaining the required nutrient balance in the soil. Plant tissue labs set up under Mission Mode scheme of horticulture development have remained highly underutilised. The following measures are suggested for economising the cost of fertilisers:

- Soil and leaf testing laboratories should be established in each district and leaf tissue analysis should be used as a diagnostic tool for determining the sufficiency/deficiency levels of different macro and micro-nutrients on which fertiliser needs should be based. Leaf analysis studies should be encouraged to develop nutrient guides for recommendations on manures and fertilisers required for economic optimum yield under integrated nutrient management.
- Biofertilizers/ vermiculture should be used simultaneously to reduce the cost of cultivation and increasing the quality and production. There is need for more research in INM and organic farming.
- Nutrient needs must be addressed at right time and amount following integrated nutrient management practices. Encouraging organic farming in high value crops.
- Proper training to prepare vermi-compost and advisory service for proper guidelines on use of biofertilizers, INM and organic farming technology should be provided to the farmers.

2 Economizing cost on Use of Pesticides

Risk to human and animal health from the contamination of the ecosystem as a result of indiscriminate use of pesticides is a serious concern worldwide. The pollution of the environment and the food web has already become a serious threat to humanity. There are outbreaks of secondary pests eliminating useful natural fauna. Continued development of pest resistance has led to formulation of newer pesticides and their influx into the production system. Presence of high level of pesticide residues in farm gate samples of vegetables is common. On top of it these chemicals are very expensive and add to the cost of production. There is therefore urgent need for adequate knowledge about the pests and diseases of horticultural

crops and for developing low cost and effective control measures. The strategies suggested are:

- Adoption of IPM technologies in a participatory mode should be encouraged thereby gradually reducing the dependence on chemical pesticides.
- To achieve this farmers should be encouraged to use bio-pesticides and bio-agents creating awareness about bio control agents and their availability.
- Ensure easy availability of bio-pesticides and bio-agents. Provision of subsidy on purchase of bio-agents and for adoption of bio-control methods and creation of cold chain for bio-inoculants.
- Develop disease resistant hybrids.

4. Economizing cost of Labour by Mechanization

Horticulture is not only highly labour intensive but often requires skilled labour for various operations also. Thus labour cost forms a major part of cost of production. Over the years availability of labour has become scarce and now the MGNREGA scheme of rural employment has made it worse. Mechanisation and automation can bring down the required cost on labour besides reducing drudgery and improving product quality. But non-availability of modern tools of farming and small implements and tools affordable by small farm holders is a big constraint. Partial mechanisation of input operations like digging of soil, application of fertilisers, weeding, spray of chemicals, micro-irrigation, training and pruning, harvesting, washing, grading, sorting, packaging, processing, value addition in horticultural crops depending upon the orchard size and availability and skill of labour in the region can considerably decrease the cost of management and improve efficiency in operations. Lot of progress has been made by several Institutes and organisations to develop tools and machinery for different operations in a number of crops. The technologies recommended for adoption are listed below:

4.1 Fruit Crops :

- i. Adoption of mechanization for pruning for canopy management. Adoption of manually held, petrol engine operated canopy shakers for harvesting of

aonla and ber. These machines are available commercially.

- ii. Adoption of tractor operated pit hole digger and JCB (Back hoe) for digging pits for plantation of mango, guava, citrus, sapota, ber and aonla.
- iii. Adoption of air assisted sprayers for spraying fruits crops. The tractor operated sprayers are available commercially.
- iv. Adoption of mango, guava, sapota and lime harvesters developed at Indian Institute of Horticultural Research/ CISH Lucknow/MPKVV Rahuri.

4.2 Vegetable Crops :

- i. Adoption of raised bed or ridge cultivation of cauliflower, carrots, tomato and radish.
- ii. Adoption of rotary dibbler cum seeder for seeding nursery portrays.
- iii. Adoption of drip line cum plastic mulch layer for vegetable crops.
- iv. Adoption of raised bed former cum transplanter developed at Indian Institute of Horticultural Research for transplanting chilli, cauliflower and tomato. The commercially available transplanter (CIAE / PAU design) can also be adopted.
- v. Use of ridger or raised bed weeder, developed at Indian Institute of Horticultural Research, Bangalore for weeding of chilli and cauliflower.
- vi. Adoption of tractor operated boom sprayer for spraying of vegetable crops, sown on ridges or raised bed.
- vii. Use of tractor operated automatic planters (vertical belt with cups) for sowing of potato.

4.3 Spices :

- i. Adoption of tractor operated seed cum fertilizer drill for sowing coriander and fenugreek.
- ii. Adoption of raised bed former cum transplanter/ potato planter for planting of turmeric and ginger. The semi automatic potato planter, available commercially can also be adopted.

Adoption of tractor front mounted reaper for harvesting fenugreek and coriander.

CHAPTER IX : RISK MANAGEMENT

Climate change in agriculture has become a reality. Excessive rain, drought, high/low temperature result in moisture stress. While more and more research is required to be conducted on ascertaining the effects of climate change in different horticultural crops and development of management, mitigation strategies efforts need to be directed towards development and cultivation of stress tolerant varieties. Some such crops/varieties have already been developed by IARI. Proper safeguards to manage risk factors likely to be encountered are crucial to achieve optimum productivity of horticultural crops. Being highly perishable, farmers very often face problems related to timely marketing of produce for various post harvest uses at remunerative price. Risks that arise due to natural calamities though unavoidable, their adverse effects on productivity can be reduced. Fluctuations in intensity and time of weather factors related to temperature, rainfall, humidity, wind and hail storm may give rise to outbreak of pests and diseases sometimes leading to epidemics. Different stress conditions resulting from drought, stagnation, salinity, heat and wind storm cause decline in productivity and quality of produce. To minimise the effects of these risk factors, farmers use a variety of indirect strategies such as crop diversification, intercropping, use of drought, pest resistant and short duration varieties, canopy management and use of inputs that provide protection from occurrence and development of pests. However the following strategies are suggested for risk management in horticultural crops in Haryana.

1. Managing Weather related risks

Drastic climatic change on planet Earth owing to global warming has led to wide variations in temperature and rainfall giving rise to flood and drought conditions. Frequency and intensity of drought and wind storms in arid regions of Haryana State is much higher. Therefore, it has become necessary to develop varieties tolerant/ resistant to these stresses. Such stresses have detrimental effects on the growth, productivity and quality of horticultural crops. The following strategies should be adopted to minimise the effect of weather related risk factors:

1.1 Cultivation of abiotic stress tolerant varieties

Certain plant species and ecotypes seem to have a combination of key genes,

quantitative trait loci and molecular networks that mediate plant responses to drought, salinity, heat and other abiotic stresses and thereby adapt to stress conditions. Several varieties of vegetable crops like cabbage, carrot, cauliflower, radish, tomato and turnip suitable for growing under high/low temperature conditions developed at IARI, New Delhi, IHR, Bangalore and IIVR, Varanasi, some varieties developed IARI are listed in Table 26. Haryana State being near the NCR, can successfully take advantage of these varieties. The following additional strategies are suggested:

- i. Emphasis should be laid on studies to identify/develop genotypes that can profitably perform under temperature stress.
- ii. Cultivation of vegetable crops like cowpea, pea and cucurbitaceous vegetables needs to be encouraged in drought prone areas.
- iii. Research should be undertaken on molecular marker development for utilizing genes of interest in marker assisted selection (MAS) procedure for developing multiple biotic stress resistant hybrids.
- iv. Planting wind breaks around ground crops should be encouraged in areas frequented by strong wind storms.

List of some tolerant varieties to abiotic stresses is given in Table 23.

Table 23: List of tolerant vegetable varieties/hybrids

Crop	Variety	Stress
Carrot	Pusa Vrishti	Heat & Humidity
	Pusa Meghali	Heat
Radish	Pusa Chetki	High temperature
	Pusa Himani	Low temperature
Turnip	Pusa Sweti	High temperature & humidity
Tomato	Pusa Sheetal	Low temperature (cold set)
	Pusa Sadabahar	Low & high temperature
	Pusa Hybrid 1	High temperature (hot set)
Cauliflower	Pusa Meghna	High temperature & humidity
	Pusa Kartik Sankar	High temperature & humidity
Cabbage	Pusa Ageti	High temperature

1.2 Use of Drought Tolerant Rootstocks

Rootstock is an important and essential component of fruit production enterprise as it influences the growth, vigour, stature, precocity, productivity and fruit quality of the scion besides imparting resistance to abiotic and biotic stresses. This two way communication between scion and rootstock has been an area of intensive research leading to the development of standard rootstocks for different fruit crops for successful and profitable production. Such rootstocks are already in use for citrus (Troyer citranges and Swingle citrumelo tolerant to Phytophthora, virus and nematodes), grape (Dogridge tolerant to drought and salinity) and mango (13/7 from Israel). But standard rootstocks are still to be developed in most of the subtropical and tropical fruits like mango, sapota, guava, litchi, aonla and ber. Development and use of such rootstocks needs to be encouraged in drought prone areas besides in areas with alkaline/ saline soils. There is need for research using clonally propagated materials of indigenous wild species besides introduction of rootstocks developed elsewhere that may be relevant under Indian conditions.

2. Managing Pest Related Risks

2.1 Pest and Disease Distribution Maps

The whole of Aravalli Hill area in Haryana is infested with aphids, grasshoppers and locust. There is high incidence of white fly and heavy infestation of termites in the area, particularly during post rainy season. The incidences of nematodes, mosaic, Orobanche and Helicoverpa in tomatoes, wilt in guava, and die back in citrus are also observed. In potato, PALCD (Potato Apical Leaf Curl Disease) and late blight are quite prevalent. No systematic information is available regarding the type of pests and the intensity of their incidence in different regions of Haryana on which information should be collected and distribution maps prepared and related to weather conditions in respect of important crop clusters in the State for use to develop strategies to meet such risks.

2.2 Forecasting of pest and disease incidences

Variations in seasonal fluctuations in weather components from normal conditions are often responsible for sporadic outbreaks of certain diseases / pests that otherwise

do not occur normally. Risks from losses to several pests and diseases can be minimised by forecasting their occurrences. This is particularly possible for pests whose appearances are related to change in temperature/ humidity. However, this is possible only by having access to weather data of such regions where such pests appear. There is therefore need to identify these patterns including presence of preferred host plant to be able to predict outbreaks. This calls for establishment of weather stations at appropriate locations in the State to issue warning for the impending attack of any pests considering the interaction between the living organisms the host plant, pathogen/insect and the vectors) through laboratory, greenhouse and field tests for each pathogen / pest and the surveillance data collected from the identified mapped infested areas. Research efforts need to be devoted to devise suitable forecasting models for soil-borne pathogens / pests also. Some Plant Disease Forecasting labs have been set up under the NHM but these are not able to generate plant disease forecast bulletins. These need to be made operational. There is a need to establish agro- meteorological services for weather forecasting and advising farmers to protect crops against diseases, insect pests and frost.

2.3 Growing pest and disease resistant varieties

A number of pest and disease resistant varieties in horticultural crops are available both in open – pollinated (OP) and F1 hybrids of vegetable crops and spices which are listed in Table 24. Varieties resistant to Phomopsis blight, black rot, black leg, downy mildew, TMV, YVMV, bacterial blight, etc. developed at IARI in brinjal, cabbage, cauliflower, chilli, cowpea and okra besides varieties of fenugreek and coriander resistant to Cercospora leaf spot, powdery mildew and stem gall developed by CCS HAU, Hisar.

The State Agricultural Universities should strengthen research to develop pest and disease resistant varieties and cost effective safe control measures utilising effective pesticides and bio-agents. There is urgent need to understand the pathometry and other related intricacies to prevent the outbreak of these at proper time. In case of potato varieties having multiple resistance against late blight and apical leaf disease should be developed to ensure efficient management and enhancing productivity.

Table 24: Vegetable varieties/hybrids resistant/tolerant to diseases

Crop	Variety/hybrid	Disease
Brinjal	Pusa Bhairav	Phomopsis blight
Cabbage	Pusa Mukta	Black rot
	Pusa Drum Head	Black leg
Cauliflower	Pusa Hybrid 2	Downy mildew
	Pusa KT 25	Black rot & Sclerotinia rot
Chilli	Pusa Sadabahar	CMV, TMV & Leaf curl virus
Cowpea	Pusa Komal	Bacterial blight
	Pusa Sukomal	Virus & black leaf spot
Lablab	Pusa Sem 2	Viral diseases, jassids, aphids & fruit borer
	Pusa Sem 3	Viral diseases, jassids, aphids & fruit borer
Okra	Pusa A-4, HBH-143	YVMV, shoot and fruit borer
	Hissar Naveen	
Tomato	Pusa 120	Root-knot nematode
	Pusa Hybrid 2	Root-knot nematode

2.3 Control of Animal Pests

Serious damage to horticultural crops by wild animals particularly blue bulls in areas adjoining forest plantations in Ambala, Gurgaon and Rohtak districts of Haryana has been reported. These animals damage fruit and vegetable gardens by trampling the plants causing huge losses to the farmers. There is, therefore, need for effective control of this menace by restricting their movement only within the forest areas. This can be achieved partially by providing adequate subsidy for fencing to control damage to crops from blue bulls and other wild animals. Developing and implementing a programme to castrate these animals to restrict their population may also be helpful.

3. Managing Risks due to Price Fluctuations

Price fluctuations arise as a result of gluts in production primarily in the produce of daily use crops like potato, onion and tomato. Whether it is a price hike during the event of drought or a price fall during gluts, both are equally harmful to the interests of the farmers. Under such price volatility the farmer has to subsist depending upon

a variety of strategies such as off-farm work, savings or diversification of crops. However, it is necessary to develop a viable strategy to address the risk to the livelihood of farmers. Government policies could include price intervention through direct payments to farmers.

4. Crop Insurance

Crop insurance was started as an instrument of risk management in agriculture in 1972. It became a country wide scheme in 1985. Since then it has been continuously renewed, modified and expanded. It is based on a variety of indices such as weather, biomass or crops. Crop insurance provides insurance coverage and financial support to the farmers in the event of natural calamities and pests and disease attack and is of immense help in providing financial security against losses due to crop failure on account of fire & lightning, storm, cyclone, hailstorm, typhoon, hurricane, tornado, flood, inundation & landslide, drought, dry spells, pests so as to restore their credit worthiness for the subsequent season. This encourages farmers to adopt progressive farming practices and technologies and high value inputs required in horticultural crops. It also helps to stabilise farm income particularly in disaster years.

The National Agricultural Insurance Scheme, as a country wide yield guarantee scheme of the Ministry of Agriculture, is rated as the world's largest crop insurance programme covering over 50 crops and about 25 million farmers annually. The Weather Index Based product is used as an alternative to yield index. Thus GoI scheme provides insurance protection to the farmers against yield and quality losses due to adverse incidences of weather deviations with respect to rainfall, temperature, relative humidity, wind speed, etc. The horticultural crops covered under the scheme are mainly mango and grape. The National Medicinal Plants Board also has been engaged in designing insurance for medicinal and aromatic plants. The insurance programmes in the agriculture sector that provide risk protection in horticulture sector are summarised in Table 25.

Despite constraints, crop insurance needs to be promoted in the larger interest of promoting horticulture industry in the State. Establishment of a weather station network in the State and its modernization would go a long way in this regard. The State Government may take it up on priority so as to implement schemes on

Table 25 Insurance Packages available for horticulture Crops

Type of Insurance	Crops covered				
	Fruits	Vegetables	Flowers	Spices	MAP
Weather based (AIC & private sector companies)	Mango, Kinnow Orange and Pomegranate	Brinjal, Cabbage, Cauliflower and Tomato		Chilli (red), Coriander, Cumin, Fenugreek, Garlic, Ginger and Turmeric	Isabgol
National Agricultural Insurance Scheme Area yield Insurance		Potato		Chilli, Coriander, Cumin, Fenugreek, Ginger and Turmeric	
General Insurance Public Sector Companies	Banana, Citrus (orange, Lime, Sweet lime), Grape, Pomegranate and Sapota				

weather related risks. To achieve this, weather stations are required for every 10 km radius and a rain gauge for every 5 km radius.

CHAPTER X : ALTERNATIVE PRODUCTION SYSTEMS

In recent years, several alternate horticultural systems have emerged and are in practice in several countries of the world. These include protected cultivation, organic farming, conservation agriculture and urban and peri-urban horticulture. The status of such alternate production systems in India and their opportunities and scope for adoption in Haryana has been analysed to sensitise the R&D agencies of the State.

1. Protected Cultivation

Protected cultivation is a technique of growing crops under protected conditions against the vagaries of weather. It has proved to be advantageous in terms of enhancing the productivity and quality of produce and thus offers good returns to the growers. It has been well adapted in Europe and USA, China and Japan are the leading countries besides the Netherlands, Israel, Canada, Spain and Egypt. Protected cultivation is also picking up fast in India.

The low cost, medium cost semi-automated or high cost automated polyhouses can be used depending upon the need besides the plastic low tunnels or shade-net houses. These have several uses such as producing off-season vegetables, flower and vegetable nursery, early crop of vegetables, extending growing season and production in cold regions. Different hi-tech interventions like micro-irrigation, fertigation, soilless culture, automation and intelligent computer programming can also be integrated with this system depending upon requirements.

The choice of crops depends on the size of the greenhouse structure and the economics of production. The high-value low volume flower crops like rose, gerbera, chrysanthemum and carnation, vegetable crops namely tomato, capsicum and cucumber, and fruit crops like strawberry have more scope for cultivation in greenhouses. In addition, multiplying planting material, raising seedlings, and hardening of tissue cultured plants are other advantageous modes of use of greenhouse technology. The potential yield realization under protected cultivation has been reported as high as 1960 q/ha in capsicum, 1300 q/ha in cucumber and 2,500 q/ha in tomato. Thus this production system allows high production from less surface area and resources.

Protected cultivation structures are useful for combating both biotic and abiotic stresses that limits the productivity and quality of horticultural crops. This requires careful planning and attention and details about timing of production as well as harvest to coincide with high market prices. This technology has very good potential especially in peri urban areas around major cities of the country, since it can be profitably used for growing high value vegetable crops like, tomato, cherry tomato, coloured peppers, parthenocarpic cucumber, healthy and virus free seedlings, high value flowers etc.,

All kind of protected technologies may not be economical and suitable to the various groups of farmers in Haryana, because of their very high initial, running and maintenance cost, but some protected technologies are low cost, simple and highly profitable under Haryana conditions, which can be adopted. Some of the technologies like low pressure drip irrigation and low cost nursery raising technology are already practiced in some pockets of the state.

Haryana Govt. has taken a lead in promoting protected cultivation in the State. A Centre of Excellence for Vegetables has been established at Gharaunda, (Karnal) at an estimated cost of 600 lakhs under Indo-Israel agreement. Since inception in 2006, 60 structures have emerged covering over 12,000 m² area in 16 districts of Haryana. The prominent districts identified for this purpose are Punchkula, Panipat, Kaithal, Gurgaon and Sonipat. Besides, 14 Front-line Demonstration Centres for hi-tech vegetable cultivation on farmers' fields have been established under NHM scheme in 14 districts. The requirements of initial high investment and of developing operational skills are the two major constraints in wide scale adoption of this technology. Some of the major constraints are listed below;

- Lack of proper knowledge and training of farmers.
- High cost and low subsidy on the infrastructure.
- Varieties and seeds of greenhouse vegetable crops are costly and are sold mostly by private companies.
- Import/ quarantine system is not easy.
- Lack of professional manpower for handling such units.
- Lack of marketing system/ linkages for sale of high-value produce.

In spite of the above constraints, the State has already made considerable progress in promoting the protected cultivation in the State. Some of the major initiatives are

- a. Establishment of Center of Excellence for fruits and vegetables in Sirsa and Gharaunda respectively.
- b. Plug plant production of seedlings in modern nurseries.
- c. Low / walk in tunnels for off season production of vegetable crops
- d. Establishment of packing, branding mechanism and highway shops to market the horticultural produce raised in protected structures.
- e. Increase in subsidy from 50 to 65%
- f. Subsidy on cost of vegetable and flower crop planting material.

Owing to the favourable environment created, the State must capitalise on this technology and increase area under protected cultivation. Potential avenues where the protected cultivation needs to be promoted in the state are summarised hereunder.

1.1. Plug plant production of vegetable seedlings

Most of the Indian farmers raise vegetable seedlings under open field conditions, which is always inferior in quality, as the seedlings are infected with viruses when raised in open during rainy and post rainy season. Raising of vegetable seedlings in plug trays is already commercialized in states like Karnataka, Maharashtra and Andhra Pradesh. Under this system seedlings are raised in multi-celled plastic plug-trays in artificial soil-less media in specially designed greenhouses or other protected structures. A large number of virus free healthy seedlings of different vegetables can be raised in a small area of greenhouse using soil-less media during main season or off season. This enterprise has good prospects to create employment opportunities especially for unemployed agriculture graduates and rural youth. The State must replicate the success models in all the districts.

1.2 Disease and insect free vegetable cultivation

Usually the farmers grow their vegetable crops like tomato, chilli, sweet pepper, okra etc under open fields. But during rainy and post rainy season it is very difficult to

grow these crops successfully due to insects and diseases like leaf curl and yellow vein mosaic and other viruses. The only way to control the viruses and fruit borer is to put a mechanical barrier between the crops and open environment and this is possible with the use of insect proof nets of 40 or 50 mesh in form of net houses or insect proof net over the walk in tunnels. By this way the growers can directly reduce the use of insecticides and can grow virus free crops. These structures can be fabricated with in a cost of Rs.350-400/m². Such structures can be covered with 40-50% shading nets during critical summer months (April – June) and with plastic during critical winter months (Dec- Feb) with transparent plastic under arid and semi-arid climatic conditions. The State must promote such low cost technologies for implementing in all the districts.

1.3 Zero energy naturally ventilated greenhouses for high value vegetable cultivation

Naturally ventilated greenhouses are the protected structures where no heating or cooling devices are installed for climate control. These are simple and medium cost greenhouses which can be erected with in a cost of Rs.650-700 sq. meter and 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. Three successful crops of cucumber can be grown in a naturally ventilated greenhouse in a period of one year. Muskmelon is the second crop, which can be successfully cultivated for its complete off-season availability, which can fetch very high price of the off-season produce in the up markets of NCR.

1.4 Off season vegetable cultivation under Shade net houses

Shade nets are perforated plastic materials used to cut down the solar radiation and prevent scorching or wilting of leaves caused by high temperature from strong sunlight. These nets are available in different shading intensities ranging from 25% to 75%. Leafy vegetables and ornamental greens are recommended to be grown under shade nets whose growth rates are significantly enhanced compared to open grown plants. Black color shade nets are most efficient in reduction of temperature compared to other colors like green, white or silver etc. Mostly leafy vegetables like beet leaf and green coriander are preferred to be grown under shade nets, but it is

also suitable for growing early cauliflower and radish during June to September months. State must focus on such off season cultivation to capture the huge market in Delhi.

1.5. Off season vegetable cultivation under walk in tunnels

The demand for off-season vegetables is increasing day by day in several big and medium sized cities of the country. Walk-in- tunnel technology is a simple and profitable technology for off-season cultivation of cucurbits during the winter season in northern plains of our country. Crops like summer squash can be grown as a complete off-season crop, whereas other cucurbits like muskmelon, round melon, bottle gourd, cucumber, bitter gourd, watermelon are mainly grown during off season. Walk in tunnels are the temporary structures erected by using G.I. pipes and transparent plastic. The ideal size of a walk in tunnel can be of 4.0 m width and 30m length (120m²) and total cost of fabrication may be around Rs.16000-18000/

1.6 Quality seed production of vegetables under protected conditions.

Recently there has been a technical shift towards the production of high quality hybrid seed of important high value vegetables under protected conditions. Generally semi-climate controlled greenhouses are only suitable for hybrid seed production of determinate type varieties/hybrids of standard tomato, cherry tomato, sweet pepper and parthenocarpic cucumber varieties, which are suitable for protected cultivation. Seed yield of such crops can be enhanced by 3-4 times compared to their open field cultivation along with high quality of seed through this system. Similarly, zero energy naturally ventilated greenhouses are also equally suitable for hybrid seed production of these high value vegetable crops, where the seed yield is usually 2-3 times more than open fields, but the cost of seed production is only one third (1/3) of the seed produced under semi-climate controlled greenhouse conditions.

Insect proof net houses are the most suitable and low cost protected structures suitable for quality hybrid or seed production of OP varieties in large number of vegetables viz., tomato, sweet pepper, chilli, okra, brinjal and several cucurbitaceous vegetables. Insect proof net houses also provides protection to the seed crops against mild frost conditions. Some other low cost protected structure like

walk in tunnels and plastic low tunnels are used for off season seed production or advancing the season of seed production, particularly in Haryana.

1.7 Recommendations for Promoting Protected Cultivation

- i. Research on protected cultivation should be taken up in collaborative mode by CCS HAU, Hisar, Centre of Excellence in Vegetables (CEV), Gharaunda and other FLD villages to develop package of practices and on identified gaps in different aspects of protected cultivation such as structures, fertigation, development of varieties, low cost fertilizer formulations, IPM and automation.
- ii. Efforts should be made to identify and develop clusters of villages in NCR for protected vegetable and flower cultivation. All the protected cultivation clusters must be mandatorily clubbed with rain water harvesting infrastructure and facilities. A special cluster club of protected cultivation growers may be established to promote scientist and farmer interface. Practical demonstration units at each cluster may be established for ensuring the demonstrations of all low cost protected structures along with the production and pest management strategies.
- iii. Large scale motivation and training to educated unemployed youths in the field of protected cultivation need to be launched in the State. Centre of Excellence in Vegetables (CEV), Gharaunda should have housing/ accommodation facilities for farmers along with a canteen for the trainers and visiting farmers.
- iv. Government support must be extended for self fabrication of temporary low cost structures like insect proof net houses, shade net houses, walk-in-tunnels and plastic low tunnels for production of horticultural crops.
- v. 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. Unfortunately

the reviews of the flagship programmes like NHM and other State programmes are based on the physical targets achieved i.e., number of polyhouses/net houses sanctioned/constructed rather than on the basis of the successful production of the crops under such protected structures. This needs to be reviewed.

- vi. Promotion of large scale mechanization in vegetable and flower cultivation by using raised bed makers, plastic laying machines, plastic low tunnel making machines, pipe bending machines for making walk-in – tunnels, drip lateral laying and binding machines
- vii. Promote use of solar energy for running drip system and up to some extent for running heating and cooling devices of the protected structures to conserve the energy. The Government must promote such initiatives by extending the subsidy for such applications also.

2. Peri Urban Horticulture

It is a practice of growing, processing and marketing of vegetables and ornamental plants in and around peripheries of the city and towns for household consumption as well as for the rapidly growing urban population largely in response to daily demand of consumers within a town, city or metropolis. It makes use of city water and natural resources and wastes for growing crops by intensive methods. The practice is suitable for small to medium size land holders within outskirts of the city for growing annual and some perennial crops. It provides livelihood support by making fresh fruits and vegetables available in urban areas and helps to manage solid wastes. However, the use of domestic sewage contaminated with heavy metals and nitrates for irrigation can lead to food safety problems resulting in amoebic dysentery and methemoglobinemia.

By 2030-2050, in India more than 40-65% of population will be living in urban areas. In this context urban and peri-urban horticulture will have a vital role to play to meet the growing demands of fruits, vegetables, flowers and mushroom. Recognising this need, the Government of India launched an initiative on urban and peri-urban vegetable production during the last year of the XI Plan. Emphasis on

peri urban horticulture has now become a necessity around several towns that are expanding at a fast rate.

A number of varieties of exotic vegetables like lettuce (Great Lakes, Chinese Yellow Slobolt, Iceberg), broccoli (Pusa Broccoli,1 Packman, Palam Samridhi, Palam Vichitra), sweet corn (VL-42, MEH-114, Gold Cup, Silver Queen) and cherry tomato (Sun Cherry, Cherry Wonder) and dwarf varieties of fruits like mango, guava, papaya, lime and lemon besides strawberry can be grown in the peri-urban areas under intensive system. Some of these that have already become popular should be promoted. Similarly, high-value greens like coriander, mint, sage, onion and garlic leaves, ethnic vegetables, drumstick, etc. can be grown for round the year supply. Quality planting material of mint, tulsi, Aloe vera and stevia should be provided to the farmers along with guidance on cultivation technology and processing by the Government agencies.

Some of the avenues that are promising for promoting peri urban horticulture in Haryana state which need to be encouraged and promoted are summarized hereunder.

- i. Quick growing Fruits : Some quick growing fruit plants which can be the choice for urban peri-urban locations like banana, guava, lemon, berries like raspberry, gooseberry and strawberry need to be promoted.
- ii. Vegetable Soybean-a new nutrient-rich crop : Green soybeans have great role in human diet and health and are easy to digest, high in fiber content, rich in glutamic acid isoflavones which is very effective against prostate cancer. Such potential crops need to be promoted in the State.
- iii. Rain shelter : The cultivation of chrysanthemum, cabbage, cauliflower, broccoli, tomato grown under rain shelter are more sustainable. Rain shelters are long lasting or permanent structures where only the plastic roof and side netting need to be changed every 3-5 years.
- iv. Simple post-harvest technologies : Establish and strengthen the post-harvest technologies such as modified atmospheric packaging (MAP), evaporative cooling storage (ECS), solar drying and fermentation for fruit

and leafy vegetables in the urban and peri urban areas to augment the production.

- v. Home garden technology- for nutrition security : The State must encourage the concept of home/kitchen gardens wherever it is feasible. Models for growing flowers and vegetables that are sufficient for a family need to be developed and promoted.
- vi. School gardens : Encourage the students and staff of public and private schools to utilise the land within the school for growing vegetables, fruits, flowers, medicinal plants for promoting the gardening among the young minds as well as generate nutritious fruits and vegetable that can be integrated with the Government Mid day meal scheme.
- vii. Community gardens : is a single piece of land gardened collectively by a group of people to grow vegetables and other crops. A community garden brings community closer and ensures urban community's food security besides allowing citizens to grow their own food. The State may consider such models under suitable programmes.
- viii. Container/terrace gardens : Lack of space for people living in an apartment, condominium ; can grow vegetables using different containers placed on sidewalks, patios, window boxes, porches or balconies.

Suitable models need to be devised and promoted.

Some of the strategies for promoting urban and peri-urban horticulture are

- Develop State government policy to promote urban and peri-urban horticulture by integrating it in the city plan and supporting strategies to make the best use of city space and water resources for local production.
- Promoting kitchen, terrace and roof top gardening by incentives to women.
- Promoting mushroom cultivation, Hi-tech nurseries, production of plug plants, pot plants and cut-flower and protected cultivation in the vicinity of upcoming town and cities on massive scale

- Develop crop production technologies and training programme on this aspect.
- Initiatives on use of waste water only after treatment for irrigating crops.
- Educating the community to promote horticulture as an integral part of urban life by organizing training programmes.
- Investment in cold storage facilities and distribution of infrastructure would result in price stabilization for both producers and consumers. Utilize the potential of processing and value addition in the peri-urban areas.

3. Conservation Agriculture

Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations. CA holds tremendous potential for all sizes of farms and agro-ecological systems, but its adoption is perhaps most urgently required by smallholder farmers, especially those facing acute labour shortages. It is a way to combine profitable agricultural production with environmental concerns and sustainability and it has been proven to work in a variety of agroecological zones and farming systems. It is been perceived by practitioners as a valid tool for Sustainable Land Management (SLM). CA can only work optimally if the different technical areas are considered simultaneously in an integrated way.

Conservation Agriculture (CA) is a resource-saving concept in production system that strives to achieve satisfactory profits through high and sustained production levels while concurrently conserving the environment. It is based on enhancing natural biological processes above and below the ground. Interventions such as soil tillage are reduced to an absolute minimum, and the use of external inputs of agrochemicals and nutrients of mineral or organic origin are kept at an optimum level in quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by minimum mechanical soil disturbance, permanent organic soil cover and diversified crop rotations in the case of annual crops or plant associations in case of perennial crops, which are linked to each other.

Conservation Agriculture advocates the following three strategies :

3.1 Direct seeding or planting

Direct seeding involves growing crops without mechanical seedbed preparation and with minimal soil disturbance since the harvest of the previous crop. The term direct seeding is understood in CA systems as synonymous with no-till farming, zero tillage, no-tillage, direct drilling, etc. Planting refers to the precise placing of large seeds; whereas seeding usually refers to a continuous flow of seeds. The equipment penetrates the soil cover, opens a seeding slot and places the seed into that slot. The size of the seed slot and the associated movement of soil are to be kept at the absolute minimum possible. Ideally the seed slot is completely covered by mulch again after seeding and no loose soil should be visible on the surface.

3.2 Permanent soil cover

A permanent soil cover is important to: protect the soil against the deleterious effects of exposure to rain and sun; to provide the micro and macro organisms in the soil with a constant supply of "food"; and alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots.

Keeping the soil covered is a fundamental principle of CA. Crop residues are left on the soil surface, but cover crops may be needed if the gap is too long between harvesting one crop and establishing the next. Cover crops improve the stability of the CA system, not only on the improvement of soil properties but also for their capacity to promote an increased biodiversity in the agro-ecosystem.

While commercial crops have a market value, cover crops are mainly grown for their effect on soil fertility or as livestock fodder. In regions where smaller amounts of biomass are produced, such as semi-arid regions or areas of eroded and degraded soils, cover crops are beneficial as they:

- Protect the soil during fallow periods.
- Mobilize and recycle nutrients.
- Improve the soil structure and break compacted layers and hard pans.
- Permit a rotation in a monoculture.

- Can be used to control weeds and pests.

Cover crops are grown during fallow periods, between harvest and planting of commercial crops, utilizing the residual soil moisture. Their growth is interrupted either before the next crop is sown, or after sowing the next crop, but before competition between the two crops starts. Cover crops energize crop production, but they also present some challenges.

3.3 Crop rotation

The rotation of crops is not only necessary to offer a diverse "diet" to the soil micro organisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients.

Conservation agriculture strives to fulfil the following benefits.

- Provide and maintain an optimum environment of the root-zone to maximum possible depth. Roots are able to function effectively and without restrictions to capture high amounts of plant nutrients and water.
- Ensure that water enters the soil so that (a) plants never, or for the shortest time possible, suffer water stress that will limit the expression of their potential growth; and so that (b) residual water passes down to groundwater and stream flow, not over the surface as runoff.
- Favour beneficial biological activity in the soil in order to (a) maintain and rebuild soil architecture; (b) compete with potential in-soil pathogens; (c) contribute to soil organic matter and various grades of humus; (d) contribute to capture, retention, chelation and slow release of plant nutrients.
- Avoid physical or chemical damage to roots that disrupts their effective functioning.

Large number of policy intervention and financial support issues would be required for timely delivery of location specific packages of conservation agriculture to help the farmers of Haryana.

- Adoption of a new way of thinking as far as weed management, crop

production and livestock / cropping interactions are concerned. Promote in situ rainwater conservation instead of water harvesting. Encourage pressurised system of irrigation for use of low quality water. Promote use of mulching for water conservation.

- The university must standardise the direct seeding technology wherever relevant and workout the strategy for continuous green cover on the fields. It should standardise suitable crop rotation schedules in all the districts to harness the potential of the CA.
- Reduce incentives from tillage machinery that enhances soil degradation and compaction. Promote CA storages in identified clusters. Encourage farmers to buy quality machines from nearby retail outlets. Encourage ITIs and Cooperatives to set up service centres for agricultural implements in each block.

4. Organic Farming

Organic Farming is mainstreaming in the country faster than expected. The factors attracting public and private attention include; one -- increasing prospects of organic agribusiness trade because of increasing demand for safe food; two -- an approach to sustainable development of farming based rural livelihoods in marginal areas and for small farmers. The first factor dominates the organic priorities of the developed world and the second factor dominates organic farming priorities of the developing world. Even though India is a late starter but during the past few years organic as farming and agribusiness option has spread across the country. From the view point of commodities, India today produces range of organic products from fruits and vegetables, spices to food grains, pulses, milk and organic cotton. In addition Indian produce also includes wild harvest of medicinal, aromatic and dye plants. Some of these are organically cultivated and exported.

Organic farming production system totally avoids the use of synthetic fertilizers, pesticides, growth regulators, etc. and relies heavily on animal manures and on farm production of biomass by cultivation of legumes or green manure crops. Organic foods are becoming popular both in domestic and overseas market.

The Ministry of Commerce, GoI has setup National Standards for Organic Production and defined the system of Certification and Accreditation in April, 2001 under National Programme for Organic Production (NPOP). Hence, farmers must be encouraged to follow organic farming of high value crops such as baby corn, speciality vegetables, annual fruit crops like strawberry, mushrooms, honey production and several spices and MAPs. Haryana farmers can benefit from this production system as the State is ideally located close to all kinds of communication networks and niche markets.

The use of organic farming is regarded as the best solution to restore our natural resources, and to safeguard our environment. It is a holistic production management system, which promotes and enhances agro eco-system health including bio-diversity, biological cycles and soil biological activities. The farming system emphasizes upon management practices wherein agronomic, biological and mechanical methods are used for sustainable production avoiding the use of synthetic materials. With increasing health consciousness and concern for environment, organic farming system has been drawing attention all over the world. As a result, there is widespread organic movement. Demand for organic products, especially in developed countries, has been increasing by leaps and bounds. Besides, it is also an alternative for safe agriculture with assured returns.

The farmers in Haryana are already cultivating brinjal, cauliflower, garlic, onion, cucurbits, peas and tomato organically. The total area under organic cultivation is 10,180 ha including 650 ha in Mewat and Jind districts 600 ha in Rohtak district. Under NHM 30-40% assistance is being provided to the individual farmer. The programme is successfully under operation in 15 districts most of which have IC-I certification status. The service providing agencies are providing training at both block and district levels. It has been observed that there is low production in the first two years which stabilizes in the third year. Marketing of the produce is assisted by organizations like Dhani Suphalam, Sirsa, ITSL, New Delhi, Gulab Fruit and Vegetable Society, Sonipat, ICCOA, Bengaluru, Kisan Welfare Club, Barota, KV BioScience India, Hyderabad, IPL, New Delhi The quality consciousness amongst the consumers is picking up very fast in India, especially in the big cities and metros. Therefore, popularisation of organic farming to a reasonable extent for a few focus

crop having demand is justified.

- i. Constraints : The major constraints faced by the organic producers are;
- Organic farming requires exclusive organic facilities separate from the conventional farm facility from nursery to harvesting and storage along with on farm production of majority inputs. This requires proper sensitisation of farmers.
 - Non-availability of organic manures, green manure, vermi-compost and bio-fertilisers in sufficient quantities.
 - Non-availability of suitable package of practices for different crops for organic farming.
 - High cost of certification and poor institutional support.
 - Poor market access and lack of premium price realization of produce in the domestic market.

Strategies for Promoting of Organic Cultivation

- Target crops need to be identified and emphasis should be given on fruits like aonla, guava, Kinnow, etc.
- Identification of selected pockets for organic cultivation of roses especially fragrant varieties like Rose Sherbet for preparing value-added products like Gulkand.
- Popularise accreditation and certification agencies located in clusters of 2-3 districts.
- There is need to provide appropriate incentives to the farmers for conserving environmental resources.
- Subsidy should be given to farmers during conversion period prior to certification
- Farmers need training and financial support to prepare quality organic manure using gobar gas units, solar energy and bio-pesticides, organic manures, green manure, vermi-compost and bio-fertilizers to encourage

IPM/INM and nutrient management.

- Strengthening research on different aspects of organic farming and INM.
- Creating awareness about organic produce through radio and TV programmes.
- Proper policy, incentives need to be put in place for carbon trading in case of farmers who adopt organic farming and CA practices.

The Farmer's field schools should be organised to acquaint them with identification of important pest and diseases and for their effective control measures.

Section - III
Post Harvest Management



CHAPTER XI : POST-HARVEST MANAGEMENT

Losses of agricultural produce occur after harvest owing to their inefficient handling and transportation. These are considerably large (10-40%) in case of the perishable horticultural produce. Thus although the area and production of fruits and vegetables has increased manifold, there is considerable gap between their gross production and net availability to the consumer. Quality of a sizable produce deteriorates by the time it reaches the market consumers, which adversely affects the competitiveness in the market and the profits earned by farmers. Mechanical damage during handling and transport results in bruising, cracking and cuts which predisposes the produce to microbial spoilage. Physiological changes caused by respiration and ethylene liberation or changes in pigments, organic acids and flavour during ripening may lead to undesirable quality. Efficient management of the produce during harvest, grading, packaging, transport, storage and marketing can prevent these losses. There are also constraints of poor infrastructure and involvement of too many middlemen in the market. At present, post-harvest management of horticultural produce in the country is far from satisfactory. Strategies aimed at reducing post-harvest losses right from farmers` field until the produce reaches the end users have to be worked out and put in place to achieve our national goal of food and nutritional security. Several post harvest management technologies that have been developed by different ICAR, CSIR institutes and State Agricultural Universities can be effectively utilised in addressing postharvest problems. The strategy to be followed during the period between harvesting and marketing is discussed.

1. Maturity Standards

Horticultural crops should be harvested at their appropriate stage of maturity, failing which the produce is likely to have poor colour, flavour, poor quality and low keeping quality or storage life. Harvesting at the right stage leads to enhanced shelf life, ensures sensory quality, regulates harvesting and packaging operations, minimizes losses and maximizes profits. Although, it is difficult to decide the appropriate stage of harvesting for a particular crop, the following maturity indices Table 26 can be considered for crops grown in Haryana.

Table No 26. Maturity indices for some horticultural crops grown in Haryana

Crop	Maturity index	Crop	Maturity index
Fruit Crops		Vegetable Crops	
Aonla	Change in fruit colour from green to yellow green or reddish green	Pepper	30-40 days after fruit set
Ber	Change in colour from green to light yellow	Onion	One week after leaf fall
Guava	Specific gravity between 0.8 to 0.9 0.9 and TSS between 10° to 15° brix	Brinjal	15-20 days after fruit set
Kinnow	TSS : acid ratio = 14.1:1	Cucumber	15-20 days after anthesis
Mango	Specific gravity between 1.01-1.02; Change of peel colour from green to light yellow or red; fullness of cheek.	Tomato	Local markets : pink/light red state fruits, distant markets : colour break stage
Pomegranate	TSS: acid ratio: 55-60:1	Okra	6th day after anthesis
Sapota	Arrest of latex flow; potato colour of fruit surface; change in pulp colour towards orange red.	Peas	When pods are filled, green and turgid.
Strawberry	For distant markets: 3/4th red coloured fruits Local markets : fully red fruits	Gourds	8-10 days after fruit set
Flowers			
Gladiolus	When 1-2 florets start opening	Potato	When halms start drying.
Rose	When 1-2 buds start opening	Radish	Indian: 40-45 days after sowing Japanese : 55-60 days after sowing

2. Harvesting

Fruit harvesting at proper stage of maturity has direct effect on quality and market value of the produce. Stage of harvesting influences the post-harvest enzymatic activities of horticultural produce, which determine the levels of different pigments, sugars, acids, flavours and vitamins. Different crops require different methods of harvesting and proper handling. To ensure better after-harvest quality of produce, farmers must observe the following basic rules.

Harvesting at proper stage of maturity and suitable method during the coolest part of the day; early morning or late afternoon. Do not harvest produce when it is wet from dew or rain. Protect harvested produce in the field by keeping it under shed when transport is not immediately available. Pre-cool the produce immediately after harvest if facility is available with the farmers for refrigerated transport/refrigerated storage.

2.1 Use of Harvesting Tools and Gadgets

Care in harvesting and handling is necessary to preserve subsequent quality of horticultural produce. Rough handling at the farm directly affects market quality. Lack of knowledge in harvesting and handling technique results in a substantial waste of horticultural produce. At present aonla, ber, jamun are harvested by shaking the trees and fruits falling on the ground are collected. Mango, citrus, pomegranate, bael, sapota and acid lime are individually hand plucked after giving twists. These methods damage the fruits which thus become prone to post-harvest losses. The fruits of citrus, pomegranate and sapota should be harvested by cutting by a scissors, secateurs retaining a small fruit stalk (0.5 cm). Use of simple gadgets/techniques while harvesting can reduce the damage considerably. Some of the simple gadget for harvesting are listed below:

- Use of decapper developed for mango by CISH, Lucknow.
- Use of fruit pickers attached with net bag developed for mango, ber by IHR, Bangalore, IARI, New Delhi, and CISH, Lucknow.
- Onion/potato diggers, planters developed by CPRI, Shimla and CIAE, Bhopal can be promoted among the growers.
- Use of tripod ladder, clippers, flexible fruit harvesting PVC pipes developed by CIPHET, Ludhiana and CIAE, Bhopal are useful for farmers and need to be popularised.
- Use of plastic crates while harvesting, collection and transportation needs to be popularized further.

2.2 Use of Pre-Harvest Chemicals

Auxins, gibberellins, cytokinins, ethylene, growth retardants and inhibitors, abscisic acid are commonly used for regulation of various physiological processes so as to increase production and enhance post-harvest life of horticultural produce which is mentioned as follows.

- Pre-harvest application of GA₃ at mature stage delays ripening and improves storage life in mango and guava and also improves colour in citrus.
- Pre-harvest sprays of 0.6% calcium chloride 10-12 days prior to harvest improves shelf- life and reduces physiological losses in weight in grape and ber.
- Application of 2,4-D @ 20 ppm may be gainfully utilized for reducing fruit drop in Kinnow, Malta, Sweet Orange and Lime.
- Foliar application of urea (10%) may be practiced to control unwanted rainy season crop of guava.

Table No 27. Plant growth regulators/chemicals and their effective use

Growth regulator	Crop	Concentration (ppm)	Application time	Remarks
NAA	Guava	400	2 weeks after fruit set	Effective in avoiding rainy season crop
Ethephon	Pear	150-200	1½-2 months after fruit set	Improves fruit set and yield
2, 4-D	Citrus	20	During the month of June	Reduces fruit drop
Urea	Gauva and Pomegranate	10%	Full bloom stage	Effective in avoiding rainy season crop
CaCl ₂	Ber, Guava, Grapes, Kinnow	0.6 % to harvest	10-12 days prior	Improves shelf life
Ga ₃	Pear	15-20	20-25 days after full bloom	Improves fruit set and yield

2.1 Handling and Transport

Handling and transport are important components which come right after harvesting. Multi-hand handling of fresh produce is the main cause of qualitative and quantitative deterioration. Furthermore, there is non-availability of adequate and efficient equipment and machinery to be used in the production catchment areas. Mostly the handling and transportation is done by tractor trollies/trucks which make produce vulnerable to speedy loss either by physical, biological or pathological means. There is lack of technical knowhow at farmers' level regarding handling and transportation techniques. This component requires adequate attention in order to strengthen post-harvest value-chain right from field itself. Some of the basic tips which can be practised by the growers are:

- Adoption of plastic crates / bins in entire handling chain, by farmers , wholesalers, and retailers at field and market levels.
- Use of vegetable washing machines at farmers` level and promotion of mechanised sorting, grading and washing at production catchment area and marketing site.
- Use of appropriate packaging material, viz. punnets for strawberry and mushrooms; individual skin wrapping in citrus, tray-packaging for okra, tomato, mushroom, cut vegetables and fruits.
- CFB boxes for guava, Kinnow, pomegranate and mango.
- Use of refrigerated vans containers for long-distance transportation of fruits, vegetables and flowers.

2.2 Curing

Curing is required to be performed immediately after harvest in root, tuber and bulb crops, in which the produce is exposed to relatively high temperature and Relative Humidity. In root and tuber crops, curing causes wound healing with the development and suberization of new epidermal tissue, which acts as an effective barrier against infection and water loss. In bulb crops, curing is the process of drying of neck tissues and of the outer leaves to form dry scales. Onion and garlic can be cured in the field. After harvesting and neck cutting, onions and garlic should be

cured heaped and covered with jute bags and thatches until the temperature reaches upto 30-35°C. To reduce storage losses in onion and garlic, the following recommendations may be followed:

Popularize produce handling protocol, i.e., curing, neck cutting, sorting, grading, and packaging developed by NHRDF. Generally 5-10 days of field curing with 10 days shade curing of onion and garlic bulbs along with neck cutting by leaving 2.5 cm is recommended.

2.3 Post-harvest Management

In India, fruits like mangoes and bananas are ripened artificially by using calcium carbide, which is a dangerous practice as it is highly carcinogenic. Technologies are now available to artificially ripen some fruits with the use of chemicals, e.g., ethrel (500 ppm). Banana ripening chambers and ethylene generation systems should be established nearby production/ marketing sites for artificial ripening of such fruits. Post-harvest losses are at present considerably large and can be reduced by simple treatments like sprays of Ca salts and growth regulators that slow down the ripening process. The harvested fruits, if scanned to detect presence of fruit fly particularly in mango and guava followed by sorting out the affected ones can reduce post-harvest losses and improve their market price and thus returns of the growers.

a. Use of CIPC in Potato

Sugar development takes place when potatoes are stored at 0-4°C temperature. This becomes a negative quality parameter for both processing industries as well as for the table purpose. However, this problem could be avoided by storing potatoes at 10°C. But at this temperature potato tubers undergo severe sprouting leading to their poor marketability. CIPC is reported as a potential sprout inhibitor. This chemical is widely used both in India and abroad under different commercial names and formulations. Pre-storage application of Chlorpropham 18.0 g.a.i/ tonne has proved effective in maintaining tuber firmness, checking sprouting, sugar formation, rotting and weight loss of potato tubers. The state government should facilitate availability of this chemical to curb potato, onion and garlic sprouting problem.

b. Degreening

Some special treatment like degreening designed to improve the eating quality of fruit need popularization. This process is applicable to citrus fruits especially light green colour on half of the surface which can be degreened completely in 48 hrs at 26-30°C with ethylene gas. Degreening unit with one tonne fruit holding capacity has been developed at NRCC, Nagpur. This technique could be popularized in Haryana.

c. Waxing

Surface coating of fruits or vegetables with food grade edible wax emulsions is a common post-harvest practice followed after removal from the cold storage. Food grade waxes are used to replace some of the natural waxes removed during harvesting and sorting operations and can help for reducing water loss during handling, storage and retail marketing. It also helps in sealing tiny injuries and scratches on surface of fruits and vegetables. It improves their cosmetic appearance and prolongs the storage life. The commercial available waxes are Citrashine, Stafresh, Sta-fresh 451, Semper fresh, Carnuba wax and Bee wax. These waxes can be gainfully utilized in commercial waxing of crops like Kinnow and Guava. Among the vegetables tomato, brinjal, capsicum and cucurbits can also be waxed for improving storage life.

d. Vapour heat treatment (VHT)

VHT is very effective in controlling infestation of fruit flies in fruits after harvest. The temperature and exposure time are adjusted to kill all stages of insects (egg, larva, pupa and adult), ensuring that the fruit is not damaged. A recommended treatment for guava, mangoes and papaya is 43°C in saturated air for 8 hours and then holding the temperature for further 6 hours. VHT is mandatory for export of mangoes to Japan and America. This technology may be adopted in the production catchment area of mango and guava. Highly specialised machinery for VHT are presently not available in India but could be imported.

2.4 Handling

a. Grading

Although sorting and grading are very important unit operations for appropriate post harvest management of horticultural produce, yet it is seldom being used in commercial operation in India barring a few recently established supply chains. Small size of holdings through influence of a large number of middlemen between harvesting and retailing and lack of awareness on the concept of pack house operations are the major impediments in popularization of these technologies. However, through Government and Cooperative's initiative, some organised grading facilities could be set up where farmers can get their produce graded on custom hire basis. Mechanical grading for citrus in Punjab (Kinnow) is being undertaken at packaging centers installed with mechanical graders. Grading and sorting of Kinnow over the mechanized line is undertaken at several waxing and grading units installed by Punjab Agro in various Kinnow growing belts, where Kinnow fruits are graded and sorted on custom hire basis. The Haryana government has also created similar facilities for Kinnow and which need to be extended to other fruit clusters.

b. Packaging

Packaging fresh fruits and vegetables is one of the important steps in the long and complicated journey from grower to consumer. Proper packaging of a product can reduce not only bruising due to impact/ compression, but can also facilitate marketing, reduce moisture loss, prevent microbial contamination, reduce pilferage and maintain suitable environment during marketing. Most farmers in the state either are ignorant or not convinced to adopt existing standardized packaging technologies developed for various fruits and vegetables. In view of this, the farmers need to be trained in some selected fruit and vegetable growing clusters about different packaging material and packing methods. A lot of standard packaging of commercially important fruits and vegetables are available with NHB, APEDA, IIP and in the market which could be adopted commercially. Some packaging practices in use include:

Shrink wrapping of individual fruits : Tomato, potato, onion, mango, kinnow, sweet corn and cauliflower. Technology of individual shrink wrapping of packaging in non-woven netlon bags, plastic punnet trap etc. could be highly beneficial.

Packaging in mesh bags : Onion, Potato, Sweet corn, Ber.

Rigid plastic punnets and trays : Strawberry, Mushroom, Baby corn and cut vegetables.

2.5 Storage

High field temperatures at harvest are detrimental to the keeping quality of horticultural produce, thus reducing physiological and biochemical changes. Fruits like mango, grape, and vegetables like pea and okra which deteriorate fast need pre-cooling treatment. There are several methods of cooling, namely, forced air cooling, vacuum cooling, hydro cooling, package icing and top icing. There is need to establish pre-cooling units and a cold chain for storage and transportation of fruits & vegetables. This needs to be tried and adopted.

a. Low cost Storage

Erratic power supply of electricity, rising energy costs resulting in mounting maintenance expenditure has been impeding the growth of cold storage industry. Efforts have been made to partially substitute the sophisticated high cost energy efficient evaporative cooling system for short term storage of fruits and vegetables.

b. Seed Potato Stores

Cool dry rooms are essential for seed potatoes kept on floor or on bamboo racks with proper ventilation. CPRI, Shimla has developed (9.1 x 4.6 x 3.7) m of a cool store of brick masonry structure which is helpful in increasing storage life of potato.

c. Onion Stores

NHRDF has developed a low cost storage structure for onion. A structure of 4.8 x 1.5 x 1.2 m size with side walls of bamboo splits raised from the ground level by about 20 cm, with a capacity of 40 quintals with proper bottom ventilation is recommended. This structure may be popularized in onion and garlic-growing clusters of Haryana.

d. Zero Energy Cool Chambers

For short term storage of fresh fruits and vegetables, zero energy cool chamber has been developed by IARI, based on evaporative cooling. During summer when outside temperature goes beyond 48°C, the temperature inside the cool chamber can be maintained around 25-28°C with 90-95% RH. This chamber is very useful during summer months and could be utilized for short-term storage of freshly harvested fruits and vegetables except onion and garlic.

e. Cold storage

Cold storage in India has been largely adopted for long-term storage of potatoes, onions and high value crops like apple, grape and flowers. The existing cold storages were designed and developed for the storage of some selected commodities which need storage temperature between 3-8°C coupled with 80-90% RH. Practically Table 28. Recommended Temperature & RH for high cost-long term storage of horticultural produce

Commodity	Temperature°C	RH%	Storage Life
Fruits			
Ber	6-8	90-95	5 weeks
Grapes	0-0.5	90-95	6-8 weeks
Guava	5-13	90	2-3 weeks
Kinnow	5	90-95	3-4 weeks
Litchi	1-2	90-95	3-5 weeks
Mango	10-13	85-90	2-3 weeks
Pomegranate	5-8	90-95	12-13 weeks
Strawberries	0-4	90-95	Upto 1 week
Vegetables			
Beans	4-7	95	25-40 weeks
Carrots	0-2	95-98	30-35 weeks
Cauliflower	0-1	95-98	3-4 weeks
Cucumber	10-12	95	Upto 2 weeks
Okra	7-10	90-95	1 week
Onion	0-2	65-70	8-25 weeks
Potato	4-5	95-98	3-4 weeks
Radish	0-2	95-98	3-4 weeks
Mushrooms	0-2	95-95	3-4 days

these cold storages are utilized to store diverse crop groups requiring a temperature range between 0-15°C (Table 28). However, this practice is undesirable and does not yield desirable results. Therefore, there is an urgent need to develop multipurpose cold storage facilities focusing on all fruits and vegetables.

a. Storage compatibility grouping of fruits and vegetables

The state has 107 cold stores that cater primarily to vegetables and onions. The total capacity of these stores is more than 64,000 MT. Various fruits and vegetables have different respiration, ethylene liberation and aroma production traits. Similarly, they are also not alike in their sensitivity to chilling injury, ethylene injury and storage humidity requirements. Most of the producers generally ignore this basic requirement of individual commodity and store them together inside the cold chamber. This undesirable practice leads to faster deterioration of physical appearance, internal quality and overall acceptability of the produce. According to sensitivity towards ethylene, chilling injury, moisture and temperature requirements, fruits and vegetables could be grouped into five major groups.

Table No 29. Storage compatibility groups of fruits and vegetables

Group	Temperature	Relative Humidity	Crops
Group-I (Sensitive to ethylene)	0-2°C	95-100%	Asparagus, Broccoli, Cabbage, Carrots, Cauliflower, Sweet Corn, Leafy Vegetables, Peas
Group -II (Sensitive to Moisture)	0-2°C	65-75%	Garlic, Onions
Group-III (Sensitive to Chilling injury)	4-5°C Potatoes	90-95%	Lemons, Mandarin, Oranges,
Group-IV (Sensitive to Chilling injury)	10°C	85-95%	Beans, Cucumber, Brinjal, Okra, Capsicums
Group-V (Sensitive to Chilling injury)	13-15°C	85-90%	Banana, Sapota, Grapefruit, Guava, Lemons, Limes, Mangoes, Watermelon, Papaya, Pumpkin, Tomato

Farmers need to be trained on storage aspects to ensure proper storage of their produce according to their requirements of temperature and humidity.

CHAPTER XII : VALUE ADDITION OF HORTICULTURE CROPS

Despite huge production of horticultural crops, only about 2% of the total production is processed. A considerable amount of fruits and vegetables produced are lost due to improper post harvest management and lack of appropriate processing technologies. Out of the total production of about 150 million tonnes of fruits and vegetables in the country, only 1 million tonne value added processed products are produced. About 30% of the produce worth several crores of rupees is wasted every year.

Value addition for a product can be aimed at economic gain, time and money saving in preparation, quantity and quality improvement or any other processes that lead to enhanced return of investment of harvested produce. With increased incomes, urbanization and changing eating habits, the demand for processed foods has increased manifold.

About 60 per cent of the consumers live in the rural sector. As a result the processed food is transported back to where it was produced at much higher prices and after incurring substantial losses. Had the produce been processed in the production catchment, the consumers would have accessed the processed food there at lower prices, post harvest losses would have been avoided and more employment would have been created in the rural areas. Rural folk can play an important role in post harvest management right from harvesting and can salvage a large part of the loss. It will also help in higher availability of this dietary material, which comes under protective foods at lesser cost and improve the nutritional status of vast population of our country. If the rural women and younger generation are trained in some of the simple and low cost, energy efficient techniques for proper management and value addition of fresh fruits and vegetables at farm level, it will help in reduction of losses, fetching better returns to the growers making produce available at reasonable price to the consumers and create rural employment base.

1. Status of processing Industry

Less than 2 per cent of fruits and vegetables produced are processed in India as against 65 per cent in the US, 70 per cent in Brazil, 78 per cent in the Philippines, 80 per cent in South Africa and 83 per cent in Malaysia. The Ministry of Food

Processing Industry has drawn up a 'Vision 2015' for the processing industry entailing an expenditure of Rs 1,00,000 crore.

In Haryana, ber, aonla, guava, citrus, mango and litchi are leading fruit crops accounting for over 66% of the area under fruit and over 62% of the total fruit production. The main vegetables grown in Haryana include potatoes, cauliflower, cucurbits, carrots, tomatoes, radish and onions. These constitute over 61% of the total area and over 67% of production of vegetables in the state. The main spices grown are garlic, fenugreek, coriander and turmeric while the major flowers grown are marigold, rose, tuberose and gladiolus.

The integrated strategy for processing should include

- i Cluster based and demand-driven farming for processing.
- ii Integration of food processing infrastructure from farm to market and
- iii Promoting a dynamic food processing industry that could result in high growth of the processed food sector

This can be achieved by augmenting the level of processing of perishables from 6 to 20 per cent, value addition from 20 to 35 per cent and share in global trade from 1.5 to 3.0 per cent by 2015. Advances in processing technologies of perishable crops will help to curb the post harvest losses and result in giving a boost to the food processing industry to accomplish the goals of 'Vision 2015'.

In Haryana, there are 29 fruit and vegetable processing centres at present. Major processing centres for horticulture produce are enlisted in the Table 30.

2. Technologies developed

Most of the fruits and vegetables produced in India are still consumed fresh except for small quantity used for the manufacture of various products such as pickles, tomato ketchup, jams, dried and fried potato, raw banana and fruit drinks. With changing dietary pattern, demand of fresh and processed fruits and vegetables in domestic market has increased. To meet the challenge, fruit and vegetable production has increased manifold in the last few decades. The production of frozen peas, garlic and ginger paste, tomato puree, mango pulp etc. has been taken up in a

Table 30: Horticulture Produce Based Processing Industries in Haryana

District	No.	Products
Ambala	2	Fruit and vegetable products
Bhiwani	1	Guar gum
Gurgaon	4	Barley malt extraction, mushrooms
Panchkula	1	Aloevera gel, health products
Panipat	5	Pickles, jams, sauces, murabba
Kaithal	1	Pickles
Rewari	4	Pickles, barley malt
Rohtak	3	Pickles, jam, sauces
Sonipat	8	RTE vegetables, curries, pickle, mushrooms
Total	29	

big way only recently in India. Some of the popular processed or value added products in the country are dried onions and garlic powder, ginger and garlic paste, jams of mixed fruits, juice and concentrates of orange and litchi, squashes of litchi, canned beans, frozen beans, cauliflower and okra; pickles of mango, lime, chillies

Table 31: Existing and newer products from fruits

S.No.	Fruits	Existing Products	New Products
i.	Aonla	Preserve, pickle	Juice and concentrate, osmo-dried segments, powder, salted segment preserve
ii.	Bael	Pulp	Preserve, canned, frozen slab, powder, RTS beverage
iii	Citrus	Canned slices, pickle, squash, extraction of citric acid, essential oil from peels	Limonene extraction, flavours, pectin
iv	Grape	Raisins, juice, wine	Canned grapes, concentrate
v	Guava	Jelly, juice, nectar	Pulp, concentrate, bars, powder
vi	Kinnow	Blended juice	Debittered juice, concentrates
vii	Litchi	Juice, squash, canned	Wine, juice concentrate, instant quick freezing, litchi nuts
viii	Mango (Green)	Pickle, chutney, dried slices, powder	Drink, juice concentrate
ix	Mango (Ripe)	Canned slices, pulp, juices, nectar jam, bar	Frozen slice, mango powder, concentrate, wine, vinegar, Instant Quick Freezing(slices)
x	Papaya (Raw)	Tutti-fruity	Papain/pectin, Instant Quick Freezing, candy

and mixed fruits and vegetables; tomato ketchup and puree; mango fruit drink and nectar, chilli sauce, mango chutney etc. In addition to offering higher returns, value added products can open new markets, create recognition for a farm and expand the market season. The processing centres in the state of Haryana can explore the possibility of the processing line to develop newer products in fruits and vegetable as listed in Table 31 & 32.

Table 32. Processed products from vegetables

S.No.	Vegetables	Existing Products	Newer Products
i	Bittergourd	Dehydrated	Juice, powder
ii	Carrot	Juices, dehydrated	Colour extraction, osmotically dried shreds
iii	Cauliflower	Dehydrated	Minimally processed, frozen
iv	Chilli	Chutneys, pickle, dehydrated	Puree, essential oil
v	Cucumber,	Slices, whole in brine solution	Pickled
vi	Mushroom	Canned, dehydrated, ketchup, pickle	Phytochemicals, freshcut
vii	Okra	Minimally processed, dehydrated	Coated
viii	Onion, garlic	Dehydrated, paste	Ready-to-use gravy base
ix	Shelled beans and peas	In brine, frozen, canned	Protein isolates
x	Tomato	Juice, puree/concentrate	Ready-to-use gravy base, lycopene extraction

The value added products from flowers include dry flowers and pot pourri, essential oils, flavours and fragrances, pharmaceutical and nutraceutical products, pigments and natural dyes, gulkand, rose water,

It is recommended to use suitable processing varieties wherever available for particular type of processed fruit and vegetable product to maintain uniformity in quality. Hisar Lalit ,Hisar Surkha and Apple Color guava varieties are best for nectar and RTS preparation. Tomato varieties like Pusa Gaurav, Pusa Uphar and Pusa Hybrid 2 are suitable for sauce,ketchup and chutney preparation. Arkel and Pusa Pragati pea cultivars are ideal for frozen and canned products.

3. Farmer centric public private partnership

During last decade's public sector institutions have enormously contributed to

research and development of Indian agriculture, while private sector has played a significant role in translating the research into products for farmers' use. Despite all this development, farmers have been working in isolation and did not get fair share of these development. In context of Haryana, this theme becomes more relevant as a good number of Agro-industries are already existing in processing sector. Firms like Pachranga pickles and Food Pvt.ltd and MDH Masale Pvt.ltd are doing commodity specific domestic and overseas business .These firms may be persuaded for having commodity specific buy-back linkages with the farmers. Proper placement of products in the departmental stores, super markets, shopping malls etc. backed-up by publicity is the key to success. It is also possible to have tie-up with exclusive restaurants, star hotels, renowned caterers etc. for regular supplies. Govt. can act as facilitator for entering into future agreements and for negotiating terms of benefit sharing. Necessary changes in the contract farming modules in the APMC Act with respect to policy of Haryana Govt. May be framed.

2. Future strategies

The horticulture industry has major contribution for improving food security, enhancing rural employment, alleviating poverty and export-promotion. Increased urbanization, improved standards of living, and the convenience needs of dual income families poised to major market potentialities in the food processing and marketing sectors.

The main issues to be addressed are minimizing of post harvest handling losses, value addition, by-product utilization and promotion of export through public-private partnership. Our ultimate aim should be convergence of technologies and emergence of products or processes, by interfacing and networking of various stakeholders.

The country has made rapid strides in production of a variety of products through different technologies as under.

- i. The production of conventional products from fruits and vegetables such as juices, nectars, squashes, cocktailed beverages, carbonated beverages, preserves, candies, pickles, sauce, jams, and marmalades continues to be in limelight. If prepared of good quality and with food safety attributes, these

can find ways in the organised sector. Large production base in Aonla, guava can be used for this purpose.

- ii. There has been lot of emphasis on conventional dehydration and recently solar dehydration due to abundance of sunshine and advances in technology. The country is exporting significant quantities of dehydrated potato and white onion. There is potential for dehydration and sale of many more vegetables.
- iii. There have been major inroads in aseptically packed juices and other liquid products.
- iv. Last few years have been successful in marketing of a number of thermally processed fruits and vegetables such as vegetable curries/ pastes, fruit purees.
- v. Minimum processing of fruits and vegetables commodities has also become popular over the years. Marketing of pre-cut fruits and vegetables processed and packaged this way for sale is a major development of the last decade. The State may promote such initiatives to capture the lucrative markets in the vicinity.
- vi. Frozen foods have become popular in urban localities in case of number of seasonal fruits and vegetables e.g. strawberry, green peas, cauliflower, beans, sweet corn, diced potato salads, stuffing, garnishing and have adequate shelf life when refrigerated.
- vii. A number of minimally processed fruits and vegetables such as mango, banana, potato, cauliflower, carrot, beet root, cabbage, ridge gourd and pumpkin have been developed by Defence Food Research Laboratory, Mysore. These have a shelf life of 7-14 days at room temperature and 6-7 weeks under refrigerated condition. Besides processing the catering industry offers a great opportunity for entrepreneurship in the food processing sector.
- viii. Another newly emerging area is the area of health foods as fruits and vegetables are considered to play a significant and important role in human

nutrition by producing not only essential nutrients but also other bioactive compounds for health promotion and disease prevention. Some important crops which can be exploited are mango, strawberry, pomegranate, jamun, aonla, ber, bael among fruits and carrot, tomato, broccoli, radish, cactus, peas, turmeric among vegetables and spices. Horticulture Division IARI has also developed some products and technologies based on black carrot, jamun, chilli and pomegranate.

The following recommendations are made to promote the processing of horticulture commodities in Haryana.

- i. There is paucity of value addition and processing units for horticulture crops in the state. While the state has some good agro industries mostly in and around cities, rural based small scale industries are required for processing of surplus produce. This will not only help in reducing post harvest losses but also benefit farmers considerably.
- ii. In view of the cluster approach in area expansion, need based primary processing facilities or processing factories should be located around such clusters. Hence emphasis is required on creation of multipurpose low cost rural based agro-processing complexes / parks in identified clusters.
- iii. Suitable processing varieties, wherever available need to be introduced in the State.
- iv. The existing industry like Panchranga Pickles Food Pvt. Ltd. and MDH Masalae Pvt. Ltd. may be approached to have commodity specific buyback linkages with farmers.

Training in primary processing may be imparted around different horticulture crop clusters in Haryana state. There is good scope of ready to serve food, dehydrated fruits and vegetables industry in Haryana due to its location.

CHAPTER XIII : MARKETING & EXPORT

Horticulture crop marketing though is as important as production it is the weakest link in the producer-consumer chain in the entire country. It is characterized by a long supply chain consisting of too many (607) intermediaries. Good Agricultural Practices (GAP) are not followed by farmers. There is also inadequate knowledge about quality standards and packing requirements for domestic and export market. This results in produce of poor quality, deterioration and value loss. As a result, the primary producers receive only 20-25% of the consumer price. Producers also get less share in profits and low income due to inadequate infrastructure unorganized marketing inefficient operation and transaction costs resulting in exploitation by commission agents. Very few mandies exist for horticultural crops with grading, packing and storage facilities supported by market intelligence.

Lack of proper infrastructure practices procuring information rules and regulations are thus responsible for inconvenience harassment and poor returns especially in case of perishable horticulture commodities. The marketing system thus needs to be more strong and efficient in the interest of development of horticulture.

1. Implementation of APMC Act - As a consequence of recommendation by many committees/ Task force on marketing the Dept. of Agriculture and cooperation, Ministry of Agriculture recommended a Model APMC Act during 2003 for adoption.

It has several provisions like

- Establishment of private markets/ yards/ consumer/ farmer markets for direct sales
- Promotion of Public/ private partnerships in the development and management of markets and constitution of special markets for horticulture commodities like fruits, vegetables, flowers, onion etc.
- Legislation to regulate and promote contract farming arrangements in the country.

While several states have amended and notified this act, the Haryana state has only partially amended the act and allowed Contract Farming. The act has also been

withdrawn after initial notification by states like Bihar. While there has been notification of reforms in many key areas in states like Andhra Pradesh, Gujrat and Karnataka, there is need for revision and promotion of Model APMC Act by allowing establishment of private, co-operative markets as well as permission of direct sales by farmers/ producers of horticulture commodities.

2. Establishment of Modern Terminal Markets – This concept has been introduced under the National Horticulture Mission to be implemented in PPP mode for establishing a main market and collection centres by private entrepreneurs. There is a provision of equity participation by a Producer Association up to 26% of the total equity. The scheme is reform linked and can be implemented by states who have amended APMC Act. Such markets are required to ensure direct procurement from producers and lower prices for the final consumers. While the private sector is expected to catalyse bringing in the required investment and management skills for development of such markets, the scheme does not seem to have received a response from private sector. Haryana state however proposes to develop a national market at Ganaur near Sonipat.

3. Contract farming : Contract Farming which is a partnership between a company and a farmer is designed to overcome raw material supply constraints. As a result it confers benefits to both producers and purchasers i.e. assured remuneration and marketing opportunities to the farmer of produce of desired quality at a predetermined price. Many well known corporate like M/S Pepsi Foods Pvt. Ltd., Tata, Rallies, Mahindra Shub Labh, Kargill India have been working in partnership with farmers and providing them with R&D, extension support, timely vital processing and marketing avenues, thus strengthening the contractual relationship. The focus is on enhanced productivity, reducing cost of cultivation, reduced marketing transactions risks, assured price and elimination of wastage resulting in enhanced farm income. Some of the important crops which have been in vogue in different parts are onion, gherkin, papaya, sweet corn, chillies which has been successful.

However, several constraints have also been reported by the farmers in the system by way of

- Delay in payment, lifting produce, high cost of inputs, buyers manipulating grabs and delay in access to seeds.

Further contract farming is considered a partnership among unequal as it empowers the farmer to exploit the small farmers through manipulation in terms and condition of the contract. However, experience has shown that there has been increase in income to farmers from participation in contract farming.

4. New marketing initiatives – Several new initiatives have been undertaken both in public and private sector which in marketing of perishable commodities serve as successful models for adoption with certain modifications to suit the local conditions. These are detailed below:
 - a. HOPCOM (Karnataka) – It is a government organization established by Government of Karnataka in 1959. It secures its supplies of fruits and vegetables from about 1500 farmer members through its collection centres which act as outlet for delivering of inputs and services to them. HOPCOM fixes prices at 10-15% higher than the prevailing market prices in the whole sale market. Farmers realize 70-75% of the consumers price. The organization markets more than 500 tonnes of vegetable every day through 504 retail outlets mostly in Bangalore. It owns 5 cold stores and one processing unit.
 - b. Mahagrape (Maharashtra) – This is a successful cooperative model linking horticulture producers to market. Established in 1991, it is an apex organization of 16 grape growers cooperative societies with 2500 members established to improve grape growers access to international markets not possible by individual producers. The organization has been a great success in improving yield quality and export of grapes for India.
 - c. Mother Dairy – Mother Dairy Fruits and Vegetable Ltd. (MDFVL) have promoted informal production associations for sourcing its fruits and vegetable to meet growing demand of consumers in Delhi. Marketing of produce can be encouraged at remuneration prices on the pattern of mother dairy.

- d. ITC Chaupal (Madhya Pradesh) – This is a model promoted by ITC and consists of setting a number of small internet kiosks at village level to provide farmers real time information related to prices, availability of inputs and other matters related to farmers. Extension services are provided on line. The ITC intervention in supply chain has permitted farmers to increase their sales realization by 10-15%. There is potential of testing this concept for selling produce in Haryana.
- e. APPTA (Andhra Pradesh) – It is a modern (unregulated) fruits and vegetable market established in Tamilnadu at Nagercoil which serves as an assembling centre for fruit and vegetables in a radius of 50 km. The infrastructure facilities provided are wholesale shops (131), retail shops (504), covered auction hall, open auction platform storage godowns, precooling and ripening chambers and drying yard. Input shops for seed, fertilizers, pesticides besides public utilities are also provided. The handling capacity of the market is about 3000 MT of fruits and vegetables / day. Market revenue comes from entrance fee, rent and maintenance charges.
- f. Kissan Bazar (Andhra Pradesh) – The Andhra Model of Kissan Bazar i.e. farmers bringing their own produce extended free marketing space travel and transportation for a reasonable. Kissan Bazars are working effectively in some states namely Raita Bazar in Andhra Pradesh, Apni Mandi in Punjab, ITC e chaupal in Madhya Pradesh enable farmers to avoid exploitative practices by traders. These bring consumers and producers in direct contact.
5. Alternate Marketing Structures – Although reforms in APMC laws is a step in the right direction, it is felt that it may not succeed in bringing in the desired results. Haryana is a state of small producers with an average land holding of 1.6 ha. Most of the small and marginal farmers may not be in a position to deal with buyers on an equitable footing. Thus there is need to empower farmers by aggregation. Different organizational structures have been tried in the past e.g. Joint Help Group, Joint Liability Group, Farmers Association and Producer companies. However, to make it a success, there is a need for the Government and financial institutions to

support such farmer organizations through technical, managerial and financial help till they become strong enough to stand by themselves.

- a. Organised Retail Chains – Supply chain management is mainly about the integration of producers with wholesalers, retailers and end consumers. A number of retail chain have tried their hand on sale of fruits and vegetables, but without any impact since these continue to depend on existing channels of marketing. Those which have established backward linkages with farmers for procuring fresh fruit and vegetables have been successful. Farmers do not have to deal with consumers, agents, brokerage which enables them to get better prices. Selling of fresh fruits and vegetables has been witnessing a slow but steady change by its inflow into areas of organized retail.

A number of new domestic and international companies e.g. Bharati Retail Ltd., Birlas, More, Heritage, Food India Ltd., HOPCOM, Mahindra & Mahindra, Shub Labh, Reliance Fresh, Tatas, Rallies India, Thapar, Global Green, Mother Dairy Fruits and Vegetable have recently set up Food chains many of which sell fruits and vegetables. India stands at 4% in organized horticulture trade when compared globally to 56%. Further the Indian Government decided to open FDI in retail has opened up debate about the potential available in this sector for horticulture produce and products. With organized retailing there is probability that marketing infrastructure will be built which will lead to better access to the market. Organized retail does provide some hope provided it is a joint effort of public and private sector to develop an efficient and effective horticulture retail ventures.

Introduce quality standards through retail chain outlets.

Retail chain purchase only good quality fruits and vegetables which results in farmers not finding the market for rejects.

- b. Producer Companies – In recent years a new model in the form of Producer Companies a hybrid between a private sector company and cooperative society has been proposed to link farmers to markets. Its

membership is open only to those who participate in such companies are registered under companies act.

6. Strengthening of marketing intelligence – There is need to strengthen the infrastructure of Market intelligence which is of use in taking decisions with respect to prices, products, places. Price intelligence consists of current price, anticipated price and seasons of higher and lower prices. Product intelligence however, consists of characteristic features of a commodity to get maximum price e.g. stage of maturity/ ripening colour etc. Place intelligence denotes the markets where the commodity gets the maximum price. One market intelligence centre has been funded at CCS HAU Hissar since 2009 under NAIP. Its usefulness needs to be assessed and improved in respect of horticulture commodities.

CHAPTER XIV : MISCELLANEOUS ISSUES

1. Public Private Partnership

A number of PPP models are being adopted in India like Pepsico, Namdhari Seeds, Field Fresh etc., as a result farmer beneficiaries who hitherto barely managed to make the ends meet, are now able to produce more, get fair returns of their produce in the markets and are realising their aspirations for better life.

At Central level, Indian Council of Agricultural Research in pursuit of ultimately bringing farmers away from subsistence further recognises and realizes the need to become more innovative-n-competitive. Since the implementation of ICAR's guidelines, it has entered into 196 PPPs with 119 private organizations for 56 horticultural technologies from its research institutes. With increasing commercialization and market dependence of agriculture, the demand for several agricultural and related services in the village at the door step of the farmers has increased. This step will be beneficial to create rural employment and enhance rural earnings. To develop a supportive and competent service system agri-service/custom having centres run by agri-graduates/ trained farm youth and women should be promoted. Both public and private sectors are required in all necessary sectors:

- Inputs - Fertilizer (trade, regulation, information on best prices)
- Seeds and other inputs (research, supply, regulation)
- Research- Pre-technology
- Prototype technology
- Usable technology
- Extension (includes services)
- Broadly applicable, highly scientific
- Crop management services (curative, preventive, promotive)
- Financial Services (rural credit)- Credit supply
- Produce marketing services.

Haryana state has already developed a policy document on PPP in 2011. In this

document it defines Public Private Partnership broadly as a long term contractual partnership between public and private sector agencies specifically targeted towards financing, designing, implementing and operating infrastructure facilities and services that are traditionally provided by the Government and/ or its entities. It aims that PPPs will take advantage of the strength of the public sector through stable governance, citizen's support and those of private sector by their enhanced operational efficiency, innovative technology, managerial effectiveness so as to deliver higher standard of service to the people with better value for money. In this policy Agriculture sector is also one of the key areas of PPP development.

Public Private Partnership mode will definitely hasten the process of horticultural development in the state of Haryana. Already some PPP projects have started in the state which have yielded good results.

Table 33 : PPP projects in Haryana.

Name of the project	Status	Sector
Pack House cum Cold storage facility at Rohtak and Karnal	Completed	Horticulture
Pack House cum Cold storage facility at Gurgaon Panchkula, Hisar, Narnaul, Jhajjar, Sonipat, Faridabad, Jind, Pehowa and Yamunanagar	Ongoing	Horticulture
Terminal market for fruit and vegetables at Ganaur Dist., Sonipat	Pipeline	Horticulture
iFlora-Haryana Govt. at Panchkula	Proposal	Cut-flower production

PPP has been successfully tried in management of parks and green spaces in many parts of the country particularly in Punjab. All the Municipal Corporations have handed over many parks to the park management committees of the residents. These committees are paid a predetermined amount according to the area of park and are responsible for their regular maintenance. Water and electricity are provided by the corporation. This arrangement has worked very well for most of the areas and the green spaces are in a much better state than before. Private agencies have also been roped in to develop and maintain traffic rotaries and side strips with the agency covering the expenses through advertising rights.

The Government of Tamilnadu initiated a floriculture infrastructure park Tan Flora

in PPP mode where the infrastructure and logistics are developed by TIDCO and private entrepreneurs are invited to operate these green houses for production. Such model may be introduced in Haryana for the promotion of high value vegetable and flowers in the districts which are close to NCR.

To make PPP ventures more effective and win-win situation for all stakeholders, it is required that all the provisions made in the State Policy on PPP are adhered to or modified if the need be for effective operation. It is envisaged that the partnerships are based on common goals of the each partner to achieve objectives of mutual interest and take care of the growth of farmers' incomes through horticulture-led development. The partners should have matching resources; have mutual trust and commitment to serve the farmers of Haryana and not merely for financial gains. Some of the suggestions for Haryana state are listed below;

Recommendations

- The Haryana Govt. should look partnership in different sectors of horticulture like Crop improvement and Biotechnology, planting material production, enhancing NUE/WUE, Precision Horticulture, Post harvest management, Organic production, Landscaping for better carbon sequestration etc.
- Hybrid Seeds Production of varieties developed by the University by the private sector or in PPP/ PFP mode to reduce the cost and enhance availability.
- Government should take initiatives in developing contract farming models under PPP mode high-value vegetables, organic villages, speciality mushrooms,
- Special initiative may be taken in Post Harvest and food processing industry sector for strengthening packaging, value addition and export promotion. Development of Food Parks and Cold chain in different clusters and ensuring liberal financial support by the government agencies and financial institutions to establish marketing chains in all Public Private Partnership model.

2 Database in Horticulture

Authentic or reliable database in Horticulture can be the basis of systematic development of policies and programme both at national and state level covering

area estimate, production, productivity, market arrivals, wholesale prices, exports, value addition, storage etc. At present different agencies involved in compiling databases on horticultural commodities are Directorate General of Commercialization Intelligence and Statistics, Ministry of Commerce, Kolkata; Directorate of Marketing Intelligence, Deptt. of Agriculture and Cooperation, Ministry of Agriculture with market Intelligence Scheme (MIS) component carried out by the National Horticulture Board, Gurgaon which has 35 field offices all over the country which collects wholesale prices and arrival of all commodities. Presently its jurisdiction is spread over 11 fruits, 10 vegetables, flowers (cut and loose), coconut, cashew nut, areca nut and cocoa. Similarly, there are several commodity boards under Ministry of Commerce which also collect data of crops/produce. A pilot Scheme named as Crop Estimation Survey (Fruits and Vegetables) was launched in 1983-84 by the Directorate of Economics and Statistics, DAC, MoA. There are also state level statistics agencies as State Agriculture Statistics Authority (SASA), which compile data for the state. In ICAR, Indian Agricultural Statistics Research Institute, New Delhi also publishes a database in agriculture. At international level, The Food and Agricultural Organizations of the United Nations publish crop statistics and database on all agricultural commodities in its Production Yearbook.

The database in horticulture sector is too complex owing to diversity in crops which range from fruits, vegetables, tuber crops, spices, floriculture crops, plantation crops, medicinal and aromatic crops etc. which further comprise of several crops and varieties. Unlike field crops which are mostly annual in nature, horticultural crops are annual, biennial or perennial. Furthermore, they are cultivated as organized plantations, kitchen garden, road side plantation, with varying gestation periods, multiple pickings, and multiple fruiting seasons (guava, lemon, pomegranate etc.), mixed and intercropping, multi-storeyed cropping, mixed land use etc. Hence, there are lacunae in sampling techniques, estimates, for area and production, productivity etc.

The Haryana State has SASA on Horticulture with focus on crops like mango, guava, grapes, potato, onion and tomato. However, during the compilation of the report, several discrepancies were noted in data available with the state. It is therefore, necessary to take steps to ensure a suitable data collection procedure by

the state to ensure a accurate data base in different categories of crops.

3. Transfer of technology and HRD

Extension has played a key role in promoting scientific and commercial cultivation of agricultural crops. However, the role specificity of Extension system in promotion of horticulture remained limited and needs to be addressed.

Some of the lacunae found in the extension system in India are

- Horticulture extension is extremely weak due to lack of extension professionalism as well as lack of manpower adequately trained in extension science placed in horticultural technology transfer.
- Lack of regular training programs for the field functionaries to keep the abreast of technological advancements.
- Lack of training centers for capacity building of farmers in advanced /modern practices, entrepreneurship development, marketing skills, financial management, quality standards and biosafety measures for export, IPR issues, etc.
- Low budgetary provision for extension of horticultural technology
- Lack of policy and infrastructure support for small farmers and womenfolk in terms of subsidy, credit, market integration, etc hinders the promotion of hi-tech horticulture

In order to overcome the above lacunae the following measures are suggested.

Skill Development

The State must train the manpower in the core areas to meet the future challenges. Skill development in sophisticated production systems, operation of complex packaging sorting machines, operation of efficient cool chain are to be given priority. Therefore, there is a long term need for investment in strengthening, to impart formal technical training programs, practical skill courses through skill development facilities.

Technical Literature

1. There is a mismatch between package of practices recognized by HAU Hisar

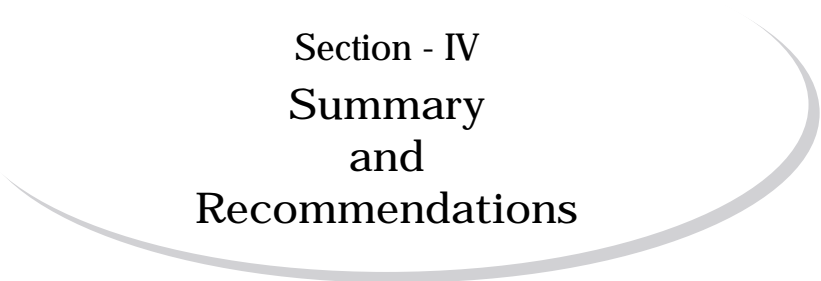
and literature available in the market. It needs to be rectified.

2. Horticulture be taught in schools to create interest and motivate youth to remain in horticulture farming.

Future Training and Manpower needs

- i. The training infrastructure for Horticulture available in state should further be strengthened.
- ii. The state level training institutes should be upgraded to widen the horizon.
- iii. Due to lack of infrastructure and qualified trainers at grass root level the training and other capacity building efforts are found to be inadequate. Hence the private sector (Infrastructure & Consultants), N.G.O.s and Commodity based farmers' organizations, Agri-horti Societies should be involved for training and capacity building, besides the public sector institutions, K.V.K.s etc.
- iv. In order to adopt the emerging technologies, exposure visits of faculty members and farmers to other institutions within and outside India need to be given priority.
- v. There is a need to strengthen extension facilities to train farmers in the field of hi-tech horticulture, identification and better control of pest, diseases and quality seed production of vegetable and planting material of horticultural crops.
- vi. Trained manpower for crop production may be deployed to look after and guide a specific area of 500 to 1000 ha and a demonstration centre should be established in that area which should be maintained by a team of experts.
- vii. Adequate trained manpower for TOT should be provided to the department of Horticulture to take care of the expanding horticulture industry. Strengthening of state horticulture training institute will ensure the availability of crop specialists in required technology areas.

Section - IV
Summary
and
Recommendations



SUMMARY AND RECOMMENDATIONS

Issue 1: Potential of Agricultural Diversification Through Promotion of Horticulture

Haryana State has excellent geographical location with its climate ranging from dry sub humid to arid along North-East and South-West and is ideally suitable for a wide range of horticultural crops. While the State has made significant progress in Agriculture, the swot analysis reveals that the State has lot of strengths for promoting diversification to horticultural crops which has been identified to play an important role in the future growth of economy of the country and State. Already horticulture sector contributes nearly 6% of the total GDP of agriculture in the State and there is considerable scope to improve this production. 2/3rd of the State has assured irrigation and also proximity to NCR with access to a number of national and international markets. The State has good funding support and has created good infrastructure. Further, cultivation of mushrooms, honey production and production of specialty crops like baby corn, cherry tomato, strawberry, protected cultivation of quality vegetables and flowers has already picked up. However, the soil health of the State has been declining. Rising salinity, depleting ground water and declining water quality are some challenges. There is also lack of quality control on seed and planting material. Besides, post harvest management and marketing infrastructure are poor. There is also lack of quality control on seed and planting material. Uncertainty of electricity and labour shortage and damage by wild animals also hamper horticulture development.

Despite the above, Haryana State is fast emerging as one of the leading horticultural States and has made significant progress in this sector in recent years. The present area under horticulture is 4.23 lakh ha which is 6.34% of the total cropped area. It has also scope for further development of horticulture in the State with several programmes under operation. However to further horticulture development programmes have to be farmer driven and developed programme.

Issue 2: Research Infrastructure, Achievements, Constraints and Recommendations

2.1. Research Infrastructure : Research on horticultural crops in Haryana, which is key to increasing productivity, is primarily the responsibility of CCSHAU. Other agencies supporting R&D activities in the State include National Horticulture Research and Development Foundation, IARI Regional station Karnal and 18 KVKs located in the State. Besides these, some research work carried out by universities and Institutes in the neighbouring States i.e. Punjab (PAU, CIPHET), Rajasthan (NRC Seed Spices) and Delhi (IARI) can be usefully adopted for development of horticulture in the State. There is, however, need to strengthen research infrastructure in the State and continue systematic demand driven research.

- a. Manpower : The scientific, technical and supporting staff in various departments involved in horticulture research, teaching and extension is inadequate. This needs to be strengthened keeping in view the increasing demand for horticulture technology and its transfer.
- b. Equipment and Facilities : Most of the equipment in different laboratories is old and obsolete and requires replacement. There is lack of farm machinery like pit diggers, planters etc. There is lack of insect-proof net houses for work on crop improvement and production of nucleus and hybrid seeds in vegetable crops. Some of the research areas on research farms lack suitable roads and fencing. There are inadequate transport facilities for conduct of field trials. Facilities for work on protected cultivation, biotechnology and post harvest management are inadequate. The State may consider easing the above indicated bottlenecks by granting one time grant to strengthen the required infrastructure in Horticulture Departments.
- c. Contingency and HRD : Contingency per scientist is insufficient to carry out effective research. Exposure visits of faculty members to other institutions within and outside India have not been adequate. The State may consider increasing the contingency and encourage exposure visits of university staff outside India to improve their skills.

- d. Setting up of Centre for Excellence on Kinnow : While research on fruit crops is being conducted at Hissar, Buria an Bawal, it is felt that keeping in view the importance of Kinnow in the State economy, a centre of Excellence on Kinnow be developed to address all the problems related to production and post-harvest management of Kinnow.
- e. Establishment of Separate Department of Floriculture, Medicinal and Aromatic Plants – Research and Teaching on Floriculture is now being carried out in the Department of Fruit Crops, while that of Medicinal and Aromatic crops by the Department of Genetics and Plant Breeding. It is recommended that a full-fledged Department of Floriculture, Medicinal and Aromatic crops be set up for systematic and intensive work on these crops.
- f. Establishment of College of Horticulture – Keeping in view the demand for trained manpower in horticulture in the country in general and Haryana in particular, it is recommended to consolidate all horticulture R&D and teaching activities both in Undergraduate and Post graduate level by establishing a College of Horticulture either within the University Campus at Hisar or at an appropriate location.

2.2. Research Priorities : The University has developed a number of varieties in guava, ber, vegetable crops, marigold and spices. Because of which there has also been significant impact production and productivity of these crops. Development of high yielding varieties of coriander, fennel and fenugreek and technologies of their cultivation has resulted in scientific cultivation of these spice crops. R&D work in mushroom covering production technology spawn and organising of training programmes has led the State to a place of pride in mushroom production. However, future efforts should be focussed on demand driven research. The following areas of research need to be given priority to meet the changing needs of the horticultural industry.

- a. Crop Improvement –
 - i. Introduction and evaluation of potential indigenous but less exploited fruit

and vegetable crops.

- ii. Introduction and evaluation of low chilling varieties of pome and stone fruits in northern districts of Haryana.
 - iii. Development of F1 hybrids in vegetable crops and high yielding varieties in spices.
 - iv. Development of varieties for Kharif onion.
 - v. Development of potato varieties resistant to PALCVD and late blight.
 - vi. Evaluation and development of varieties of horticulture crops for changing climate, resistant/tolerant to abiotic and abiotic stress conditions and problem areas.
 - vii. Development of varieties suitable for urban and peri-urban horticulture, off season and all the year round production in vegetables.
- b. Production Technology
- i. Standardisation of high density planting in mango, guava, kinnow, sapota and litchi.
 - ii. Developing of intercropping systems in horticulture crops.
 - iii. Rejuvenation for old senile orchards.
 - iv. Development of leaf analysis based fertiliser recommendations for perennial crops.
 - v. Standardisation of water requirements of various crops at different stages of crop growth through micro irrigation.
 - vi. Standardisation of fertigation schedules for different crops
 - vii. Rootstock research for important tree fruits.
 - viii. Development package of practices for major crops and varieties commercially grown in the State under open cultivation and different species of mushroom like button, oyster and milky besides medicinal and aromatic plants.

- ix. To locate suitable areas for potato seed production to reduce frequency of seed renewal.
- x. Develop protocols for micro propagation in guava, mango and shoot tip grafting in citrus.
- xi. Research on optimisation of seed yield in hybrid varieties.
- xii. Research on protected cultivation should be taken up in collaborative mode by CCS HAU, Hisar, Centre of Excellence in Vegetables (CEV), Gharaunda and other FLD villages to development of varieties, low cost fertilizer formulations, fertigation, IPM, develop package of practices and on identified gaps in different aspects of protected cultivation such as structures and automation.
- c. Plant Protection
 - i. Identify major pest and diseases in different regions. Develop IPM protocols for safe and cost effective control of pests.
 - ii. Develop weather based pest forecasting systems and forecast based pest management strategies.
 - iii. Intensify work on epidemiological problems like malformation (mango), wilt (guava) and decline (citrus).
 - iv. Monitoring of pesticide residues in different horticultural commodities.
- d. Post Harvest Losses
 - i. Standardisation of techniques to reduce post harvest losses in important perishable horticultural crops
 - ii. Storage behaviour of important horticulture crops and varieties commercially grown in Haryana.
 - iii. Market intelligence studies in important horticultural commodities.
 - iv. Screening of crops and varieties for value addition and nutrition.

Issue 3: Development Infrastructure, Achievements, Constraints & Recommendations

3.1. Development Infrastructure

The horticulture development programmes in Haryana are being undertaken by the Directorate of Horticulture which produces and supplies quality planting material through its 25 nurseries besides being responsible for extension services in the field. The Directorate has a clear vision and sound objectives, good budgetary support but inadequate staff with poor qualifications and pay scales. It is implementing a large number of flagship programmes under Central Plan (4), Centrally Sponsored (2) and State Plan (15). The Department has taken a number of far reaching policy initiatives and has created a sound R & D infrastructure. The Directorate has been promoting integrated development of horticulture covering area expansion, establishment of nurseries, creation of water resources, and infrastructure for water management, post harvest management, value addition and transfer of technology. The progress of the Directorate in terms of budget utilization and achieving physical targets has been quite good. As a result it has received the Best State Award for its achievements under NHM. There are however several aspects which require the attention to ensure continued development of horticulture in the State. These are as follows:

- a. Need for Increasing Staff Strength : Even though there has been significant strengthening of staff by the State Govt. after launching of new schemes, well qualified and well trained manpower is required to be provided for implementation of several hi-tech based horticulture development programmes now in operation in the State.
- b. Fund Allocation : There has been significant increase in the fund allocation (670.60 cr after X plan) both by State and central government and a number of useful schemes (21) are under operation in the State. These need to be continued with allocation of adequate funds to allow unfettered development of horticulture in the State.
- c. Implementation of Cluster Development Concept : The State does not seem to have adopted the cluster development concept in its true spirit.

Currently, three clusters of a number of groups of crops are under implementation covering several districts denying full advantages of the concept. There is, therefore a need to rationalize the concept of a cluster. The minimum area of a crop in a cluster and the area spread needs to be clearly defined and followed.

- d. **Planting Material** : While efforts are underway to set up more nurseries and upgrade the present ones, the accreditation process is very slow. Inadequacy in production of plants in some crops and excess production in other requires attention. Much remains to be done as far as the quality of planting material and procurement process is concerned. Detailed recommendations in this respect are given later under Issue 4.
- e. **Bee Keeping for Pollination** : While the policy of promoting bee keeping for promoting honey production is good, preference should be given to supply of bee hives for use in pollination of horticulture crops to promote productivity.
- f. **Water Utilization** : While the initiative of the State in linking area expansion, micro-irrigation and construction of tanks has been quite successful, there is also need to provide micro-irrigation facilities to existing horticulture plantations established prior to NHM. For promotion of micro-irrigation, the area limit needs to be raised from 5-7 ha. Drip irrigation guidelines do not cover closed spaced vegetables and flowers. This requires attention.
- g. **Control of Blue Bull Menace** : Policy decision is required to effectively control the menace of blue bull in horticulture plantations. Adequate subsidy for fencing to control damage to crops from blue bull and other animals needs consideration.
- h. **Mechanization** : Due emphasis needs to be given on mechanization to offset the constraint of non availability of adequate labour.
- i. **Crop Insurance** : Insurance of horticulture crops to safeguard against climate change and other natural hazards needs to be promoted.

- j. Supply of Electricity : Availability of electricity is now a pre-requisite for several hi-tech horticultural operations including micro-propagation, protected cultivation, micro-climate management etc. Currently electric supply for horticulture is available for 4-5 hours in inconvenient splits. The Directorate should try to ensure electricity supply for 8-10 hours at a stretch preferably during day time or at a fixed time at night. Electricity rate for horticulture crop production and mushroom production or any other horticulture based enterprises should be at par with agriculture.
- k. Increase in Subsidy for Medicinal Plants : There is need for parity in the rate of assistance given for promotion of cultivation of medicinal plants under NHM and NHPB. This needs to be rectified.

Issue 4: Planting Material: Status, Constraints & Recommendations

Over a period of time there has been a continuous increase in demand for true to type horticulture planting material due to a number of programmes launched by the Central and State Governments like area expansion and replacement of old and senile orchards. Inadequate availability and non-availability of high quality planting material is one of the major constraints in the development in horticulture. As a result, this has been one of the priority area under NHM which focuses attention on the establishment of new model nurseries, up gradation of existing tissue culture labs,, infrastructure for maintenance of mother stock blocks under polyhouses, raising rootstock seedlings in net houses, hardening and maintenance in insect proof houses, installation of pump houses, sterilization equipment etc., However much needs to be done in this regard. The following steps are recommended to meet the demand of quality planting material in different horticultural crops.

4.1. Fruit Crops

a. Requirement of Planting material

There are 25 government gardens and nurseries being run by the Department with production capacity of 9 lakhs plants per year besides 4.5 lakhs plants/year in the private nurseries. There is a need to critically review the crop wise requirement of plants for the next ten years as per projection of area increase so as to provide need based support.

b. Selective Production of Planting Material

Nursery production needs to be augmented in case of Kinnow and guava plants where there is a short fall and regulated in case of mango, sapota, peach and bael where it is excess. New nurseries should be established in fruit belts to avoid distant transportation. There is a need for advance planning in assessing requirements and placement of indents to source plants.

c. Establishment and Upgradation of Nursery Activity

All nurseries should be encouraged to have modern facilities and follow standard nursery practices using latest propagation technique, recommended rootstocks, raising plants in containers and using sterilised potting mixture. The nurseries should have mother blocks of scion and rootstocks to ensure quality planting material.

d. Emphasis on Disease and Pest Free Planting Material

Technologies available for raising disease free planting material like micro propagation in banana shoot tip grafting and bud wood certification in citrus need to be adopted and promoted.

e. Accreditation of all Nurseries

The pace of accreditation of nurseries in the State is quite slow. All nurseries in public and private sector need be accredited by the National Horticulture Board.

f. Procurement System

Procurement of plant material from unregistered nurseries or through quotations if prevalent should be banned. Procurement of planting material only from registered and accredited nurseries should be made compulsory for eligibility of financial assistance from government to avoid compromise on the quality of planting material.

g. Traceability Record

Traceability Record should be introduced to identify mixtures or contamination during different stages of production and distribution of planting material.

4.2. Vegetable Crops

a. Pure line Selections from Right Source

There are several deficiencies in the production and supply of seeds of pure line selections namely inadequate, unreliable seeds with poor germination and seeds produced without technical help adversely affecting productivity. Procurement of pure line seeds should be promoted only from institutions producing Foundation and Certified seeds.

b. Promote Public Sector Hybrids

While the hybrid seed supplied by private companies is of good quality, it is also beyond reach of small and poor farmers. It is therefore recommended that hybrid seeds of crops released in the public sector organizations may be produced for supply to farmers either by public sector institution or in PPP mode to make it available at cheaper rate. The State department of horticulture should also make arrangements for procurement and supply of adequate seeds of onion and garlic for interested farmers.

c. Vegetable Plug Plant Production

Raising of vegetable nurseries in trays using artificial media under controlled conditions has become quite popular in recent years. Whereas Centre of Excellence in Vegetable Crops at Gharaunda is supplying a large quantity of plug plants to the farmers, more such nurseries are recommended to be established around vegetable clusters of the State.

d. Improving Availability of Certified Potato Seeds

Multiplication schedule of certified potato seed for breeder seed supplied by CPRI, Shimla should be adhered to and suitably monitored. Initiative has been taken to produce potato micro-tubers at the Horticultural Biotechnology Centre, Karnal since 2006-07. While a modest beginning has been made by supplying 52.5 qt. of seed material during 2010-11, the programme needs to be strengthened through technical support.

4.3. Flower Crops

a. Flower Seed Production

Haryana State has enormous potential to produce open pollinated seeds of summer, winter and autumn flowers for domestic and export markets. This should be explored and exploited.

b. Pot Plant Nurseries

Owing to the proximity to the NCR the State has huge potential for production of potted plants. Special incentives may be offered to establish satellite nurseries in villages which are close to the national capital for promoting urban & peri-urban horticulture.

c. Lawn Grass for Turf Industry : The State has a huge potential for growing lawn grass for supplying to the emerging turf grass industry of the country. Selected clusters in the vicinity of NCR may be promoted for growing lawn grass for this purpose.

d. Quarantine Facilities : The State may establish State of the Art quarantine facilities to prevent the entry of crippling diseases and insect pests in the State.

4.4. Spice Crops

The Department of Vegetable Sciences, CCS HAU has been producing and supplying breeder/truthfully labelled seeds (TLS) of improved varieties of coriander, methi, onion, garlic and turmeric to farmers under ICAR seeds project. This activity needs to be strengthened to meet the growing demand in the State.

4.5. Mushrooms

Emphasis needs to be given on timely availability of quality spawn by enforcing spawn standards. There is also scope for supply of spawn cum substrate in urban and peri urban areas to popularise the production of mushrooms.

4.6. Medicinal Aromatic Plants

Five small nurseries for production of planting material of medicinal and aromatic

plants have been established in 2010-11 by the Department of Horticulture. Focus should be given to crops having potential in the State. Some medicinal plants like Mulhati are perennial in nature and require indenting at least 3 years in advance. The Department must plan for such crops well in advance.

Issue 5: Improving Availability of Horticultural Produce

The availability of horticulture produce has to be improved to meet the increasing needs of population resulting from urbanisation, change in food habits and growing emphasis on nutritional security, value addition and export. This growth has to be achieved by area expansion, expanding cultivation of horticulture crops in arid areas, wastelands and intensive cropping systems. The following strategy to achieve area expansion is recommended.

- a. Bringing 10% of cultivated land under horticulture crops – The current area under horticulture crops is estimated at 6.2% of the total cropped area. It is recommended that this may be increased to 10% during the next 10 years. This calls for a growth rate of 0.38% per year. The Directorate of Horticulture has projected a growth rate of 0.24% during the XII Five Year Plan. Efforts may be made to achieve a growth rate of at least 0.32% to enable to achieve the above targets in the next two Five Year Plans.
- b. Identification of new clusters – Dividing the Haryana State into 3 clusters does not justify the concept of cluster approach. This needs review and cluster should focus on a limited area rather than covering several districts of the State. New clusters may be developed in areas which are underutilised, barren and undulating in South Haryana for citrus, guava & ber.
- c. Greening of arid areas – A number of crops have potential for cultivation in arid regions of Haryana. A list of such crops is given in Table 15. Some of these crops merit introduction and evaluation before these can be introduced for commercial cultivation. Short term crops and varieties requiring less irrigation should be selected based on the available seasons and their suitability to endure the dry period efficiently.
- d. Reclamation of wastelands – There is potential of expanding area under

horticulture crops in wastelands and saline areas which occupy 5.3% of geographical area. These marginal areas can be put to productive use by appropriate policy framework followed by suitable adoptive conservation and planting by hardy cultivars suiting different categories of wasteland (salt & moisture stress) and land reclamation practices. A list of potential crops is given in Table 16. Early maturing summer dormant fruit plants should be preferred for extreme environmental conditions and growers should be trained in soil reclamation practices.

e. Emphasis on focus crops – The present focus on different horticulture crops seems to be in order. The following observations are however made:

- i. Area expansion in aonla and ber may be made in relation to their marketing and processing potential.
- ii. There is scope for area expansion under mango, sapota, lime, litchi; strawberry has an excellent market in NCR.
- iii. Area under guava may be expanded under High Density Planting, with soft seeded, red pulped and juicy varieties.
- iv. There is scope for banana & papaya cultivation in areas with assured water & freedom/protection from frost.
- v. Suitable areas may be located for introduction, evaluation and commercial cultivation of Bael, olive, custard apple, jamun, and pomegranate.
- vi. All the major vegetable crops need to be focused, because of proximity to the NCR.
- vii. Area under kharif onion and garlic may be increased.
- viii. Ornamental crops like gladiolus, tuberose and foliage plants could be promoted in a big way.
- ix. More emphasis may be laid on outdoor cultivation of flowers like marigold and potted foliage plants for production of fresh as well as dry flower and extraction of xanthophyll pigment.
- x. Essential oils from rose, tuberose and jasmine have a great scope

- xi. There is scope for production of bulb crops, corms, rhizomes and tubers of rainy and winter season flowering ornamental plants.
 - xii. There is scope of increasing area under coriander, cumin and fennel.
 - xiii. Tulsi, Aloe vera, citronella and mint crops have considerable potential in Haryana State.
 - xiv. Preference may be given to crops which are quick bearing.
 - xv. Haryana is one of the leading producers of mushroom. Emphasis on expanding area coverage under mushroom may be intensified. Besides button & oyster mushroom other speciality mushroom could be promoted.
- f. Promoting Round the Year Vegetable Cultivation – A number of crops namely radish, carrot and cauliflower can now be raised All the Year Round as a result of development of new varieties. This needs to be promoted. A list of suitable varieties, their sowing and harvesting time in different crops is given in Table 17.
- g. Promoting Off Season Crops
- i. Off season production of vegetables which fetches premium price to farmers needs to be promoted. The approach will help in higher price realisation and longer season of availability.
 - ii. Promotion of low cost protected structures already underway needs to be strengthened for vegetable production.
 - iii. Cultivation of photo and thermo insensitive chrysanthemum variety Pusa Anmol that flowers thrice in an year and marigold during summer, winter and rainy season must me be encouraged. Off season cultivation of gladiolus needs to be promoted at higher altitudes.
 - iv. Promotion of off season herbs like green coriander, mint, palak that fetches good premium in the lean season.
- h. Inter and mixed cropping – Intercropping with short duration crops is recommended in widely spaced perennial fruit trees to ensure optimum use of space and increase in production per unit area. A number of possibilities have been detailed in respect of intercropping and mixed cropping of vegetables and flowers in chapter 5.

i. Integrated farming systems - There is a need to develop location specific viable integrated farming system models in Haryana. Since land is limited and majority of farmers in Haryana are small, there is need to promote horticulture based cropping systems to increase availability.

Issue 6: Improving Productivity and Quality : Constraints & Recommendations

The per unit productivity of most crops in Haryana is low compared to the best obtained in other States. The Haryana Government has targeted to improve the productivity of fruits and vegetables from the present level of 13.04 and 13.42 MT/ha (2010-11) to 17.03 and 18.5 MT/ha by the end of XII plan, respectively. This can be achieved by adopting improved package of practices developed in the State or in other parts of the country. The following interventions are recommended.

a. Rejuvenation of existing plantation

In Haryana about 25 to 35 per cent orchards / plantations are senile that need rejuvenation. However, the programme under rejuvenation of orchards needs to be practiced differently under different situations to achieve the targeted results.

- i. Gap filling should be done in young and productive orchards.
 - ii. Trees of old and traditional varieties should be top worked.
 - iii. IPM should be used to rejuvenate plants that are damaged by pests and diseases.
 - iv. Package of practices should be devised for young low productive orchards.
 - v. Old senile and overgrown plants should be removed and replanted.
 - vi. CCS HAU should standardize such schedules jointly with the Directorate of Horticulture, Haryana.
- b. Promotion of high yielding, good quality and disease free varieties
- i. A number of new varieties with high yield potential and better quality have been developed e.g. highly coloured regular bearing, semi dwarf mango, soft seeded and pink fleshed guava, early bearing and crack tolerant litchi,

sapota and pomegranate by various research centres. Many of these are yet to be introduced and evaluated for their commercial potential in Haryana. This should be taken up both by CCS HAU and Directorate of Horticulture.

- ii. In vegetable crops several disease resistant / tolerant varieties are available in brinjal, cabbage, capsicum, cauliflower, cowpea, chilli, okra, onion, French bean, pea, tomato, musk melon / watermelon. They need to be tested and promoted in areas with severe incidence of these diseases.
- iii. A list of recommended varieties in different horticultural crop should be jointly prepared by the State in consultation with the CCS HAU to guide farmers and simultaneously meeting the planting material/ seed requirements for the same.

c. Pollination Enhancement Through Bee-keeping

Fruit set and production has been shown to increase by 15-30% if honey bee hives are kept in orchards, which also gives additional income . This aspect needs to be intensified.

d. High Density Planting (HDP)

Decline in the availability of cultivable land has necessitated adoption of High Density Planting (HDP) in perennial tree fruits. It is not only easily manageable but lends early and higher yields of better quality /unit area. The technology is especially useful for small and marginal farmers. While a good beginning has been made under NHM, the following recommendations are made to achieve maximum benefit from this technology.

- i. As a matter of policy all new plantations in mango, guava, Kinnow in the State should be established under HDP. This would enhance productivity considerably.
- ii. Till definite recommendations from R&D organizations are available for spacing to be followed in respect of different fruits and varieties too close spacing (2.5x2.5m) in mango should be avoided and moderate spacing (e.g5x5m) adopted.

- iii. Meadow orcharding in guava has been successfully adopted in Maharashtra & Andhra Pradesh. This needs to be promoted in Haryana.
- iv. Use should be made of dwarfing rootstocks/ scion wherever available besides manipulation of canopy through training systems, pruning practices and use of growth retardants.
- v. Canopy management practices need to be standardised in different crops & varieties and specific recommendations given.
- e. Nutrient management
 - i. There is need to avoid excessive and indiscriminate use of fertilisers in commercial horticulture crops and improve fertiliser use efficiency by proper placement of fertilisers.
 - ii. Use of diagnostic tools for nutrient management in horticultural crops is considered important in the use of optimum qualities of fertilizer.
 - iii. Location, crop and variety specific leaf analysis based nutrient guides need to be developed by the university.
 - iv. Micronutrient deficiency based disorders should be identified and suitably managed through the use of multiple micronutrient mixes.
 - v. Practices like green manuring, soil reclamation and organic matter enrichment should be encouraged.
 - vi. Large scale promotion of bio-fertilisers will enhance quality of produce.
 - vii. Fertigation should be promoted where micro irrigation facilities and liquid fertilisers are available.
- f. Use of Chemicals

Recommendations for plant growth regulators/ chemicals which have been found useful for improving productivity through their effect on flower induction, enhancing fruit set, causing thinning, controlling fruit drop or improving fruit quality should be promoted on the basis of information already generated.
- g. Water Management – The policy initiative taken by Directorate of

Haryana though an integrated model linking orchard plantation, micro-irrigation and water ponds has given good dividend. To harness full benefit of this technology the following strategy is recommended.

- i. Systematic research needs to be undertaken to determine the exact quantity of water and placement of drippers in different crops at different stages of their growth.
- ii. Small and marginal farmers should be encouraged to install low cost zero-energy drip irrigation system.
- iii. In Haryana, 54% of the ground water is brackish, which can be profitably used by micro-irrigation. In highly saline water areas low-cost, desalinization units should be established.
- iv. Micro-irrigation facility which is currently available only for new orchards should be extended to old existing orchards.
- h. Mulching - Mulching also reduces run-off (20-30%), increases penetration of rainwater, controls erosion, corrects the chemical balance of the soil and reduces damage done by pests and diseases, thus increasing the yield (10-30%). Reduces the extent of blossom end rot and infection by soil-borne diseases. Several new mulching materials have been tested and specific recommendations in this regard need to be made by the university in consultation with the Dept. of Horticulture.
 - i. Promotion of IPM effective pests and disease management
 - i. Adoption of IPM technologies should be encouraged thereby gradually reducing the dependence on pesticides.
 - ii. Use of bio-pesticides and bio agents should be promoted depending upon availability.
 - iii. Provision of subsidy for the purchase of bio agents for adoption of bio control is recommended.
- j. Mechanization
 - i. Horticulture is labour intensive and also requires skilled labour. Labour cost

forms a major part of cost of production. Mechanisation/ automation is, therefore, recommended to bring down the cost, reduce drudgery and improve product quality. To achieve this :

- ii. There is need to develop low cost effective suitable tools, implements and machinery.
- iii. Even partial mechanisation of pit digging, weeding, training, pruning and harvesting operations can considerably decrease the cost of management and improve efficiency.
- iv. A list of operations which can be mechanised is given in Chapter 5 report.

Issue 7: Reducing Cost of Cultivation- Strategies

Cost of cultivation of crops has been increasing at a very fast pace primarily because of increase in the cost of various inputs like planting material, fertiliser, pesticides and labour. The high cost of production has negative impact on the domestic and international markets. Hence it is important to ensure that the cost of production is kept at the minimum by economizing on various inputs without sacrificing the produce quality. The following strategy is recommended

- a. Economy in Cost of Planting Material
 - i. The varieties / hybrids produced by public sector are not available in required quantity. These should be popularised and promoted. For this purpose some new public/private sector organizations need to be identified for multiplication of hybrids which match private sector hybrids in their performance with respect to yield, quality, pests and disease resistance.
 - ii. There is need to ensure that the seeds of these hybrids are available at comparatively lower cost to enable small and marginal farmers of the State to take advantage.
 - iii. Emphasis on large scale multiplication and marketing of planting material through suitable organisations in PPP mode is called for.
- b. Economizing cost of Fertilizers

In Haryana, the use of nitrogenous fertilizers has been more than the recommended

ratio of NPK. Also there is imbalance in the use of phosphatic and potassic fertilisers. The following measures are suggested for economizing the cost of fertilisers:

- i. Soil and leaf testing laboratories be established in each district and leaf tissue analysis be used as a diagnostic tool for determining the sufficiency/deficiency levels of different macro and micro-nutrients on which fertiliser needs should be based. Leaf nutrient guides needs to be developed for different crops & their varieties.
 - ii. Biofertilizers/ vermiculture should be used simultaneously to reduce the cost of cultivation and increasing the quality and production. There is need for more research in INM and organic farming
 - iii. Nutrient efficiencies can be improved by their application at right time and amount with proper placements.
 - iv. Proper training to prepare vermi-compost and advisory service for proper guidelines on use of biofertilizers, INM and organic farming technology should be provided to the farmers.
 - v. Fertigation needs to be promoted to reduce the cost.
- c. Economizing cost of pesticides

Indiscriminate use of pesticide causes risk to human and animal health, environmental pollution, pest resistance and presence of high level of pesticide residues in farm gate samples. Its careful use can reduce the cost of cultivation & other risks significantly. The following recommendations are made:

- i. Adoption of IPM technologies in a participatory mode thereby gradually reducing the dependence on chemical pesticides.
- ii. Ensure easy availability of bio-pesticides and bio-agents to promote their use.
- iii. Develop disease resistant hybrids.
- iv. Provide subsidy on purchase of bio-agents and for adoption of bio-control methods.

- v. Creation of cold chain for bio-inoculants.
- d. Economizing cost of Labour by Mechanization

Shortage of skilled labour raises the cost of production. Mechanisation and automation can bring down the required cost on labour besides reducing drudgery and improving product quality. The strategies suggested are:

- i. Developing small machines and tools for helping small and marginal farmers and bringing these under the umbrella of subsidy to improve both the quality and availability.
- ii. Allowing purchase farm implements from any dealer meeting required specifications and quality standards.
- iii. Removing restrictions on the import of farm machinery and proper incentives to be given.
- iv. Regulated MGNREGA programme by stopping its operations during peak sowing and harvesting time to ensure the availability of labour for major agricultural operations.

Issue 8: Risk Management Strategies

Global warming has detrimental effects on the growth, productivity and quality of horticultural crops. Risk to crop production has therefore been increasing progressively due to abiotic and biotic stresses. Damage is also caused by wild animals. Price fluctuations also result in income. The following strategies are recommended for risk management.

- a. Mitigation losses due to climate change and abiotic stress
 - i. Several varieties of vegetable crops like cabbage, carrot, cauliflower, radish, tomato and turnip suitable for growing under abiotic stress conditions of high/low temperature and humidity have been developed and need to be promoted under relevant situation.
 - ii. More research is required on ascertaining the effects of climate change on different horticultural crops and development of risk management, mitigation strategies.

- iii. Efforts need to be directed towards development and cultivation of stress tolerant varieties.
- iv. Use of abiotic stress tolerant, rootstocks can minimise weather related risks.
- b. Forecasting of Pest and Disease incidence
 - i. High incidence of aphids, grasshopper on different crops, locust, whitefly, nematode, mosaic, and wilt has been reported in the State. However, systematic information not available regarding the type of pests and intensity of their incidence in different regions. There is also need to identify presence of a preferred host plant. This information can help in preparation of distribution maps.
 - ii. Risks from losses to several pests and diseases can also be minimized by forecasting their occurrence particularly when related to temperature and humidity. Establishment of agro-metrological services at appropriate locations in the State to establish a Pest and Disease Forecasting Advisory servers is recommended.
 - iii. While some Plant Disease Forecasting Labs have been set up under NHM, these are not able to generate plant disease forecast bulletins. These need to be made operational.
- c. Control of damage by Wild Animals – Wild animals and blue bulls in areas adjoining forest plantations in Ambala, Gurgaon and Rohtak districts of Haryana cause serious damage. There is need for effective control of Blue bull and other wild animals by restricting their movement within the forest area particularly by providing adequate subsidy for fencing to control their damage to crops. There is also a need to develop programmes of castration to restrict the blue bull population.
- d. Growing pest and disease resistant varieties – A no. of pest and disease resistant varieties have been developed by IARI and CCS HAU in vegetable & spice crops. These need to be promoted in high incidence areas.
- e. Managing Risks due to Price Fluctuations – Being highly perishable, fluctuations in prices often affect the producers of commodities adversely.

Government policies could include price intervention through direct payments to farmers.

f. Crop Insurance – While some packages are already available for horticulture crops, there is a need to develop new packages covering all important crops. Crop insurance needs to be promoted in the larger interest of promoting horticulture industry in the State.

Issue 9: Alternative Production Systems: Scope & Recommendations

In recent years, several alternate horticultural systems have emerged and are in practice in India. These include protected cultivation, organic farming, conservation agriculture and urban and peri-urban horticulture. The status of such alternate production systems in India and their opportunities and scope for adoption in Haryana has been analysed to sensitise the R&D agencies of the State.

9.1. Protected Cultivation

a. Establishment of Protected Cultivation Clusters

- i. 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 some subsidy.
- ii. Efforts should be made to identify and develop clusters of villages in NCR for protected vegetable and flower cultivation. Government should promote input hubs for protected cultivation in these clusters for timely availability of inputs.
- iii. All the protected cultivation clusters must be mandatorily clubbed with rain water harvesting infrastructure and facilities.
- iv. A special cluster club of protected cultivation growers may be established to promote scientist and farmer interface.
- v. Suggest most suitable crop sequences for different protected structures and seasons based on research data.

- b. Fabrication & Design
 - i. Government support needs to be extended for self fabrication of temporary low cost structures like insect proof net houses, shade net houses, walk-in-tunnels and plastic low tunnels for production of horticultural crops.
 - ii. Promotion of large scale mechanization in vegetable and flower cultivation by using raised bed makers, plastic laying machines, plastic low tunnel making machines, pipe bending machines for making walk- in – tunnels, drip lateral laying and binding machines.
 - iii. Promote large scale installation of low pressure drip irrigation system for low cost small scale protected cultivation in various parts of the State.
 - iv. Promote use of solar energy for running drip system and up to some extent for running heating and cooling devices of the protected structures to conserve the energy to the extent possible. The Government must promote such initiatives by extending the subsidy for such applications also.
- c. Training
 - i. Centre of Excellence in Vegetables (CEV), Gharaunda should have housing/ accommodation facilities for farmers along with a canteen for the trainers and visiting farmers.
 - ii. Large scale motivation and training to educated unemployed youths in the field of protected cultivation needs to be launched in the State.
 - iii. Practical demonstration units at each cluster may be established for ensuring the demonstrations of all low cost protected structures along with the production and pest management strategies.

9.2. Urban and Peri Urban Horticulture

By 2030-50, more than 40-65% of population of India will be living in urban areas. The following policies and programmes need to be initiated to meet the scenario.

- i. Educating the community to promote horticulture as an integral part of urban life by organizing training programmes.

- ii. The State government developing the policies to promote urban and peri-urban horticulture by integrating it in the city plan and supporting strategies to make the best use of city space resources for local production.
- iii. Need to conduct research to monitor load of microbes and heavy metals in soils, water and environment system in the areas irrigated by sewage water and industrial effluents. Use waste water for irrigating crops only after treatment.
- iv. Promoting kitchen, terrace and roof top gardening by incentives to women.
- v. Promoting mushroom cultivation, Hi-tech nurseries, production of plug plants, pot plants and cut-flower and protected cultivation in the vicinity of upcoming town and cities on massive scale.
- vi. Develop crop production technologies for urban horticulture.

9.3. Organic Farming

Organic foods have become highly remunerative both in domestic and overseas market especially for crops like baby corn, strawberry, mushroom, honey, spices and medicinal and aromatic plants. However, non-availability of suitable package of practices for different crops and lack of exclusive organic facilities separate from the conventional farm facility from nursery to harvesting and storage along with on farm production of majority inputs are the major constraints.

The following strategies are recommended for its promotion:

- i. Strengthening research on different aspects of organic farming.
- ii. Crops with comparative advantage need to be identified.
- iii. Identify selected pockets for organic cultivation of roses especially fragrant varieties like Rose Sherbet for preparing value-added products like Gulkand.
- iv. Farmers need training and financial support to prepare quality organic manure using gobar gas units, solar energy and bio-pesticides, organic manures, green manure, vermi-compost and bio-fertilizers to encourage IPM/INM and nutrient management.

- v. Proper policy, incentives need to be put in place for carbon trading in case of farmers who adopt organic farming and conservation agriculture practices.

9.4. Conservation Agriculture

There is need to adopt practices related to conservation agriculture through: .

- i. Change in crop management system. i.e. management of crop residue and their effective utilization.
- ii. Adoption of new technologies for water conservation and weed management through mulching.
- iii. Strategy should be developed for ensuring continuous green cover through suitable crop rotations in different districts of the State.
- iv. Promotion of in situ rainwater conservation instead of water harvesting. Encourage pressurized system of irrigation for use of low quality water.
- v. There is need to provide appropriate incentives to the farmers for conserving environmental resources.

Issue 10 : Post- harvest management: infrastructure, constraints & strategies

A sizeable proportion of horticulture produce deteriorates by the time it reaches the consumers as a result of harvesting at premature stage, mechanical damage during handling and transport and physiological changes during ripening. There is also constraint of poor infrastructure. A number of strategies can be adopted to reduce post harvest losses.

10.1. Reducing Losses Through Harvesting

Losses up to 10-40% in case of perishable horticultural produce can be reduced by the following strategies:

- a. Maturity Standards at harvesting – Harvesting at appropriate stage of maturity leads to enhanced shelf life, ensures sensory quality, regulates harvesting and packaging operation, minimizes losses and maximizes farm profit. Education is required on these aspects.
- b. Harvesting Practices

- i. Harvesting fruits and vegetables at premature stage affects their colour, flavour quality and storage life. Some guidelines regarding maturity standards are available (Table 26). These need to be refined and promoted.
- ii. Maturity standards in different crops and varieties based on number of days from harvest besides physio-chemical characters need to be established.
- iii. Even when harvested at full maturity, there is need to avoid harvesting during hot part of the day or when the produce is wet.
- iv. Immediate pre-cooling is required for produce requiring cold storage or refrigerated transport.
- v. Use of simple gadgets/techniques like decapper, fruit pickers, onion / potato diggers, plastic crates developed by various institutes can reduce the damage considerably.

10.2. Reducing Losses through Regulation of Physiological Processes

- i. Technologies available for artificially ripening fruits like mango, banana and papaya need to be promoted to avoid use of harmful and carcinogenic chemicals like CaCl₂.
- ii. Use of plant growth regulators chemicals like GA₃, 2,4-D, CaCl₂, MH, Ethephon at recommended dose reduce the post harvest losses.
- iii. Banana ripening chambers and ethylene generation systems should be established at various sites of production and marketing for artificial ripening of such fruits.
- iv. Technique of degreening designed to improve the eating quality of citrus fruits needs to be tried where relevant. Degreening units with one tonne fruit holding capacity developed by NRCC, Nagpur may be utilised for this purpose.
- v. Several commercial waxes available in the market can be gainfully promoted for improving storage life in fruits like kinnow, guava and vegetables like brinjal, tomato, capsicum.

- vi. Proper curing in root, tuber, bulb and medicinal crops reduces losses and improves quality.
- vii. Use of CIPC in Potato, degreening, waxing, VHT reduce losses during storage.
- viii. Vapour Heat Treatment (VHT) which is an effective means of controlling infestation of fruit flies should be promoted in case of fruits like mango and guava intended for newly established retail chains as also for export.

10.3. Reducing Losses during Handling

Lot of care is required in grading, packing and transport operations in perishable commodities. Small size of holdings, large number of middlemen between harvesting and retailing and lack of awareness on the concept of pack house operations are the major impediments in popularization of these technologies. Recommendations are given below:

- i. Grading of produce needs to be promoted and adequate grading for domestic market can be done keeping in view size, colour and maturity. Sorting and grading facilities need to be set up in all major fruit & vegetable market.
- ii. Adequate availability of CFB boxes and plastic crates for packaging and long distance transport should be ensured.
- iii. Mechanized sorting, grading and handling systems need to be introduced.
- iv. Adequate knowledge should be made available to the exporters about quality and packing standards for export in different countries.
- v. A lot of packages are now available and are in commercial use. These should be popularized e.g. shrink wrapping of individual fruits (mango, Kinnow, sweet corn and cauliflower, mesh bags for ber, onion, potato; and rigid plastic punnets and trays (strawberry, mushroom, baby corn and cut vegetables).
- vi. There is need for suitable vehicles for safe transportation of fruits & vegetables including refrigerated containers/vans.

10.4. Reducing losses through storage

A number of storage systems/ structures are in vogue and found successful for different situations. These should be promoted as below.

- i. Low cost storage evaporative cooling system for short term storage of fruits and vegetables needs to be promoted at the identified clusters. Pre-cooling centers need to be established in specific commodity producing areas.
- ii. Cold storages with a temperature range of 0-15°C for strong diverse horticulture commodities should be discouraged. Multipurpose cold storage and pledged storage facilities focussing requirements of different commodities should be encouraged near production catchment areas and large markets to prevent distress sale at normal rates.
- iii. While R&D based recommendations in respect of temperature and RH are available (Table 27), these need to be standardised in respect of commodities and varieties relevant to the State.
- iv. All fruits and vegetables are not alike in their sensitivity towards chilling injury, ethylene injury and storage/ humidity requirements. Farmers' needs to be trained to ensure proper storage of commodities in five compatibility groups as listed in Table 28.

Issue 11 : Value Addition of Horticultural Crops : Status & Opportunities

In recent years, while the consumption of fruits and vegetables has gained increased importance in human diet, there has not been much growth in the agri-processing sector which is still around 2% against 60-80% in US, Brazil, Philippines, South Africa and Malaysia. Important issues in this respect are discussed.

- i. To improve availability of raw material: Cluster based and demand-driven farming needs to be encouraged. New plantations should be made keeping in view the emerging needs of the processing industry.
- ii. Suitable processing varieties, wherever available need to be introduced in the State.
- iii. Necessary changes in the contract farming modules in the APMC Act with

respect to policy of Haryana Government may be framed and PPP models be encouraged.

- iv. While the State has some good agro industries mostly in and around cities, rural based small scale industries are required for primary processing of surplus produce.
- v. Promoting a dynamic food processing industry that could result in high growth of the processed food sector
- vi. This will not only help in reducing post harvest losses but also benefit farmers considerably.
- vii. Emphasis is required on creation of multipurpose low cost rural based agro-processing complexes / parks in identified clusters.
- viii. The existing industry like Panchranga Pickles Food Pvt. Ltd. and MDH Masalae Pvt. Ltd. may be pursued to have commodity specific buyback linkages with farmers.
- ix. Training in primary processing may be imparted around different horticulture crop clusters in Haryana State.

Issue 12: Marketing & Export: Present System and Suggestions for Improvement

Marketing infrastructure for horticulture in Haryana suffers from major constraints prevalent all over the country. The Haryana Agri Marketing Board mainly deals with the marketing of food crops. There is inadequate infrastructure for marketing. The marketing chain from farmer to retails is very important. Marketing of seed spices is a major constraint in the expansion of area under these crops. Currently the APMC Act is also highly rigid. There are too many intermediates and exploitation by commission agents resulting in low farmer income. There is also inadequate knowledge about quality standards and packing requirements both for domestic and export market. There are few specialized markets and existing markets are operating inefficiently. Several innovations have been made in marketing in different States and Haryana need to replicate some successful models. In view of the existing inadequacies urgent reforms are needed in marketing. To be successful, the following reforms are recommended.

- a. Need for relook on APMC Act
 - i. The model APMC Act of GOI provides for a number of provisions in respect of establishment of private markets/yards; consumer/ farmer markets for direct sale, promotion of public private partnership in development and management, constitution of special markets and regulation and promotion of contract farming. The State has notified the act only for contract farming. As marketing of agri produce is a State subject and the FDI is close to being a reality, there is need to relook on the provisions and implement those which are expected to be acceptable and effective. The following recommendations are made:
 - ii. The Act restricts the farmer from entering into direct contract with any processor/ manufacturer/ bulk processor as the produce is required to be routed through regulated markets. There is a need to revisit the present policy.
 - iii. Contract Farming should be encouraged and should be a three party agreement between framer/farmer groups, private group and State agency with well spelt out terms and conditions to avoid exploitation of growers.
 - iv. The State must ensure that enough provisions are built on mutual respect for the contract agreed by all the stakeholders. Provision for stringent action in case of default must be incorporated as a policy.
 - b. Contract farming system
 - i. Contract farming tried in Haryana and resulted in income gains to farmers. Constraints reported are delay in payment, delay in lifting of produce, delay in access to seeds and buyers manipulating quality grades. Contract arrangements made with farmers need to be flexible i.e. less complex and highly transparent with focus on maximizing the farmer's revenue.
 - ii. Success stories available with Pepsico India (tomato, potato, chilli) in Punjab, oil palm in Andhra Pradesh, hybrid seed production contracts by seed companies. While there are chances of opportunities in contract farming when prices are pre-determined, experience shows better success if output

prices are linked to the market situation. The above issues need to be resolved.

c. Create environment for PPP

There is need to create an environment for private sector to develop State of the art infrastructure for post harvest management and marketing to improve service, quality and delivery system at competitive cost to both firms and farmers. To ensure this, there is need for an independent regulation to ensure level playing field between the APMC and the private markets.

d. Provide competitive marketing channels

Many models have been tried in various States eg. NDDDB, Hopcom, Mahagrape, ITC e-choupal, Apni Mandi etc with varying success. While some of the successful models need to be replicated the State Government should develop a sustainable and integrated model which is acceptable to all the stakeholders. Promotion of producer companies is now widely recommended.

Kisan Bazar/ Apni Mandi promoted with logistic support for grading, storage and stay facilities have proved successful.

Development of roadside markets alongside highways can also provide remunerative marketing avenues.

e. Development of special markets

There is need to develop specialized mandis for crops like Kinnow, potato, onion, mushroom, medicinal and aromatic plants and flowers.

f. Development of organized retail chains

Intermediate Contracts and Producer's Organization are an efficient way to aggregate produce of small farmers and empower them to comply with food standards and quality requirements without much transaction costs. Organized retail chains provide some hope provided there are joint efforts of public and private sector to develop an efficient and effective horticulture retail ventures.

g. Strengthening of farmers' self help groups (SHG)

Making the Self Help Groups (SHG's) well equipped and aware of latest markets

including forecasting of prices, on line auctions and market intelligence can help in proper marketing.

h. Strengthening of market information

While market information in respect of some commodities is available in the current information systems e.g. NHB and AGMARKNET depend on the information received from markets based on inputs by brokers which are not real. There is need therefore to develop reliable market intelligence system of important horticultural commodities in Haryana.

i. Promotion of exports

There is scope for promoting export of mango, guava, fresh vegetables, flowers, mushrooms and dry flowers from the State provided these products are prepared as per international standards by following Good Agriculture Practices (GAP) keeping emphasis on quality & safety.

Issue 13: Miscellaneous Issues

There are a number of important issues like Public Private Partnership, Database management, Transfer of Technology and HRD which are equally important in the overall development of horticulture in the State. These issues are discussed hereunder.

13.1 Public Private Partnership

Public Private Partnership mode will definitely hasten the process of horticultural development in the State of Haryana. It is required in areas of inputs, research, extension, credit supply, and marketing.

- i. The Haryana Govt. should look for partnership in different sectors of horticulture like Crop improvement and Biotechnology, planting material, enhancing Nutrient and water use efficiency, Precision Horticulture, Post harvest management, Organic production and Landscaping for better carbon sequestration etc.
- ii. Government should take initiatives in developing contract farming models under PPP mode for high-value vegetables, organic villages, speciality

mushrooms,

- iii. Special initiative is needed in Post Harvest and food processing industry sector for strengthening packaging, value addition and export promotion.
- iv. Development of Food Parks and Cold chain in different clusters need to be initiated in PPP mode.
- v. Ensuring liberal financial support by the government agencies and financial institutions to establish marketing chains in Public Private Partnership model.

13.2. Database

Database system in the country is one of the weakest links in the development of horticulture and Haryana State is no exception. Therefore, there is an urgent need for scientific collection of reliable data on area and production ensure systematic for horticulture development planning in the State..

13.3. Transfer of Technology and HRD

a. Filling up of vacant posts:

The University is facing an acute shortage of manpower in scientific, technical supporting cadres. Similarly the Department also faces severe shortage of extension personnel. It is paramount importance to fill these vacancies to fulfil the emerging challenges. The State has ambitious projects in hand. However until unless adequate manpower is in place to execute the programmes the investment would therefore not yield the expected dividends.

b. Skill development

The State must train its manpower in the core areas to meet the future challenges. Skill development in sophisticated production systems, operation of complex packaging sorting machines, operation of efficient cool chain are to be given priority. There is therefore a long term need for investment in training institutes, schools, technical institutes and universities to impart formal technical training programs, practical skill courses and professional degrees.

c. Technical literature

There is a mismatch between package of practices develop by the university those followed by the State. There is a need to form a co-ordinal committee of staff university & Directorate of Horticulture to ensure better transfer of technology. There is need to teach horticulture in schools to create interest and motivate youth to remain in horticulture farming.

d. Future Training and Manpower needs

- i. In order to adopt the emerging technologies, exposure visits of faculty members to other institutions within and outside India need to be given priority.
- ii. There is a need to strengthen extension facilities to train farmers in the field of hi-tech horticulture, better control of pest & diseases, quality seed production of vegetable and planting material of horticultural crops.
- iii. Progressive farmers should be sent for exposure visits to foreign markets for training on quality standards, proper packaging and marketing intelligence so as to boost export of horticultural produce from Haryana.
- iv. Trained manpower for crop production may be deployed to look after and guide a specific cluster of 500 ha or so and a demonstration centre should be established in that area which should be maintained by a team of experts.
- v. There is an urgent need to train the faculty and the extension personnel on the latest advancements in horticulture sector. The State must focus on imparting advanced training in India and abroad.
- vi. Adequate trained manpower for TOT should be provided to the Department of Horticulture and university to take care of the expanding horticulture industry. Strengthening of State horticulture training institute will ensure the availability of crop specialists in required technology areas.

Details of meetings & visits of working group

S.N.	Date	Place	Purpose
Meetings			
1	Aug.30, 2011	HKA,Camp office Gurgaon	First meeting of working group
2	Dec. 16-17, 2011	HRM Building, CCS HAU, Hisar	Stakeholders workshop on horticulture development
3	May, 28-30, 2012	HKA Building, CCS HAU , Hisar	Meeting of working group Horticulture Development in Haryana for drafting the report
Discussions			
4	March 12-14, 2012	Udyan Bhawan, Punchkula	Discussion meetings of working group with DG Horticulture and staff
5	April 11, 2012	Udyan Bhawan, Punchkula	Discussion meeting of working group with DG Horticulture and senior HDOs Haryana
Field Visits			
6	April 10, 2012	Field visit to Rohtak and Sonipat Districts	Visit to Centre of Excellence, Gharaunda, HTI and Hort. Biotech Centre Karnal and modern mandi and field plantations in & around Rohtak.
Report Presentation			
7	December 6, 2012	NASC Complex, New Delhi	Presentation of Final Report

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