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# Horticulture for food, nutritional and socio-economic security in India

**India is bestowed with several agro-ecological regions which provides ample opportunities to grow a variety of horticultural crops which form a significant part of total agricultural produce in the country comprising fruits, vegetables, root and tuber crops, flowers and other ornamentals, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms. India is the second largest producer of fruits and vegetables in the world. Only 17% of arable land is being utilized for the cultivation of horticultural crops (27.2 million ha) and produced 329.86 million tonnes in 2020-21 with 2.05% higher than the previous year and 8.5% higher than the previous five years. The total production of fruit was 102.76 million MT with an average productivity of 14.51 MT/ha and vegetable production was 196.27 million MT with an average productivity of 17.11 MT/ha.**

THE horticultural crops contributed 30% to Gross Net Value (GNV) of agriculture. Fruit and vegetable availability per capita increased from 397 g/day in 2004-05 to 540 g/day. Exports increased by more than 3 times in 10 years. After independence, there has been tremendous growth in area and production of horticultural crops but on the other hand productivity has left far behind as compared to several advanced countries. The low productivity is mainly attributed to several factors including cultural practices, environmental, physiological

**High yielding hybrids/varieties in fruit crops**

Arka Udaya

Arka Udaya

Arka Prabhat

Arka Surya

Arka Kiran

Arka Sahan

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# Horticulture for food...

**Promising vegetable hybrids from IIHR**

Arka Rakshak

Arka Samrat

Arka Harita

Arka Meghana

Arka Bheem

Arka Sharath

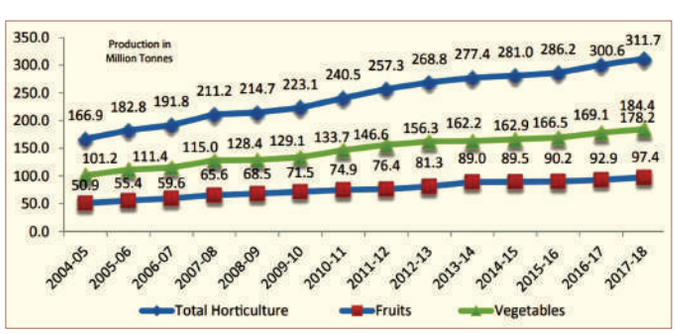
and biological factors. But over the years, climate change is playing a significant role on the occurrence of erratic rain, rising temperature, flood, snowfall, landslides, droughts, etc. resulting in variation in the production pattern of several horticultural crops.

## Scenario of horticulture in India

The area and production trend shows that there has been a sharp rise in production of horticulture crops with production during the year 2017-18 (Final) reaching 311.7 million tonnes which is 3.7% higher than the previous year and 10% higher than the past 5 years' average production. Production of fruits is estimated at 97.35 million tonnes which is 4.8% higher than previous year. Production of vegetables is estimated at about 187.5 million tonnes which is about 3.5% higher than the previous year. With an increase of 3.7%, the production of onion during the year 2017-18 is estimated at 23.26 million tonnes as against 22.4 million tonnes in 2016-17. Production of potato in the year 2017-18 (Final) is estimated at 51.3 million tonnes as against 48.6 million tonnes in 2016-17 (5.6% higher than 2016-17). India is the largest producer of ginger and okra amongst vegetables and ranks second in production of potatoes, onions, cauliflowers, brinjal, cabbages, etc. Amongst fruits, the country ranks first in production of bananas (25.7%), papayas (43.6%) and mangoes (including mangosteens and guavas) (40.4%).

## Production trend of horticulture in India

The vast production base offers India tremendous opportunities for export. During 2017-18, India exported fruits and vegetables worth ₹ 9,410.81 crore/ 1,459.93 USD millions which comprised fruits worth ₹ 4,229.03 crore/ 655.90 USD million and vegetables worth



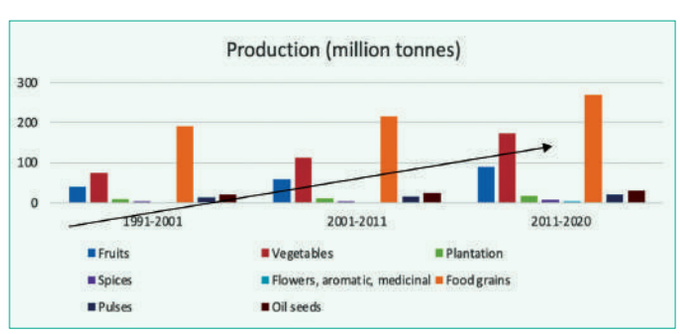




Fig. 1. Production trend of various horticultural crops

Tomato (300 t/ha/year)

Capsicum (200 t/ha/year)

Gherkin and muskmelon in polyhouse

₹ 5181.78 crore/ 804.03 USD million. Mangoes, walnuts, grapes, bananas, pomegranates account for larger portion of fruits exported from the country while onions, okra, bitter gourd, green chilies, mushrooms and potatoes contribute largely to the vegetable export basket. The major destinations for Indian fruits and vegetables are UAE, Sri Lanka, the Netherland, Bangladesh, Malaysia, Nepal, UK, Saudi Arabia and Qatar.

Indian floriculture industry comprises flowers such as rose, tuberose, glads, anthurium, carnations, marigold, etc. The Indian floriculture market was worth INR 157 billion in 2018. The market is further projected to reach INR 472 billion by 2024, growing at a CAGR of 20.1% during 2019-2024. India's total export of floriculture was ₹ 571.38 crore/81.94 USD million in 2018-19. The major importing countries were United States, the Netherlands, United Kingdom, Germany, and United Arab Emirates.

There has been a progressive positive trend in area, production and productivity of horticultural crops as compared to agricultural crops over last 3 decades. Horticulture Development received major boost in X Plan where several schemes were launched for development of horticulture. During this plan, several initiatives like Technological Mission for Integrated Development of Horticulture in North East Region, National Horticulture Mission, Micro-irrigation Mission Technology, Mission for Integrated Development of Horticulture in North East Region and Himalayan States, the Technology Mission for Integrated Development of Horticulture were launched in 8 states of north-east region in 2001-02 to harness the potential of horticulture development.

**Hi-tech horticulture**

*Improved high yielding varieties*

Several high yielding varieties in horticultural crops have been developed and released in fruits, vegetables, flowers and many other crops for various regions. The tapping hybrid vigor or heterosis in vegetable crops has revolutionized vegetable farming both in self and cross pollinated crops. Further, the development of male sterile lines and their commercial exploitation economized the hybrid seed production, which led to the emergence of private sector catering to hybrid seeds of vegetables. Last five decades the main focus was given for the development of varieties and hybrids for high yields, quality and resistance to various biotic and abiotic stresses. Research work is being carried out for improvement and production aspects of various horticultural crops such as fruits, vegetables, ornamental crops, medicinal and aromatic plants and mushroom. In fruit crops, a total of 40 hybrids/varieties in fruit crops have been developed and released for commercial cultivation of which the varieties such as Arka Udaya (mango), Arka Kiran and Arka Mridula (guava), Arka Surya and Arka Prabhat (papaya), Arka Sahan (custard apple) are being popular among the farmers. In vegetable crops, improvement and production work is being carried out in 30 different vegetable crops, and more 136 hybrids were released of which the hybrids/ varieties such as Arka Samrat and Arka Rakshak (tomato), Arka Anand (brinjal), Arka Anamika (okra), Arka Khyati and Arka Meghana (chilli), Arka Manik (water melon), Arka Suvidha, Arka Komal and Arka Anoop (French Bean), Garden Pea (Arka Ajit), Arka Garima (cowpea), Arka Jay and Arka Vijay (dolicos bean), Arka Bahar (bottle gourd), Arka Harit (bitter gourd) and Arka Sujat and Arka Sumeet (ridge gourd) are very popular among vegetable growers. Besides, research on improvement and production techniques are being carried out in 19 ornamental crops, 6 medicinal plants and 2 aromatic crops. A total of 75 hybrids/varieties in ornamental crops, 9 hybrids/varieties in medicinal plants and 3 varieties in aromatic crops have been released of which the varieties such as Arka Prajwal (tube rose), Arka Bangara and Arka Agni (marigold), Violet Cushions and Poornima (China aster) and Arka Alankar (crossandra) are being popular among farmers. Besides this, several promising lines of betelvine for commercial cultivation were also developed.

*Protected cultivation of flowers and vegetables*

Protected cultivation is a cropping technique for growing horticultural crops under protective structures to shield them from pests and weather for assured, climate-resilient and enhanced production of quality products. India has a long tradition of cultivating flowers mainly for use in religious and social functions apart from making floral ornaments for personal adornment. The area under floriculture in India is only 0.76 % of the global area. The area under protected cultivation is very low in India as compared to many flower producing countries. In between 1991 and 1996, about 170 export-oriented floriculture units with 1,545 million stems capacity (small and big) were started in various parts of the country involving more than 1,500 crore for growing 40 varieties of roses in an area of 500 ha, of which 70 units are operational. Indian

floriculture is constrained by lack of awareness, weak infrastructural support, lack of quality planting material, post-harvest facilities, exploitation by middlemen, lack of organized markets and weak database. There are more than 300 export-oriented units in India. More than 50% of the floriculture units are based in Karnataka, Andhra Pradesh and Tamil Nadu. With the technical collaborations from foreign companies, the Indian floriculture industry is poised to increase its share in world trade.

*Drip fertigation*

The new technologies of micro-irrigation now include drip/trickle systems, surface and sub-surface drip tapes, micro-sprinklers, sprayers, micro-jets, spinners, rotors, bubblers, etc. Micro-irrigation is popularly practised in about 30 crops, and is more popular in horticultural crops which allow relatively wide spacing. It is however critical that micro-irrigation is popularised and facilitated in field crops grown in rainfed cultivation systems. This will benefit the small and marginal farmers, who are predominant practitioners of field crops and rainfed farming systems. Studies have revealed that water savings ranging between 25 and 50% are possible by drip irrigation compared with surface irrigation. Micro-irrigation also facilitates application of controlled quantity of water and nutrients in the vicinity of each plant, such that the crop, water and nutrient needs are almost matched with irrigation water supplies.

*High-density planting*

High density means to increase the plant population per unit area for increasing the production of fruit crops or HDP is one of the novel methods to achieve high productivity per unit area both in short duration and perennial horticultural crops. In mango, HDP at 1111 trees/ha on 'Olour' rootstock with Paclobutrazol application from 4$^{th}$ year at 0.125g/tree/year of age, stabilized by the 10$^{th}$ year resulted in 6-fold increase in productivity. Similarly, cv. Amrapali at 2.5 × 2.5 m in triangular system accommodation of 1600 and cv. Dashehari at 3.0 × 2.5 m in square system–1333 plants/ha. Increase in yield per ha was 2.5 times in Amrapali than that of the low density orchards of vigorous cultivar. In cv. Dashehari, the average yield in high density is reportedly 9.6 tonnes compared to 0.2 tonnes in low density planting. In citrus, kinnow on Troyer Citrange and Karnakhatta rootstocks could be planted at 1.8 × 1.8 m and 3 × 3 m to accommodate 3,000 and 1,088 plants/ha, respectively. In pineapple, population density of 63,758/ha coupled with improved package of agrotechniques resulted in increase in yield from 15-20 to 70-80 t/ha.

In banana, the following HDP methods are being commercially practiced:

| | |
|---|---|
| Robusta | 4400 plants/ha (1.5 m x 1.5 m spacing) -- 120 t/ha |
| Dwarf Cavendish | 4400 plants (1.5 m x 1.5 m spacing) --100 t/ha |
| Ney Poovan | 5120 plants/ha (1.5 m x 1.5 m- triangle planting) recommended, which is 16% more than 4440 plants/ha (1.5 m x 1.5 m planting). |

The concept of HDP and UHDP or meadow orcharding is very successful in apple (Table 1) and it is being commercially practiced by many growers.


Enhancing water efficiency

Fertigation in fruit crops

*Canopy management*

Canopy management is the manipulation of tree canopies to optimize the production of quality fruits. The canopy management, particularly its components like tree training and pruning, affects the quantity of sunlight intercepted by trees, as tree shape determines the presentation of leaf area to incoming radiation. An ideal training strategy centers around the arrangement of plant parts, especially, to develop a better plant architecture that optimizes the utilization of sunlight and promotes productivity. Light is critical to growth and development of trees and their fruits. Strong bearing branches tend to produce larger fruits. The problem of a fruit grower is initially to build up a strong and balanced framework of the trees, then equip them with the appropriate fruiting. Obviously, pruning in the early years has to be of a training type to provide strong and stocky framework with well spaced limbs or any other desired shape.

*Soilless culture*

Soilless culture is one of the best techniques to overcome local water shortages, while also producing high quality produce, even in areas with poor soil structure and problematic conditions. Soilless culture is a method of growing plants without soil. The application of these systems is likely to increase close to existing cities as well as in mega-cities worldwide in the near future.

In order to meet out the growing demand for soilless culture technology, ICAR-IIHR has initiated a project on development and standardization of soilless cultivation of vegetables on Arka Fermented Cocopeat under open and protected conditions during the year 2015. Under this project, the production technology including nutrient formulations for open and polyhouse soilless cultivation of most commonly consumed vegetables, viz. tomato, chilli, cabbage, cucumber, brinjal, cow pea, dolichos, French bean, garden peas, ridge gourd and leafy vegetables and few exotic vegetables like zucchini, broccoli and colour cabbage using Arka Fermented Cocopeat as substrate has been standardized. The results of most of the experiments conducted with different vegetable crops in grow bags under open-field and polyhouse soilless culture indicated that the plants grown in soilless culture recorded higher yield and better quality particularly in mineral nutrient content compared to soil grown plants.

*Vertical farming*

Vertical farming is the practice of growing crops on a smaller land area, by the utilization of vertical space, which is usually left unutilized in traditional agriculture. Though vertical farming has been in vogue since ancient times as evinced by the Hanging Gardens of Babylon, the modern concept of vertical farming involves the union of plant biology and suitable engineering know-how. lt can be considered as an extension of indoor farming that evolved in the 1700s with the advent of greenhouses, with the primary objective of harnessing the off-season crop cultivation potential during unfavourable seasons. This involves the stacking of crops growing platforms in a vertical fashion and providing the necessary nutrition and lighting by artificial means in order to cultivate crops all-round the year. Most commercial vertical farm ventures in developed countries operate from existing warehouses or abandoned factories/buildings that have been suitably converted to hydroponic/aeroponic facilities with LED based illumination systems. Further, utilizing vertical space, is highly energy intensive since artificial illumination needs to be provided for crop production in multi-tiered structures. Therefore, uninterrupted power supply would be a limiting factor for vertical farming under Indian conditions. Apart from this, the high initial costs of the infrastructure and the operating costs may act as deterrents for large scale vertical farming, therefore, there is a need to develop country specific infrastructure and technology before vertical farming can be adopted on a large scale in India. Other limitations of the vertical farming include the cultivation of crops without sufficient scientific validation, lack of varieties/hybrids that have been exclusively bred for the purpose of vertical farming, lack of Good Agricultural Practices for vertical farming situations and the design of existing high-rise structures that are not amenable for vertical farming. The above limitations could be taken up as researchable issues to promote vertical farming in India.

*Quality planting material production*

Availability of planting material (Table 2) of good quality is one of the most important elements of successful horticultural production. Planting material available to small-scale farmers in different areas is often of insufficient quality, which undermines potential yield

Table 1. High density planting of apple

| Canopy management system | Number of plants/ha (spacing) | Recommended rootstock | Average yield (t/ha) (Age of plants) |
|---|---|---|---|
| Modified central leader system | 625 (4 × 4 m)<br>1600 (2.5 × 2.5)<br>2222 (3.0 × 1.5) | Seedling<br>M-106<br>M-9 | 25-40 (10-12 yrs)<br>40-45 (8-10 yrs)<br>30-35 (7-8 yrs) |
| Spindle bush | 2222 (1.5 × 3.0 m) | M-9 | 35-45 (7-8 yrs) |
| Head and spread | 2222 (1.5 × 3.0 m) | M-9 | 40-50 (7-8 yrs) |
| Cordon system | 8888 (1.5 × 0.75 m) | M-9 | 55-60 (4 yr ) |
| Espalier | 2222 (1.5 × 3.0 m) | M-9 | 62-66 (5 yrs) |
| Vertical axis | 8888 (1.5 × 0.75 m) | M-9 | (5 yr) |


Soilless cultivation of vegetables

and performance of crop production. There has been a significant increase in the production of horticultural crops in recent years in India. At present in India more than 4,409 fruit nurseries including 1,575 under government sector and 2,834 under private sector are functioning which have an annual target of producing 1,387 million fruit plants. This accounts for 30-40% of the demand of planting materials of fruit sector.

In order to produce true to type planting materials, most of the fruit crops are propagated by asexual or vegetatively except the crops like papaya, phalsa and mangosteen.

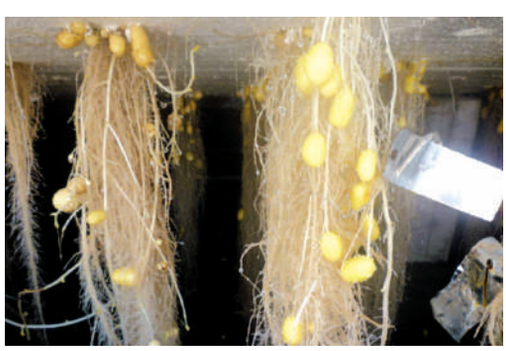
Table 2. Planting material requirements in fruit crops

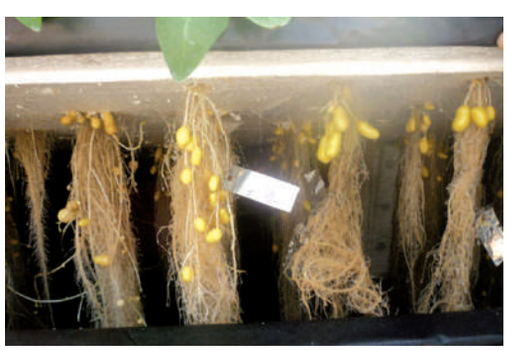
| Crop | Annual growth rate (%) | Area (ha) | No of plants / ha | Total requirement of plant materials (crore) |
|---|---|---|---|---|
| Mango | 4.0 | 92,000 | 156 | 1.43 |
| Banana | 6.0 | 48,000 | 3086 | 14.81 |
| Citrus | 6.0 | 38,000 | 300 | 1.14 |
| Sapota | 4.0 | 6,400 | 100 | 0.64 |
| Guava | 6.0 | 13,800 | 400 | 0.55 |
| Grape | 4.0 | 4,000 | 2400 | 0.96 |
| Papaya | 5.0 | 5,000 | 3086 | 1.54 |
| Pomegranate | 8.0 | 12,000 | 400 | 0.48 |
| | | | Total | 21.55 |

**Climate smart horticulture**

The world has been experiencing a dramatic change, especially in the last few decades. Although the nature and extent of the changes cannot be accurately quantified, the experts of the Inter governmental Panel on Climate Change (IPCC) are unanimous on the impact of this phenomenon which is nowadays perceptible in all regions of the world. A significant change in climate at global and national level is certainly impacting horticulture and affecting the production and quality. The understanding of impact of climate change on horticultural crops production system and its potential effects have drawn a little attention of researchers. Due to severe cold wave, horticultural crops suffer a yield loss of 10-100% depending upon crop and varieties. The issue of climate change has thrown up greater uncertainties and risks, further imposing constraints on production systems. As per the estimate, India's total population will be more than 1.5 billion, the largest in the world, with the urban population of around 600 million by 2030. The influx of population from rural to urban areas in search of jobs has been increasing in the recent past due to growth in

**Aeroponics for mini-tuber production**

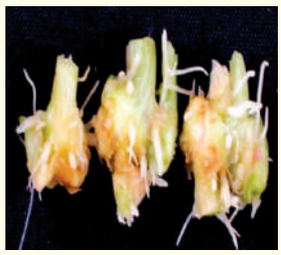




- Plant are grown in troughs, tubes or other type of chambers
- Roots are hung in air and are sprayed with nutrient mist
- Easily absorb nutrients
- Easily absorb oxygen
- Less chance of root diseases

**Micro rhizomes – disease free plants and germplasm exchange**

Ginger



Turmeric – rhizomes harvested using micro rhizomes as planting material

Tuber crops

In crops like potato, ginger, turmeric and a few tuber crops, micro rhizome technology is very efficient in production of disease free clonal planting material of elite genotypes.

services and manufacturing sector as a result ensuring the adequate food supply, environmental pollution reduction, employment and income generation are real challenges which may be addressed through urban and peri-urban horticulture.

**Farmers' friendly production technologies in horticulture**

There are several farmers' friendly technologies for enhancing the yield and quality of various horticultural crops. The details are as follows:

- A process for the production of organic formulation of bio-pesticide bioagent (*Pseudomonas fluorescens).*
- Methyl eugenol pheromone traps for mango and guava fruit fly.
- Cuelure pheromone trap for cucurbit fruit fly.
- Neem soap for agricultural use.
- Pongamia soap for agricultural use.
- Use of neem cake for the management of insect pests of vegetables.
- IPM modules for major pests of fruits, vegetables and flower crops.
- IDM modules for major diseases of fruits, vegetables and flower crops.
- Dogridge a salt and drought tolerant root stock for grapes recommended.
- Salt tolerant variety of acid lime Tenali recommended for saline areas.
- Crop specific micronutrient formulations for banana, citrus, mango and vegetables developed and commercialized.
- Nutrient feeding of banana bunches by denavelling through nutrient blended cow dung.
- Arka microbial consortium for fruits and vegetable productions.
- Arka cocopeat for nursery raising of fruits and vegetable seedlings.
- Seed pelleting of onion and tomato.
- Technologies for protected cultivation of tomato, capsicum, cucumber and lettuce have been stanadardized and transferred to State Agri/Hort. Departments of many states.
- Production of RTS beverages and flavoured wine from Muscat grapes to Coimbatore grape growers association, Coimbatore.
- Long term preservation of raw mango slices for pickling to MTR Ltd., Bengaluru.
- Short term preservation of vegetable baby corn to M/s Kevina Foods Ltd., Bengaluru.
- Production of osmotically dehydrated fruits like mango, pineapple, papaya and aonla and mango fruit bar to M/s PEE PEE Industries, Chennai.
- Preparation of beverages of mango, pineapple and aonla was transferred to M/s PEE PEE Industries, Chennai.
- Hot water treatment of mango for uniform ripening to Kisan products, Bengaluru.
- Low temperature storage of pineapples for long distance transport by ship to M/s TEDMAG, Bengaluru.
- Ready-to-pluck (RTP) mushroom packs are being commercialized to two private companies.

**Conclusion**

The horticulture sector in India possesses unique advantage because of availability of varied climatic conditions for production of various horticultural crops and several ICAR institutes and SAUs are working for the benefit of farmers and other stakeholders. Besides, there is a huge varietal diversity in most of the cultivated fruits, vegetables, flowers, plantation and spices, which increase the harvesting season and more revenues to the farmers. The production and supply of quality planting materials, implementation of INM, IDM and IPM, multi cropping system, integrated farming system (IFS), pollinators, pre- and post-harvest management, forward and backward linkages in marketing are very important for successful cultivation of horticultural crops. In spite of higher production, the quantity of processed products from the raw materials are poor and very low in quantity produce, which is due to the lack of GAP for most of the horticultural crops and poor post-harvest handling. Several prediction models have suggested that the area under horticultural crops are going to increase and


Osmotically dehydrated fruits

RTS beverages and squash

Tomato crush technology

Medicated wine

cereal crops will be decreasing, hence, it is time to breed the climate resilient varieties to withstand the climatic aberrations. Hence, a comprehensive plan covering R&D aspects for all horticultural crops is must and convergence of scientists, policy makers and public is the need of the hour for marching ahead and to take the horticulture to newer heights. However, there are certain cause of concerns like-horticulture does not enjoy a safety net like the Minimum Support Price (MSP) for foodgrains; lack of good cold chain storage and transport networks to extend the life of perishable products; very less or limited input by machinery and equipment so it is tough to minimise the time restraints; higher input costs than foodgrains make it a difficult set up, especially when there is no support from the local governments to the smaller farmers; and limited availability of market intelligence, mainly for exports–make it a tougher option to choose.

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**Flowers always make people better, happier, and more helpful; they are sunshine, food and medicine for the soul.**

***– Luther Burbank***