

# FRUIT PRODUCTION AND ENHANCING FARMERS INCOME

## Abstract

India is blessed with a diverse range of climatic and soil conditions that allow it to grow various kinds of fruits from tropical, subtropical, and temperate zones. Horticulture is a vital and rapidly expanding sector of agriculture that helps to reduce poverty, enhance nutrition, and create income and employment opportunities for farmers and agro-industries. In recent years, horticulture has transformed into a more commercial venture than a rural one. This has drawn the attention of the private sector to invest in improving the production system. The adoption of technologies such as GIS based cultivation practices, micro-irrigation, precision farming, greenhouse cultivation, and better post-harvest management has boosted the growth, but also posed several challenges. Despite the advances in research, there is still a huge gap between the actual and potential yields of many horticultural crops. This is due to various factors that affect the productivity and quality of these crops.

**Keyword:** Horticulture, Fruits, Yield.

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## I. INTRODUCTION

India has a diverse climate that allows for the production of various fresh fruits, ranging from tropical to temperate. According to the National Horticulture Database (3<sup>rd</sup> Advance Estimates) published by the National Horticulture Board, India was the second largest producer of fruits in the world, after China, in 2021-22, with a total output of 107.24 million metric tonnes. The area under fruit cultivation was 11.35 million hectares. **According to the FAO Statistical Yearbook 2021, the total fruit production in the world in 2021 was estimated at 913.6 million tonnes.** India has a prominent role in the global fruit industry, as it accounts for 11.73% of the total fruit output in the world. The country has a diverse range of climatic conditions and soil types that enable it to grow a variety of fruits throughout the year. Horticulture is seen as optimal option for crop diversification in agricultural sectors that face challenges such as climate change, land degradation, and market fluctuations. The per unit land earning capacity of farmers is much more than in case of food grains and it also addresses environmental concerns. Despite these challenges, horticulture remains a vital source of income and nutrition for many farmers and consumers. However, to increase the profitability and sustainability of this sector, it is essential to overcome the barriers that limit the access and quality of market linkages, post-harvest infrastructure and connectivity. These are the key factors that determine the value addition and competitiveness of horticultural products.

According to the data from the Ministry of Agriculture and Farmers Welfare, banana was the most produced fruit in India in 2022, with a total production of 32.1 million metric tons. It was followed by mango, which had a production of 20.6 million metric tons, and citrus, which had a production of 13.3 million metric tons. These three fruits accounted for more than 70% of the total fruit production in India in 2022. According to the Food and Agriculture Organization of the United Nations, India ranked first in the world in the production of bananas, mangoes, and papayas in 2019, with 26.4%, 43.8%, and 39.3% of the global output, respectively. India also contributed significantly to the global production of other fruits, such as guava, apple, pineapple, grape, pomegranate, sapota, and litchi.

The fruit production in India was dominated by seven states in 2022. These were Andhra Pradesh, Maharashtra, Madhya Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka and Gujarat. Andhra Pradesh was the top fruit producer in the country, with 19 million metric tons of fruits in 2022. Maharashtra followed with 12.4 million metric tons of fruits in the same year. India was a leading producer of fresh fruits with a production share of 11.73% globally. However, its export share was only 0.5%, indicating a huge gap between potential and performance. India exported fresh fruits worth Rs. 6,219.46 crores/ 770.70 USD Millions in that year, mainly to UAE, Bangladesh, Nepal, Malaysia, Netherland, Sri Lanka, U.K., Qatar, Oman, and Iraq. The most popular fruits exported from India were grapes, pomegranates, mangoes, bananas, and oranges.

India has a diverse range of climate and soil conditions that allow it to grow many kinds of tropical, subtropical, and temperate fruits. Horticulture is a rapidly growing sector in agriculture that helps reduce poverty, improve nutrition, and create more income and employment opportunities for farmers and agro-based industries. Presently horticulture contributes 33 per cent of agricultural gross domestic products (GDP). To achieve the national goal of 4.0 per cent growth in agriculture, horticulture plays a vital role. Horticulture

is well suited for India's topography and agro climate, which became evident after the Green Revolution in the mid-sixties. Horticulture has undergone a major transformation in the last decade, shifting from a rural activity to a commercial enterprise. This has attracted private sector investment in managing the production system. The adoption of technologies such as micro-irrigation, precision farming, greenhouse cultivation, and improved post-harvest management has enhanced the development, but also posed various challenges.

The export of fresh fruits from India faces a major challenge in terms of low productivity (cost competitiveness) compared to the global standards. This is because of the absence of advanced pre-harvest and post-harvest technologies, as well as the compliance with international quality standards. In addition, the market channels are distorted and do not support efficient trade. Hence, there is a need for a paradigm shift in this sector to achieve a better balance between production and other sub-systems, such as pre-harvest technologies, post-harvest processing, quality management, export infrastructure, supply chain, market information and marketing strategies.

## **II. FRUIT PRODUCTION LIMITATION**

Despite the advances in research, many horticultural crops still have a large gap between their actual and potential yields. This is due to various factors that affect the productivity and quality of these crops. They are:

### **1. Low Productivity of Crops Due to**

- Poor quality planting materials of improved cultivars, inferior genetic stocks and poor management.
- Lack of mechanism for assessing quality of planting materials.
- High risk of transmission of virus diseases from one generation to other, in propagated materials.
- Predominance of old and senile orchards which needs replacement / rejuvenation.
- Vast majority of holdings are small and rainfed.
- Unawareness about the Hi-technology, poor capacity of farmers to invest and poor credit support coupled with problems of infrastructure.
- Lack of knowledge on seasonal growing to meet the export demands.

### **2. Inferior Fruit Quality Due to**

- Poor post-harvest management practices.
- Absence of infrastructural facilities for handling and storage.
- Absence of efficient marketing system coupled with seasonality and perishability.
- Weak processing infrastructures.
- Lack of adequate standards for quality produce.
- High capital investment hinders effective utilization of raw materials.

**3.** The high capital cost investment required in establishing an orchard as also setting up of related infrastructure is a serious constraint in expansion of area under various horticultural crops as well as improvement in existing orchards.

4. A reliable and comprehensive database is essential for horticultural development planning in the long term. Otherwise, the planning process will face difficulties and lack realism.
5. One of the major challenges faced by fruit growers is the high incidence of pests and diseases attack. Pests and diseases can reduce the yield and quality of fruits, as well as increase the cost of production and post-harvest losses.
6. Chronic production problems due to major disorders like alternate bearing, malformation and spongy tissue in mango, guava wilt, citrus decline, *Phytophthora* diseases in large number of crops etc. remain largely unresolved.
7. Lack of technologies for the improvement in wastelands and hilly terrains being the potential future expansion areas.
8. Less improved technologies for the large scale production of underutilized crops which are best suited for wastelands, and poor and marginal soils.

### **III. FUTURE STRATEGIES FOR IMPROVED CROP PRODUCTION TECHNOLOGIES FOR AUGMENTING PRODUCTION, PRODUCTIVITY AND QUALITY**

1. **GIS in Horticulture:** Planners can use remote sensing and geographic information system technologies to plan for efficient use of natural resources at national and regional levels. These technologies are becoming more popular in natural resource management because of the improvements in space borne remote sensing satellites. These satellites can capture data with high spatial, temporal, spectral and radiometric resolutions.

The integration of information sciences, geographic positioning capabilities, and remote sensing systems has enabled modern management of agricultural resources to become more sophisticated and efficient. However, there are still significant challenges in applying remote sensing GIS techniques and horticultural farming database information to practical plans at the field level and ensuring that the actual beneficiaries adopt the technology at the grass root level. For these technologies to have a lasting and positive impact on agricultural and horticultural sector at micro level, they need to be disseminated and adapted effectively.

Horticulture crops are an important source of income and nutrition for many farmers and consumers around the world. However, they also face many challenges such as pests, diseases, climate change, water scarcity, and market fluctuations. To overcome these challenges and increase production, horticulture farmers can benefit from using geographic information system (GIS) technology. GIS is a tool that allows users to collect, store, analyze, and visualize spatial data related to horticulture crops. GIS can help horticulture farmers in various ways, such as:

- Mapping and monitoring crop areas, yields, and quality using satellite imagery, drones, sensors, and GPS devices.
- Identifying optimal locations and conditions for planting, irrigating, fertilizing, and harvesting crops using spatial analysis and modeling techniques.
- Detecting and managing pest and disease outbreaks using remote sensing and geospatial intelligence.
- Assessing and reducing environmental impacts of horticulture practices using spatial indicators and sustainability metrics.

- Enhancing market access and competitiveness of horticulture products using geospatial marketing and traceability systems.

GIS technology can thus provide horticulture farmers with valuable information and insights that can help them improve their decision-making, productivity, profitability, and resilience. By adopting GIS technology, horticulture farmers can contribute to achieving the Sustainable Development Goals of ending hunger, ensuring food security, promoting sustainable horticulture, and conserving natural resources.

- 2. Safeguard for Intellectual Property Rights (IPR):** The exchange of plant genetic resources is a crucial aspect of horticultural research and development. However, there are many challenges and risks involved in this process, such as intellectual property rights, biosafety, quality standards, and phytosanitary measures. To address these issues, a comprehensive and transparent system of varieties registration, material transfer agreement, and germplasm distribution needs to be established and implemented. Furthermore, the export potential of indigenous fruits and vegetables depends on the adherence to international quality and codex standards, which need to be developed and harmonized with the global market requirements. Finally, the import of vegetatively propagated materials poses a threat to the domestic plant health and biodiversity, which requires a careful review and revision of the existing phytosanitary regulations and their strict enforcement.
- 3. Diversifying Fruit Crops and Products:** Diversification of fruit crops and products is a key strategy for fruit farmers to enhance their resilience, profitability, and market access. By cultivating a variety of fruits that have different harvesting seasons, nutritional and medicinal benefits, and value addition potential, fruit farmers can reduce their exposure to climatic and market shocks, increase their income sources, and cater to the needs of diverse consumers. Some of the value-added products that fruit farmers can produce from their fruits are juice, jam, jelly, pickle, wine, etc., which have longer shelf life and higher value than fresh fruits.
- 4. Quality Planting Materials:** For various fruit crops, improved propagation techniques have been developed to produce quality planting material that is free of diseases. Micro propagation protocols have been established for different fruits, which enable the production of large numbers of disease-free plants. The plant standards for various fruit crops have also been profiled, including traceability.

These techniques and protocols are based on scientific principles and rigorous testing, and aim to enhance the productivity and quality of fruit crops. They also help to conserve the genetic diversity and reduce the risk of spreading pests and diseases. The plant standards provide guidelines for the identification, certification and labeling of the planting material, ensuring its authenticity and traceability throughout the supply chain.

- 5. High Density Planting:** HDP stands for high density planting, which is a way of growing perennial horticultural crops with high productivity and early maturity in a limited space. This method is suitable for farmers who have small landholdings and want to increase their horticultural output and income. HDP involves planting more trees per hectare than

the conventional system, using different levels of intensity. Semi-intensive HDP has 500-1,000 trees/ha, intensive HDP has 1,000-10,000 trees/ha with special training systems, and super-intensive or ultra-high density HDP has 20,000-1,00,000 trees/ha. HDP has many advantages, such as precocity, easy management, higher yield potential, better fruit quality and higher returns/unit area. However, HDP also requires more capital investment and scientific management to be successful.

To increase the yield and quality of fruits, high-density plantings (HDP) are recommended for various crops such as banana, pineapple, grape, guava, mango, litchi, apple, peach, pear and cashew nut. HDP involves planting more trees per unit area than the conventional spacing, which results in early and sustained production of fruits. However, HDP requires specific strategies for each crop and climatic zone. Some of the key aspects of HDP are:

- Selection of dwarf and compact varieties or rootstocks that can tolerate high planting density and reduce the need for pruning. This is especially important for temperate fruits like apple, pear and peach, where dwarfing rootstocks are still under development and evaluation. For mango and citrus, some suitable rootstocks have been identified, but more research is needed.
- Adoption of appropriate training and pruning methods to shape the canopy and maintain the balance between vegetative and reproductive growth. This helps to optimize the light interception, air circulation and pest and disease management in HDP orchards. Some success stories have been reported in guava and mango, which need to be replicated in other regions.
- Use of growth regulators or chemicals to control the tree size and induce flowering and fruiting. Paclobutrazol is one such chemical that has been widely used in HDP orchards, but it has some residual effects on the soil and plant health. Therefore, alternative methods or chemicals need to be developed and standardized for different fruit crops.
- Integration of micro irrigation and fertigation systems to provide precise and timely supply of water and nutrients to the HDP orchards. This helps to improve the water use efficiency, nutrient uptake and fruit quality. The irrigation and fertigation schedules need to be tailored for each crop and soil type.
- Diversification of HDP orchards with intercropping or mixed cropping of compatible crops. This can enhance the income and sustainability of small and marginal farmers who cannot afford the high cost and technology involved in mono-species HDP. For example, coconut and arecanut can be intercropped with pepper, tree spices, tuber crops, banana and pineapple in south India.

HDP is a promising technique to boost the productivity and profitability of fruit crops, but it requires careful planning and management based on scientific principles.

- 6. Protected Cultivation:** Protected cultivation is a technique that allows fruit crops to grow in controlled environments, such as greenhouses, tunnels, or net houses. This method can improve the quality and yield of fruits, as well as reduce the risks of pests, diseases, and adverse weather conditions. Protected cultivation can also extend the growing season and enable the production of off-season fruits. Some of the fruit crops

that can benefit from protected cultivation are strawberries, raspberries, blueberries, grapes, melons, and kiwis.

7. **Rejuvenation of Old and Unproductive Orchards:** The technology for rejuvenation of old and unproductive orchards of mango, guava, aonla and cashew nut has been developed. Technology for rejuvenation of old and unproductive mango orchards has been optimized at CISH, Lucknow. Heading back is done on selected unproductive trees during December to encourage new growth during April at lower heights. By proper cultural management (thinning of excessive sprouts, nutrition and water management and pest management) such trees develop new canopy and start fruiting from third year of heading back. Farmers get additional income by sale of pruned wood and intercropping in such orchards. After rejuvenation, fruit yield is enhanced by about 4 times than earlier yields. This technology is being adopted under National Horticulture Mission.
8. **Micro Irrigation System:** Drip irrigation system is a highly efficient irrigation method well suited to many horticultural crops. The drip tubing or tape has small holes called emitters that allow water to drip out at a controlled rate. The emitters are positioned close to the plant to minimize evaporation and runoff. The drip tubing can be placed uncovered on the soil surface, under plastic mulch, buried in the soil, or suspended above the ground (e.g., on a trellis system).

The water flow is relatively low and the irrigations are very frequent. Drip-irrigation systems can improve the profitability of fruit crop production and increasing farmers income if they are well designed and maintained.

Drip irrigation system allows precise fertilizer application because it has high uniformity and efficiency in irrigation application. It also reduces soluble nutrient losses by minimizing deep percolation and surface runoff. This lowers fertilizer costs and enhances crop yields.

9. **Nutrient Management:** Many farmers are adopting the practice of combining organic matter and bio-fertilizers with inorganic fertilizers to deal with the challenges of high cost and low supply of fertilizers, and to enhance the quality and fertility of the soil. This practice is known as Integrated Nutrient Management (INM), which is a system that aims to maintain and increase crop productivity, and also to address the emerging issues of micro-nutrient deficiencies in the soil.

By combining different sources of plant nutrients, integrated plant nutrient management ensures that the soil fertility and the crop productivity are maintained at a high level. This approach also reduces the cost and the wastage of fertilizers, as they are applied in a balanced and efficient way. Integrated plant nutrient management is a holistic strategy that optimizes the use of all available plant nutrient resources in a synergistic manner.

10. **Pest Management:** The production of high-quality fruits is vital for satisfying the local consumption and the export opportunities. However, insect pests can pose a serious threat to the quality of fruits by damaging them or transmitting diseases. Therefore, effective pest management strategies are needed to protect the fruit crops and ensure their

profitability. Therefore, it is imperative to adopt effective pest management strategies to ensure the optimal yield and quality of fruits. Farmers are largely not able to ascertain the damage caused by insects and do not aware about the technology to manage them. They are compelled to influence by pesticides firms and dealers which may lead to pause many social and environmental consequences. In this contest, farmers need to be advocated properly for effective implementation of IPM technologies generated by researchers. Truly speaking, IPM does not mean only Integrated Pest Management but it can be also understood as Integrated People Management. A central shift in pest management philosophy to Integrated Pest Management (IPM) can offer immense potential benefits, as it focuses on controlling the pest rather than eradicating it. However, IPM requires a clear understanding and a collaborative approach among the extension workers and the farmers, who should act as consultants and facilitators in disseminating the knowledge and participating actively in the process. While individual adoption of IPM can bring benefits at the farm level, its adoption at the area-wide (AW-IPM) or village level can enhance the sustainability of the technology. However, many socio-economic factors can discourage collective action and increase free riders. Therefore, to reap all possible benefits of IPM technology, IPM also needs to stand for Integrated People Management.

- 11. Post Harvest Management:** Post harvest management of fruit production is a process that aims to minimize the losses that occur after the fruits are harvested. It involves harvesting the fruits at the right stage of maturity and quality, handling them carefully to prevent mechanical damage, cooling them rapidly to remove field heat, storing them in a modified atmosphere - if suitable technologies are available for the harvested species - and maintaining appropriate temperatures during storage. Post harvest management of fruit production is essential for preserving the quality and shelf life of fruits and reducing food waste. Post-harvest handling activities are crucial for preserving the quality of horticultural crops as they move along the supply chain. Different types of fruits require different packing and storage conditions, depending on factors such as their variety, post-harvest processing, maturity level, and harvest season. For example, apples and pears are best stored at low temperatures and high humidity, while bananas and pineapples need to be ripened at room temperature and low humidity. The factors that affect the optimal conditions for fruits are related to their physiology, biochemistry, and susceptibility to diseases and pests. One way to improve the fruit sector is to use both traditional and modern processing technologies before and after harvesting. This can help reduce the length of the distribution chain and increase the profits. Vertical diversification is the term for this strategy. Therefore, it is essential to adopt appropriate post-harvest practices that suit the specific needs and conditions of each crop and situation.
- 12. Biotechnological Approach:** Plant biotechnology can help produce fruit crops in a sustainable way. Some fruit crops that are propagated by vegetative means can be genetically modified to resist diseases and pests. This can be done faster and more efficiently than conventional breeding, especially if multiple traits are introduced at once. This can also help adapt some fruit crops to drought conditions, and increase their production in different regions. This can benefit food security and poverty reduction. However, biosafety experiments and risk assessment are very important, because these crops are eaten by many people and mostly by children.



- 13. Export Promotional Research:** To increase the export potential of tropical fruits, a bulk handling system that includes pre-cooling, CA/MA storage and post-harvest protocols for sea transport is essential. These measures are needed for major fruits such as banana, mango, papaya, grapes, litchi, sapota, kinnow and pomegranate, which have high demand in international markets. Another important aspect is the disinfestation technology, such as vapour heat treatment (VHT), which can ensure the phytosanitary standards of fresh fruits and extend their shelf life by preventing desiccation. These technologies can help in promoting the export of tropical fruits and increasing their competitiveness.
- 14. Accessing Markets and Policies:** Fruit farmers have the potential to increase their income and livelihood by accessing markets and policies that can offer them better opportunities and resources for their fruits. To access domestic markets, they can adopt strategies such as direct marketing to consumers or using online platforms that can reduce intermediaries and increase their profit margins. To access export markets, they need to comply with the quality standards and certifications demanded by the importing countries and seek assistance from agencies that can facilitate their exports. Moreover, they can avail of the policies and schemes of the government such as MIDH, NFSM, PM-KISAN, etc., that can provide them with various forms of financial and technical support such as subsidies, grants, loans, insurance, etc.

#### IV. CHALLENGES FOR ENHANCING FARMERS INCOME

Horticulture is an essential part of modern agriculture, providing food, income, and environmental benefits to many communities. However, horticulture faces several major challenges that affect its productivity and sustainability. These include climate change, pests and diseases, water scarcity, labor shortages, market volatility, and consumer preferences. To address these challenges, horticulture needs to adopt innovative solutions and technologies that can enhance its resilience and competitiveness. Research and development play a key role in generating and disseminating such solutions, but it also needs to align with the changing needs and priorities of horticultural producers and consumers. Many of these challenges are quite recent and are of considerable magnitude.

1. Economic considerations
2. Competitive pricing
3. More accurate yield models
4. Banking Facilities
5. Extending precision farming database to smaller farm size to bigger farm size
6. A need for year-round supply to allow consumers continuity of access to specific items of produce
7. Growth in supermarkets and corporate farming, poor marketing infrastructure
8. Inadequate post-harvest infrastructure and processing facilities
9. Complexity in the incidence of pests and diseases
10. Identifying ways and means of reducing the cost of RS, GIS technologies and collection, interpretation and dissemination of data to enable their usage on a large scale.
11. Availability of trained experts/ human resources.