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POMOLOGICA

A Magazine of Fruit Research and Development

Published by:
Indian Pomological Society
(A Society for Nutritional Security)



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From the Desk of President
Indian Pomological Society



It is my immense pleasure and proud that Indian Pomological Society bringing the first edition of e-magazine, Vol. 1, Issue 1 (2026). This issue marks another step in our continued efforts to promote scientific interaction, innovation, and excellence in the field of fruit science. With increasing concerns related to production challenges, climate issues, environmental sustainability, processing, value addition, pests and diseases, this magazine provides a platform for sharing new knowledge, emerging technologies, practical experiences, and research findings that can contribute to the future development of fruit cultivation in India.

In this issue, we present a diverse collection of articles covering production areas and emerging developments in fruit cultivation. The contributions address subjects ranging from

Miyawaki Fruit Orchard, Robotic Grafting, Molecular Markers, Unfruitfulness in fruit crops, Hidden Strength of fruits, Value addition and Digital marketing. Collectively, these contributions reflect the expanding horizons of fruit science and its potential to support sustainable horticulture, nutrition, and environmental well-being.

I extend my sincere appreciation to all the authors, reviewers, and members of the

editorial board for their valuable contributions, support, and commitment to this endeavour. As we move ahead, I encourage the fruits scientists, research scholars, entrepreneurs and farmers to embrace innovation, promote the adoption of modern technologies, and strengthen collaboration among different disciplines and stakeholders. By working together to address existing challenges and capitalize on emerging opportunities, we can contribute to the sustained growth and development, profitability, and sustainability of India's fruits industry. Let us continue to advance through scientific knowledge, innovation, collaboration, and a shared vision for the future.

K. Subrahmaniyan

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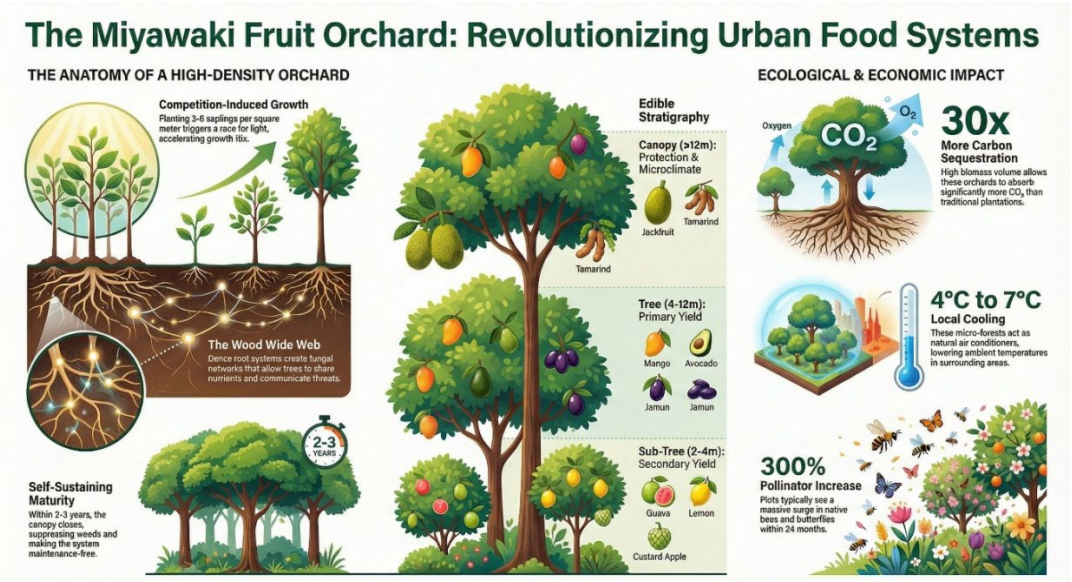
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The Miyawaki Fruit Orchard: A Revolution in Ultra-Dense Edible Landscapes

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Introduction

A **Miyawaki fruit forest** is an intensive high-density orchard system developed by Japanese ecologist Akira Miyawaki adapted to include fruit-bearing trees along with native forest species. This method mimics natural forest structure by planting multiple layers canopy, sub-canopy, shrubs and ground cover within a very small area resulting in rapid growth, early canopy closure and efficient resource use. Unlike conventional orchards with wide spacing and monoculture planting, Miyawaki fruit forests emphasize **biodiversity, soil regeneration and ecological balance.** Fruit trees such as mango, guava, citrus, jackfruit and minor fruits are integrated with support species that improve soil fertility, conserve moisture and reduce pest incidence.

Due to dense planting and accelerated growth these orchards start yielding earlier and produce higher output per unit area. Miyawaki fruit forests are especially suitable for urban and peri-urban horticulture, homesteads, institutional campuses and degraded lands offering a sustainable solution that combines food production, carbon sequestration and microclimate regulation. In a short span of 3 to 5 years, they transform small plots into self-sustaining productive green ecosystems.

The Science of High-Density Competition

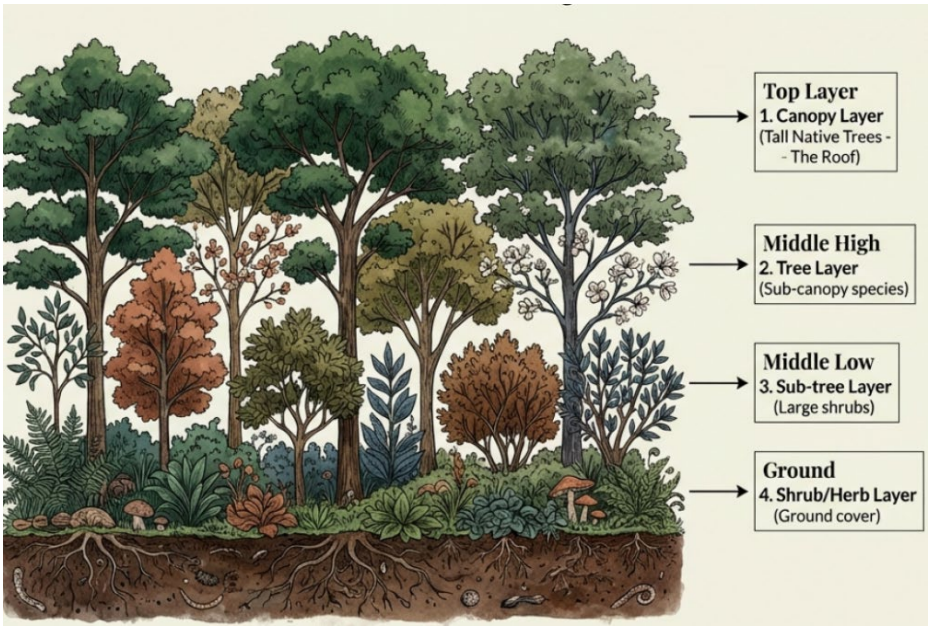
The core of a Miyawaki orchard is competition-induced growth. In a traditional orchard, trees are spaced 6 to 10 meters apart to avoid resource overlap. In a Miyawaki orchard 3 to 5 saplings are planted per square meter. This extreme density triggers a shade avoidance response. Saplings race upward toward the light growing up to 10 times faster than their isolated counterparts. Recent research has highlighted the role of the 'Wood Wide Web' in these plots. The dense root systems create a massive network of mycorrhizal fungi, allowing trees to share nutrients and communicate about pest threats significantly reducing the need for chemical fertilizers.

In high-density systems like Miyawaki fruit orchards, this natural competition is intentionally created by planting multiple species at close spacing. The plants quickly form a closed canopy, reducing weed growth, conserving soil moisture and improving microclimate conditions. As different species occupy different ecological niches tall trees forming the canopy to medium trees and shrubs filling the middle layers and ground covers protecting the soil resources are utilized more completely and efficiently.

This layered competition and cooperation leads to **accelerated growth, early fruiting, improved soil fertility and higher productivity per unit area**. Instead of individual trees growing in isolation the system functions like a miniature forest ecosystem where biodiversity and close planting create a self-sustaining and highly productive environment.

Designing the Edible Stratigraphy

Layer	Function	Recommended Fruit Species
Canopy (>12m)	Protection & Microclimate	Jackfruit, Tamarind, Mahua
Tree Layer (4-12m)	Primary Yield	Mango, Amla, Jamun, Avocado
Sub-Tree (2-4m)	Secondary Yield	Guava, Custard Apple, Lemon
Shrub Layer (<2m)	Soil Shading & Pollinators	Karonda, Phalsa, Pomegranate



Technical Implementation of Miyawaki forest

Phase I: Site Assessment and Planning

Site assessment is the first and most crucial step in establishing a Miyawaki forest. It begins with a detailed analysis of the soil including its type, texture, drainage capacity, pH and overall fertility status. Understanding the local climate, rainfall pattern, sunlight availability and wind direction is equally important as these factors directly influence species selection and growth performance. Based on these conditions, suitable native species that are well adapted to the local ecology are identified to ensure long-term sustainability. The planting area is then clearly marked, including the boundaries and layout of the site. The number of species and the required plant density typically ranging from three to five plants per square meter are determined to create a dense multi-layered forest structure.

Phase II: Species Selection and Layering

Species selection is a critical step in the Miyawaki method as the success of the forest depends on choosing native or locally adapted species that can thrive under the given environmental conditions. Native species are naturally suited to the climate, soil and rainfall patterns of the region making them more resilient low-maintenance and ecologically beneficial.

The selected plants are then grouped into four distinct forest layers to mimic the structure of a natural forest. The **canopy layer** consists of tall long-lived tree species that eventually form the uppermost cover. Below this is the **sub-canopy layer** which is made up of medium-height trees often including fruit species and support plants. The **shrub layer** contains smaller fruit plants or nitrogen-fixing species that enrich the soil and

support overall ecosystem health. At the base, the **ground cover layer** includes herbs and low-growing plants that protect the soil, reduce erosion and conserve moisture.

To achieve true forest-like diversity a wide range of species is selected, usually between 20 and 40 species depending on the size of the area. In the case of Miyawaki orchards fruit trees are integrated along with support species, ensuring both ecological balance and productive yields within the dense multi-layered system.

Phase 3: Soil Preparation and Amendment

Proper soil preparation is essential for the successful establishment of a Miyawaki forest. The soil is first loosened to a depth of about 1-1.2 meters to facilitate deep root penetration and improve aeration. This process enhances the soil structure and allows roots to grow freely leading to faster plant establishment. After loosening organic materials are incorporated into the soil to enrich its fertility and biological activity. These materials typically include compost or farmyard manure for nutrients, cocopeat or rice husk to improve aeration and dry leaves or other biomass to increase organic matter content. Such amendments help improve water retention to stimulate microbial activity and create a healthy growing medium for plants. In areas with poor drainage raised beds are formed to prevent water stagnation and ensure proper root development.

Phase 4: Planting and Mulching

Once the soil is prepared, the planting layout is designed to replicate the randomness and density of a natural forest. A grid pattern is marked across the site to guide planting positions, with spacing generally maintained between 30 and 60 cm. Different species are mixed randomly rather than planted in rows, which helps mimic natural forest distribution and promotes ecological balance. Typically, three to five saplings are planted per square meter to create the desired high-density effect. Care is taken to include species from different forest layers ensuring a multi-layered arrangement that supports rapid canopy formation and efficient use of space and resources.

Phase 5: Irrigation and Early Maintenance (0–2 Years)

During the first one to two years regular irrigation is essential to support the establishment and healthy growth of the young plants. Consistent watering helps the saplings develop strong root systems and adapt to the site conditions. Any dead or weak plants should be replaced promptly to maintain the desired density and diversity of the plantation. Invasive weeds are controlled manually to reduce competition for nutrients, water and light especially during the early stages of growth. The use of chemical fertilizers and pesticides is avoided as the Miyawaki method relies on natural soil enrichment and ecological balance. Throughout this period, plant growth and overall health are monitored regularly to ensure the forest develops into a stable self-sustaining ecosystem.

Phase 6: Self-Sustaining Forest Stage (After 2–3 Years)

As the forest matures the canopy gradually closes and reducing the amount of sunlight reaching the ground and naturally suppressing weed growth. With the establishment of a dense multi-layered vegetation structure the need for regular irrigation and maintenance becomes minimal. The continuous fall of leaves and organic matter enriches the soil enhancing microbial activity and improving overall soil fertility. Over time, the plantation transforms into a self-sustaining ecosystem characterized by high biodiversity improved soil health and increased productivity.

Carbon Sequestration & Microclimatic Regulation from Miyawaki forest

Miyawaki fruit forests play an important role in **carbon sequestration** due to their high planting density and rapid biomass accumulation.The competition stimulates faster vertical growth and quicker canopy formation. As the trees grow, they absorb **carbon dioxide (CO_2)** from the atmosphere through photosynthesis and store it in their trunks, branches, leaves and roots.

Because Miyawaki forests contain a mix of canopy, sub-canopy, shrub and ground-cover species they accumulate more total biomass per unit area compared to conventional orchards or single-species plantations. The continuous addition of leaf litter and organic matter also increases **soil organic carbon** as decomposing plant material enriches the soil and supports microbial activity. Over time this leads to both **above-ground and below-ground carbon storage,** making Miyawaki fruit forests effective tools for climate change mitigation.

Recent studies have quantified the 'Miyawaki Effect' that carbon sinks in Miyawaki orchard can sequester up to 30 times more CO_2 than a conventional plantation due to the sheer volume of biomass per square meter. Creating the cooling effect these micro-forests have been recorded lowering local ambient temperatures by 4°C to 7°C acting as a natural air conditioner for surrounding residential buildings. Within 24 months, these plots often see a 300% increase in native pollinator species (bees, butterflies), which are essential for fruit set in nearby urban gardens.

Economic analysis

Although the Miyawaki fruit forest system requires a relatively high initial investment mainly for intensive soil preparation and the use of a large number of saplings its long-term economic performance presents a very different picture. A Life Cycle Assessment (LCA) reveals that these systems become highly cost-effective over time. Once the canopy closes usually within three years the dense vegetation naturally suppresses weeds and maintains soil moisture reducing the need for irrigation, weeding and regular maintenance. As a result, maintenance costs drop to nearly zero after the establishment phase. Moreover, the intense competition among closely spaced trees often induces

earlier flowering and fruiting. A study reported a 44 percent increase in early-flowering behaviour among medicinal and fruit species grown under Miyawaki conditions further enhancing the system's economic returns.

Case Study: The Prayagraj & Kerala Success Stories

In India, the Miyawaki method has been successfully applied in diverse contexts, from large urban events to small, degraded private lands. Two notable examples are the **'Oxygen Banks'** created in **Prayagraj** during the 2025 Mahakumbh Mela and the **'Nature Labs'** developed on rocky plots in Kerala.

In Prayagraj, these micro-forests were created on small, underutilized urban spaces such as roadsides and public areas. By planting native species at high density, the sites quickly developed dense vegetation that helped reduce dust, improve air quality and create cooler shaded zones for visitors. Even after the event, these 'Oxygen Banks' continue to function as permanent green assets, enhancing biodiversity.

Meanwhile, in Kerala the Miyawaki method has been used to transform rocky and degraded lands into productive fruit forests. In and around Thiruvananthapuram the private landowners adopted an innovative approach by drilling pits into rocky substrates and filling them with organic-rich Miyawaki soil mixtures. Within a few years these previously unproductive plots evolved into dense multi-layered ecosystems known as 'Nature Labs'. Today, they produce fruits for improving the soil fertility to support pollinators and enhance groundwater recharge.

The Future is Dense

Unlike conventional orchards that rely on wide spacing, monoculture and long gestation periods, Miyawaki fruit forests emphasize **diversity, density and ecological balance.** The intense competition among plants accelerates growth, encourages earlier flowering and fruiting and maximizes biomass production per unit area. At the same time, the multi-layered structure improves the soil health, enhances carbon sequestration, conserves moisture and creates a cooler, more stable microclimate. The future of sustainable food systems may well be **dense, diverse forest-like**.

Robotic Grafting for the Future of Fruit Plant Propagation

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Introduction

Quality planting material is the foundation of successful fruit cultivation. In fruit crops such as mango, jackfruit, sapota, citrus, apple, guava and grape, vegetative propagation through grafting is widely practiced to maintain varietal purity and improve productivity. Traditionally, grafting is done manually and requires skilled labour, patience, and time. However, the shortage of trained workers and increasing labour costs has become serious challenges for fruit nurseries. To overcome these limitations, modern agriculture is slowly adopting robotic grafting systems. This technology uses machines to perform grafting with high precision, similar to a surgical operation.

What is Robotic Grafting?

Robotic grafting is an automated system where machines perform the grafting process instead of humans. First, the machine identifies the rootstock and scion using cameras. Then, it makes precise cuts at the correct angle and joins both parts accurately.The process is very similar to how skilled workers perform grafting, but robots can do it faster and more uniformly. Each graft is made with the same accuracy, reducing human error. Once grafted, the plants are placed in controlled conditions to allow proper healing and growth.

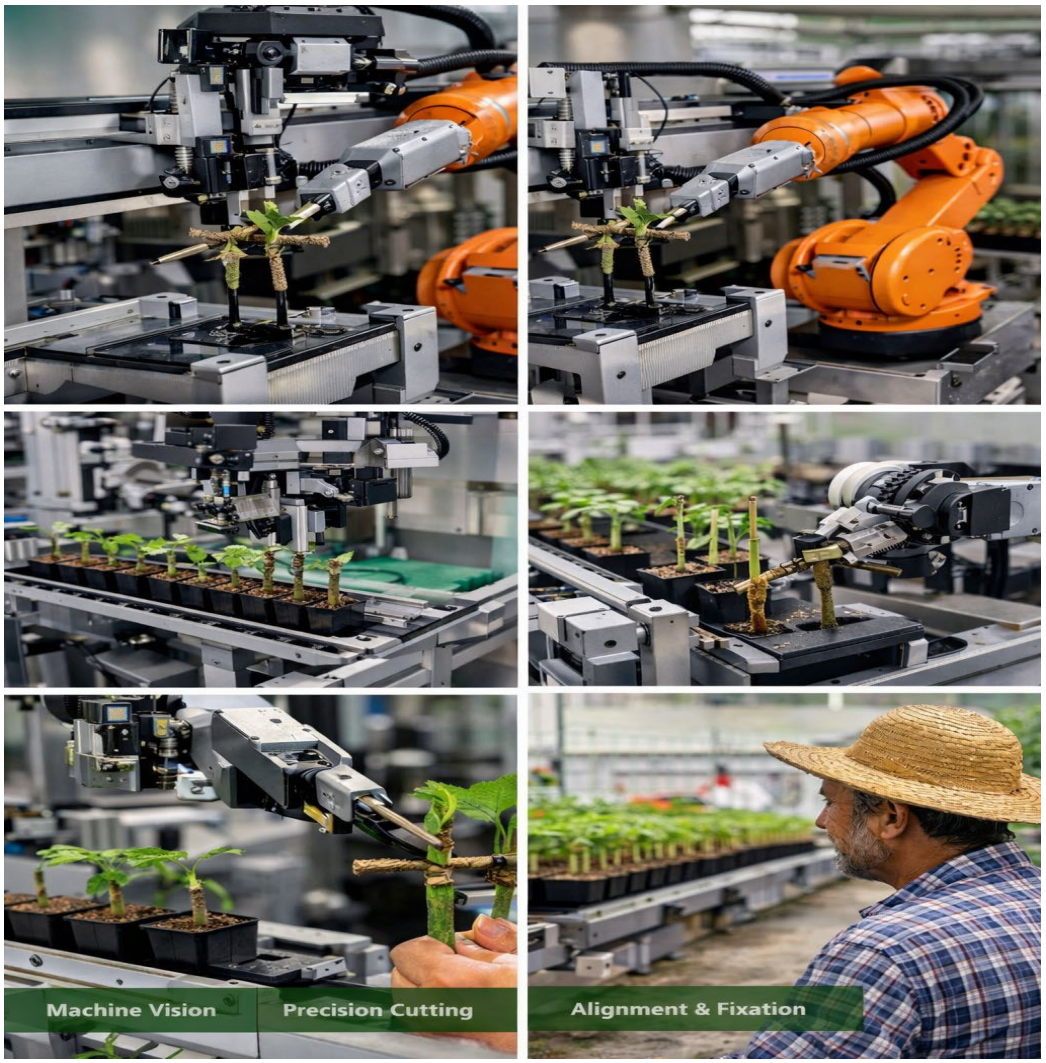
How Does Robotic Grafting Work?

Robotic grafting works by combining modern machines with plant science to perform grafting in a very careful and precise manner. Just like a skilled nursery worker selects healthy plant parts and joins them correctly, robotic systems follow a step by step process using cameras, sensors and computer control. The main aim of this technology is to reduce human error, improve graft success and produce uniform, healthy planting material. Scientists have designed these systems so that plants are handled gently, without stress or damage. The entire operation is carried out under clean and controlled

conditions, similar to a medical procedure. For this reason, robotic grafting is often compared to “surgery for plants.”

1. Machine Vision (Seeing the Plant like a Human Eye)

- High-resolution cameras help the robot “see” the rootstock and scion before grafting.
- They measure stem thickness, detect the correct cutting point, and check size compatibility.
- Computer software instantly analyses this data and selects the best grafting position.
- This ensures uniform and accurate grafting for every plant.



2. Precision Cutting (Clean and Accurate Cuts)

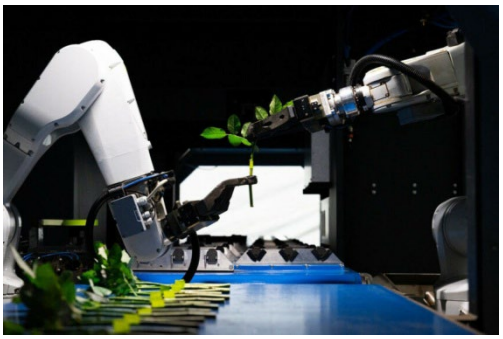
- The robot uses sharp, specially designed blades to make clean and exact cuts.
- Cuts are made at fixed angles and depths, reducing damage to plant tissues.
- Unlike manual grafting, robotic cutting is consistent and repeatable.
- Clean cuts improve healing and increase graft success.

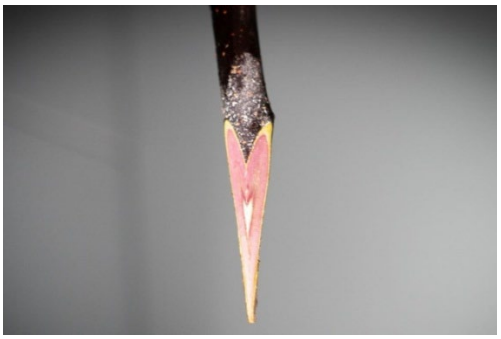
3. Alignment and Fixation (Joining and Healing the Plant)

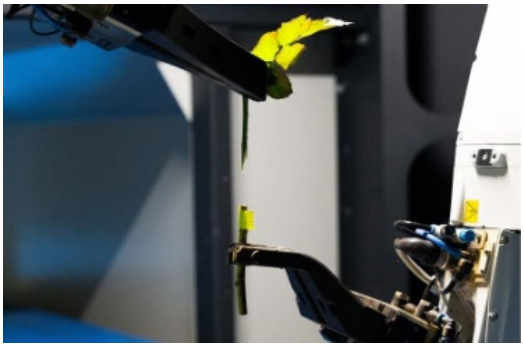
- The robot precisely aligns the rootstock and scion so their inner tissues match.
- Sensors control the pressure applied during joining to avoid injury.
- The graft is fixed and placed in a controlled healing environment.
- This results in strong graft unions and healthy, uniform plants.

Robotic grafting is designed to support farmers, not replace them. With increasing labour shortages and rising costs, this technology helps nurseries produce quality plants more efficiently. It ensures better disease management, uniform growth, and higher productivity.By understanding how robotic grafting works, farmers and the public can appreciate how modern science is shaping the future of agriculture in a safe and sustainable way. Apart from fruit crops, vegetable crops like tomato, cucumber and eggplant also use robotic grafting extensively. These machines can precisely cut, align, and join seedlings, producing thousands of uniform plants with high survival rates. This technology reduces labour requirements, ensures consistent quality, and shows the potential for wider adoption in fruit tree nurseries as well.

Advanced robots like the Horti Robotics Grafting Robot use 3D scanning and automated cutting to deliver high-precision grafts for a wide range of woody crops, including fruit trees, with consistent success and reduced labour requirements. These technologies, which enable year round grafting and uniform plant production, are gradually expanding from research and specialized nurseries into broader commercial use as demand for high-quality fruit planting material increases (Horti Robotics, 2025).



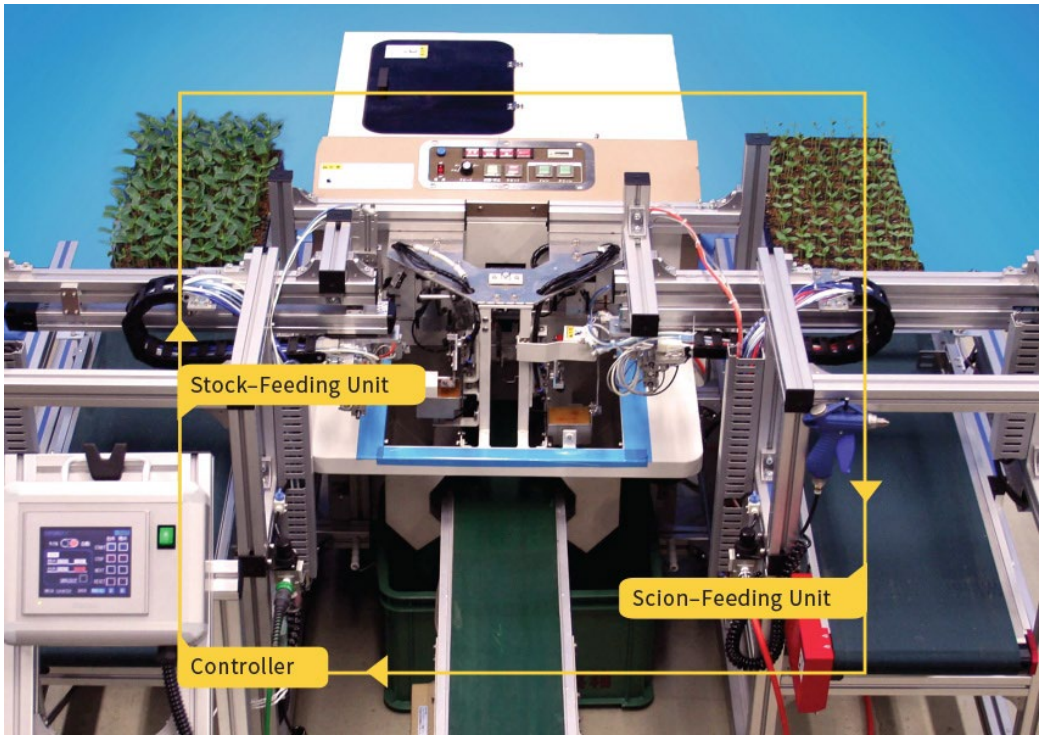







Role of Cameras and Artificial Intelligence

The success of robotic grafting largely depends on machine vision and artificial intelligence (AI). Cameras help the robot identify stem thickness, cutting point, and alignment (Karkee, 2024). AI based software analyses this information and decides the best way to perform the graft.These intelligent systems can adjust cutting angles and pressure automatically, ensuring better graft union and survival. Compared to manual grafting, robotic systems reduce damage to plant tissues and improve success rates. In the future, such systems may even diagnose plant quality before grafting.



Application in Major Fruit Crops

Robotic grafting has progressed from proof-of-concept studies to large-scale commercial deployment in several major fruit crops, supported by advances in machine vision, precision cutting, and automated handling systems. In grapevine (*Vitis vinifera* L.), fully automated bench grafting lines are extensively used in Europe (France, Italy, Spain) and China.

These systems integrate optical sensors and robotic manipulators to identify diameter compatibility between dormant scions and rootstock cuttings, followed by standardized omega or splice cuts with micron level precision. Automated alignment and pressure controlled joining ensure optimal cambial contact, while immediate sealing with biodegradable grafting clips or wax minimizes desiccation and pathogen entry. Studies have reported grafting success rates exceeding 90–95% with throughputs of 2000 – 4000 grafts per hour per line, significantly reducing labour costs and variability compared to manual grafting (Mazzon, 2006).

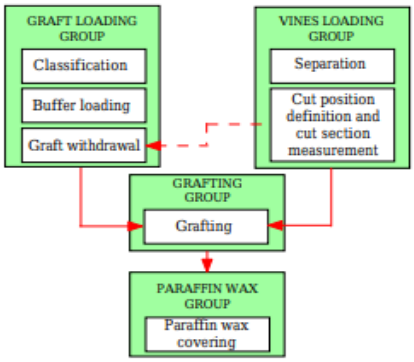


Fig. 1. Block diagram of the system



Fig. 2. Images of a graft, left, and the resulting paraffined vine cutting, right.

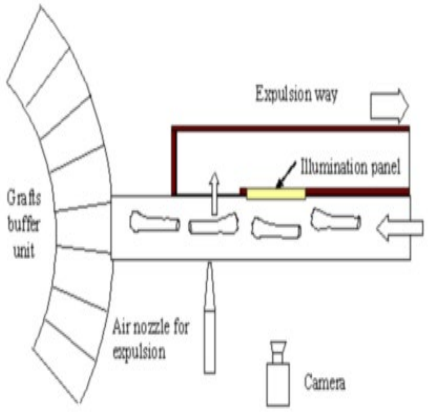


Fig. 3. First vision unit for grafts inspection

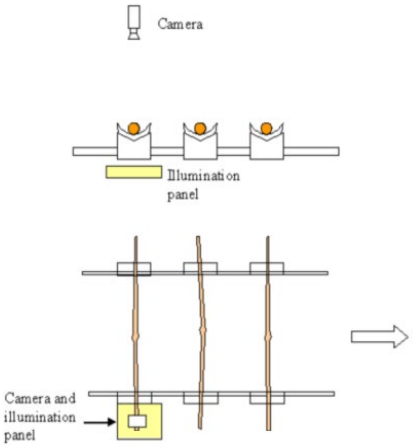


Fig. 4. Second vision unit for vines inspection. Frontal view (top) and view from the top (bottom).

(Mazzon, 2006)

In pome fruits such as apple (*Malus domestica* Borkh.) and pear (*Pyrus communis* L.), semi-automated and robotic grafting platforms have been developed and refined in Japan, China, and parts of Europe. These systems primarily focus on whip and tongue or splice grafting, where precision cutting modules create uniform interlocking surfaces, enhancing mechanical stability and vascular reconnection. Machine vision algorithms are employed to select compatible scion–rootstock pairs based on stem diameter and straightness, improving graft uniformity. Experimental evaluations have shown that robotic grafted plants exhibit comparable or improved callus formation, vascular differentiation, and early field establishment when compared to skilled manual grafting, particularly under controlled nursery conditions (Khanchana, 2024).

In citrus (*Citrus* spp.), automated grafting technologies are being actively tested and adopted in China and Israel to address challenges associated with soil borne pathogens, citrus decline, and replant disorders (He *et al.,* 2022). Robotic grafting systems facilitate the rapid production of plants grafted onto disease tolerant or stress resilient rootstocks such as *Citrus trifoliata* hybrids. Research trials indicate that automation improves grafting consistency, reduces nursery production time, and enhances uniformity in rootstock scion combinations, which is critical for large-scale dissemination of improved planting material. Tropical fruit crops such as guava (*Psidium guajava* L.) are currently under pilot scale evaluation for robotic grafting applications. Guava seedlings often exhibit relatively uniform stem diameter at the nursery stage, making them suitable candidates for mechanized grafting with minor design modifications (Njoroge *et al.,* 2024). Preliminary studies suggest that adaptation of existing robotic systems through adjustable cutting angles, flexible clamping mechanisms, and optimized healing environments can achieve graft success rates comparable to manual methods. On-going research is focused on optimizing physiological compatibility, healing chamber conditions, and post-grafting management protocols to enhance adoption in tropical nursery systems.

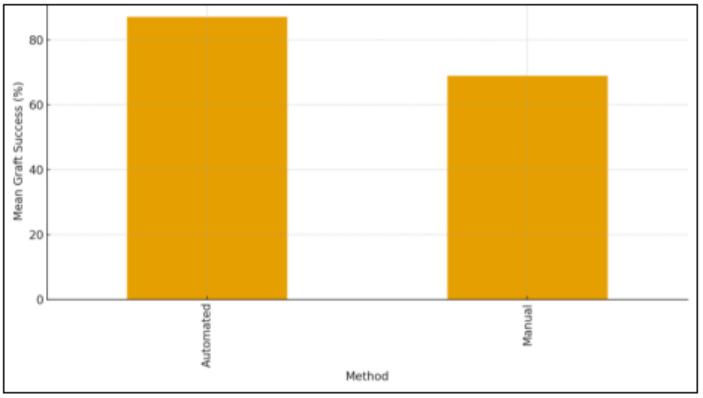


Fig. 5. Mean graft success by method Bar chart of mean graft success for manual vs automated**.**

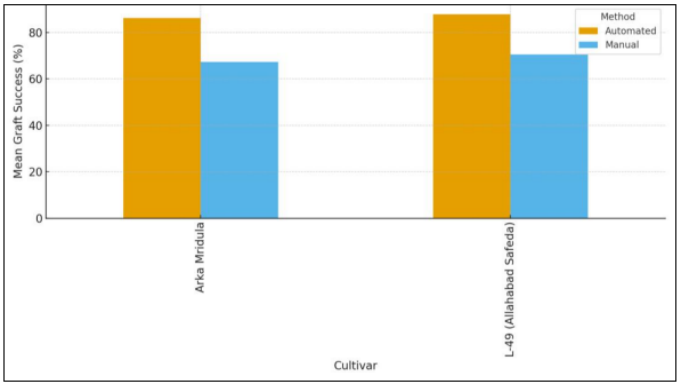


Fig. 6.Graft success by method and cultivar Bar chart comparing success across L-49 and Arka Mridula

Overall, the scientific evidence indicates that robotic grafting not only increases operational efficiency and reduces dependence on skilled labour but also enhances graft uniformity, traceability, and scalability across both temperate and tropical fruit crops. These attributes position robotic grafting as a key enabling technology for modern, high throughput fruit tree nurseries.

The success of robotic grafting in these crops is possible because grafting is carried out under controlled nursery conditions, where plant size, age, and spacing can be standardized. This same approach can be realistically introducethrough large government nurseries, Krishi Vigyan Kendras (KVKs), agricultural universities, and private commercial nurseries. Initially, robotic grafting need not replace all manual work but can be introduced as a centralized service, where elite rootstocks and scions are grafted in bulk and supplied to farmers. Demonstration units, farmer scientist interactions, and training programs can help build confidence in this technology. With rising labour shortages and increasing demand for quality planting material, robotic grafting offers a practical, scalable solution that can gradually reach farmers through institutional support, public private partnerships, and technology driven nursery modernization.

Scope in Minor and Traditional Fruit Crops

Minor and traditional fruit crops such as sapota (*Manilkara zapota*), jackfruit (*Artocarpus heterophyllus*), aonla (*Phyllanthus emblica*), jamun (*Syzygium cumini*), bael (*Aegle marmelos*), and custard apple (*Annona* spp.) are predominantly propagated through conventional grafting techniques that rely heavily on skilled manual labour. In these species, graft success rates are often inconsistent due to variability in seedling vigour, stem diameter, wood hardness, latex exudation, and operator skill. Such inconsistencies limit large scale multiplication of elite cultivars and constrain the commercialization and conservation of these underutilized fruit crops.

Robotic grafting presents a significant opportunity to standardize propagation practices in these crops by minimizing human-induced variability and improving precision in scion rootstock alignment. Although these species exhibit greater morphological heterogeneity than major fruit crops, advances in adaptive clamping systems, adjustable cutting modules, and machine vision based diameter detection allow robotic platforms to be reprogrammed for different grafting techniques such as wedge, veneer, cleft, or splice grafting. Modifications such as variable blade angles, latex handling mechanisms, and flexible holding fixtures can further enhance compatibility with woody or latex rich species like jackfruit and sapota.

From a research perspective, public sector research institutions and agricultural universities have a crucial role in customizing robotic grafting systems for region specific fruit crops. Multidisciplinary collaboration among horticulturists, agricultural

engineers, and computer scientists is essential to develop crop specific grafting protocols, optimize healing chamber conditions, and evaluate post grafting physiological responses. Experimental trials in these crops can generate critical data on graft union formation, callus development, survival percentage, and early field performance under robotic grafting compared to traditional methods.

The adoption of robotic grafting in minor and traditional fruit crops can significantly accelerate the multiplication of elite, location specific cultivars and facilitate the conservation of valuable germplasm through rapid clonal propagation. In the long term, this technology can support nursery based entrepreneurship, reduce dependence on diminishing skilled labour, and contribute to the revitalization and commercial expansion of underutilized fruit species, particularly in biodiversity-rich regions such as India.

Significance of Robotic Grafting in Modern Agricultural Systems

Modern agriculture is increasingly challenged by a declining availability of skilled labour, particularly in labour intensive operations such as nursery management and vegetative plant propagation. In this context, robotic grafting has emerged as a viable technological intervention for ensuring the large scale production of uniform and high quality planting material. Automated grafting systems enable precise and repeatable scion rootstock alignment, resulting in consistent graft unions and reduced variability associated with manual grafting practices. This standardization is especially critical in commercial nurseries, where uniform plant growth and predictable field performance directly influence productivity and profitability.

The integration of robotic grafting significantly enhances operational efficiency by increasing throughput and reducing reliance on highly skilled labour. Automated systems can operate continuously under controlled conditions, allowing nurseries to produce a greater number of grafted plants within a shorter time frame while maintaining high success rates. From an economic perspective, this leads to lower labour costs, improved resource use efficiency, and higher returns on investment, particularly in regions where labour shortages and rising wages pose constraints on nursery expansion.

The adoption of robotic grafting represents a key component in the broader modernization of agricultural production systems. Effective implementation requires coordinated support from research institutions, commercial nurseries, and government agencies to facilitate technology validation, capacity building, and infrastructure development. Through targeted training programmes, demonstration units, and phased scaling strategies, robotic grafting can be adapted to diverse crop species and local production environments. Such collaborative efforts will improve farmers' access to reliable and disease free planting material, strengthen nursery based value chains, and contribute to the development of a more efficient, sustainable, and future-ready fruit production system.

Conclusion

Robotic grafting represents an important step towards the modernization of fruit crop nurseries and propagation systems. By combining plant science with advanced technologies such as cameras, sensors, and automated machines, this method ensures uniform, healthy, and high-quality planting material. Although still new to Kerala, robotic grafting has already proven successful in several countries and shows strong potential under controlled nursery conditions. With proper support from research institutions, government agencies, and private nurseries, this technology can gradually be introduced to benefit farmers. Embracing such innovations will help overcome labour shortages, improve productivity, and strengthen the future of fruit cultivation in Kerala.

Sea Buckthorn: A gold mine of the cold deserts

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Introduction

Sea buckthorn (*Hippophae rhamnoides* L.) is a Himalayan shrub or tree popularly known as Siberian Pineapple, Sand Thorn, Sallow Thorn, Sea Berry, Wonder Plant, Golden Bush, Gold Mine. Sea buckthorn belongs to the family of *Elaeagnaceae*. It is a thorny willow-like plant species native to Europe and Asia. In ancient Greece, leaves of sea buckthorn were used as horse fodder for improving weight and shiny hair, thus gaining the sea buckthorn genus a Graeco-Latin name 'Hippophae' (Hippo – Horse; Phaos – to shine). It is a pioneer tree species for soil improvement, wind and soil and water conservation. It is an ancient miraculous plant of great interest because of its tenacity, rich in nutritionally active substances and biological activity. Every part of this plant (fruits, leaves, stems, branches, roots and thorns) has been traditionally used in medicine, nutritional supplement, soil and moisture conservation and for the establishment of wildlife habitats.

The leaves can be used as feed, particularly for ruminants. Due to its tolerance against strongly eroded, nutrient poor and sometime salty soils, the plant is also used for land reclamation or as shelterbelt. Due to its immense use, it has aptly been called a wonderful plant, magic plant, super food, functional food and bank of vitamins. The fruits are processed and then used in the food industry, in traditional medicine, as part of drugs or in the cosmetic industry. It is rich in antioxidants, anti-inflammatory, anti-carcinogenic and anti-atherosclerotic properties. With its late maturing attribute, sea buckthorn offers interest as an ornamental bush. Sea buckthorn contains nearly 200 nutritional and bioactive compounds and is known as a "natural vitamin treasure house" and a "source of nutrition and health care".

It is recognized differently in different parts of the world for eg. 'Oblepicha in Russia', 'Sanddorn' in Germany, 'Argousier' in France, 'Espino Armarillo' in Spain. In India, it is known as 'Chharama' in Himachal Pradesh, 'Chuck', 'Dhurchuk' or 'Chuma'/ 'Tarwa' in Uttaranchal, 'Tare' or 'Taroobo' in North East region (Sikkim and Arunachal Pradesh)

and ‘Tsestalullu’ in Ladakh. In India, sea buckthorn naturally thrives in various regions, including Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. In late 2023, the Geographical Indication Registry officially awarded the **GI tag to 'Ladakh Sea Buckthorn,'** making it the fourth product in Ladakh to receive this recognition for its unique regional origin, protect the "wonder plant" from counterfeit and enhance its market value. It also grows in several countries like China, Russia, Britain, Germany, Finland, Romania, France, Nepal, Bhutan and Pakistan at an altitude of 2500-4300 meters height.

Uses

- Sea buckthorn berries are rich in beta-carotene, vitamins C, E and B12, offering anti-inflammatory properties and immune boosting benefits.
- Consuming sea buckthorn juice is recommended during pregnancy for its vitamin content. While safe to eat raw, they're most flavorful when cooked.
- They're versatile in the kitchen, used in purees, juices, jams, syrups and liquor. Dried berries make delicious tea or powder. Sea buckthorn oil, extracted from the berries, is popular in cosmetics.
- Sea buckthorn is a very good fodder for sheep, goats and cattle as it contain many nutrients and bioactive substances.
- Leaves and fruit residue used as supplementary food can promote growth of animals and poultry.
- As fuel wood: In the Hindu-Kush Himalaya region, plant biomass is the most important source of energy.
- Sea buckthorn has proved to be a popular green energy plant because of its quality biomass. It is a good source of firewood.

Importance of Sea buckthorn

Sea buckthorn is a multipurpose fast growing species which is serving as a measure of biodiversity conservation, soil conservation, medicines, food, fodder and fuel wood. It has an extraordinary capacity to grow and survive under adverse conditions (-40 to 40º C). For the farmers living in the mountains it offers the opportunity to maintain a sustainable livelihood. Sea buckthorn berry is very rich source of vitamins and is called treasure of bioactive substances, for these reasons, it is also called a wonderful plant.

Pharmaceutical Importance

About ten varieties of sea buckthorn drugs have been developed and are available in the form of liquid, powder, plaster, paste, pills, liniments, aerosols, etc. The most important pharmacological functions attributed to sea buckthorn oil are: anti-inflammatory, antimicrobial, pain relief, and promoting regeneration of tissues. Sea buckthorn oil is also touted as a treatment for oral mucositis, rectum mucositis, vaginal mucositis,

cervical erosion, radiation damage, burns, scalds, duodenal ulcers, gastric ulcers, chilblains, skin ulcers caused by malnutrition and other skin damage.

Nutraceutical importance

Sea buckthorn fruit consists of sugars, sugar alcohols, fruit acids, vitamins (C, E, and K), polyphenols, carotenoids, fiber, amino acids, minerals and plant sterols. Major sugars in sea buckthorn fruits are fructose and glucose, with total sugar content of 2.7-5.3 g/100 ml of juice. Typical sourness of the fruits is due to high content of malic acid (0.8-3.2 g/100 ml of juice) while astringency is related to quinic acid (1.2-2.1 g/100 ml of juice). Major sugar alcohol in fruit is L-quebrachitol (0.15-0.24 g/100 ml of juice). The concentration of vitamin C in sea buckthorn fruit, ranged from 100–300 mg/100 g fruit, which is higher than strawberry, kiwi, orange, tomato, carrot, and hawthorn. Additionally, fruits have high concentrations of carotenoids, vitamin E and vitamin K. The most prevalent dietary minerals in sea buckthorn fruits are potassium (300– 380 mg/100g), manganese (0.28–0.32 mg/100 g) and copper (0.1 mg/100 g).

Cosmetical Importance

Many kinds of sea buckthorn cosmetics have been developed and tested in hospitals. It is proved that sea buckthorn beauty cream has positive therapeutic effects on melanosis, skin wrinkles, keratoderma, keratosis, senile plaque, xeroderma, facial acne, recurrent dermatitis, chemical corrosion and inchthyosis, as well as freckles. Other sea buckthorn extracts can improve metabolism and retard skin maturation.

Socio-economic Importance

Due to its unique biological features, sea buckthorn has been used in various ways to maintain the ecology of the Himalayas. In winter, the importance of sea buckthorn increases as it is almost the only food available for birds. Sea buckthorn provides long-term benefits in terms of maintaining the ecological equilibrium and improving the environment.

Nitrogen-fixing capacity

An 8 to 10-year old sea buckthorn forest can fix 180 kg of nitrogen/ha/year.

Conclusion

To conclude, further research will unlock its full therapeutic potential, particularly for conditions like ulcers and gastritis, integrating sea buckthorn into daily wellness routines offers a natural, versatile path to enhanced vitality.



TREE



FRUIT



SEEDS AND OIL



JUICE



BARK POWDER



DRIED BERRIES



PLANTS



LEAF TEA



ROOT EXTRACT

Molecular Markers: Simple DNA Tools That Can Revolutionize Fruit Farming in India

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Molecular markers act like unique DNA barcodes for fruit plants, helping farmers and gardeners in India to identify and improve varieties such as mangoes, bananas, and guavas without waiting years to see the fruits. These tools make modern farming smarter and more reliable for people growing crops in backyards or small fields. They ensure better yields, disease-free plants, and higher incomes from markets.

What Are Molecular Markers?

Molecular markers as invisible tags in a plant's genetic code, much like an Aadhaar number for humans. They highlight small DNA differences between varieties, staying constant regardless of soil, water, or weather. Common types include SSRs (simple sequence repeats) and SNPs (single nucleotide polymorphisms), used widely in Indian labs for crops like Alphonso mango or Nagpur orange.

Key Applications in Fruit Crops

- **Variety Identification:** Confirms if a sapling is genuine Dashehari mango, preventing sales of fake plants in nurseries.
- **Genetic Diversity Check:** Measures variety within local guava or pomegranate collections, helping preserve India's rich fruit heritage.
- **Marker-Assisted Selection (MAS):** Speeds up breeding disease-resistant bananas by early picking seedlings with good genes, cutting years off traditional methods. Fruit trees like mangoes or apples often take 5 to 10 years to bear their first fruits. In the traditional method, breeders plant a seed and wait about 8 years to taste the fruit, only to discover it might be sour or of poor quality. With molecular markers, scientists test a tiny leaf piece from a one-month-old seedling; if the DNA marker for desirable traits like sweetness is absent, they discard it early, saving years and accelerating the development of superior fruit varieties by decades.
- **Disease Detection:** Spots markers linked to citrus greening or mango malformation before symptoms appear. Further, molecular markers help identify

"resistance genes" against pests and diseases, enabling breeders to create naturally tougher fruit varieties. For the common man, this translates to fruits that need fewer chemical sprays during farming, resulting in healthier produce and a cleaner environment.

- **Solving the "Male vs. Female" Mystery:** In crops like papaya or kiwi, only female or bisexual plants produce fruit, leaving male plants barren. Farmers traditionally planted numerous seeds and waited months to identify the non-fruiting males, which they then uprooted—a wasteful process. Now, molecular markers reveal the plant's sex right in the nursery tray, allowing farmers to plant only the fruitful ones and secure a reliable harvest.
- **Protecting Traditional Varieties:** Molecular markers serve as a DNA test to safeguard traditional varieties. They verify Geographical Indication (GI) tagged fruits, such as Alphonso mango or Coorg orange. This ensures buyers receive authentic premium produce instead of cheaper imitations.

Benefits for Indian Farmers

These markers boost productivity for smallholders, where fruits drive rural economies. They reduce crop losses by 20-30% through better hybrids and cut breeding time from 10-15 years to half. Affordable kits now available in Indian institutes and make this tech accessible, promising sweeter fruits and stronger markets.

"Health or Wealth – Guava in the list" Producing Guava under High Density Planting

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Guava (*Psidium guajava* L.; Myrtaceae), a fruit valued not just as a dessert but considered a medicine with its richness in vitamin C, antioxidants and good roughage. This nutritionally and medicinally valued fruit crop is suited for cultivation even in marginal lands. Guava presently occupies about 4 per cent of the total area under fruit crops in India and mostly cultivated under the conventional production system with poor yielding varieties. Globally, marginal lands make up about 21 percent (2.74 billion ha) of the total land (13.5 billion ha) area. However, about 1,558 million ha of these lands are used for agriculture, out of which about 224 to 300 million ha is classified as agriculturally marginal areas (FAO, 2022). The global population is expected to grow to almost 10 billion by 2050 and to satisfy the global demand of food and agricultural products, the need for cultivation in marginal lands with improved technologies capable of enhancing the productivity becomes essential. Of the estimated 39.00 m.ha. of marginal lands in India only less than 5 per cent is reported to be under cultivation as they experience different kinds of stress and the problems further becomes complex with the changing climatic conditions.

Increasing the productivity without compromising the quality and reducing the gestation period of fruit crops are imminent considering the current requirements for fruit production amidst increasing stress on crop cultivation. High Density Planting (HDP) is a proven technology of intensive fruit cultivation helping to achieve the above objectives and guava being highly amenable for canopy management, besides its suitability to marginal lands offer greater scope for cultivation under HDP system. While the conventional system of planting guava with 6 m x 6 m spacing accommodates just 275 plants, the High Density (3m x 3.0 m) and Ultra High Density (3.0 m x 1.5 m) planting systems could accommodate nearly 1100 and 2200 plants ha^{-1} respectively, offering tremendous scope for enhancing productivity, though the yield of individual tree gets reduced.

HDP being intensive practice, though appears to be a high-cost technology it proves economical as it is easier to manage and harvest, precocious in bearing and produce more yield form unit area all leading to ease of management resulting in better net returns. Guava under HDP is claimed to produce about 25 to 40 tonnes of fruits ha^{-1} as it offers scope for effective utilisation of both vertical and horizontal space leading to enhanced photosynthetic assimilate production. HDP also proves better in land and other input use efficiency.

The concept of HDP could be achieved through the use of dwarfing rootstocks, selection of dwarf statured cultivars, identification and planting of cultivars more amenable for canopy management besides the use of growth regulating chemicals, if necessary. The Chinese Guava "*Psidium friedrichsthalianum*" is found to induce dwarfing if used as root stock and "Pusa Sirija" is a potentially dwarfing rootstock identified for Allhabad Safeda to establish HDP. The varieties Pusa Aarushi (Pink Fleshed) and Pusa Pratiksha (white fleshed) are capable of producing around 35 to 40 t ha^{-1} of fruit yield under HDP at a spacing of 3 x 3 m. The varieties / hybrids identified from Indian Institute of Horticultural Research, Bangalore *viz*., Arka Mridula (white fleshed), Arka Kiran (pink fleshed) and Arka Rashmi (pink fleshed) are all semi vigorous offering scope for planting under HDP system. Among them "Arka Kiran" is most popular among consumers with its richness in pigment (antioxidant) and hence recently on preference by the cultivators. Besides, guava which is popularly known as '**Poor man's Apple**' has now become the taste of even the rich, as it is considered a good fruit for diabetic.

The Central Institute of Subtropical Horticulture, Lucknow recommends 6 m x 3 m (555 plants ha^{-1}) or 3 m x 3m (1111 plants ha^{-1}) or 3 m x 1.5 m (2222 plants ha^{-1}) spacing for guava under HDP to choose depending on the soil fertility and water availability. The layers or grafted plants of guava are planted in a square or rectangular system in pits of 0.5 to 0.75 m^3. The management of plant canopy is one of the most important and skilled technique for guava to be grown under HDP as the unmanaged plant canopy would have a limited bearing area as the interior of the plants become unproductive. To maintain the stature the plants are topped at 60 to 70 cm height in about three months of planting. Of the emerging shoots 3 or 4 well balanced scaffold is retained and are again pruned on attaining around 50 cm long, by reducing its length to half to induce further branching. These shoots are also pruned to half of their length in about 3 – 4 months to geta compact canopy. Pruning is generally done twice in a year to contain the growth within the 2m hedge row and to get two crops a year. Shoot pruning is continued every year and is restricted to 50 per cent so as to maintain the shape without losing the productivity. The height is generally restricted to 4 to 6 feet depending on the planting system adopted.

The HDP system warrants timely application of nutrients to the plant and wherever micronutrient deficiencies are noted (as in marginal lands) foliar feeding of such nutrient elements is also essential. A grown-up plant requires about 15 - 20 litres of water, which could be supplied through drip irrigation. Guava plants of 5 years and more are supplied with 1300 gm of urea1875 gm of Super phosphate and 500 gm of MOP every year (CISTH, Lucknow) and one year old plant is supplied with 1/5 of the above dosage and incremental dose is given every year. Application of 1 kg each of NPK in two split doses is recommended by the Tamil Nadu Agricultural University. Spraying Urea 1 % with Zinc sulphate 0.5 per cent twice a year during March and October and spraying 0.3% borax during flowering and fruit set stage (reduction in size of leaves and fruit cracking and hardening due to boron deficiency) is also recommended. The menace of spiralling whitefly is found to be a recent threat for guava cultivation and regular monitoring from new flush appearance after pruning is crucial in management. Field sanitation, application of 3 % Neem Oil or 5 % NSKE, release of coccinellid predator *Cryptolaemus montrouzieri* and application of triazophos 40 EC at 0.06 % if warranted are the recommendations for managing spiralling whitefly.



Broad Beds with Furrow for planting



Field planted with Guava Layers



Established Field



Basin Cleaning



Fertiliser in Rings



Pruned Field



Harvested Fruits

Unfruitfulness in fruit crops: Causes and Remedies

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Fruit growing is one of the most important and profitable venture in horticulture. The art and science have now developed into one of the most deviled, skillful and intensive forms of land utilization. Today the standard of living of different people of countries is judged by the production and per capita consumption of fruits. Fruitfulness' refers to the state where a plant is not only capable of flowering and bearing fruit, but also takes these fruits to maturity. The inability to do so is known as 'unfruitfulness' or 'barrenness'. It may be defined as the plant not only develop flowers, but set fruits and carries them up to maturity. The conditions under which plants are unable to bloom or set fruits or carry them upto maturity is called unfruitfulness.

Unfruitfulness is one of the leading problems in many fruit crops which results in huge loss to growers thus make fruit cultivation less profitable.Although tree produce adequate flowering, low initial fruit set and subsequently higher fruit-let abscission leads to unfruitfulness. Besides any interference with the development of reproductive cells and organs leads to unfruitfulness

CAUSES OF UNFRUITFULNESS

The causes of unfruitfulness in fruit plants have been broadly classified into two categories:

(i) Internal factors and
(ii) External factors.

- External factors

1. Environmental factors
   i. Temperature
   ii. Rainfall
   iii. Wind
   iv. Frost
   v. Hailstorm
   vi. Cloudy weather
   vii. Light intensity
2. Disturbed water relations
3. Nutrient supply
4. Rootstocks
5. Pruning
6. Age and vigour of the plant
7. Locality
8. Seasonal influence
9. Spraying fruit plants during flowering
10. Insect-pest and diseases
11. Miscellaneous factors

Classification and explanation of unfruitfulness

- External factors

1. Environmental factors

i. Temperature

It affects the flowering, pollination, fruit set, growth and development of the plants. Every species requires certain optimum range of temperature for growth, flowering and fruit set. Extreme temperature fluctuations and continuous high temperature etc., are injurious to fertilization process.

Examples

The pollen of most of the fruit crops grown in temperate climate, like apple, pear, cherry, plum, walnut, pecan nut etc., germinate freely at a temperature of 50 ^{0}F or above, but the fertilization process is practically inhibited if the temperature falls below 40 ^{0}F.

Of the different climatic factors, temperature appears to have some relation with the variability in the incidence of mango malformation. Higher temperature and dry atmosphere appear to be associated with the increased production of pollen per anther in mango crop. It has indirect influence on fruit set through its effect on the activity of pollen carrying insects. Influence of temperature on fruit set has also been reported in papaya such as sex reversing male plants

Rainfall

It is necessary for proper growth and development of a plant, but rainfall at blossoming is recognised as one of the most important factors limiting the fruit set and ultimately the fruitfulness in fruit crops. Rain at time of blossoming causes the loss of more fruits than any other climatic agency. Rain washed off the pollens from the anthers.

Wind

It is an important pollination agency in many fruit plants like walnut, pecan nut, oak, hickory, hazelnut, coconut etc. (Anemophilous or Wind pollinated). In insect pollinated fruit plants, wind hinders rather than help in pollination, because pollen carrying insects work more effectively in a still atmosphere. It may also cause the stigmatic fluid to dry prematurely thus affecting the pollen germination

Frost

This factors responsible for causing even a regular bearing cultivar or a plant in an orchard to become an irregular bearer. Spring frost are harmful to the plants in temperate climate. It may either kill the sexual. organs of a flower or completely

destroys the blossoms, there by influencing the fruit set and ultimately the fruitfulness (mango, banana, guava, litchi, etc.)

Hail storm

- ✓ It has been found to be very harmful if it occurs at any time between flowering and fruit development stages. In temperate fruit orchards, hail destroys all the flower buds and injuries almost all the developing fruits. In hail-prone areas, anti-hail nets should be stretched over the orchards.

Cloudy weather

It also makes unfruitfulness in many fruits plants by making conditions favourable for development and spread of diseases. For example, powdery mildew, a most serious disease of many fruit crops, usually appears immediately following cloudy weather which consequently dry up and drop. It is most destructive during March-April, especially during cloudy weather.

Light intensity

Light supply is also important in determining fruit-set in almost all the deciduous fruit plants. Effect of Light has been reported in strawberry, as the development of pistils and stamens take place only when plants are exposed to certain light intensity. Poor fruit set, yield and color development in high density mango orchards have been mainly attributed to dense and overlapping tree canopy, rendering poor light penetration, for which pruning is recommended.

Disturbed water relations

For fruitful production, adequate supply of water is required, and disturbance in water or moisture in soil may lead the formation of an abscission layer, resulting in the dropping of the blossoms, leaves or fruits, thereby affecting fruitfulness of the plant.

Moisture deficit may be responsible for disturbance in C:N ratio and composition of other chemicals, which are responsible for fruit drop. It is not true that moisture deficit is always responsible for drop of flowers and fruits but excess moisture causes flower and fruit drop in apples and olives. In general, avoid irrigating orchards during flowering as it may sometime lead to complete shedding of flowers as reported in citrus

Nutrient supply

Balanced supply of nutrients is always desirable for realizing optimum fruit production.

However, it is often impossible to distinguish clearly between the influence of nutritive conditions within the plant and the conditions without nutrient supply on fruit set, fruitfulness and fertility. Excess supply of manures and fertilizers, though, may result in vigorous growth of the plants, but it affects flowering and fruiting adversely. It is assumed that **Example:** Jonathan apple Self sterile on rich land in Victoria (Australia), becomes self-fruitful when grown on land of low productivity. The Hope grape (perfect flower variety) and Muscadine group, produce hermaphrodite flowers only when proper nutrient supply is given. Under inadequate management practices, most of the flowers produced by these varieties are staminate.

Some cultivars of strawberry produce perfect flowers and are productive when grown under ordinary management cultural practices, but produce only little pollen for satisfactory crop when grown on rich soils.

4. Rootstocks

Rootstocks are known as the backbone of fruit industry. Thus many rootstocks are used for inducing various desirable benefits on the scion cultivar. In some instances, stocks exerts considerable influence on flowering and fruit set of the scion cultivar. Example: Troyer Citrange (Citrus), Dogridge (Grapes), Pusa Srijan (Guava), Khirni (Sapota), etc. Seedlings plants are relatively slow to come into bearing, but it can be hastened by grafting on trees of some kind that are bearing. Thus, rootstocks, directly or indirectly influence the fruitfulness of the plants

5. Pruning

Pruning is very old horticultural practice in which undesirable parts of plant are removed judiciously. It is a very important cultural practice to maintain the rhythm of fruiting in deciduous fruit plants, but it is rarely done in evergreen fruit plants, though they also respond favourably to pruning. **Example:** Cane-pruned grapevines produce flowers and fruits better than the severe spur-pruned grapes. Heavy pruning has been on the change of sex, from staminate to pistillate or to hermaphrodite in papaya.This is regarded as extreme illustration of influence of pruning practice on flower formation, fruit setting and productivity.

6. Age and vigour of the plant

The effects of age and vigour on bearing behaviour of fruit plants are well known. The age of the plant has been the factor, apparently associated with the degree or percentage of fruit setting. Example: Young and vigorous plum trees are known to produce higher proportion of defective pistils than older trees of the same variety. Young vigorous apple trees often fail to set fruits under controlled cross-pollination, whereas old and less vigorous trees of the same

variety set freely. The problem of *coulure* is very serious disease in the initial years of bearing in Muscat of Alexandria grape, but later it is less serious.

7. Locality

Fruit setting on trees of the same variety is often much better in one locality than in another. It is the only environmental complex, which influences the fruit set in a locality.Example: The American grape varieties have been found to be self sterile in Columbia, although, perfectly self fertile in California, which is in the south The Jonathan apple is almost sterile in Victoria (Australia), although it is fertile in USA. The Bose pear is self sterile in many localities, but becomes partially fertile in New York (USA). The South Indian variety (Neelum and Baneshan) of mango don't perform better under North Indian conditions

8. Seasonal influence

It is almost impossible to distinguish the influence of locality from that of season, because the seasonal variations at a given place may give rise to practically the same changes in environment which are due to differences in localities in a single season. Example: Trees of some plum varieties have been found to be greatly in fertility from season to season and a plum variety, which is protandrous in one season, may be protogynous in the next season. a) End season fertility (Grape varieties – Ideal)

b) Change of sex with season (Japanese Persimmon, *Myrica gale*, Grapes Hybrid – *Vitis riparia* x *Vitis Labrusca*)

9. Spraying fruit plants during flowering

Although, spraying of fruit trees with adequate insecticides and fungicides may be an effective aid in preventing the attack of certain insect-pests and disease, but it would seriously reduce fruit setting and thereby affecting fruitfulness of the orchard. Example: Jhumka, the disorder has occurred in orchards due to excessive spraying of insecticides, which result in decline in pollination of pollinating insects. Arsenicals cause the greatest injury to the pollen and pollen carrying insects, if they are sprayed on trees during flowerings.

10. Insect-pest and diseases

At times insect are considered useful to the flowers as they are the chief pollination agents and thereby they help in adequate fruit set. Yet, the flowers of many fruits are attacked by numerous insect-pests, fungal, viral and bacterial diseases, rendering them unfruitful too. Example: Houseflies strictly do pollination in mango, but mango hopper may infest it blossoms in such a number as to blast off all the flowers on a tree or even in the whole orchard. Among diseases blight is most serious diseases, which limits fruit setting in pears

considerably. Others like Scab (Apple and Pear), Powdery Mildew (Mango, Grape, Ber, etc.)

11. Miscellaneous factors

Management of orchard, Presence of illuminating gases in the atmosphere (Black tip of mango) Presence of high salt concentrations (Chloride) Continuous spray of certain chemicals (Lime sulphur)

Internal factors

It is a common observation that some fruit plants even produce abundant flowers, but usually fail to set adequate number of fruits and sometimes they do not produce fruits at all. This failure of fruit set may be due to various reasons, like failure of pollination, sterility or even nutritional deficiency. Stout and his co-workers in 1916 recognised that such type of unfruitfulness is mainly due to the following three internal factors.

1. Sterility from impotence
2. Sterility from incompatibility and
3. Sterility from embryo abortion

Impotence

Sterility from impotence arises when one or both the sex organs fail to develop the fruit properly.The impotence may be complete, in which either no flower or no sex organs are formed, or it may be partial, in which either stamens or pistils are abortive

Incompatibility

Sterility from incompatibility arises, when, although the sex organs are completely formed, they fail to function properly. The pollen grains are unable to germinate freely on stigma or stigma is not compatible with the pollen. Thus in incompatibility, the properly developed gametes fail to unite together, although the sex are organs are completely formed or functional

Abortion

In sterility due to abortion, even after the proper pollination and fertilization, the abortion of the embryo takes place before reaching the maturity. However, sterility associated with the internal factors are based upon the following fundamental processes:

a) due to evolutionary tendencies
b) due to genetic influences and
c) due to physiological factors

(A) Evolutionary tendencies

Due to evolutionary tendencies, cross fertilization must be done in order to maintain the vigor of the species. In these species, self fertilization is difficult.

The evolutionary factors leading to unfruitfulness are:

Imperfect/defective flowers-

a) Monoecious (Cashewnut, Annona, Aonla, Ber, Litchi, Jackfruit)

b) Dioecious (Papaya, Date palm)

Dichogamy

a) Protandrous (Ber, Passion fruit)

b) Protogynous (Sapota, Annona, Mango, Avocado)

Heterostyly: Difference in the length of style and stamens.

Pin (Sapota, Pomegranate) and Thrum (Carambola) type flowers.

Stigmatic receptivity

Abortive flowers or aborted pistils or ovules

Fruit plant	Causes of flower abortion
Grapes	Degeneration of nucleus
Mandarin	Abnormal pistil
Litchi	Embryo abortion
Olive	Pistil abortion
Kiwi fruits	Pollen degeneration

Impotence of pollen

- Unfruitfulness in Muscardine grape is due to defective pollen.
- In Ber Illaichi variety is male sterile.
- In Citrus Kagzi Lime and Eureka Lime are male sterile due to non-viable pollen.
- Pollen sterility is common in many Olive cultivars.

(B) Genetic influences

Unfruitfulness due to incompatibility: Incompatibility between pollen and ovule.

✓ **Self-incompatibility:** In ability of a plant with functional pollen to set fruits or seeds when self-pollinated. In mango, self-incompatibility is reported in cvs. Dashehari, Chausa and Langra (Ram *et al.,* 1976). In loquat varieties like Golden Yellow, Pale Yellow pollen tube penetrate in to stylar canal up to $1/4^{th}$ to $1/3^{rd}$ of its length and did not go further below, even after 72 hrs. of pollination (Singh and Rajput, 1964).

Unfruitfulness due to hybridity: Generally, the wider the cross, greater is the degree of sterility encountered.

- ✓ Waugh (1900) reported that a hybrid between 'Troth Early' peach and 'Wild Goose' plum, which has been named as 'Mule' bears flowers abundantly, but the flowers neither have petals nor pistils. The seedlessness of many commercial cultivars of banana and pineapple is attributed to the hybrid nature of their ancestors i.e. due to chromosome number. A number of hybrids between *Vitis rotundifolia* and Euvitis group are almost sterile due to hybrid condition

iii. Inter-fruitfulness and inter-fertility: The ability of two plants or two varieties to set fruits and develop seeds with each other's pollen is called as inter-fruitfulness or inter-fertility. **Example:** Smyrna fig, Datepalm, some varieties of Grapes. Gardner (1913) reported in sweet type cherry, he found that leading varieties of sweet cherries in many locations are inter-sterile or inter-unfruitful. Similar type of inter sterility has been also reported in other fruit crops like almond, plum, pear and some varieties of filberts.

iv. Reciprocal crossings

- ✓ In certain fruit species, it has been observed that, if a certain crossing proved sterile, its reciprocal crosses were also sterile and if one variety proved to be incompatible with the other, those two were likewise incompatible with each other.
- ✓ However, in other, a certain set of crossing has been fruitful, but the reciprocal crossing being sterile.

Example:

- ✓ Tragedy plum (European type) good pollinizer for several varieties of Japanese type, but fail to set fruits when Japanese varieties is used for the Tragedy plum.
- ✓ *Vitis Vinifera, V. labrus*ca and *V. cordifolia* species of grape set fruits freely either with *V. rotundifolia* and *V. munsoniana*, but when *V. rotundifolia* and *V. munsoniana* are used as pollen parents either for *V. Vinifera, V. labrusca* and *V. cordifolia*, they never set fruits freely.

(C) Physiological influences

i. **Slow growth of the pollen tube (Clementine mandarin)**
ii. **Poor pollen germination**
iii. **Premature or delayed pollination (Kagzi Kalan)**
iv. **Nutritive condition of plant:**

- ➢ Poor nutritive condition of the plant not only affects vegetative growth, but also results in the production of defective pistils and poor pollen production.

- One of the factors associated with alternate bearing in many fruit plants has been the exhaustion of food reserves by heavy crop load in 'on' year, leaving very little or no food reserves for flowering and fruiting in the next year.

Remedial measures

- **Use of suitable rootstocks**
- **Control of frost damage**
- **Proper nutrition**

Eg. Nitrogen application after terminal bud formation led to the development of flower with enhanced embryo sac longevity (Jackson, 2003).

- **Control of pollination**
- **Proper used of pollinzers**
- **Application of plant growth regulators**
  Eg. Litchi application of TIBA and KNO_3, Increase pollen fertility
  (Sanyal *et al*., 1996)
- **Balancing vegetative and reproductive growth with proper pruning and thinning**

Impact of climate change on fruit production

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Climate change has emerged as a major challenge to global fruit production by demonstrating long-term changes in temperature, rainfall patterns, and extreme weather events. Fruit crops are highly sensitive to climatic variations due to their perennial nature and specific requirements for flowering, fruit set, and quality development. Rising temperatures, irregular rainfall, and increased pest and disease incidence have significantly affected fruit yield, quality, and geographical suitability. Disruptions in flowering, pollination, and water availability further intensify production risks. Adoption of climate-resilient varieties, efficient water management, and integrated pest management are essential adaptation strategies. Strengthened policy support and climate-smart horticultural practices are crucial for sustaining fruit production under changing climatic conditions.

Introduction

Climate change refers to long-term alterations in temperature, rainfall, and weather patterns driven by both natural processes and human activities. Over the past century, greenhouse gas emissions, deforestation, and intensive land use have accelerated global warming, resulting in significant changes to agriculture and horticulture. Among all agricultural sectors, fruit production is particularly vulnerable because fruit crops are perennial, sensitive to climatic variations, and require specific environmental conditions for flowering, fruiting, and quality development.

Climate Variables Affecting Fruit Production

Fruit trees depend heavily on climatic factors throughout their life cycle. The key climate variables that influence fruit production include:

1. Temperature:
Optimal temperature ranges are essential for vegetative growth, flowering, pollination, and fruit setting. Extreme heat can cause flower drop, reduced fruit set, and sunburn on fruits, while late cold spells in spring can damage newly opened flowers, reducing yield drastically.

2. Rainfall and Water Availability:
Adequate soil moisture is vital for nutrient uptake and fruit development. Changes in rainfall patterns--such as prolonged droughts or heavy unexpected rains--disrupt irrigation schedules, reduce water use efficiency, and increase plant stress.

3. Extreme Weather Events:
Storms, hail, floods, heatwaves, and prolonged droughts adversely affect fruit orchards. Such events can lead to tree damage, increased pest and disease outbreaks, and severe yield losses.

4. CO2 Concentration:
Elevated atmospheric CO2 can enhance photosynthesis and potentially improve growth in some crops. However, this benefit is often negated by the combined stress of heat, water scarcity, and pest pressures.

Effects of Climate Change on Fruit Production

1. Altered Flowering and Pollination
Fruit trees rely on precise temperature cues to flower at the right time. Climate change is disrupting these cues:

- **Early flowering:** Warmer winters lead to premature bud break. If subsequent frost occurs, flowers are damaged, leading to crop failures.
- **Pollination mismatch:** Bees and other pollinators may not be active when flowers open early, resulting in poor fruit set.

In crops like apple and pear, inadequate chilling hours due to warmer winters reduce flowering and yield potential. Similarly, mango and citrus show altered flowering behavior, affecting seasonal production cycles.

2. Reduced Fruit Quality and Yield
Temperature and moisture fluctuations influence fruit quality:

- **Heat stress** increases respiration and reduces sugar accumulation, affecting sweetness and taste.
- **Water stress** leads to smaller fruit size, uneven ripening, and internal disorders like cracking or dry pith development.
- **Sunburn** due to high temperatures affects skin quality, marketability, and shelf life.

Research shows that yield reductions vary by crop and region, but overall trends point toward lower productivity and quality in sensitive fruit species.

3. Increased Pest and Disease Incidence

Climate change alters pest and pathogen dynamics:

- Warmer and wetter conditions favor faster reproduction of insects such as fruit flies, aphids, and mites.
- Many fungal diseases (like powdery mildew and anthracnose) spread more rapidly with increased humidity and warmer nights.
- New pests previously limited by cooler climates are migrating into previously unaffected areas.

This increases production costs due to more intensive pest management and can lead to greater use of chemicals, which carries environmental and health concerns.

4. Water Scarcity and Irrigation Challenges

As rainfall becomes unpredictable and drought events increase:

- Water for irrigation becomes scarce, especially in arid and semi-arid fruit growing regions.
- Groundwater depletion forces farmers to invest in deep bore wells or alternative water sources, increasing costs.
- Efficient irrigation systems (drip, micro-sprinkler) become essential but require capital and technical know-how.

In regions dependent on monsoon rains, delayed or weak rainfall directly affects fruit crop establishment and development.

5. Shifts in Suitable Growing Areas

Climate maps suggest that many traditional fruit-growing regions may become less suitable over time:

- Apples may shift to higher altitudes or latitudes requiring cooler conditions.
- Tropical fruits like mango might expand into areas previously unsuitable but face new disease pressures.
- Wine grapes and cherries are already showing production shifts in response to climate warming.

Such geographical shifts require adaptation strategies, replanting costs, and long-term planning.

Adaptation and Mitigation Strategies

Though the challenges are significant, proactive measures can reduce the negative impact of climate change on fruit production:

1. **Climate-Smart Orchard Management**
   - ✓ Use of Climate-Resilient Varieties: Breeding and selecting fruit cultivars with improved tolerance to heat, drought, or reduced chilling requirements.
   - ✓ Protected Cultivation: Shade nets, greenhouses, and tunnels help regulate microclimates, reduce heat stress, and protect crops from extreme weather.

2. **Improved Water Management**
   - ✓ Implementation of efficient systems such as drip irrigation, soil moisture sensors, and rainwater harvesting.
   - ✓ Scheduling irrigation based on crop needs and weather forecasts to optimize water use.

3. **Integrated Pest and Disease Management (IPM)**
   - ✓ Monitoring pest populations and using biological control agents reduces chemical reliance.
   - ✓ Forecasting systems help predict disease outbreaks and plan timely interventions.

4. **Agroforestry and Landscape Planning**
   - ✓ Intercropping with legumes or grasses improves soil moisture retention and reduces wind speeds.
   - ✓ Trees and hedgerows around orchards serve as windbreaks and reduce micro-climate extremes.

5. **Policy and Farmer Support Systems**

Government and institutional support play a vital role:

- ✓ Providing climate advisories, weather forecasts, and real-time data to farmers.
- ✓ Subsidies for water-efficient technologies and protected structures.
- ✓ Training programs on climate-resilient horticulture practices.

Conclusion

The impact of climate change on fruit production is multidimensional, affecting flowering, yield, fruit quality, pest dynamics, and resource use. Fruit growers increasingly face challenges that require adaptation through innovation, technology, and sustainable practices. While climate change threatens fruit production, proactive measures--supported by research institutions, governments, and farming communities--can strengthen resilience and secure fruit crop sustainability for the future.

Wood apple lassi

Sita Pendurthi .
Mahalakshmi Ceuticals LLP

The aromatic citrus pulp of this uncommon fruit is used to make Bel Ka Sherbat, extremely popular in parts of India during summers and relished for its cooling properties. Rich in tannins, calcium, phosphorus, protein and iron, wood apple is believed to cure digestive disorders, boost immunity and fight infections. Wood Apple Lassi is a sure- shot hit during the hottest days of the year.

Preparation time -5 mins ; Serves -1

Ingredients

Cold water	1/2 cup
Wood Apple (bel) pulp	1/2 cup
Sugar	to taste
Fresh Curd	1/4 cup

Method

- In a large bowl of cold water, add wood apple pulp and sugar. Mash the pulp using your hand
- Using a strainer, strain the juice in another bowl.
- In a separate bowl, add curd and whisk well.
- In a juicer, add Wood Apple juice along with the whisked curd. Blend well.
- Serve Chilled.

Udhayam : A promising new banana variety for Tripura

Dr. Sukhen Chandra Das
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Banana is good in taste as well as good for health. The climatic condition of Tripura is suitable throughout the year for the production of banana. College of Agriculture, Tripurahas produced a promising new variety with 45 kg, 42kg, 35 kg weight and 5.5 feet long banana bunch by scientific process. Udhayam variety is similar to karpuravali variety of banana. Udhayam variety is suitable for cultivation in the North Eastern states viz., Tripura, Mizoram, Nagaland etc. In the last five years of continuous scientific studies, it was found that, the soil and climatic condition of Tripura are very much congenial for commercial cultivation of Udhayam variety. The crop duration is 14-15 months under Tripura conditions with Zeo-tilage with half mone trace system of cultivation in hill slope. It has cylindrical bunch with 20-23no of hands and 20-25 fruits per hand. Fruits are elongated with 16-18 cm in length and 13-14 cm in circumference. The total no of bananas in 1 bunch is near about 200-250 nos. Weight of 1 banana is 250gm, 240gm and 220gm. The fruits have high sugar content with 30, 31, 29 degree brix and suitable for processing into value added products like figs, banana juice, wine etc.Presently,College of Agriculture, Tripura, Lembucherra, produced wine from ripen fruit with locally made yeast on experimental basis. The selling price on average ranges from Rs. 500/- to Rs 1000/- per bunch of Udhayam. While the local Champa, Bangla/ Samaikela bunches were sold only at Rs. 200/ to 300/- per bunch. The distance from plant to plant and row to row is 2 meter(2mt x 2mt.). The pit size, 60cm x 60 cm x 60cm. One(1) hector (10,000 m^2) area equal to 6.25 kani. One (1) kani equals to 1600 m^2 area. In 1 kani area, 400 plants can be accommodated along with the production of 400 hundred Banana bunches, so the income from 1 kani on an average would be Rs 2 lac (minimum income) to Rs3 lacs (Maximum income) approximately. Per hector plant population is 2500 plants. There is an additional income of Rs. 5,00,000 to 6, 00,000 from this Udhayam plantation. The potential yield of Udhayam is very high compared to local types. The investment in the whole production is Rs 34-45,000 in 1 kani (including land preparation, pit digging, planting material, fertilizer, maturing, fencing cost). Per hector income is Rs. 10 lac to 12 lac in farmer field with systematic cultivation. 30%-40 % high yielder, which is locally grown in Tripura, with high TSS are suitable for long distance transportation and are also less prone to fruit damage during transit. By replacing local varieties like Champa, Bangla/ Samaikela, Ketch kela, the Udhayam variety will give 30-40 % percent more income i.e, (Per hector income of Rs. 10 lac to

12 lac). For the local varieties like Champa, Bangla/ Samaikela, the per hector income ranges from Rs. 2 lacs to 3 lacs only, which is very less. Moreover, systematic Banana cultivation is very less, hence income is also less. Most of the farmers are practicing home state cultivation of local Banana (Champa, Bangla/ Samaikela, Ketch kela). In Tripura, Udhayam variety has been cultivated under rainfed condition. This variety is also tolerant to nematode and leaf spot diseases, which makes its productivity 30-40% higher than other local varieties grown in Tripura. The ratoon crop recorded better performance over plant growth with reduced plant height and shortened crop cycles.





Figure 1 and Figure 2 : Dr Sukhen Chandra Das with 5.5 feet long bunch of 45 kg weight at Department of Horticulture, College of Agriculture, Lembucherra, Tripura

National Research Centre for Banana (NRCB) has recorded the highest weight of banana bunch at70kg. But this record has been broken now by the Department of Horticulture at College of Agriculture, Tripura, with the production of a bunch weighing 45 kg, under the guidance/supervision of banana scientist Dr. Sukhen Chandra Das, Department of Horticulture, College of Agriculture, Lembucherra. Recently, the Additional Chief Secretary (Sri S. K. Rakesh), Govt. of Tripura along with the Director of Agriculture and Farmers Welfare, had visited our college and seen Banana bunch weighing 45 kg. They also appreciated the cultivation of Udhayam variety of Banana. Our College was also visited by the Honorable Agriculture Minister,who expressed his appreciation on visitingthe Banana field. Presently, some of the interested farmers have started cultivating successfully thus resulting in generation of high income.



Figure 3: Banana farmers visited the garden at Department of Horticulture, College of Agriculture, Lembucherra, Tripura



Figure 4: Visit and appreciation by Additional Chief Secretary (Sri S. K. Rakesh), Government of Tripura, Department of Agriculture and Farmer Welfare, and Dr. D.P. Sarkar, Government of Tripura, Director, Department of Agriculture and Farmer Welfare, and other faculties of College of Agriculture, Lembucherra, Tripura



Figure 5: Field performance of Udhayam variety under Tripura conditions.



Figure 6: Field visit and appreciation by the honorable Agriculture Minister, Tripura, Shri Pranjit Singha Roy

Summary

Udhayam has been creating influence by virtue of enhancing yield by 30-40 %, quality fruit production and high market value in Tripura. With systematic cultural practices and good management, Udhayam has proved to be a boon to banana production system in Tripura and other North-Eastern States. For Further interaction, please Contact:- 9436767547, Dr. Sukhen Chandra Das, College of Agriculture, Tripura-799210. We have been evaluating this variety for last eight years, since 2015-2022 in Department of Horticulture, College of Agriculture, Lembucherra, Tripura.

Acknowledgement

We sincerely acknowledge the Director, NRC Banana, for providing quality planting material to Department of Horticulture, College of Agriculture, Lembucherra, Tripura, for successful evaluation and commercial cultivation under Tripura conditions. Our sincere thanks to the project funding authority, NMHS, Almora, Uttarakhand, Government of India for their support. We also extend our sincere thanks to the Principal, College of Agriculture, Lembucherra, Tripura for his kind support.

Hidden Strength of Fruits: The Role of Dietary Fibers

Dharshni.A
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Introduction

In recent years, there has been a substantial rise in the production and consumption of highly processed foods that are low in dietary fiber, an essential component that influences metabolic functions and physiological processes in the human body. It is included in the two of the six specific health claims permitted in the US Nutritional Labelling and Education Act (1990) due to its beneficial effects in reducing the risk of cancer and coronary heart disease. Fruit fibers are also known to house significant amounts of antioxidants as bioactive compounds and polyphenols. The short-chain fatty acids formed by the intestinal microbiota from DF play a major role in metabolism. Health benefits associated with consuming dietary fiber include preventing constipation, improving intestinal peristalsis, preventing colon cancer. Fruit fibers can also be a good source of antioxidants in the diet.

Dietary fibres:

Dietary fiber is the indigestible part of plant foods, a type of carbohydrate that human digestive enzymes can't break down, passing through the stomach and intestines relatively intact to keep the digestive system healthy.

They are of two types: soluble and insoluble fibers. Soluble fiber dissolves to form a gel, slowing digestion, lowering cholesterol/blood sugar while insoluble fiber doesn't dissolve, adding bulk to stool, speeding transit, and preventing constipation. Both are vital, so a varied diet of fruits, veggies, whole grains, and legumes provides both types for overall gut and metabolic health.

Sources and distribution of fibers in fruits:

Apple: Majority of the total fibre was located in the peel of the apple (0.91% fresh weight [FW]). The percentage of insoluble (0.46% FW)to soluble fibre (0.43% FW)was found to be well balanced in terms of receiving a health benefit.

Lemon: The levels of dietary fibre to be 14 g/100 g dry matter in the peels of lemons, incomparisonto7.34 g/100 g dry matter in the peeled fruit itself. The total dietary fibre contained insoluble fibre of 9.04 g/100 g dry matter and 4.93 g/100 g dry matter soluble fibre.

Mango: For about, 51.2% total dietary fibre in dry matter is reported. This comprised 19% soluble fibre and 32% insoluble fibre.

Oranges: They found the peel to contain 57% total dietary fibre (dry weight); of this 47.6% DW was the insoluble fraction and 9.41% DW was the soluble fraction. The insoluble fraction is the dominant fraction thus providing health benefits such as intestinal regulation and increased stool volume. It was also determined that pectic polysaccharides and cellulose were the main constituents of the fibre.

The studies are reporting that the Total Dietary Fibre and Insoluble Dietary Fibre contents of the fruits ranged between 0.6 and 0.3g% in watermelon and 10.9 and 9.1g% in sapota, respectively. The Soluble Dietary Fibre content ranged from 0.3g% in watermelon to 2.4g% in fig. The Soluble Dietary Fibre as % of Total Dietary Fibre was low in pear (7.0%) and high in sweet lime (51.8%). Interestingly, the majority of the fruits had 30% of Total Dietary Fibre as Soluble Dietary Fibre. The Soluble Dietary Fibre expressed as % of Total Dietary Fibre was around 50% in fig, mango, orange, papaya, sweet lime and watermelon indicating that these fruits are rich in SDF.

Some of the fiber content in selected fruits are listed below:	**Serving Size**	**Total Fiber/ Serving (g)**	**Soluble Fiber/ Serving (g)**	**Insoluble Fiber/ Serving (g)**
Fruits				
Figs, dried	1 ½	3	1.4	1.6
Mango, fresh	½ small	2.9	1.7	1.2
Orange, fresh	1 small	2.9	1.8	1.1
Pear, fresh, w/skin	½ large	2.9	1.1	1.8
Apple, red, fresh w/skin	1 small	2.8	1	1.8
Strawberries, fresh	1 ¼ cup	2.8	1.1	1.7
Plum, red, fresh	2 medium	2.4	1.1	1.3
Apricots, dried	7 halves	2	1.1	0.9
Peach, fresh, w/skin	1 medium	2	1	1
Kiwifruit, fresh	1 large	1.7	0.7	1
Blueberries, fresh	¾ cup	1.4	0.3	1.1
Banana, fresh	½ small	1.1	0.3	0.8

Revolutionizing juice extraction: The power of cold plasma technology Author details:

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Introduction

A chilled glass of orange juice rich in antioxidants, vitamins and fresh flavor is something many people enjoy. Cold plasma technology aims to preserve exactly these qualities. Cold plasma is a unique state of matter in which gases become ionized at ambient temperature, producing relative particles capable of gently breaking down fruit cell walls to release juice more efficiently. Far from science fiction, this innovative technology is gaining attention in modern food processing. Traditional juice extraction methods such as heat treatment, enzymatic processing and mechanical processing can reduce nutrient levels or alter taste and aroma. In contrast, cold plasma works at low temperatures, helping to retain nutritional value and natural flavor while improving extraction efficiency. This article explores the principles behind cold plasma technology, its advantages and limitations and the extraction efficiency of various fruits.

The principle behind Cold plasma technology

In fruit juice extraction, cold plasma generates reactive oxygen and nitrogen species (ROS and RNS) that act like microscopic molecular scissors, weakening the pectin and cell walls of fruit tissues. Produced using systems such as dielectric barrier discharge or atmospheric plasma jets, this process disrupts cell structures without heat, helping to preserve sensitive nutrients like vitamin C, polyphenols and enzymes. Unlike the extremely hot plasma found in welding arcs, cold (non-thermal) plasma operates at near room temperatures.

How cold plasma works compared to other methods

Mechanical pressing: Mechanical pressing is simple and cheap but often yields lower juice volumes (around 50 -70% for many fruits) and can introduce oxygen, leading to oxidation and nutrient loss. By contrast, cold plasma pre-treats the fruit to soften cell walls, boosting yields to 80-95% without mechanical stress.

Enzymatic extraction: This method involves addition of enzymes like pectinase to break cell walls. It is time consuming and can alter flavor or introduce allergens. Cold plasma achieves similar breakdown in minutes, with no added chemicals.

Thermal methods: Steam or Hot water extraction methods softens fruit tissues but destroys heat-sensitive nutrients like vitamin C (up to 50% loss) and can create off-flavors. Cold plasma is non-thermal, retaining up to 90% of antioxidants and flavors, making juices taste fresher.

Ultrasonic or Pulsed Electric Field methods: These methods use sound waves or electric pulses for cell disruption. They are efficient but require high energy. Cold plasma requires lower energy per liter of juice and is scalable.

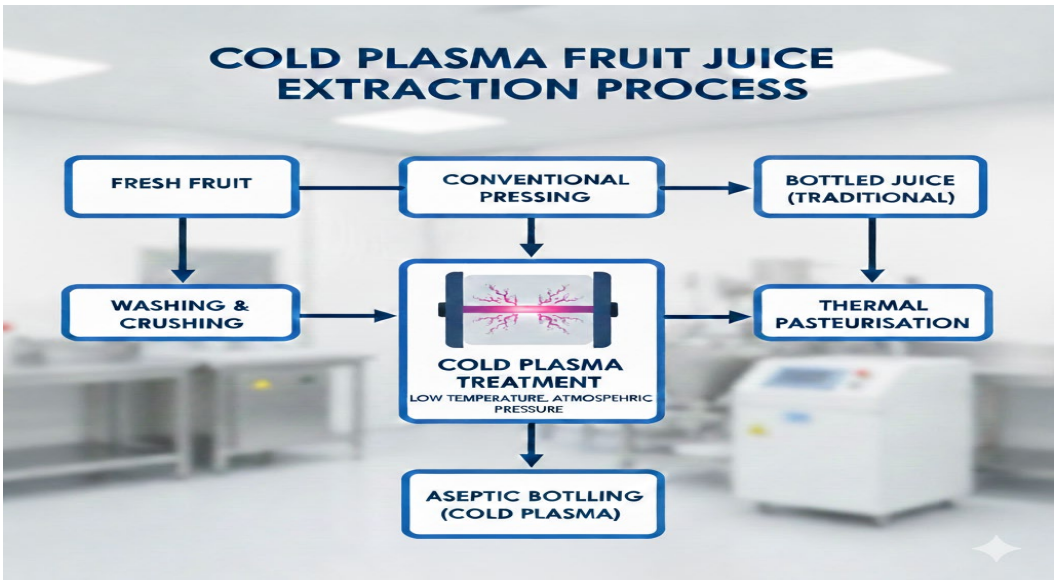


Fig.1: Cold plasma fruit juice extraction process

Advantages of Cold plasma technology

- Nutrient preservation: It retains more vitamins, antioxidants and bioactive compounds. Studies show up to 20-30% higher levels of vitamin C and polyphenols compared to thermal methods.
- Higher yields and efficiency: It can increase juice yield by 10-40%, reducing waste and boosting profitability. The process is fast, often completing in under an hour and requires less water and energy.
- Eco-friendly: Cold plasma is a sustainable option for organic juices, aligning with consumer demand for clean labels.

- Improved quality and safety: Juices from cold plasma-treated fruits have better color, flavor and microbial stability with fewer pathogens due to the plasma's sterilizing effects.
- Versatility: Works on a wide range of fruits, from soft berries to tough citrus and can be integrated into existing processing lines.

Disadvantages of cold plasma technology

- High initial costs: Equipment like plasma generators can cost more, making it pricey for small-scale operations. Maintenance and energy for high-voltage systems add up.
- Scalability challenges: Scaling to industrial levels (e.g., tons of fruit) requires more research to ensure uniform treatment and avoid hotspots.
- Limited data on long-term effects: There is less long-term data on juice stability or human health impacts from any residual plasma byproducts.
- Complexity: Not all fruits respond equally and requires tweaks for optimal results.

Fruit-wise extraction percentage

Cold plasma's effectiveness varies by fruit due to differences in cell structure and pectin content. The following table summarizes extraction percentages of different fruits based on recent studies.

Fruit	Cold plasma extraction (%)	Traditional mechanical extraction (%)	Improvement (%)
Apple	85-90	60-70	20-30
Orange	80-85	50-60	25-35
Pineapple	75-80	55-65	15-25
Grapes	90-95	70-80	15-25
Kiwi	85-90	65-75	15-20
Mango	80-85	60-70	15-25
Strawberry	85-90	70-80	10-20

Note: Percentages are based on average yield from studies.

Conclusion

Cold plasma technology has completely transformed the fruit extraction process by providing an innovative, highly efficient alternative to traditional methods of obtaining higher yields from our favorite fruits without compromising quality. The benefits of using cold plasma for fruit extraction are many, including preservation of nutrients, increased yields and lower environmental impact, which distinguishes cold plasma from the traditional heat and/or chemical-based methods of fruit extraction. As research continues to advance, we will likely see cold plasma technology in every juice aisle in

grocery stores despite cost and scalability challenges. Whether you are a food developer or someone who is focused on health, cold plasma extraction provides an even brighter future for everyone. So, remember, the most interesting new method of extracting juice could become the most interesting new method of extracting juice the next time you drink a glass of juice.

Nature's Nutrition: Understanding the Importance of Fruits in Human Health

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Fruits have long been recognized as an essential component of a balanced and nutritious diet. Rich in vitamins, minerals, dietary fiber, and bioactive compounds, fruits play a vital role in maintaining overall health and preventing a wide range of chronic diseases. Regular consumption of fruits supports physical growth, strengthens the immune system, enhances digestion, and contributes to long-term well-being. In an era marked by increasing rates of lifestyle-related illnesses, understanding the importance of fruit consumption is more relevant than ever.

One of the primary benefits of eating fruits lies in their high nutritional value. Fruits are natural sources of essential vitamins such as vitamin C, vitamin A, and several B-complex vitamins. Vitamin C, commonly found in citrus fruits, strawberries, and guavas, is crucial for immune function, wound healing, and the absorption of iron. Vitamin A, abundant in fruits like mangoes and papayas, supports good vision, healthy skin, and proper functioning of the immune system. Additionally, fruits provide important minerals such as potassium and magnesium, which help regulate blood pressure, support muscle function, and maintain proper nerve signaling.

Another significant advantage of fruit consumption is its role in disease prevention. Fruits are rich in antioxidants, including flavonoids, carotenoids, and polyphenols, which help protect the body from oxidative stress caused by free radicals. Oxidative stress is linked to the development of chronic diseases such as cardiovascular disease, diabetes, and certain types of cancer. Studies have consistently shown that individuals who consume fruits regularly have a lower risk of heart disease and stroke, as fruits help reduce cholesterol levels, improve blood vessel function, and decrease inflammation.

Dietary fiber, a key component of fruits, plays a crucial role in maintaining digestive health. Fiber aids in proper bowel movement, prevents constipation, and promotes a healthy gut microbiome. Fruits such as apples, pears, berries, and bananas are

particularly high in fiber and contribute to improved digestion and nutrient absorption. Furthermore, a fiber-rich diet helps regulate blood sugar levels by slowing the absorption of glucose, making fruits especially beneficial for individuals at risk of or managing type 2 diabetes.

Fruits also contribute significantly to maintaining a healthy body weight. Compared to processed foods, fruits are low in calories and fat while being high in water and fiber content, which promote a feeling of fullness. This helps reduce overeating and unhealthy snacking, supporting weight management and obesity prevention. Replacing high-calorie snacks with fresh fruits can lead to improved dietary habits and better overall health outcomes.

Beyond physical health, fruit consumption has been linked to improved mental well-being. Certain fruits contain nutrients that support brain health and cognitive function. For example, berries are associated with improved memory due to their high antioxidant content, while bananas contain tryptophan, which contributes to the production of serotonin, a neurotransmitter that helps regulate mood. Regular intake of fruits has been associated with reduced symptoms of depression and anxiety, highlighting the connection between diet and mental health.

In addition to individual health benefits, promoting fruit consumption has broader public health implications. Encouraging people to eat more fruits can help reduce healthcare costs associated with preventable chronic diseases. Fruits are widely available in many regions and can be consumed in various forms, including fresh, dried, or blended, making them a practical and accessible dietary option. Nutrition education programs that emphasize fruit intake can play a vital role in improving community health and fostering lifelong healthy eating habits.

In conclusion, eating fruits is essential for maintaining optimal health and preventing disease. Their rich nutritional profile, disease-fighting properties, digestive benefits, and positive impact on mental well-being make fruits a cornerstone of a healthy diet. Incorporating a variety of fruits into daily meals not only enhances dietary quality but also supports long-term physical and mental health. As modern lifestyles continue to challenge healthy eating practices, prioritizing fruit consumption remains a simple yet powerful step toward achieving overall well-being.

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(In black Letters) ……

Address……. **QR CODE**

……

…….

A total remittance details …… Date …….

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MEMBERSHIP APPLICATION FORM
(fill in CAPITAL letters)
Address for sending Proforma : General Secretary

INDIAN POMOLOGICAL SOCIETY

Horticultural College and Research Institute, TNAU
Periyakulam- 625604, Theni District,
Tamil Nadu, India
Ph: 04546-231726 FAX: 0422-2430781
Email: ipspkm2024@gmail.com

Please paste passport size Photo

MEMBERSHIP APPLICATION FORM

(fill in CAPITAL letters)

Name (Dr/Sh/Mr/Mrs/Ms)					
Designation					
Institution /Organization					
E Mail id					
Contact No					
Type of Membership	Corporate Rs. 25,000/-		Patron Rs.15,000/-		Institution Rs. 10,000/-
	Individual (National)				
Membership Category	Life membership (For 15 Years)	Annual membership	Farmers/ SHGs (Annual)	Entrepreneurs /FPO/NGOs (Annual)	Students (Annual) UG/PG/PhD
	Rs.4000/-	Rs.1500/-	Rs. 1000/-	Rs.2500/-	Rs. 500/-
Other Countries	$ 1000	$ 100	$ 80	$ 200	$ 50
Address for correspondence email id Mobile No.					
Permanent address					
Account Details for Payment	Indian Pomological Society (IPS), HC RI, PERIYAKULAM Acc.No. 8033113768 Indian Bank, Periyakulam, IFSC: IDIB000P222				
Transaction Details					
Membership No and Year (to be filled by society)					
Signature with date					

Address for sending Proforma : General Secretary
Indian Pomological Society (IPS)
Horticultural College and Research Institute
Tamil Nadu Agricultural University
Periyakulam-625604, Theni District, Tamil Nadu, India
9380823451

UPI ID : 8033113768@indianbk

Promoting Commercial Pomology by Enhancing the National Horticulture Board, Maximum Subsidy to Rs 40 Lakh



B. Raja
Deputy Director
National Horticulture Board (NHB)
Ministry of Agriculture & Farmers Welfare, Government of India, Bengaluru-560022

Introduction

The National Horticulture Board (NHB) was established by the Government of India in 1984 as an autonomous organization under the administrative control of the Ministry of Agriculture & Farmers Welfare. Registered under the Societies Registration Act, NHB has its headquarters at Gurugram, Haryana, and presently operates through **29 field offices** across the country. **The organization is headed by Shri Kapil Meena, IAS, Managing Director**.

NHB is committed to promoting integrated high-tech commercial horticulture by developing production clusters, strengthening post-harvest and cold chain infrastructure, ensuring the availability of quality planting material, and encouraging the adoption of modern technologies, tools, and scientific cultivation practices. It also promotes protected cultivation under polyhouses and net houses, enabling the establishment of horticulture hubs that generate employment and enhance farmers' income.

NHB Subsidy Schemes

The National Horticulture Board implements the following two flagship credit-linked back-ended subsidy schemes:

1. **Development of Commercial Horticulture through Production and Post-Harvest Management of Horticulture Crops.**
2. **Capital Investment Subsidy Scheme for Construction, Expansion and Modernization of Cold Storage and Storage Infrastructure for Horticultural Produce.**

The first scheme supports commercial horticulture in both open-field and protected cultivation on a project basis, along with integrated post-harvest management infrastructure. The second scheme provides financial assistance for the construction, expansion, and modernization of scientific cold storage facilities for horticultural produce.

Scheme I: Development of Commercial Horticulture through Production and Post-Harvest Management

Commercial Horticulture Development in Open Field Conditions

The scheme encourages scientific commercial cultivation of horticultural crops under open-field conditions on a project basis.

Eligible Activities

The project may include the following eligible components:

- Quality planting material
- Plantation establishment
- Drip Irrigation and fertigation systems
- Borewell/open well / water harvesting structures
- Farm mechanization/ tractor/power sprayer
- Good Agricultural Practices (GAP)
- Land development
- Store room
- Labour quarters
- Other approved project components as per NHB norms

Projects should cover an area of **more than 2.00 hectares (5 acres).**



Grapes plantation

Pattern of Assistance

NHB provides **credit-linked back-ended subsidy at 40% of the eligible project cost**, subject to a **maximum subsidy of Rs 40.00 lakh per project** in general areas.

The enhanced subsidy ceiling of **Rs 40 lakh** provides a significant financial boost to entrepreneurs and progressive farmers interested in establishing modern commercial orchards.

Eligible Pomology Crops

Financial assistance is available for a wide range of fruit, plantation, spice and medicinal crops, including:

- Aonla
- Almond
- Apple
- Apricot
- Banana
- Ber
- Lime
- Lemon
- Mandarin
- Sweet Orange
- Custard Apple
- Fig
- Grapes
- Guava
- Kiwi
- Mango
- Papaya
- Passion Fruit
- Peach
- Pear
- Pineapple
- Plum
- Pomegranate
- Sapota
- Strawberry
- Jackfruit etc

Revised NHB Scheme Guidelines

To simplify implementation and improve transparency, NHB introduced major reforms in its scheme guidelines with effect from **1 January 2023**.

Grant of Clearance (GoC)

Applicants are now required to apply directly for **Grant of Clearance (GoC)** after obtaining sanction of a term loan from a bank or financial institution.

The sanctioned term loan should be within three months from the date of online GoC application. However, the bank can disburse the loan and the applicant can commence the project only after GoC is issued by NHB. The GoC remains valid for three months for obtaining the first instalment of the term loan and commencing the project.

Salient Features of the Revised Procedure

1. Discontinuation of IPA

With effect from **15 March 2023**, NHB accepts only applications for Grant of Clearance (GoC). Applications submitted before this date are processed under the earlier system.

2. Complete Digital Processing

The GoC application process is now fully digital covering:
Online submission, Digital scrutiny, Online approval, Timeline monitoring and automatic alerts
This has significantly improved transparency and efficiency.

3. Aadhaar-Based Registration

Applicants are required to register on the NHB portal through Aadhaar authentication using OTP verification. Where the project is financed under the **Agriculture Infrastructure Fund (AIF)**, loan details are automatically fetched through API integration, thereby reducing duplication of information.

Procedure for Availing NHB Assistance

Farmers and entrepreneurs should follow the steps below:

1. Obtain a term loan sanction from a scheduled commercial bank or financial institution.

2. Submit an online application for **Grant of Clearance (GoC)** through the NHB portal along with:
    - Detailed Project Report (DPR)
    - Bank Sanction Letter
    - Bank Appraisal Note
    - Legal Search Report
    - Land ownership documents
3. Wait for GoC approval from NHB.
4. Commence the project only after receiving GoC.
5. The lending bank should release the first instalment of the term loan only after GoC approval.

Projects started before GoC approval or where the loan has been disbursed before GoC issuance are **not eligible** for NHB subsidy. The project must be completed within **18 months** from the date of first disbursement of the term loan.

Joint Inspection and Subsidy assistance

After completion of the project, a **Joint Inspection Team (JIT)** comprising officials from NHB, the lending bank and the State Horticulture Department conducts a detailed inspection. The team assesses all eligible project components as per NHB Scheme guidelines. Based on NHB cost norms, the Joint Inspection Team determines the **Eligible Project Cost (EPC).**

The applicant is required to submit:

- Project Completion Certificate
- Term Loan Disbursement Certificate
- Chartered Accountant's Certificate
- NOC from NHM/MIDH from State Horticulture Department
- Undertaking and other prescribed documents



Farm Mechanisation



Water Harvesting Structure

The subsidy is released after approval by the Internal Committee (IC) or Project Approval Committee (PAC), based on the Eligible Project Cost determined during the joint inspection.

Conclusion

The enhancement of the maximum subsidy to **Rs 40 lakh** under the National Horticulture Board Scheme is a significant initiative for promoting commercial pomology

and high-tech horticulture in India. The simplified application process, digital approvals, scientific project evaluation, and higher financial assistance encourage farmers, entrepreneurs, agribusiness companies etc to establish modern fruit orchards and adopt advanced production technologies.

This initiative is expected to enhance productivity, improve fruit quality, strengthen post harvest management, generate rural employment and contribute substantially towards increasing farmers' income and the sustainable growth of India's horticulture sector.

For more details, please visit www.nhb.gov.in

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UPCOMING AWARDS OF
INDIAN POMOLOGICAL SOCIETY IN FRUIT SCIENCE



- **Lifetime Achievement Award**
- **Best Farmers Award**
- **Best Entrepreneurs Award**
- **Young Pomologist Award**
- **Women Scientist Award**
- **Best FPO Award**
- **Best Thesis Award**

Notification of awards will be announced shortly