The banyan is great, not because of its trunk, but because of its offshoots.

We take pride in our partners, because it is they who enable us to reach out to rural India.

Sectoral Paper

Plantation and Horticulture
NABARD’s Vision
Development Bank of the Nation for fostering rural prosperity

NABARD’s Mission
Promote sustainable and equitable agriculture and rural development through participative financial and non-financial interventions, innovations, technology and institutional development for securing prosperity.
Sectoral Paper on Plantation and Horticulture

NABARD

Farm Sector Policy Department
National Bank for Agriculture and Rural Development
Mumbai
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India’s horticulture output reached 300.54 million tonnes in 2016-17 (surpassing food grain production of 273.38 million tonnes) cultivated over 25 million ha and is expected to reach 305.43 million tonnes in 2017-18. Gross value of Horticulture production in the country is estimated to be about ₹ 5 lakh crore, with an average value of about ₹ 2 lakh/ha of area under these crops.

Plantation and Horticulture is an important segment in the Indian Agriculture, contributing more than 33% of the agricultural output by value and registering higher annual growth rate (about 7%) than agriculture per se (about 2%). Adoption of progressive technologies such as use of hybrid seeds, micro-irrigation techniques, micro-climate modification, protected cultivation, hydroponics, etc., has led to the increased crop productivity and income per unit area in this sector.

This sector is important from the perspective of doubling of farmers’ income by 2022, as the sector is amenable for adoption by small and marginal farmers by offering agro-climate related crop diversity across the country. Organizing the Horticulture Farmers into Fruit / Vegetable Producers Organizations (FPOs/VPOs) in identified fruit and vegetable clusters in various states shall enable aggregation of produce at village level collection centers and enable their linkage to the pack houses/ processing units, and ultimately to markets with a resultant increase in better margin for farmers.

NABARD believes that the Horticulture and Plantation sector is expected to play a prominent role in the overall economic prosperity of the country in the coming years. This Sectoral Paper on Plantation and Horticulture encompasses subsector-wise status, potential, opportunities & challenges, discussion on the expected impact of climate change and the strategy on adaptation & mitigation measures as suggested by various think-tanks in the country. I hope that this paper will help all stakeholders in harnessing the horticulture potential of our country through appropriate measures including policy interventions, effective delivery mechanisms and credit-supported interventions.

**Foreword**

Dr Harsh Kumar Bhanwala  
Chairman  
National Bank for Agriculture and Rural Development  
Mumbai  
February 2018
Plantation and Horticulture sectors covers a rainbow of crops like fruits, vegetables, spices, flowers, medicinal and aromatic crops, mushrooms, bee keeping and plantation crops like tea, coffee, rubber, coconut, oil palm, etc. Importance of this sector in rural economy is increasing for its diversity, higher productivity, export orientation and intensification of production system, even amongst small and fragmented farmers.

Between 2012 to 2014-15, there has been an increase of 10 per cent in horticulture production compared to an increase of 6 per cent in the production of food grains. Since 2012-13, the production of horticulture has outpaced the production of food grains. Horticulture sector is not only important from economic perspective to farmers but also assumes significance from the nutritional perspective of our population.

Horticulture is poised to play as a key sector for achieving the GoI’s efforts for doubling of farmer’s income by 2022, owing to willingness of growers in adapting technology for increased crop productivity and in effective natural resources management, rapid growth in consumption demand, value chain approach in linking farmers to markets, peri-urbanization of horticulture production systems, amenability for organizing growers of horticultural crops into effective aggregation models like Village Producers Organizations (VPOs), Producer Companies (PCs), etc.

Cultivation of horticulture crops in clusters brings advantages of scales of operations and can spur establishment of entire chain from production to marketing, besides giving recognition to the districts for specific crops. Thus, reorientation of their cultivation through cluster-based development is the focus area of the Government, as announced by the Hon’ble Union Finance Minister in his Budget Speech for 2018-19.
The key challenges that the Horticulture sector face in India are post-harvest losses, availability of quality planting material and lack of market access for the produce of small farmers. The combined wastage (harvest and post-harvest) for horticulture crops between 5 to 15 per cent in the case of fruits and vegetables is very high, compared to the range of 5 to 6 percent in the case of cereals, around 6 to 8 per cent for pulses and 5 to 10 per cent for oilseeds (CIPHET, 2015). However, at the same time the horticulture produce is amenable for various levels of value addition viz., grading, standardization, storage, retail packing and processing. Significant investments are required for setting up backward and forward infrastructure, viz. collection/aggregation centers, cold stores, pack houses, refrigerated transportation, etc. The attractive capital grant provided by the GoI through the Ministry of Food Processing Industries with an allocation of ₹ 1650 crore to be utilized by 2020 may be effectively utilized by the existing and potential cold chain logistic players dealing with perishable agri commodities, including the horticulture crops.

The vegetables and fruits segments of the Horticulture sector can be key drivers of agricultural growth and can be further developed by appropriate investments in harvesting, low cost storage facilities and processing technologies along with development of marketing infrastructure.

Besides providing production and investment credit as refinance support to the bankers, NABARD focuses to explore the demand for horticulture credit on a value chain perspective at grassroots level and using Area Development Projects (ADPs) as a platform for bringing bankers, state government and industry for supporting horticulture sector in the country.

I believe that the integrated approach addressing all the chain in the development would be essential to sustain the ‘Golden Revolution’ and provide a foundation for Horticulture-led transformation in the country addressing the issues of employment, nutritional security and environmental concern resulting in poverty alleviation and improved quality of life in Rural India. I compliment the Team C-TAG of Horticulture Discipline for bringing a well-documented sectoral paper on this important component of Indian Agriculture depicting its sub-sectoral analysis of potential and issues.

H.R. Dave  
Deputy Managing Director  
National Bank for Agriculture and Rural Development  
Mumbai  
February 2018
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1. Introduction
1.1 The canvas of Horticulture and Plantation in India is broad-based and multifaceted with fruits, vegetables including onion and potato, ornamentals, medicinal and aromatic plants, spices and condiments, plantation crops and mushroom. Temperate fruits, vegetables, flowers and spices are grown in the North Himalayan region while subtropical and tropical fruits, vegetables, ornamentals, mushroom, spices are cultivated in the rest of India. Spices and plantation crops are found in the peninsular region. Arid zone crops are concentrated in western India.

1.2 India is ranked second, both in fruits and vegetables with regard to the area and production, after China and stands first in the production of Peas and Okra, second in Onion, Brinjal, Cabbage, Cauliflower, Potato and Tomato. It ranks first in the area and production of mango and banana and holds the world record for highest productivity in grapes and over 17 per cent of the world’s coconut production. The country has significant stake in global cashew nut output, processing and kernel trade.

1.3 Horticulture and Plantation sector is widely heralded as sunrise sector that provides the dynamic tool for improving economic conditions of the farmers and entrepreneurs, creating diversification opportunities with high value crops, increasing the productivity of land, providing nutritional security, generating employment, ensuring ecological sustainability and enhancing the export earnings. Analysts are of the view that the emergence of agri-business ventures in India is directly correlated to the progress in the Plantation and Horticulture sector in the country.

1.4 The Twelfth Plan has set a target of 8 per cent growth over the five year period 2012-13 to 2016-17 and this target of accelerating GDP growth is accompanied by a specific target to accelerate growth of agricultural GDP. While agricultural growth registered 3.6 per cent during Eleventh Plan, the Twelfth Plan aims at accelerating agricultural growth further to 4 per cent. The bulk of the acceleration in growth is expected to come from diversification towards Horticulture, Animal Husbandry and Fisheries.

1.5 Government of India has set out to double the farmers’ income by 2022 by addressing the issue of agriculture sustainability in the face of climate change, market and technological developments and the need of effective policy measures to aid the farmers. Horticulture sector with its wide crop diversity suiting to different agro climatic conditions, amenability to be taken up by small and marginal farmers, large scope for adoption of improved water productivity at affordable investments, availability of low cost technologies for improving crop productivity, etc., is poised to play a significant role in achieving this mission.
2. Growth in Area and Production

2.1 Horticulture crops *per se*
2.2 Fruit crops
2.3 Vegetables
2.4 Aromatic Crops
2.5 Medicinal Plants
2.6 Spices
2.7 Flowers
2.8 Plantation crops
2.9 Protected cultivation
2.10 Organic farming
2.11 Precision Farming
2.12 Value chain financing - Integrated Value Chain approach
2.13 Integrated cold chain infrastructure for perishables
2.1. Horticulture crops per se

The Horticulture sector has been a driving force in stimulating a healthy growth trend in Indian Agriculture. As per the data of National Horticulture Board’s for 2016-17, India produced 300.54 m MT of horticulture produce from an area of 24.85 m ha, surpassing the food grain production of 273.38 m MT. In comparison to the previous year (2015-16), the increase in area under horticultural crops was 1.9% while the production recorded a growth rate of 3.2%. The highest growth rate in area was recorded with regard to flower crops (11.4%), followed by fruits (2.8%) and vegetables (2.0%). The growth rate in production was highest in vegetables (3.6%), followed by fruits and flowers (2.9%). With a production of 37.14 m MT Uttar Pradesh was the largest producer of horticultural crops in the country, followed by West Bengal (30.15 m MT), Madhya Pradesh (24.01 m MT), Gujarat (23.16 m MT) and Maharashtra (21.67 m MT). These 5 states accounted for about 46% of the total horticultural crop production in the country.

Over the last decade, the area under horticulture grew by about 3.8% per annum but production rose by 7.6% per annum. The higher growth rate in Horticulture sector, therefore, was brought about by improvement in productivity of various horticulture crops rather than due to increased area under cultivation, which increased by about 28% between 2001-02 and 2011-12. The special thrust given to this sector, especially after the introduction of the Horticulture Mission for North East & Himalayan States (HMNEH) and the National Horticulture Mission (NHM) in the X Plan, has yielded positive results.

Horticulture growth during the XI Plan at 4.7 per cent was only marginally short of the 5 per cent target. The targeted growth rate for the sector during the XII Plan is 5 per cent. The growth in area and production under various plantation and horticulture crops for the last five years is given in Table-1.

Table-1. Growth in Area and Production of Plantation and Horticulture Crops during 2012-13 and 2016-17

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>6.98</td>
<td>81.28</td>
<td>7.22</td>
<td>88.98</td>
<td>6.23</td>
</tr>
<tr>
<td>Vegetables</td>
<td>9.20</td>
<td>162.18</td>
<td>9.40</td>
<td>162.90</td>
<td>9.42</td>
</tr>
<tr>
<td>Spices</td>
<td>3.07</td>
<td>5.74</td>
<td>3.16</td>
<td>5.91</td>
<td>3.32</td>
</tr>
<tr>
<td>Plantation Crops®</td>
<td>3.64</td>
<td>16.98</td>
<td>3.67</td>
<td>16.30</td>
<td>3.53</td>
</tr>
<tr>
<td>Flowers</td>
<td>0.23</td>
<td>1.70</td>
<td>0.26</td>
<td>2.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Others</td>
<td>0.56</td>
<td>0.92</td>
<td>0.49</td>
<td>0.97</td>
<td>0.66</td>
</tr>
<tr>
<td>Total</td>
<td>23.69</td>
<td>268.84</td>
<td>24.19</td>
<td>277.35</td>
<td>23.41</td>
</tr>
</tbody>
</table>

@Excluding coffee, tea and rubber

Picture 1: Area and Production of Horticulture & Plantation Crops in India during 2012-13 to 2016-17

Source: National Horticulture Board
The per capita availability of fruits and vegetables in the country during 2013 was estimated to be 199 g per person per day and 377 g per day per person respectively. Horticultural production in the country has shown a compounded annual growth rate of 5.95% during the last ten years. The average annual growth rate of horticulture output among agri and allied sectors was next only to fibre and livestock.

2.2. Fruit crops

India is the second largest producer of fruits with a production of 92.92 m MT during 2016-17, after China. India ranks first in production of Banana, Papaya, Mango and Guava and 4th in production of oranges. Based on the production, the top three leading fruit crops in the country are Banana (31% with 29.16 m MT), Mango (21% with 19.87 m MT) and Citrus (14% with 12.87 m MT).

In comparison to 2015-16, during 2016-17, highest growth in productivity was recorded in custard apple (23%), followed by ber (13%) and citrus fruits (10%). In contrast, apple (-11%), guava (-10%) and plum (-8%) showed deceleration in production.

The production share of major fruit crops during 2016-17 is depicted in the picture below.

Between 2007-08 and 2016-17, production of fruits increased by about 42% while the area increased by about 7.6%, indicating that the increased production of various fruits in the country is largely due to increased productivity. In fact, the productivity of fruit crops registered a growth of 30%, from 11.20 MT/ha to 14.6 MT/ha during this period.

Though Maharashtra holds the largest area under fruit crops (7.05 lakh ha) followed by Andhra Pradesh (6.09 lakh ha), the latter accounts for the largest production (13.61 m MT) in the country followed by Maharashtra (10.63 m MT), due to higher crop productivity (22.3 MT in AP vis-à-vis 15.0 MT/ha in Maharashtra).

The major impediments in the growth of fruit crops are:

• Shortage of elite planting material for various fruit crops
• Large production areas under fruit orchards are old and senile with lower productivity
• Perishability and lack of/ inadequate post-harvest and cold chain infrastructure,
• Poor access to markets, extension services and credit.
• Lack of linkages and integration between various players in the supply chain, such as from farm gate to market place, from farmer to processing unit, etc.

Picture 2: Pie diagram showing the share in production of various Fruit Crops during 2016-17
2.3. Vegetables

India is the second largest producer of vegetables with a production of 178.17 m MT during the year 2016-17 after China. India ranks first in production of Okra and second in production of Onion, Brinjal, Cabbage, Cauliflower, Potato and Tomato. Top three leading crops are Potato (48.60 m MT), Onion (22.43 m MT) and Tomato (20.70 m MT). With a production of 28.19 m MT, Uttar Pradesh leads the country in vegetable production. This is followed by West Bengal (25.51 m MT), Madhya Pradesh (17.93 m MT), Bihar (14.52 m MT) and Gujarat (13.61 m MT). The production share of major vegetables during 2016-17 is given in the picture below.

The major impediments for growth of vegetable production in the country are:

• Lack of quality seeds and high cost of hybrid seeds;
• Lack of varieties suitable specifically for processing needs;
• Wide gap between current and potential level of productivity;
• Technology suitability for small and marginal land holdings;
• High post-harvest crop losses and lack of efficient post-harvest management and diversification of markets;
• Volatile prices;
• Poor access to markets, extension services and credit.

Picture 3: Pie diagram showing the share in production of various Vegetable Crops during 2016-17
2.4 Aromatic Crops
Aromatic crops are from a numerically large group of economically important species. There has been increasing demand for essential oils, aroma chemicals, drugs and pharmaceuticals in the world market since two decades. Aromatic compounds are present in various parts of plants, such as roots, wood, bark, foliage, flowers, fruits, seeds, etc. Some of the important aromatic plants like Citronella grass, Palmarosa, Vetiver, sweet flag (bach), lavender, geranium, patchouli, Bursera, Mentha, muskdan (musk mallow), dawana, Ocimum, etc. have great demand in the country. During 2016-17, production of aromatic crops including medicinal plants was 9.72 lakh MT from 6.64 lakh ha area. The leading States in production of aromatic crops are Rajasthan, Uttar Pradesh and Madhya Pradesh.

The major impediments for growth of aromatic crops are:
• Shortage of quality planting material;
• Weak producer-industry linkage
• Lack of awareness on quality standards
• Poor access to markets, extension services and credit

2.5 Medicinal Plants
About 6000-7000 species are estimated to have medicinal usage in folk and documented systems of medicine like Ayurveda, Siddha, Unani and Homoeopathy. About 960 species of medicinal plants are estimated to be in trade, of which 178 species have annual consumption levels in excess of 100 metric tons. Medicinal plants are not only a major resource base for the traditional medicine & herbal industry but also provide livelihood and health security to a large segment of Indian population. The domestic trade of the AYUSH industry is of the order of ₹ 80 to 90 billion. The Indian medicinal plants and their products also account of exports in the range of ₹ 10 billion.

There is global resurgence in traditional and alternative health care systems resulting in world herbal trade which stands at US$ 120 billion and is expected to reach US$ 7 trillion by 2050. Indian share in the world trade, at present, however, is quite low.

Major medicinal crops in the country are long pepper, periwinkle, Rauvolfia, Dioscorea, Isabgol, *Ammi majus*, Belladonna, Cinchona, pyrethrum, etc. Due to shrinkage of natural source of these medicinal plants and growing demand, the commercial cultivation is gaining importance. National Medicinal Plants Board (NMPB) is engaging in various conservation activities by developing sustainable way through central sector scheme on Conservation, Development and Sustainable Management of Medicinal Plants.

(i) In-situ Conservation
In-situ conservation deals with the on-site conservation of the wild genetic resources/ genetic diversity in natural habitat. In India, the conservation of forest areas is through development of Protected Areas like National Parks, Wildlife Sanctuaries and Biosphere Reserve. Promotion of in-situ conservation of medicinal plants is also important to AYUSH industry due to its dependence on medicinal plants. It involves survey, inventorisation and documentation of important medicinal plants in their natural habitat (in-situ). Further in-situ conservation activities have been carried out through Medicinal Plants Conservation and Development Areas (MPCDA’s) and in-situ Resource Augmentation.
Ex-situ Conservation
Ex-situ conservation deals with the off-site conservation of the wild genetic resources / genetic diversity. It includes collection, preservation and maintenance of selected genetic resources from wild. Ex-situ conservation of medicinal plants is a complementary action to conserve the genetic diversity, thereby reducing pressure on wild habitats and augmenting raw material availability. For many species of medicinal plants their wild population is at critical level and it is not suitable for dealing ex-situ conservation action. It can serve as field gene banks and also help in engaging the number of stakeholders in production and regeneration of medicinal plants.

The major impediments for growth of medicinal plants are:
• Shortage of quality plating materials;
• Weak producers-industry linkage;
• Lack of awareness on quality standards;
• Poor access to markets, extension services and credit

2.6. Spices
India is traditionally known as the spice bowl of the world. The Western Ghats region is believed to be the centre of origin of many spices, particularly black pepper, cardamom and other Zingiberaceous spices. India has been a traditional producer, consumer and exporter of spices. There are about 109 spices listed by International Organization for Standardization, and India grows about 60 of these spices. Almost all the States in the country produce one spice crop or the other. During the year 2016-17, spices are grown in an area of 3.67 m ha with an estimated production of 8.12 m tons.

Indian spices flavour foods in over 130 countries. The USA, Canada, Germany, Japan, Saudi Arabia, Kuwait, Bahrain and Israel are the main markets for Indian spices. During 2016-17, Indian spices exports have been able to continue its increasing trend both in volume and value. During the year, it is estimated that about 9.48 lakh tons of spices and spice products valued at ₹ 17,664 crore have been exported from the country as against 8.43 lakh tons valued ₹ 16,238 crore in 2015-16 registering an increase of 12% in volume and 8.8% in rupee terms of value.

Top three leading spice crops are chillies (2.09 m MT), Garlic (1.69 m MT) and Turmeric (1.07 m MT). The leading states in production of spices are Rajasthan, Andhra Pradesh, Madhya Pradesh, Gujarat and Telangana. The production share (2015-16) of major spices crops is given in the picture below.

![Pie diagram showing the share in production of various Spice Crops during 2015-16](image)
The major impediments for growth of spices crops are:

• Shortage of quality planting and seed materials;
• Low crop productivity;
• Lack of awareness regarding crop-wise country/region-specific quality standards, including the acceptable levels of pesticide residues, in respect of exportable products;
• Lack of awareness on quality standards;
• Poor access to markets, extension services and credit.

2.7 Flowers

Government of India has identified floriculture as a sunrise industry and accorded 100% export oriented status. Owing to steady increase in demand for flowers, floriculture has become one of the important commercial activities in Indian agriculture. Thus, of late, commercial floriculture has emerged as hi-tech activity with cultivation under controlled climatic conditions of greenhouse. Floriculture in India is being viewed as a high growth industry. Commercial floriculture is becoming important from the export angle. The liberalization of industrial and trade policies paved the way for development of export-oriented production of cut flowers. The new seed policy had already made it feasible to import planting material of international varieties. Indian floriculture industry has been shifting from traditional flowers to cut flowers for export purposes. The liberalized economy has given an impetus to the Indian entrepreneurs for establishing export oriented floriculture units under controlled climatic conditions.

The growth rate of production of flowers in the country is highest among the horticulture crops. The production has more than doubled to 2.39 m MT during the year 2016-17, registering CAGR of about 18% for the last five years. The major share of flower production is from marigold, chrysanthemum and rose and various types of modern cut flowers like orchid, carnation, gladiolus, jasmine, dahlia, tuberose, bird of paradise, china aster and gerbera. The major flower producing states are Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, Gujarat, West Bengal etc. North Eastern states are emerging as major contributors of modern cut flower production, especially for anthuriums, lilies and orchids.

The major impediments for growth of floriculture are:

• Shortage of quality plating and seed materials and high cost of planting material;
• Lack of awareness on quality standards;
• Perishability and lack of adequate post-harvest infrastructure;
• Poor access to markets, extension services and credit;

The major impediments for growth of spices crops are:

• Shortage of quality planting and seed materials;
• Low crop productivity;
• Lack of awareness regarding crop-wise country/region-specific quality standards, including the acceptable levels of pesticide residues, in respect of exportable products;
• Lack of awareness on quality standards;
• Poor access to markets, extension services and credit.

![Pie diagram showing the share in production of various Flower Crops during 2016-17](image-url)
2.8 Plantation crops

2.8.1. Unorganised Plantation crops

The major unorganised plantation crops grown in the country are Coconut, Areca nut, Cocoa and Cashew. The area and production under these crops during the year 2016-17 (2nd AE) are given in the table below.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (000 ha)</th>
<th>Production (000 MT)</th>
<th>Leading States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areca nut</td>
<td>455</td>
<td>723</td>
<td>Karnataka, Kerala, Assam, Meghalaya, WB and TN</td>
</tr>
<tr>
<td>Cashew nut</td>
<td>978</td>
<td>745</td>
<td>Maharashtra, Kerala, AP, Karnataka, Orissa, TN</td>
</tr>
<tr>
<td>Cocoa</td>
<td>83</td>
<td>19</td>
<td>Kerala, Karnataka, AP, TN</td>
</tr>
<tr>
<td>Coconut</td>
<td>2082</td>
<td>16486</td>
<td>Tamil Nadu, Kerala, Karnataka, AP</td>
</tr>
<tr>
<td>Total</td>
<td>3598</td>
<td>17972</td>
<td></td>
</tr>
</tbody>
</table>

The major impediments for growth of plantation crops are:

- Low Productivity. Large area is affected by coconut root wilt and areca nut yellow disease
- Low value addition in Areca nut and Coconut
- Poor linkage with processing facilities, especially for oil palm and fluctuating prices.
- Poor access to extension services and credit

2.8.2. Organised Plantation crops

Tea, Coffee and Rubber are three organised plantation crops covered under Plantation Labour Act and are not covered under Land Ceiling Act. Cardamom, a spice, is also covered under Plantation Labour Act.

2.8.2.1 Tea

India is one of the world's leading producers of tea. It boasts of about 23 per cent share by volume in the total world production of tea. The tea produced in India is among the finest in the world. This is due to strong geographical indications, good tea processing units, innovation, and strategic market expansion. Nearly 12 per cent share of world tea exports in 2016 was from India. The tea industry is also India’s second-largest employer with over 3.5 million workers employed in over 1,500 tea growing estates.
Assam, West Bengal, Tamil Nadu and Kerala are the major tea growing states. They account for 98% of the total country’s production. Other traditional states where tea is grown to a small extent are Tripura, Himachal Pradesh, Uttarakhand, Bihar and Karnataka. The non-traditional states that have entered the tea map of India in the recent years include Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Sikkim. India produces some of the world’s finest teas – Darjeeling, Assam and Nilgiris famous for their delicate flavour, strength and brightness. With diverse agro climatic conditions, India produces medley of teas suited to different tastes and preferences of consumers. The characteristics of each region are distinct, which sets them apart from one another in many different ways.

During 2015-16, the tea production in the country was 1233 million kg from the 5.67 million ha. Tea exports from India during 2015-16 was 232.92 million kg valued at ₹4493 crore and imports was 18.43 million kg valued at ₹244.48 crore. During the year 2012-13, 46% of total tea produced in the country was sold through public auctions, 8% was directly exported and the remaining 46% was sold through ex-garden private sale.

The major impediments for growth of tea in the country are:

- Limited potential for expansion of area under cultivation;
- Large number of plantations are old and senile with low productivity
- Slow progress in replanting and rejuvenation programme

2.8.2.2 Coffee

India is the seventh largest producer of coffee, after Brazil, Vietnam, Columbia, Indonesia, Ethiopia and Honduras. India accounts for around 2 per cent of the area and 3.7 per cent of the global coffee production. The total production in India stood at 3,12,000 MT in 2016-17, of which Robusta variety accounted for 217000 MT (70%) and Arabica accounted for 95000 MT (30%). Coffee industry witnessed significant growth during the past three decades, especially after the decision by the Government to allow free sales by the producers, rather than selling to a central pool.

The area under coffee plantations in India was 4.34 lakh ha during 2015-16. Most of this area is concentrated in the southern states of Karnataka (54 per cent), Kerala (20 per cent) and Tamil Nadu (8 per cent). Productivity of coffee was around 876 kg/ha during 2015-16. Out of 3.88 lakh coffee growers, 99 per cent are small growers, while 1 per cent of growers are medium to large sized. These plantations employ an average of around 6,32,993 labourers on a daily basis (2015-16).

While coffee in India has traditionally been an export-oriented commodity, coffee planters in India are finding significant traction in the domestic market as well. India’s domestic coffee consumption has increased steadily from around 50,000 MT in 1998 to 115000 MT in 2011, registering a CAGR of about 6 per cent. This has led to the setting up of a number of international and Indian coffee retail chains in the country in recent years like Lavazza, Café Coffee Day, Costa, Gloria Jean’s Coffee, Coffee Bean & Tea Leaf; and more recently in 2012, Starbucks in a 50:50 JV with Tata Global Beverages. India exports coffee to over 45 countries. The total coffee exports from the country stood at 3.55 lakh MT in 2014-15. Italy is the largest importer of Indian coffee with a share of 23% of total exports. Export earnings have increased from ₹1050 crore in 2001-02 to ₹5632 crore.
crore in 2016-17, growing at a CAGR of about 14 per cent during the period.

The major impediments for growth of coffee are:
- Limited potential for expansion of area
- Large number of coffee plantations are old and senile with low productivity
- Slow progress in expansion of area in non-traditional areas
- White stem borer infestation, especially in Arabica coffee

2.8.2.3 Rubber
Rubber cultivation in India has been traditionally confined to the hinterlands of the Southwest coast, mainly in Kanyakumari district of Tamil Nadu and Kerala. Non-traditional rubber growing areas are hinterlands of coastal Karnataka, Goa, Konkan Region of Maharashtra, hinterlands of coastal Andhra Pradesh and Odisha, the North Eastern states, Andaman and Nicobar Islands, etc., where rubber is now being grown. Humid tropical climate prevails in the rubber-growing tract. Average annual rainfall in the tract varies from about 2000 to 4500 mm. India ranks 5th in the production of natural rubber, after Thailand, Indonesia, Vietnam and China, with about 1.2 million growers, of which barring 537 big plantations having more than 10 ha area, all others are small growers with a landholding of 0.55 ha or less. The major producing states in India are Kerala (>90%), Tamil Nadu & Karnataka. About 88% of the rubber production is from small and marginal growers. The provisional figures for 2016-17 by Rubber Board show that the productivity which was 1867 Kg/Ha in 2008-09 declined to 1553 kg/ha during 2016-17.

The domestic production of rubber was 6.91 lakh MT during the year 2016-17 down from 9.14 lakh MT during the year 2012-13. The decline in production is mainly on account of poor price. The domestic requirement is met though import of about 4.26 lakh MT during the year 2016-17. The demand-supply gap is further expected to increase by about 20% taking into account the expected growth of automobile, footwear and other sectors consuming natural rubber. Increase in domestic prices due to shortage of domestically available natural rubber owing to fall in production is a point of concern for downstream industries as natural rubber is the main raw material for them. In such a situation, the industry looks at alternative sources of raw material from abroad, as international prices might be lower than domestic ones.

The major impediments for growth of Rubber are:
- Limited potential for expansion of area
- Large number of plantations are old and senile with low productivity
- Slow progress in expansion of area in non-traditional areas
- Low prices of the product coupled with high cost of labour

2.9 Protected cultivation
2.9.1 Among the major constraints in production of horticultural crops are the wide variations in key growth factors like carbon dioxide, temperature, sunlight, water deficiency or excess, relative humidity, heavy winds, and host of diseases and insect pests. Deviation from these conditions results in yield losses partially and sometimes totally. It is pertinent to mention that the magnitude of impact of climate change with unpredictable occurrence of events like unseasonal rains, hail storms and weather on agricultural productivity, more specifically horticulture productivity and quality of produce is appreciated by farmers and the scientific community. However, near optimal climatic conditions could be created by controlling the climate with the help of greenhouse using different protected structures/
methods/devices and such cultivation under controlled environmental conditions is termed as **protected cultivation**.1

2.9.2 Protected cultivation in India in the beginning was confined to a few activities like high value flower crops in potential floriculture zones, ornamental plant nurseries and for hardening and value addition of tissue culture plants. With the R&D interventions in evolving indigenous and low cost technologies, impact of interventions through Indo-Israel collaboration projects, off-season cultivation to meet lean seasons' demand and fast growing domestic preferences for quality and exotic fruit and vegetable produce, protected cultivation is fast emerging as alternative production system involving high-tech and intensive practices. This activity is also recognized as a potential growth driver for Plantation and Horticulture sector.

2.9.3 **Key advantages**

- Increase in yield up to 5 to 8 times – high productivity per unit area
- Significant saving in key inputs like water (up to 50%), fertilizers (about 25%) and pesticides.
- Better growth and uniformity in quality of the produce
- Feasible even in undulating terrains, saline, waterlogged, sandy, hilly lands, etc.

2.9.4 **Potential areas**

- Urban and peri-urban areas to meet requirement of fresh produce like vegetables, fruits and flowers round the year
- Areas with limited land and water resources
- Areas where availability of land for cultivation is restricted because of snowfall and areas where low temperature is prevalent restricting cultivation of crops under open field conditions.
- Small and marginal land holdings for adopting intensive production technologies
- As an agri-business enterprise for enterprising youth in rural and urban peripherals

2.9.5 **Potential assessment for protected cultivation**

At present, the estimated area under protected cultivation is around 23000 ha (0.23% of area under vegetables and flowers). With the incentives and promotional interventions under Central / State Government programmes like Mission for Integrated development of Horticulture (MIDH), several farmers / entrepreneurs are adopting the technology, more specifically for production of vegetables during off-season, growing exotic vegetables and flowers, nurseries and vegetable seedling production. Important protected cultivation structures include polyhouses, poly-tunnels, shade nets/anti-hail nets/net house cultivation and low cost poly houses (wooden / bamboo frame structures) especially in hilly terrains. Considering an annual growth rate of 15% in area expansion, the area under protected cultivation is expected to double in next five year period from the present level.

2.9.6 **Key Issues**

- Incentivize the farmers through credit linked back-ended subsidy
- Arrange for technology and quality input supply for protected cultivation infrastructure

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1R. S. Paroda, Former Secretary, DARE & DG, ICAR, Inaugural Address, delivered at the first National Seminar on “Advances in Protected Cultivation”, at NASC Complex, Pusa Campus, New Delhi 110 012 on 21 March 2013
• Group approach through Protected Cultivation Clusters
• Special focus on training, capacity building and hand holding support for entrepreneurs with enabling access to technology along with credit
• Promotion of institutional set-up, including Farmers’ Producer Organizations and market facilitation through linking such groups directly to institutional buyers, agri-retailers and export houses/ agencies.
• Develop region specific package of practices for protected cultivation of flowers and vegetables.
• Address constraints like transportation of soil, soil sterilization, insurance of structure and crops etc.

2.10 Organic farming

2.10.1 Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of ‘off-farm’ inputs, taking into account the regional conditions require locally adapted systems. This is achieved by using where possible agronomic, biological and mechanical methods, as opposed to using any synthetic materials to fulfill any specific function within the system (Codex Alimentarius Commission).

2.10.2 Status
• As per the available statistics, India’s rank in terms of World’s Organic Agricultural land was 15 as per 2013 data (Source FIBL & IFOAM Year Book 2015). The total area under organic certification was 5.71 million ha during 2015-16. This includes 26% cultivable area with 1.49 million ha and rest 74% (4.22 million ha) forest and wild area for collection of minor forest produces.
• India is the leading country in terms of number of organic producers with about 5.85 lakh organic producers contributing nearly 24 % to the world organic producers of 2.4 million.
• India produced around 1.35 million MT (2015-16) of certified organic products which includes all varieties of agri products namely sugarcane, cotton, oil seeds, basmati rice, pulses, Spices, pea, Fruits, Dry fruits, Vegetables, Coffee and their value added products. The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc.
• Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Himachal Pradesh and Rajasthan.
• The States of Uttaranchal and Sikkim have been declared as organic states. Most of the area in NE-Zone is being practiced with organic farming. The states like Tamil Nadu, Kerala, Madhya Pradesh, Himachal Pradesh and Gujarat are promoting organic farming vigorously.
• The total volume of export during 2015-16 was 263687 MT. The organic food export realization was around 298 million USD. Organic products are exported to European Union, US, Canada, Switzerland, Korea, Australia, New Zealand, South East Asian countries, Middle East, South Africa, etc.

2.10.3 Opportunities
The Global Organic Movement is gearing towards Organic 3.0 for truly sustainable farming and consumption. The overall goal of Organic 3.0 is to enable a widespread uptake of truly sustainable farming systems and markets based on organic principles with a culture of innovation, of progressive improvement towards best practice, of transparent integrity, of inclusive collaboration, of holistic systems, and of true value pricing.
Organic agriculture, in many ways, is an eminently preferable sustainable approach for the development of agriculture in India. Organic agriculture offers multiple benefits, such as economical aspects (e.g. price premiums, high demand); natural resource conservation (e.g. improved soil fertility and water quality, prevention of soil erosion, preservation of natural and agro-biodiversity) and social benefits (e.g. generation of rural employment, improved household nutrition and local food security, reduced dependence on external inputs). The favourable factors for promotion of organic farming in India include:

- Diverse agroclimatic conditions facilitating wide production base for important produce with export potential
- Growing demand in the domestic market for organic fruits, vegetables, rice and wheat.
- Presence of strong NGO sector with well-established close linkages to large number of small and marginal farmers, who can play catalytical role in organic farming promotion.
- Vast extent of dry lands (60% of total available agriculture land), tribal belts and hilly regions in Eastern and North Eastern region which are by default organic, facilitating easy conversion to organic.
- Potential for in situ production of organic inputs from locally available resources like crop residues, green manure, livestock manure, biofertilizers, etc.

The important products and potential states / areas for organic production in the country are indicated below:

<table>
<thead>
<tr>
<th>Table-3. Potential organic products and production areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
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<td>-------------</td>
</tr>
<tr>
<td>Tea</td>
</tr>
<tr>
<td>Spices</td>
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<tr>
<td>Coffee</td>
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<td>Rice</td>
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<tr>
<td>Wheat</td>
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<td>Vegetables</td>
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<tr>
<td>Fruits</td>
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<tr>
<td>Cotton</td>
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</tbody>
</table>

2.11 Precision Farming

2.11.1 Precision farming in the context of Indian farming scenario could be managing crop production inputs such as water, seed, fertilizers, etc., to improve yield, quality, profit, and reduce waste and become eco-friendly and sustainable. The intent of precision farming is to match agricultural inputs and practices as per crop and agro-climatic conditions to improve the accuracy of their applications.

2.11.2 Contrary to agriculturally advanced countries where precision farming is practiced in large farms, in Indian context the technology can be adopted even on small holdings by adopting compact area approach involving a group of farmers focusing on high value crops. For standardizing and testing field application of precision farming technology NABARD had earlier supported an R & D project in 1999-2000 in Dindigul district of Tamil Nadu undertaken by MS Swaminathan Research Foundation (MSSRF), Chennai which was implemented in 280 acres. One of the significant interventions for large scale commercial propagation of the technology at field level was the launching of Tamil Nadu Precision Farming Project (TNPFP) by Government of Tamil Nadu during 2004-05 to 2006-07.

2.11.3 Ministry of Agriculture, Govt. of India has established 22 Precision Farming Development Centres (PFDCs) located in different agriculture sectors.
The functional roles of PFDCs include undertaking field trials, crop specific demonstrations, training, awareness creation and technology transfer.

### 2.11.4 Precision Farming Promotion in Watershed projects
NABARD is implementing over 1600 watershed development projects under various funding arrangements spread over 16 States covering an area of about 1.72 m ha. These projects are being implemented with active involvement of watershed community. As reported by various impact assessment studies, the project implementation led to conservation and augmentation of resource base, perceptible change in farmers’ attitude towards adoption of innovative technologies and participatory management. The precision farming technology with focus on vegetable cultivation can be adopted / propagated in potential watershed projects implemented by NABARD leveraging on the inherent advantages, viz:

- Well established village community based organizations viz. Village Watershed Committees, Self Help Groups, activity based groups, etc.
- Participatory approach in development process.
- Augmentation of water resources (surface and groundwater) through soil and water conservation measures, e.g. check dams, percolation ponds, farm ponds, etc.
- Focus on improved agriculture, judicious management of water resources, productivity enhancement, etc., which forms integral component of watershed development projects.
- Awareness and adoption of collective marketing practices.
- Technical and managerial hand-holding by project facilitating agencies / NGOs

### 2.11.5 Key Issues
- Promotion of the concept calls for a well-coordinated approach among research institutes, extension workers/line departments and policy makers.
- Adoption of technology simultaneously calls for field level hand holding support till the farmers become well versed with production management systems.
- High initial investment and operational costs (mainly due to inputs like water soluble fertilizers) where institutional credit support assumes significance.
- High price and limited availability of water soluble fertilizers.
- Since crops considered for precision farming are mainly perishable vegetables, strengthening the infrastructure for post-harvest management and effective market linkages through contract farming and corporate retailing for ensuring better prices.

### 2.12. Value chain financing - Integrated Value Chain approach
#### 2.12.1 In the Indian context, under crop production system, the developmental interventions have been more towards supply chain management addressing gaps in production related investments. Integration with post production areas of processing and marketing are yet to take place to the desired extent more specifically in perishable fruits and vegetables. A few successful
examples, however, exist in areas where user-industry interventions were involved, like (a) where processing industry is involved through contract farming (e.g., gherkins, processing potato, tomato, white onion, jasmine, etc.,) and (b) where cooperative/corporate agri retailers are involved in procurement of agri produce directly from farmers.

2.12.2 With the increasing demand for quality food and emerging opportunities for export and emphasis of the policy makers on produce aggregation for marketing through farmers’ institutions like producer organizations, the opportunities for promotion of value chain approach are becoming wider. The key factors facilitating enabling environment for value chain approach include:
• Varied agro-climatic conditions and large production/consumption base.
• Gradual shift in orientation amongst farmers from conventional farming to agri-business enterprises towards commercial agriculture.
• Access to better inputs and technology options.
• Consumer basket exhibiting preferences to value-added/processed products and changing food preferences.
• Demographic advantage - Growing young urban population (in their 30s/40s) with higher disposable incomes leading to increasing discretionary spends, especially on quality food.
• New value addition avenues: Environmentally low-impact foods, fair trade practices, growing preference for organic foods, food safety issues.
• Expanding network of institutional credit dispensation mechanism/credit purveyance.
• Inclination amongst bankers on integrated value chain financing projects.

2.12.3. Value chain approach - Benefits to farming community & other stakeholders
• Professional management
• Ramping up scale exponentially - deriving economies of scale; scope/result: organized production and market aggregation.
• Access to improved technologies.
• One-stop service access (especially where user industry tie-up or contract farming are involved).
• Quality awareness.
• Attracting investment in critical infrastructure.
• Minimizing role of intermediaries, improved margins, better price discovery.
• Greater role for private players/corporate entities in extension, marketing and investment in post-harvest handling infrastructure including warehousing.

2.12.4. NABARD’S interventions in value chain financing
• Forward integration of production programmes with processing and value addition in horticultural crop-centric tribal development projects implemented under Tribal Development Programmes (wadi programmes).
• Product-specific and supply driven natural resources based value chain projects under Umbrella Programme for Natural Resources Management (UPNRM), which is a KfW assisted programme.
• Pilot projects to address critical gaps in value chain of potato, tomato and onion under implementation in three locations.
• A dedicated programme for promotion of farmers’ institutions/producer organizations for input resources management, produce aggregation and marketing - a critical intervention which can be leveraged upon in value chain project financing.

2.12.5. Approach
Current value chain models are either supply or demand driven. Integrated value chain models are yet to penetrate as the process requires crop or activity specific approach which includes comprehensive analysis, designing appropriate interventions including financial products and a well-defined implementation process with assigned role for every stake-holder. The process broadly includes:
• Commissioning of comprehensive studies for problem analysis, potential mapping, interventions and stakeholders.
• Identifying and evolving region and product specific agri-business value chain models with end to end solutions including identification of critical gaps in infrastructure and roles for different stakeholders.
• Funding of the projects to be facilitated through the producer groups/organizations to be set up as part of project interventions. Where such producer organizations are already in existence, the same to be leveraged upon.
2.13 Integrated cold chain infrastructure for perishables

2.13.1 Cold chain is an important element of post-harvest infrastructure for the perishable products, as it links all the facets of supply chain such as collection, storage and distribution of these products. India produces about 93 m MT of fruits and 178 m MT of vegetables. It is also the largest producer of milk (155 m MT per year) and produces about 8 m MT of meat and poultry, as well as about 11 m MT of fish (fresh as well as marine) a year. Although India has the potential to become one of the world’s major food suppliers, the inefficient cold chain network results in spoilage of almost 40 per cent of its total agricultural production.

2.13.2 With about 30% of fruits and vegetables produced in the country, valued at around ₹ 50,000 crore, are wasted annually, the storage facilities need to be immediately revamped with modern technologies. Inadequate infrastructure and equipment, high handling costs, etc., are plaguing the industry. In India, only 2.2% of fruits and vegetables are processed, while in the US, the Philippines and China as high as 65%, 78% and 23% are processed. This offers a huge untapped food processing market in India and calls for government initiatives to develop cold chain infrastructure. The potential and scope for addressing the needs of this sector are huge and the following data highlight/substantiate this.

- 11% of world’s total vegetables production is accounted by India but the share in global vegetable trade is only 1.7%.
- 140 million MT of milk is being produced in the country per annum, but cold storage capacity is only available for 80,000 - 90,000 MT of milk.
- 20%-30% of fish production is annually wasted in India.
- About 25,000 unregistered slaughter houses are present in India which generally lack chilling facilities.
- Growing annually at about 28%, the value of cold chain industry in India is expected to reach about USD 13 billion by 2017 through increased investments, modernization of existing facilities and establishment of new ventures via private and government partnerships.
- Most equipment in use is outdated and single commodity based, while there is need to develop multi-product, multi-chamber storage units.
- According to industry estimates, approximately 104 million MT of perishable produce is transported between cities each year. Of this, about 100 million MT moves via non–reefer mode and only 4 million MT (less than 4%) is transported by reefer mode.
- India has about 250 reefer transport operators (mostly small and non-integrated firms) that transport perishable products and >30,000 refrigerated vehicles currently ply in India. Majority of the refrigerated vehicles (approximately 80%) are utilized for milk and milk products transportation.

2.13.3 National Centre for Cold-chain Development (NCCD) has estimated that current gap in cold storage infrastructure is about 40 m MT and an investment of $ 6-10 billion in next 5-10 years is required. Other investments required include upgradation of old cold stores, development of long haul storage, CA storage, development of skilled manpower, back end pack houses and front end retail spaces. However, the paradox is in spite of having huge gap, the existing capacity is under-utilized and the units operate below the capacity. Further, the cold storages are concentrated only in a few states. Uttar Pradesh and West Bengal account for more than 65% of the total existing capacity, while other states lack investments in private sector.

2.13.5 Government Initiatives

- Accorded infrastructure status to the cold chain sector in the Union Budget of 2012
- Viability Gap Funding (VGF) scheme for public-private partnerships for setting up cold chain projects
- Excise duty exemptions for air condition equipment and refrigeration panels and also conveyor belts used in cold stores, warehouses and wholesale markets.
• Existing incentives include access to external commercial borrowings, 100 per cent FDI and extending capital investment subsidy / capital grant through Ministry of Agriculture (under MIDH) and Ministry of Food Processing Industries.

• Establishing separate Warehouse Infrastructure Fund with a corpus of ₹ 5000 crore during each of the years of 2013-14 and 2014-15, from which direct loans could be extended by NABARD to State Governments, state-promoted agencies, public and private sector entities for establishing cold stores and cold chain infrastructure projects.

• The Ministry of Food Processing Industries (MOFPI) has been implementing a Cold Chain and value Addition Scheme as a Central Sector scheme providing capital grant for establishing cold chain projects. More than 180 cold chain projects have been sanctioned by the Ministry under this Scheme. Under Kisan Sampada Yojana (KSY), the GoI has plans to support about 150 cold chain projects per year during the period up to 2019-2020. A budget allocation of ₹ 1650 crore has been made for this Scheme under KSY.

2.13.6 Challenges & mitigating measures
Various challenges being encountered in the promotion of cold chain infrastructure and possible measures for mitigation are indicated below.

<table>
<thead>
<tr>
<th>Table-4: Challenges in promoting Cold Chain infrastructure and Mitigation</th>
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<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>Cold chain infrastructure is in short supply in India</td>
</tr>
<tr>
<td>Negligible reefer (cold truck) transport for perishable inter-city movement</td>
</tr>
<tr>
<td>Commercially unviable, huge investment and power consumption</td>
</tr>
<tr>
<td>Skewed cold chain capacity across states</td>
</tr>
<tr>
<td>Shortage of skilled manpower</td>
</tr>
</tbody>
</table>
3. Export Prospects for Plantation & horticulture produce
Total export earnings from horticulture sector covering fruits, vegetables, flowers and processed fruit and vegetable products was ₹ 14847 crore during the year 2014-15, apart from annual earnings of about ₹ 25000 crore from exports of tea, coffee, cashew nuts and spices. The sector contributes about 30% of exports from agriculture. The products-wise exported quantity is given in chart below:

During 2016-17, India exported 6.35 lakh MT of fresh fruits, 4.79 lakh MT of processed fruits & juices, 29.83 lakh MT of fresh vegetables and 1.66 lakh MT of processed vegetables. There is a good potential increasing the exports of fresh fruits and vegetables and processed products.
4. Key Growth Sectors under Plantation & Horticulture

4.1 Opportunities for growth of Horticulture

4.2 Region specific growth centres/activities
4.1 Economic liberalization opened up a plethora of opportunities for the growth of horticulture in the country. The agro climatic regions, which in other parts of the world are restrictive, are diverse in India, favoring a wide range of horticulture sector activities. This global export opportunity, coupled with growing domestic demand for traditional as well as high value foods offers immense potential for growth of the sector. Some of the important activities include:

| Expanding area under Fruits and Vegetables | • Growing domestic demand for fruits and vegetables  
• Potential for diversification of Agriculture through commercial horticulture  
• Huge potential for export |
| Replanting and Rejuvenation | • Large area under fruit crops and plantation crops replanting/rejuvenation |
| Dryland Horticulture | • Tool for sustainable development and climate change adaptation  
• Huge potential for promoting as mixed farming |
| Protected Cultivation | • High value vegetables for domestic and export markets (off-season and exotic vegetables)  
• Flower/ornamental crops for domestic and export markets,  
• Seed production/Hi-tech nurseries  
• Potential for peri-urban horticulture enterprises |
| Plantation crops and Spices | • Productivity improvement though rejuvenation and replanting  
• Quality improvement  
• Promoting small growers collectives/organization  
• Promoting organic spices and beverage crops |
| Contract Farming/Supply Chain management | • For potentials crops like Gherkins, Potato, herbs, exotic vegetables  
• Promoting market oriented production  
• Promoting growers collectives  
• Improve supply chain and value chain/promote value addition |
| Medicinal and Aromatic Crops | • Potentials for commercial cultivation of medicinal plants and aromatic crops  
• Potentials to cultivate as mixed crops in plantations and fruit orchards  
• Linking with user industries and promoting value addition |
4.2 Region specific growth centres/activities

4.2.1. Southern Region

Andhra Pradesh: Dryland horticulture, high density planting technology (along with micro irrigation) for major horticulture crops, including mango, guava, aonla, citrus, production of perennial vegetables on pandals, commercial nurseries for fruits, vegetables and ornamental plants, traditional flowers, investments in critical infrastructure in value chain of perishables like sorting, grading & packing facilities, refrigerated transport, storage, etc. and integrated farming models.

Telangana: High density planting technology (along with micro irrigation) for major horticulture crops, including mango, guava, custard apple, grape, papaya, commercial nurseries for fruits, vegetables and ornamental plants, traditional flowers, investments in critical infrastructure in value chain of perishables.

Tamil Nadu: High density planting technology (along with micro irrigation) for major horticulture crops, including mango, guava, aonla, citrus, replanting/ rehabilitation of traditional plantation crops (both in organized and small growers sectors) viz. rubber, coffee and tea; commercial nurseries for fruits, vegetables and ornamental plants, traditional flowers, high value cut flowers, investments in Horticulture and Floriculture Parks (in Hosur and Krishnagiri districts), polyhouse production of high value vegetables, exotic vegetable (coloured capsicum, cherry tomato, etc.), critical infrastructure in value chain of perishables like sorting, grading, packing facilities; refrigerated transport, storage, etc., integrated farming models.

Kerala: Replanting/rehabilitation of traditional plantation crops (both in organized and small growers sectors) viz. rubber, cardamom, coffee and tea; homestead farming models, precision farming/ polyhouse cultivation of vegetables such as capsicum (green/coloured), broccoli, baby corn, leek, summer squash, lettuce, celery, etc. in Wayanad, Idukki and other hilly tracts; flower crops, especially tropical orchids and Anthurium, minor fruit crops like rambutan, mangosteen, avocado etc.) in suitable areas.

Karnataka: High density planting technology (along with micro irrigation) for major horticulture crops, including mango, guava, grape, citrus, replanting of senile and low productive coffee plantations; commercial nurseries for fruits, vegetables and ornamental plants, traditional flowers, high value cut flowers, Floriculture Parks near Bengaluru, polyhouse production of high value vegetables, exotic vegetable (coloured capsicum, cherry tomato, etc.), critical infrastructure in value chain of perishables like sorting, grading, packing facilities; refrigerated transport, storage, etc., integrated farming models.

4.2.2 Eastern Region

Odisha: Horticulture based mixed farming, betel vine, commercial nurseries, high value crops under protected cultivation (coloured capsicum and cut flowers), mushroom production, and post-harvest infrastructure.

West Bengal: Cultivation of fruit crops (mango, pineapple, litchi, citrus), plantation crops (betel vine, cashew), commercial floriculture especially high value cut flower production (gerbera, gladiolus, anthurium, carnation, etc.) for domestic and export markets; exotic vegetable production in low cost green houses, medicinal and aromatic crops including processing,
commercial nurseries for fruit, ornamental plants and vegetables.

**Bihar:** Area expansion under traditional fruit crops like litchi, mango, commercial nurseries for fruits and vegetables, bee keeping and honey processing facilities, integrated farming, critical infrastructure in value chain for major perishable crops.

**Jharkhand:** High density planting of fruit crops, rainfed horticulture, protected cultivation, organic farming, cut flower cultivation, cultivation of hybrid vegetables, commercial nurseries for fruits and vegetables, commercial floriculture (rose, gladiolus, tuberose, carnation, lilies), medicinal and aromatic crops, including post harvest processing and bee-keeping.

**4.2.3. North Eastern Region**
Replantation/rejuvenation of old tea plantations in the organized sector (Assam, Tripura), rubber production and processing (in areas identified by Rubber Board), high density planting in pineapple, location specific homestead / integrated farming models, fruits like kiwi (Arunachal Pradesh); passion fruit (Manipur, Mizoram), commercial production of exotic flowers like orchids, anthurium, carnations, gladiolus, illium, gerbera and foliage plants; production of spices like black pepper (mainly in Assam), large cardamom (more specifically in Sikkim and Darjeeling region), turmeric (Meghalaya, Tripura, Nagaland and Mizoram), ginger (Assam, Meghalaya, Mizoram and Arunachal Pradesh), capsaicin and oleoresin production from unique local varieties like Bird Eye chilli (which has high capsaicin content of 1%, compared to 0.5 to 0.6% in other varieties) and Naga chilli (Manipur, Meghalaya, Arunachal Pradesh, Mizoram, Tripura, Nagaland); potential for culinary herbs (Rosemary, Thyme, Parsley and Oregano), mushrooms and bamboo shoots.

**4.2.4 Northern Region**
**Punjab** – Honey in Patiala and Ludhiana; Kinnow in Hoshiarpur, Ferozepur, etc. 
**Haryana** – Protected cultivation of vegetables, button mushroom, peri-urban vegetable production in Sonepat, Panipat, Gurgaon, Rohtak and Jhajjar.

**Himachal Pradesh** – Nuts (walnut, almond), off-season vegetables, ginger, kiwi, sea buckthorn, etc.


**Uttarakhand** – Off season vegetables in all valley regions, ginger, flowers under open cultivation (gladiolus) and in polyhouses (carnation, gerbera and liliums), medicinal and aromatic crops and peach.

**4.2.5 Central Region**

**Uttar Pradesh** – Dryland Horticulture with ber, pomegranate, mango, aonla, and bael in Bundelkhand region, mango (in Saharanpur, Lucknow), guava (in Allahabad region), aonla (Pratapgarh), aromatic crops like mint (Rampur, Moradabad), rose for extraction of essential oils, gulkand, etc. (Aligarh, Kannauj).

**Madhya Pradesh** – Aromatic crops, Horticulture corridors (Bhopal-Indore Corridor) and hubs (around Jabalpur, Gwalior, Ratlam, Jhabua, Chhindwara and Chattarpur).

**Chhattisgarh** – Medicinal and aromatic crops and sericulture

**4.2.6 Western Region**
**Gujarat** – Hi-tech floriculture and mango in Ahmedabad, Banaskantha, Gir Somnath, Junagadh, Mehsana, Navsari, Patan and Valsad; banana in Navsari and Valsad; and Dates in Kutch region.

**Maharashtra** – Grapes in Nasik, Sangli, Pune; pomegranate in Nasik, Ahmednagar and Solapur; banana in Jalgaon; citrus in Nagpur, Amravati, Aurangabad and Nanded; cashew in Sindhudurg; mango in Ratnagiri, Aurangabad, commercial floriculture in Pune; sericulture in Bhandara, Chandrapur & Gadchiroli, minor fruit crops like kokum in Konkan region.

**Rajasthan** – Oranges in Jhalawar, date palm in Jodhpur; aonla in Dungarpur; pomegranate in Sikar, Hanumangarh, Bundi; medicinal and aromatic crops (MACS) such as isabgol, henna, aswagandha, seed spices in many districts, including Ajmer.
5. Climate Change & Horticulture
Climate change is the global phenomena and greatest threat to food and nutritional security of growing population and also existence of human kind. An alarming increase in the atmospheric concentration of greenhouse gases, such as Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O) and chlorofluorocarbons (CFCs) due to human activities is causing global warming. An increase of 70% in concentration of greenhouse gases is observed in last 35 years. As a result, average global temperature has increased by about 1°C in past 137 years and is projected to rise by 1.4 to 5.8°C by 2100. It is now well established that the changing climate worldwide will bring about higher temperatures, changes in rainfall patterns and higher levels of atmospheric CO2, ultimately affecting the output of agriculture and allied sector. As per Climate Risk Index 2015, India is one of the four countries which are likely to be severely affected by the impact of climate change.

Horticulture, with approximately 28% of GDP contribution in agriculture from cultivated area of 8% in India, is threatened with serious consequences in all aspects of its production, protection as well as quality and processing. The ease with which a crop or a variety can be changed/replaced for food crops in the climate change scenario is not the same for horticultural crops, particularly for the orchards and plantation crops, which require heavy monetary input and a long time to establish. Challenges ahead are to have sustainability and competitiveness, to achieve the targeted production to meet the growing demands in the environment of declining land, water and threat of climate change, which needs climate-smart horticulture interventions which are highly location-specific and knowledge-intensive for improving production in the challenged environment.

Impact on horticulture crops
To quantify the impacts of climate change on horticultural crops, we need detailed information on physiological responses of the crops, effects on growth and development, quality and productivity. The climate change will have impact on horticulture and a few examples are as under:

i. Production timing will change due to rise in temperature. Due to rise in temperature, photo periods may not show much variation. As a result, photosensitive crop will mature faster.

ii. The winter regime and chilling duration will reduce in temperate regions affecting the temperate crops.

iii. Pollination will be affected adversely because of higher temperature. Floral abortion, flower and fruit drop will occur frequently.

iv. The requirement of annual irrigation will increase and heat unit requirement will be achieved in much lesser time.

v. Coastal regions can expect much faster percolation of sea water in inland water tables causing more salinity.

Effect on Fruit crops
The extreme weather events of hot and cold wave conditions have been reported to cause considerable damage to many fruit crops. Delay in monsoon, dry spells of rains, and untimely rains during water stress period, sub-optimal temperatures during flowering and fruit growth, hailstorms are some of the most commonly encountered climatic conditions experienced by the fruit growers over the past decade or so. Most significant effects of climate change on mango include early or delayed flowering, multiple reproductive flushes and variation in fruit maturity, abnormal fruit set and transformation of reproductive buds into vegetative ones. The climate change increases the atmospheric temperature and change of rainfall pattern, as a result, banana cultivation may suffer from high temperature, soil moisture stress or flooding / water logging. Due to rise in temperature, citrus and grapes may mature earlier by about 15 days. Untimely winter rains promote vegetative flushes in citrus instead of flowering flushes while a dry spell during flower emergence and fruit set affects flower initiation and aggravates incidence of pest. Increase in temperature at maturity will lead to fruit cracking and burning in litchi. Excessively high temperatures for extended periods of time in grapes generally result in delayed fruit maturation and reduction in fruit quality. Specific chilling requirements of pome and stone fruits will be affected hence dormancy breaking will be earlier. On the other hand, high temperature and moisture stress increase sunburn and cracking in apples, apricot and cherries.

Studies have indicated that in Shimla district in Himachal Pradesh at relatively higher altitude orchards have been replaced from high-chilling requiring apple cultivars of apple (like Royal Delicious) to low-chilling requiring cultivars and other fruit crops like kiwi, pear and plum and vegetables. In mid hills of Shimla district, trend is to shift from apple and potato cultivation totally. It is corroborated by declining trend in snowfall and apple productivity in Himachal Pradesh. The production of apple has fallen from 10.8 to 5.8 tons/ ha. Thus in replanting orchards and plantations over the next decade, selection of lower-chilling requiring types may be advisable.

Effect on vegetable crops
Climatic changes will influence the severity of environmental stress on vegetable crops also. Vegetables being succulent are generally sensitive to environmental extremes and high temperature, limited and excess moisture stresses are the major causes of low yields. High temperatures can cause significant losses in tomato productivity due to increased flower drop, reduced fruit set, and smaller and lower quality fruits. The duration of onion gets shortened due to high temperature leading to reduced yields. Cauliflower performs well in the temperature range of 15-25°C with high
humidity. Though some varieties have adapted to temperatures over 30°C, most varieties are sensitive to higher temperatures and delayed curd initiation is observed. The quality of horticultural commodities is affected by heat and water stresses. In onion, temperature increase above 40°C reduces bulb size. In potato, reduction in marketable grade tuber yield to the extent of 10-20% is observed due to high temperature. In cucumber, low temperatures favour female flower production, which is desirable and high temperatures lead to production of more male flowers.

Water stress caused yield losses in the range of 26% in onion, 30-45% in tomato and 50-60% in chilli. Plant sensitivity to salt stress is reflected in growth reduction, decreased photosynthesis, loss of cellular integrity, tissue necrosis, and potentially death of the plant.

Most of the vegetable crops are highly sensitive to flooding due to reduction in oxygen in the root zone and genetic variation with respect to this character is limited. Onion is sensitive to flooding during bulb development with yield loss up to 30-40%. The severity of flooding symptoms increases with rising temperatures; rapid wilting and death of tomato plants is usually observed following a short period of flooding at high temperatures. The response of plants to environmental stresses depends on the developmental stage and the length and severity of the stresses.

During the last 40-50 years, air pollution level increasing at an alarming rate in the developing countries and causing potential threat to the crop production. Sulphur dioxide, nitrogen oxide, hydro fluoride, ozone and acid rain are the primary air pollutant. Ozone has adverse effect on vegetable production in terms of reducing growth, yield and quality. Risk of the air pollution is more when vegetable crops grown close to the densely populated areas. Air pollution significantly decreased the yield upto more than 50 percent in case of cabbage, cauliflower, knol khol, broccoli, lettuce, radish, etc. Many vegetable crops namely tomato, water melon, potato, squash, cantaloupe, peas, carrot, beet, turnip, etc are more susceptible to air pollution damage. Yield of vegetable can be reduced by 5-15 percent when daily ozone concentrations reach to greater than 50 ppb.

Effect on Plantation and Spice crops
Consecutive drought in India reduced the coconut production by about three lakh nuts/year for four years. Productivity loss was to the tune of about 3500 nuts/hectare/year. Cashew, which is mostly grown under rainfed conditions, is vulnerable to climatic variability and drought conditions caused due to shifts in rainfall pattern and inter seasonal variability. Studies conducted on ‘Impact of climate change in cashew’ at Directorate of Cashew Research, Puttur, Karnataka indicated that the rainfall cashew crop is highly sensitive to changes in climate and weather vagaries, particularly during reproductive phase. Cashew requires relatively dry atmosphere and mild winter (15-20°C) coupled with moderate dew during night for profuse flowering. High temperature (>34.4°C) and low relative humidity (<20%) during afternoon causes drying of flowers, resulting in yield reduction. Unseasonal rains and heavy dew during flowering and fruiting period aggravated the incidence of pests and diseases. All these situations resulted in reduction yield up to 50 to 65%.

Cocoa based agro forestry systems are credited for stocking significant amounts of carbon and hence have the potential to mitigate climate change. Carbon stocks in shaded agro forestry systems with perennial crops such as coffee, and cocoa may vary between 12 and 228 Mg/ha and could help to mitigate climate change.

A study conducted at Indian Institute of Spices Research (IISR), Calicut using GIS models has shown that many areas presently suitable for spices would become unsuitable in another 25 years. There would be new areas which are presently unsuitable, become highly suitable for cultivation of spices.

The studies revealed significant changes in weather elements and have had significant impact on the production of spices crops such as small cardamom, seed spices and black
pepper. Indian pepper production has been declining rapidly in the past 10 years due to effect of climate change. From nearly one lakh ton of annual production, it has come down by more than 50%. In general due to increase in maximum and minimum day temperature and decreasing the annual rainfall the productivity showed decreasing trend in most of the black pepper growing areas of India. Pepper in Karnataka is grown mainly in the irrigated coffee plantations and is seen to be less monsoon sensitive. Some of the saffron farmers who traditionally relied on rainwater are now looking at irrigation measures to save their rare and labour intensive crop.

Effects on flower crops
Melting of ice cap in the Himalayan regions will reduce the chilling requirement for the flowering of many of the ornamental plants like Rhododendron, Orchids, Tulips, Alstroemeria, Magnolia, Saussurea, Impatiens, Narcissus, etc. Some of them will fail to bloom or flower with less abundance while others will be threatened. Flowers do not open up fully in tropical orchids wherever temperatures fall below 15°C. High temperature leads to flower bud drop and unmarketable spikes in tropical orchids when temperature remains > 35°C.

Commercial production of flowers, particularly grown under open field conditions, will be severely affected leading to poor flowering, improper floral development and colour. In chrysanthemum, which is a short-day plant, flowering round the year in open field condition is not possible. Low temperatures below 190C shut down flowering in jasmine and lead to reduction in flower size.

Adaptation strategies
Potential impacts of climate change depend not only on climate per se, but also on the system’s ability to adapt to change. The potential depends on how well the crops adapt to the concomitant environmental stresses due to climate change. Depending on the vulnerability of individual crop in an agro-ecological region and the growing season, the crop based adaptation strategies need to be developed, integrating all available options to sustain the productivity. The scientists have already developed several technologies to cope with extreme events like high temperature, frost and limited and excess moisture stress conditions. These available technologies could be integrated and made use to reduce the adverse impacts of climate change and climate variability. Further emphasis need to be put on developing the crop, agro-ecological region and season-based technologies to reduce the impacts and increase the resilience of horticultural production systems to climate change. Resistant root stocks and varieties for various fruit crops tolerant to stresses have been identified and being used to combat climate change.

In addition to employing modified crop management practices, the challenges posed by climate change could be tackled by developing tolerant varieties. Several institutions have evolved hybrids and varieties, which are tolerant to heat and drought stress conditions, which have potential to combat impact of climate change.

Production system management
The emphasis should be on use of recommended production systems for improved water use efficiency and to adapt to the hot and dry conditions. Strategies like changing sowing or planting dates in order to combat the likely increase in temperature and water stress periods during the crop-growing season should be adopted. Providing irrigation during critical stages of the crop growth and conservation of soil moisture reserves are the most important interventions. Crop management practices like mulching with crop residues and plastic mulches help in conserving soil moisture. In some instances excessive soil moisture due to heavy rain becomes major problem and it could be overcome by growing crops on raised beds. Production of vegetables could be taken up using clear plastic rain shelters, which can reduce the direct impact on developing fruits and also reduce the field water logging during rainy season. Planting of vegetables on raised beds during rainy season will increase the yield due to improved drainage. More heat tolerant cultivars are required under climate change conditions and these cultivars need to perform at par with the conventional varieties under non-stress conditions.

Mitigation strategies
Climate change is a reality and there is enough evidence to show that the emission of greenhouse gases has caused global warming
and associated climate change. In addition to adapting the horticultural production systems to adverse impacts of climate change, Horticulture can considerably contribute to the mitigation. The improved crop management practices can considerably reduce the emission of greenhouse gasses due to reduced dependence on energy needs and intensification of perennial horticultural crops will help in sequestering carbon dioxide from the atmosphere. Mitigation efforts through carbon sequestration help to reduce the adverse impacts of climate change. The information about carbon sequestration potential of fruit trees is scanty though they contribute significantly.

**Technological changes for mitigating effect**

Grape is a temperate fruit which has been largely grown under cool climate, be it for table purposes or for wine-making. But the technological change in plant architecture and production system management has helped to produce grape in tropical situation with highest productivity in the world. Likewise, chilling will not be enough to induce flowering in apple and high temperature in the mid hill agro-climatic conditions may cause desiccation in pollen, shrivelling of fruits resulting in reduced yield and more failure of the crops. These are the likely impact which causes the concerns. But, there are innumerable examples to understand that climate has been changing and the technologies have helped in mitigating the problem. Salinity and alkalinity were a great problem for successful growing of grape but identification of suitable rootstocks has made it highly productive. If we look to potato, tomato, cauliflower and cabbage, these are thermo-sensitive crops and were productive only under long day conditions in temperate climate. But, development of heat tolerant cultivars and adjustment in production system management has made it possible with very high productivity, even in subtropical and mild subtropical and warmer climates. These indicate that through innovative research in various horticultural crops, threat of climate change could be converted into the opportunity.
6. Government Programmes and interventions for Horticulture Development

6.1 Government Programmes
6.2 Mission for Integrated Development of Horticulture
6.3 National Horticulture Board (NHB)
6.4 National Medicinal Plants Board (NMPB)
6.5 National Mission on Oilseeds and Oil Palm (NMOOP)
6.6 Centres of Excellence
6.1 Several development programmes are under implementation which aims at integrated development of horticulture crops. These include:

- Mission for Integrated Development of Horticulture (MIDH)
- National Horticulture Board (NHB) programmes focusing on hi-tech horticulture and post-harvest management infrastructure, including cold storages and reefer vans. A majority of the schemes of NHB are credit-linked.
- National Medicinal Plants Board (NMPB) which coordinates with all matters relating to medicinal plants and support policies and programs for growth of trade, export, conservation and cultivation. The Board works under the Ministry of Ayurveda, Yoga & Naturopathy, Unani, Siddha & Homeopathy (AYUSH).
- National Mission on Oilseeds and Oil Palm, which includes promotion of oil palm cultivation in select areas.
- National Bee Board (NBB) for promoting bee keeping as a means to improve crop productivity.
- Setting up of dedicated “Centres of Excellence” for identified crops across different regions to promote hi-tech horticulture enterprises through demonstration, training & capacity building, technology transfer and handholding support.
- Programmes / promotional schemes of commodity boards like Tea Board, Coffee Board, Rubber Board, Spices Board, for the respective crops.

6.2 Mission for Integrated Development of Horticulture

6.2.1 With a view to giving focused attention for horticultural development in the country, Government of India has launched a Centrally Sponsored Scheme namely Mission for Integrated Development of Horticulture (MIDH) for the holistic growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic crops, coconut, cashew, cocoa and bamboo. The Mission programmes are implemented during XII Plan by subsuming interventions under National Horticulture Mission (NHM), Horticulture Mission for North East and Himalayan States (HMNEH), NBM (National Bamboo Mission), NHB (National Horticulture Board), Coconut Development Board (CDB) and Central Institute for Horticulture (CIH), Nagaland. MIDH is considered to be the major development and promotional intervention aimed at holistic development of horticulture sector in the country.

6.3 National Horticulture Board (NHB)

The main objectives of the NHB are to improve integrated development of horticulture industry and to help in coordinating, sustaining the production and processing of fruits and vegetables. Detailed objectives of the Board are as under:

(i) Development of hi-tech commercial horticulture in identified belts and make such areas vibrant with horticultural activity, which in turn will act as hubs for development of horticulture.
(ii) Development of modern post-harvest management infrastructure as an integral part of area expansion projects or as a common facility for cluster of projects.
(iii) Development of integrated, energy efficient cold chain infrastructure for fresh horticulture produce.
(iv) Popularization of identified new technologies/tool/techniques for commercialization / adoption, after carrying out technology and need assessment.
(v) Assistance in securing availability of quality planting material by promoting setting up of scion and root stock banks/mother plant nurseries and carrying out accreditation / rating of horticulture nurseries and need based imports of planting material.
(vi) Promotion of Farm Mechanization in Horticulture through demonstration and its uses at farmers field level to reduce labour cost and increase the productivity of Horticulture crops.
(vii) Promotion of applied R & D for standardizing post-harvest management protocols, prescribing critical storage conditions for fresh horticulture produce, bench marking of technical standards for cold chain infrastructure etc.
(viii) Transfer of technology to producers/farmers and service providers such as gardeners, nurserymen, farm level skilled workers, operators in cold storages, work force carrying out post-harvest...
management, including processing of fresh horticulture produce and to the master trainers.

6.4 National Medicinal Plants Board (NMPB)
i. NMPB is implementing a Central Sector Scheme for Conservation, Development and Sustainable Management of Medicinal Plants. The main objectives of the scheme are as follows:

ii. Promote in situ conservation of medicinal plants which are important to the AYUSH and Folk systems of medicine.

iii. Promote ex situ conservation by supporting such programs in rural/ degraded forest/ public/non-public/institutional lands/ urban & peri-urban lands and waste lands.

iv. Promote R&D in all aspects of medicinal plants, development of agrotechniques, post-harvest management, storage and processing, developing molecular characterization tools etc. and promotion of IT.

v. Mapping, upgrading, modernizing of medicinal plants supply chain and creating/ optimizing market linkages and value addition.

vi. Quality standardization, Good Collection Practices (GCPs) and Good Agricultural Practices (GAPs) for medicinal plants.

vii. Promote mainstreaming of medicinal plants in climate change mitigation strategies & promote regeneration/ afforestation of medicinal plant tree species towards carbon sequestration.

6.5 National Mission on Oilseeds and Oil Palm (NMOOP)
With per capita consumption of vegetable oils at the rate of 16 kg/year/person for a projected population of 1.276 million, the total vegetable oils demand is likely to touch 20.4 million MT by 2017. A substantial portion of our requirement of edible oil is met through import of palm oil from Indonesia and Malaysia. It is, therefore, necessary to exploit domestic resources to maximize production to ensure edible oil security for the country. Oil Palm is comparatively a new crop in India and is the highest vegetable oil yielding perennial crop. With quality planting materials, irrigation and proper management, there is potential of achieving 20-30 MT Fresh Fruit Bunches (FFBs) per ha after attaining the age of 5 years. Therefore, there is an urgent need to intensify efforts for area expansion under oil palm to enhance palm oil production in the country.

Efforts of India in promoting Oil Palm cultivation
In view of the importance and significance of oil palm cultivation, a Technology Mission on Oilseeds & Pulses (TMOP) has been taken up in 1991-92 in the potential states. A comprehensive Centrally Sponsored Scheme Oil Palm Development Programme (OPDP) was taken up during VII and IX Plans. During the X and XI Plans, GoI had provided support for oil palm cultivation under Centrally Sponsored Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM). To boost oil palm cultivation, GoI had implemented a Special Programme on Oil Palm Area Expansion (OPAE) under RKVY from the year 2011-12 to 2014-15. During the XII Plan, a new National Mission on Oilseeds and Oil Palm (NMOOP) has been launched under which Mini Mission-II (MM-II) is dedicated to oil palm area expansion and productivity increases. MM-II of NMOOP is being implemented in 12 States viz. Andhra Pradesh, Telangana, Chhattisgarh, Tamil Nadu, Kerala, Gujarat, Karnataka, Odisha, Mizoram, Nagaland, Assam and Arunachal Pradesh. The objective of the Scheme is to bring additional 75,000 hectare area under oil palm cultivation through area expansion approach in the country during two years viz. 2017-18 and 2018-19.

The strategies for oil palm are as under:
i. Special focus for promotion of oil palm in all NE states.

ii. To meet the planting materials requirement for new plantation both from indigenous and imported sources.

iii. Support to farmers for planting materials, inter cropping & maintenance cost for gestation period (4 years), bore well, drip irrigation, harvesting tools.

iv. Capacity building of farmers and extension officials.

v. Assured procurement of fresh fruit bunches (FFBs) through processors.

vi. Supporting oil palm growers through Market Intervention Scheme (MIS) to provide remunerative prices of FFBs as and when international CPO price fall below $ 800 per MT.
Tree Borne Oilsseeds (TBOs) like sal, mahua, simarouba, kokum, olive, karanja, jatropha, neem, jojoba, cheura, wild apricot, walnut, tung, etc. are cultivated/grown in the country under different agro-climatic conditions in a scattered form in forest and non-forest areas as well as in waste land/deserts/hilly areas. These TBOs are also good source of vegetable oil and therefore need to be supported for cultivation.

6.6 Centres of Excellence

Considering the need to promote horticulture, Centres of Excellence (CoE) have been identified for various horticultural crops which can be of demonstrative effect for promoting horticulture. Some of the active centres of excellence set up are indicated below:

Table-5: State-wise Crop-specific Centres of Excellence

<table>
<thead>
<tr>
<th>State</th>
<th>Crop</th>
<th>Location</th>
<th>Technology demonstrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>Vegetables</td>
<td>Khartapur</td>
<td>Hi tech nursery, open filed mulching, walking tunnels, drip irrigation, fertigation, net houses, poly houses cultivation</td>
</tr>
<tr>
<td></td>
<td>Citrus</td>
<td>Khanaura, Hoshiarpur</td>
<td>Hi tech nursery, planting on ridges, spacing, grafting, pruning, drip irrigation, fertigation, plant protection</td>
</tr>
<tr>
<td>Haryana</td>
<td>Vegetables</td>
<td>Karnal, Gharunda</td>
<td>Hi tech nursery, open filed mulching, walking tunnels, drip irrigation, fertigation, net houses, poly houses cultivation</td>
</tr>
<tr>
<td></td>
<td>Citrus and pomegranates</td>
<td>Mangiana</td>
<td>Hi tech nursery, planting on ridges, spacing, grafting, pruning, drip irrigation, fertigation, plant protection, trellising (Y shape)</td>
</tr>
<tr>
<td></td>
<td>Mango</td>
<td>Ladwa</td>
<td>Rejuvenation of senile orchards, Hi tech nursery, drip irrigation, densification of the orchards</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>Pomegranates</td>
<td>Bassi</td>
<td>Hi tech nursery, planting on ridges, spacing, drip irrigation, fertigation, plant protection, trellising (Y shape)</td>
</tr>
<tr>
<td></td>
<td>Citrus</td>
<td>Kota</td>
<td>Hi tech nursery, planting on ridges, spacing, grafting, pruning, drip irrigation, fertigation, plant protection</td>
</tr>
<tr>
<td>Gujarat</td>
<td>Vegetables</td>
<td>Vradrad, Sabarkantha</td>
<td>Hi tech nursery, open filed mulching, walking tunnels, drip irrigation, fertigation, net houses, poly houses cultivation</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>Citrus</td>
<td>Nagpur</td>
<td>Hi tech nursery, planting on ridges, spacing, grafting, pruning, drip irrigation, fertigation, plant protection</td>
</tr>
<tr>
<td></td>
<td>Alphonso mango</td>
<td>Dapoli, Ratnagiri</td>
<td>Rejuvenation of senile orchards, Hi tech nursery, drip irrigation, densification of the orchards</td>
</tr>
<tr>
<td></td>
<td>Kesar mango</td>
<td>Aurangabad</td>
<td>Rejuvenation of senile orchards, Hi tech nursery, drip irrigation, densification of the orchards</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>Vegetables</td>
<td>Reddiyar Chathram, Dindigul</td>
<td>Hi tech nursery, open filed mulching, Irrigation, fertigation.</td>
</tr>
</tbody>
</table>

GoI is also considering setting up of ‘centre of excellence’ in Jalandhar (Punjab), Baramati (Maharashtra) and Thiruvananthapuram (Kerala) under Indo Dutch Cooperation project.
7. Thrust areas / Hi-tech horticulture enterprises for development with credit

7.1 Credit linkages

7.2 Approach for augmenting credit flow for P & H sector
Considering the emerging opportunities, growth potential due to widening market opportunities and relatively higher profitability, the following activities are considered as the thrust areas for promotion with institutional credit support.

i. Protected cultivation
ii. Organic farming
iii. Precision farming
iv. Integrated Value chain financing
v. Integrated Cold chain infrastructure for perishables
vi. Fruit & Vegetable processing

7.1 Credit linkages: Since investments in these thrust areas are highly capital intensive, with long gestation period, facilitating institutional credit, therefore assumes significance. Several of the interventions and incentives under the government programmes discussed under foregoing paragraphs facilitate enabling environment for investments in critical and productive infrastructure and offer scope for convergence with credit plans of financial institutions

7.2. Approach for augmenting credit flow for P & H sector
- Innovative credit products to cater to diverse credit needs of P & H sector activities.
- Crop / activity specific Banking Plans / Area Development Plans dovetailed with Government Sponsored Programmes (MIDH, NMOOP, etc.)
- Bringing more and more small holders under high value horticulture production system through incentives and adopting group / cluster approach.
- Interventions towards extension, training, capacity building and hand-holding support.
- Facilitation towards aggregation, sorting / grading and collective marketing for ensuring remunerative price of their produce on sustainable basis
- Addressing gaps in critical infrastructure in post-harvest management through investment by private sector and / or PPP mode.
- Risk mitigation through integrated farming models, crop specific insurance products for better coverage and making insurance coverage as mandatory.
- Thrust on dry land horticulture by promoting drip/micro irrigation systems.
8. Challenges
By 2050, the population in the country is expected to touch 2 billion by which time there will be pressure on supply of horticultural crops like fruits and vegetables to a tune of 450 million tonnes (from the present level of about 258 m MT). Taking the increasing demand for processing (it is estimated that for every increase in the level of processing by 1%, the additional demand for fruits and vegetables would be 2.5 to 3.0 million tonnes) and export demand, the total estimated demand by 2050 is 540 m MT). Thus, the challenge is to more than double the production of fruits & vegetables in about 3 decades period. On the other hand, the increase in demand is being / will be faced with several challenges, as discussed briefly below:

(i) Low Productivity
One of the disquieting features of Indian horticulture is the low productivity of fruits, vegetables, flowers and medicinal crops. Among fruits, with the exception of banana and papaya, average productivity is 12 MT/ha, much lower than potential biological yields of fruit crops. Similar is the case with vegetable crops, where, the average yield is 17 MT/ha. The reasons for low productivity can be attributed chiefly to non-availability of quality planting material, dwindling natural resources, resource-poor farmers, low adoption of modern technologies, etc. The challenge is to enhance productivity by increasing factor productivity in all horticulture-production inputs while sustaining it by adopting good agricultural practices and precision-farming principles.

(ii) Depleting Land-Resources and Degraded Production-Environment
Indian agriculture is predominantly small holders’ agriculture, as, over 82 per cent of the holdings are small and marginal. The average size of landholding declined from 2.28 ha in 1970-71, to 1.55 ha in 1990-91 and, to 1.23 ha in 2005-06, with concurrent increase in the absolute number of operational holdings from about 70 million to 129 million. If this trend continues, the average size of a holding in India would be a measly 0.3 ha by 2050. As a result, there will be increased pressure on land-use for horticultural crops, which would pose greater challenge for increasing production to the levels expected. In addition to this, management of a fragile natural ecosystem with depleting organic matter and nutrient status in the soils, erratic monsoons, depleting groundwater resources, deterioration in water quality, etc., is a challenge to be addressed in future. Even in good arable lands, problems of land and water degradation are daunting challenges for sustaining productivity.

(iii) Post-Harvest Losses and Value-Addition
Horticultural crops are highly perishable. In the Indian horticulture sector, substantial pre- and post-harvest losses occur at different stages of handling, transport, storage, processing and distribution of produce. Losses at pre- and post-harvest stages have been estimated at 30%. At present, there is a huge mismatch between production capacity of fruits, vegetables, flowers and medicinal crops in the country, and the infrastructure available for post-production distribution, storage and value-addition. The biggest challenge is to devise means and take measures to reduce post-harvest losses in fruits and vegetables, to maintain quality during distribution and ensure safety of the produce for consumption.

(iv) Changing Quality-Consciousness and Global Competition
Horticultural crops are powerhouses of essential nutrients and minerals required for nutritional security. With increase in purchasing power of Indian population and with consumers becoming increasingly health and quality conscious, it is imperative to ensure quality and safe horticulture produce. Apart from this, a high demand for processed products of high quality is envisaged. Further, with the changing scenario in world trade, we need to produce horticultural commodities of international standards. Non-existence of appropriate quality monitoring mechanism for domestic market is a challenge to be addressed.

(v) Climate change
Climate change is an important environmental issue of great concern that can affect the horticulture sector immensely. The increase in global average temperatures due to greenhouse gas emission could pose challenges like high temperature stress during critical crop growth stages, excess moisture stresses caused by extreme rainfall events, incidence of insect pest and diseases and emergence of new insect pests and diseases. The high temperature situations could cause water stress conditions due to increased evapotranspiration, necessitating...
higher crop water needs. The seasonal temperature changes could cause shifts in agro-ecological regions and emergence of completely new areas suitable for various horticultural crops. Thus, climate change will significantly influence productivity, production and quality of horticultural crops.

(vi) Inadequate Market Linkage and Price Fluctuations
Establishing appropriate supply chain mechanism and upgradation of market infrastructure facilities for obtaining information on fluctuating prices poses a major threat for horticultural producers in realizing higher returns.
9. Approaches
To work on the challenges indicated above, the following approaches may be the major ones that may be adopted.

(i) **For Enhancing Crop Productivity**
   a) Consolidation and management of horticultural genetic resources.
   b) Development of improved varieties/ hybrids through conventional breeding and new technologies like marker-assisted breeding, in vitro techniques, transgenic technology, nanotechnology, etc., for abiotic and biotic stresses.
   c) Application of Space Technology for improving the biological yield potential and productivity.
   d) Agro-techniques for improved productivity, canopy architecture and high density planting for efficient light interception and photosynthesis.
   e) Development of efficient techniques for production of quality seed/planting material of varieties and hybrids.
   f) Maintenance breeding and supply of adequate quantities of breeder seed and mother plant material.
   g) Multiplication and distribution of quality seed and planting material of improved varieties

(ii) **For Enhancing Crop Productivity through Efficient Resource Management**
   a) Enhancing crop productivity through protected cultivation and vertical farming.
   b) Breeding horticultural crops suitable for protected cultivation and mechanized farming.
   c) Development of technologies for aeroponics, hydroponics and soilless culture.
   d) Developing efficient water and nutrient management systems including automated and pulsed micro-irrigation and fertigation.
   e) Development of precision farming techniques, farm mechanization and energy management; nanotechnology for crop production, protection and post-harvest management; integrated crop specific nutrient management.
   f) Application of GIS / remote sensing for diagnosis of nutrient deficiency

(iii) **Enhancing the quality of Horticultural Produce**
   a) Breeding for high nutritive, aesthetic & medicinal value, processing and export quality.
   b) Breeding varieties for improved shelf-life.
   c) Technologies for production of organic fruits & vegetables.
   d) Crop production management for enhancing quality.

(iv) **Evolving Sustainable and Climate-Resilient Technologies**
   a) Integrated horticulture-crop based farming systems by adapting climate resilient technologies.
   b) Phenotyping germplasm for abiotic and biotic stress tolerance traits and genetic enhancement for developing appropriate genotypes and rootstocks.
   c) Genomic studies for better understanding of genetic variation in stress tolerance traits.

(v) **For Minimizing Post-Harvest Losses**
   a) Integrating pre- and post-harvest protocols for minimizing postharvest losses.
   b) Value-addition and product diversification.
   c) Utilization of by-products, residues and horticultural waste for value-added food and feed products forging linkage with industry

(vi) **Marketing**
   a) Establishing efficient linkages and developing appropriate strategies through alternate marketing arrangements, market intelligence and price forecast.
   b) Returns on investment and total factor-productivity studies.
10. Doubling of Farmers’ Income
Doubling real income of Farmers by 2022-23 over the base year of 2015-16, as perceived by the Government of India, requires annual growth of 10.41% in farmers’ income. It is needless to emphasize that Horticulture sector, especially vegetable and flower crops, play a major role in this endeavour. The major sources of growth within agriculture sector are:

(i) Improvement in productivity
(ii) Resource use efficiency or saving in cost of production
(iii) Increase in cropping intensity
(iv) Diversification towards high value crops

The National Round Table on Doubling Farmers’ Incomes by 2022, organized by the Indian Council of Agricultural Research (ICAR) has made 40 recommendations for increasing incomes of farmers, divided into five factors, as under:

(v) Increasing incomes by improving productivity
(vi) Water and Agri-Input policies
(vii) Integrated Farming System
(viii) Better market price realization
(ix) Special Policy Measures

Major interventions recommended/identified under the above factors are:

(i) Increasing incomes by improving productivity
   a) Biotechnology to play critical role in crop and livestock production by enhancing yields, nutritional profile, stress tolerance and crop protection
   b) Improving crop productivity in rain fed regions of India. Besides watershed management, constructing check dams and farm ponds should be taken up in a mission mode for providing life-saving irrigation for the crops.
   c) Bridging yield gaps among the States. There is urgent need for developing a strategy document for assessing the present trends of crop productivity vis-a-vis the potential yield of major crop systems, so that specific action plans can be taken up for bridging the yield gaps, which in turn will contribute to enhanced productivity of farming systems.

(ii) Water and Agri-input policies
   a) Fertilizer subsidy and rationalizing the NPK pricing for maintaining NPK ratio in the soil and better application technologies to improve efficiency and reduce fertilizer subsidy.
   b) Crop losses in India are huge and estimates range from ₹ 90,000 to ₹ 1.50 lakh crore annually. Pesticides play an important role not only in crop productivity, cost reduction and quality improvement but also in protecting crops from pests and diseases. The cost benefit ratio in using pesticides is heavily in favour of farmers. The Government however needs to check flood of spurious pesticides in market by fly-by-night operators by regulating registrations, strengthening quality enforcement and tackling corruption through provisions of joint testing of samples.
   c) Farm Mechanisation in India has been a story of tractorisation. Time has come to promote efficient equipment and tools and small engine driven tractors to address small farm requirements adequately.
   d) There is a need for integrated water use policy. India should critically examine several ongoing initiatives and develop its country-wide system for judicious and integrated use and management of water. A national commission on efficient water use in agriculture should be established to assess the various issues, regulatory concerns, water laws and legislations, research, technology development and community involvement. This will especially help resource-poor farmers in the rainfed ecosystems, who practice less-intensive agriculture.

(iii) Integrated Farming System
   a) Promotion of Integrated farming system approach involving synergic
blending of crops, horticulture, dairy, fisheries, poultry, etc. seems viable option to provide regular income and at site employment to small land holder, decreasing cultivation cost through multiple use of resources and providing much needed resilience for predicted climate change scenario.

b) Promotion of intensive vegetable production using improved varieties, organic manure and drip irrigation, can provide five times higher annual income to the tune of ₹ 2 lakh per acre (BAIF’s experience in Andhra Pradesh, Karnataka and Maharashtra).

(iv) Better market price realization

a) Revision of the APMC Act and monitoring its implementation in the states. Need to amend APMC act by all the states to encourage competitive marketing environment and participation in NAM.

b) The launch of NAM requires easing of norms of licensing to enable seamless participation of buyers from across the country, movements of goods without restriction, harmonization of tax laws (including a uniform GST), standardization of grades and recognition of electronic trades.

c) Agri infrastructure, storage systems and market yards needs to be strengthened. More multipurpose market yard complexes, comprised of warehouses, cold storage, farmers service centre etc. needs to be set up for farmers to directly participate, especially online in NAM.

d) Reducing post-harvest losses by strengthening grain storage infrastructure, cool chain systems for perishables, post-harvest processing and value addition, transport, marketing, commerce and trade. FPOs can play an important role, provided they are provided proper training.

(v) Special Measures

a) Through a nationwide crops competitiveness study, States’ profiling of crops and animal resources should be done, indexing them against national and global benchmarks on cost, quality and productivity parameters, and their short, medium and long term strategic advantages. Based on this national indexing and estimation of market demands in short, medium and long terms national crop planning needs to be done.

b) Implementing ambitious Agribusiness Hubs Model, operating on a national platform and establishing 2.40 lakh multi-functional Agribusiness hubs in all the Gram Panchayats of the country. This will revolutionize the farm economy and create jobs.

c) ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities. Information technology can support better crop, fertilizer and pesticide use planning as well as disease monitoring and prevention, both in crops and animal husbandry, besides improving farmers’ operational and financial management and to effectively connect them with the markets for better price realisation.

d) Integrating all central and state subsidies, instead of reducing costs of inputs, need to be targeted to empower farmers through infrastructure development in rural areas to promote agribusiness, food processing, water management, soil health enhancement, seed production and processing, custom hiring, plant protection, dairy, poultry, fisheries and enterprises etc.
11. Role of NABARD in development of P&H Sector
NABARD as an apex development bank is playing prominent role in development of horticulture sector through credit. The strategic action plan for enhanced role of NABARD in development of Horticulture sector is given below:

i. Mapping potential and credit planning
ii. Enhancing the credit delivery and linkage of financial assistance schemes of GOI
iii. Facilitating credit absorption at ground level- Area Development Projects/banking plans, etc.
iv. Capacity building of banks/credit institutions
v. Capacity building and promoting producers organization/collectives
vi. Piloting innovations through technology transfer
vii. Promoting dry land horticulture through watershed approach
viii. Climate resilient Horticulture and climate change adaptation
ix. Marketing-building brands, industry linkages etc.
x. Promoting food processing at all levels (primary, secondary or tertiary)
xi. R&D support for applied research and field demonstration of adoptable technologies
12. Technological Innovation in Horticulture Sector
(I) Protected Cultivation of High Value Vegetables
Protected cultivation technology is very advanced technology in the Horticulture which has the potential to increase the vegetable production from 5 to 6 times as compared to open field conditions. High value vegetables such as coloured capsicum, parthenocarpic cucumber, cherry tomato, hybrid tomato are highly recommended for this technology.

High-Tech Seedling Production
The disease free, healthy and high quality vegetable seedlings are produced under high tech greenhouse in the soil-less media. Approximate 3 million vegetable seedlings are produced on annual basis.

Vegetable Seedling Production under Hitech Green House (HGH)

Institution where technology has been developed and tested (piloted)
Centre of Excellence for Vegetables (An Indo-Israel Project), National Highway – 1, Opposite Liberty Shoe Factory, Gharunda (Karnal), Haryana, Pin Code – 132114, Tel. 01748-251621, Email: cev.karnal@gmail.com

Advantages and Efficacy of the technology
a) Increase in productivity from 5 to 6 times as compare to open fields.
b) The quality of the produce is also superior.
c) Protection from biotic factors viz. insect pest & birds.
d) Protection form Abiotic factors viz. rainfall, low temperature etc.
e) The dream of doubling the farmers’ income can be achieved by using this technology.
f) Saving of water and fertilization up to 70%.

Tentative Cost
a) HGH (High-Tech Green House/Fan & Pad Type): Approx. ₹ 1465 per sq.m.
b) NVPH (Naturally Ventilated Poly House): Approx. ₹ 850 per sq.m.
c) WIT (Walk-In-Tunnel): Approx. ₹ 600 per sq.m
   d) AINH (Anti Insect Net House): Approx. ₹ 600 per sq.m.
Scope of transfer and up-scaling of the technology
As the technologies have high potential of increase in the quality and production, therefore scope of transfer of the technology is very high.

(2) Solar Drier for Drying Fruits and Vegetables
By converting solar radiation into heat energy, fruits and vegetables can be dried successfully. A unit run by M/S Jay Veer Foods Pvt. Ltd. in Chanasma, Patan district, Gujarat has successfully demonstrated the same.

Brief Description of the Technology
The technology basically involves heating the air trapped between the solar panels and the black surfaced rooftop and then blowing the heated air into the driers for drying fruits and vegetables. The unit can dry 250 kg per day. However, duration will vary depending on the commodity used.

Advantages of the Technology over Conventional Sun Drying

<table>
<thead>
<tr>
<th>Conventional Sun Drying</th>
<th>Solar Drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires larger area</td>
<td>Large quantities can be handled in a compact area</td>
</tr>
<tr>
<td>Time consuming</td>
<td>Takes lesser Time</td>
</tr>
<tr>
<td>Highly labour intensive</td>
<td>Less labour intensive</td>
</tr>
<tr>
<td>Quality deterioration and spoilage of the produce due to exposure to moisture, wind, dust etc.</td>
<td>Produce gets dried without any deterioration in quality and spoilage</td>
</tr>
</tbody>
</table>

Tentative cost
The overall cost of the unit is ₹ 55 lakh that includes the solar panels, blowers, inlet and outlet chambers, driers, ducts and civil cost for the building. The approx. cost of the broad components is as under:

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost (₹ Lakh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar panels</td>
<td>4.00</td>
</tr>
<tr>
<td>Blowers, Inlet and outlet chambers, dryers, ducts</td>
<td>13.00</td>
</tr>
<tr>
<td>Civil cost for building</td>
<td>38.00</td>
</tr>
</tbody>
</table>

Scope of transfer/upscaling of the technology
The technology can be used for creating common facility centres for drying of vegetables/ fruits in major production centres of the State, especially in tribal districts.

Source of information: Official Websites of Coffee Board, Tea Board, Rubber Board, National Horticulture Board, Spices Board, National Medicinal Plants Board, Ministry of Agriculture and Co-operation, GOI, APEDA, Indian Institute of Horticultural Research, etc.