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Importance and Possible Approaches in Adoption of Indoor Fruit Culture for Indian Families

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ABSTRACT

Food and nutritional security are emerging as the greatest challenge of the 21st century. The pace at which population is growing, it is estimated that the food demand will be doubled by 2050. With the growing worldwide population, urbanization and present unsustainable and expanded farming practices, the risk of food and nutritional insecurity among the global population, which is regarded as a global problem for the twenty-first century, is predicted to rise even more. Fruit crops will be the best option to achieve both Food and Nutritional security due their nutritional value and higher production potential compared to other horticultural crops. The major disadvantage in fruit cultivation is land scarcity as they require large area. Still, there is scope by incorporating training and pruning and higher density planting methods. The ultimate goal of food and nutritional security only can be achieved when everyone is meeting our per capita food and nutritional recommendations. In this review the importance of fruit cultivation and possible approaches to grow them as indoor plants were discussed.

Key Words: Food and Nutritional security, Urbanization, Indoor fruit cultivation, Ultimate goal, Nutritional recommendations, Possible approaches

INTRODUCTION

FAO predicted that continuous increase in global population would reach 11 billion in 2100. As a result, we must increase our productive capacity in order to feed an additional 2.5-3 billion people. To do so, we'll need an additional 140 million hectares of arable land, which will be difficult to come by given the current rate of urbanisation.¹ Meanwhile, due to the indiscriminate use of all inputs, intensive agriculture is recognized to contribute considerably to climate change.² Overall, the conventional agriculture exploits our natural resources at maximum, and made them scarce or extinct.³ According to a report produced by FAO-UN¹ (2017), agriculture alone utilizes about 70 % of the fresh water of our planet.

Climate change, pollution, depletion of natural resources, and global loss of biodiversity due to deforestation for agricultural land conversion requirements continue to threaten our planet's agricultural potential.⁴ According to Defries et al.⁵ agricultural land conversion alone has resulted in considerable forest loss in 41 tropical nations during the Green Revolution Era through 2005.

Agriculture, forestry, and other land uses account for around 21% of total world GHG emissions. As a result, we must minimize water use and GHG emissions per unit of food. From all of this, it is obvious that preserving a sustainable natural resource base and improving agricultural productivity are the two most pressing problems in food security, both of which require attention from both rural and urban agriculture.¹ This is where the importance of indoor horticulture comes into play.

Nonetheless, due to competition for land, pollution risks from the urban ecosystem to agriculture and vice versa, contamination of food products by heavy metals and organic chemicals, and rising health concerns due to sanitation and vector diseases, urban agriculture continues to face land insecurity issues.^{4,6,7,8,9} Game and Primus¹⁰ categorized urban agriculture into 2 spheres namely, Uncontrolled Environment Agriculture (UEA) and Controlled Environment Agriculture CEA. UEA consists of open space vegetable gardens, rooftop gardens, and community gardens, all of which are widely acknowledged to play a part in food security in cities throughout the world. CEA, on the other hand, comprises

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agricultural methods that optimize the environment, often in combination with neighboring urban buildings. Greenhouses, indoor farming, vertical farming, and building-integrated agricultural are some examples.^{10,11}

Optimization of food production can be achieved by incorporating innovations such as indoor agriculture, remote sensing, vertical agriculture, hydroponic, aeroponic, aquaponic, and soilless agriculture, precision agriculture, and other novel technologies in Urban Agriculture, regardless of whether it concerns an open or closed system.^{2,12,13}

Agriculture is often ignored in India's peri-urban areas, which are plagued by institutional uncertainty, unplanned expansion, insufficient infrastructure, and environmental deterioration.¹⁴ Land availability for cultivation is also decreasing from year to year in India. However, land requirement for various socio-economic processes, urbanization is inevitable. This made lot of people to lose their farm land.¹⁵ Under this situation indoor horticulture will be one of the best solutions to meet out individual's food as well as nutritional security. While speaking about indoor horticulture instantly the question of growing fruits indoor will arise. Surely this article will reveal the answers for all the questions in your mind regarding indoor fruit cultivation.

Importance of fruits

- It is certain that fruits and vegetables are rich sources of vitamins and minerals. Their nutritional wealthiness places them on the crest of our diet.
- Having fruits on our daily diet strengthens our vitality. As per the ICMR recommendation individuals must take 120 g of fruits in their daily food intake.
- Vitamins A, B, and C are abundant in fruits such as papaya, mango, guava, jackfruit, pineapple, lemon, and so on. Calcium, magnesium, iron, and potassium are also included in them. In wood apple, litchi, almond, karamcha, and other plants, phosphorus and amino acids are abundant.¹⁶
- In India rice and wheat are the staple food which made us far away from nutritionally sound fruits. In contrast many other countries people are taking fruits as their staple food. Fruits such as banana, jack fruit, guava, pineapple, etc. can minimize our food deficit to a great extent.
- Growing food crops inside provides access to fresh, high-nutrient-value produce and serves as a significant remedy for malnutrition.
- In developing countries, urban horticulture helps to livelihoods, ensuring food security.¹⁷
- Fruit trees with low inputs not only enrich the environment, but also act as source of income to the population.
- Dubbeling et al.¹⁸ reported that an achievable yield from 1m² land *via* fruit and vegetable cultivation was about 50 kg/annum. Fruits give comparatively very

high yield.

- This shows that indoor fruit and vegetable production has the ability to provide a certain level of self-sufficiency for inhabitants' nutritional security.
- Home gardens feature a variety of fruits, vegetables, trees, and condiments that serve as additional food and revenue sources.
- Fruits are high in phytochemicals, which act as antioxidants, phytoestrogens, anti-inflammatory agents, and other protective processes in addition to vitamins and minerals.¹⁹
- Incorporating fruits and vegetables into our daily diet can help to avoid a variety of non-communicable illnesses, including cardiovascular disease, type 2 diabetes, and some cancers.²⁰

Why indoor?

- To lessen the burden on agricultural production system
- To reduce over exploitation of natural resources in order to increase productivity of intensive agricultural system to feed the growing population at the cost of environmental degradation.²¹
- No need of additional space

Because this method does not need extra area, it is referred to as indoor farming or zero farming.²²

- Reviviscency of urban environment

This has the ability to use household or industrial waste water, sunshine, and sequester larger levels of carbon dioxide utilising CO₂ created within the building or in cities while taking up no more space. This may be a small space resource recycling or saving method that could minimise a city's ecological impact and contribute to sustainability.²²

Requirements for indoor fruit cultivation

1. Containers

The container is important for plant growth because it provides support and regulates environmental variables including temperature, gaseous exchange, and relative humidity.²³ Suitable container size for different fruit crops furnished under Table 1.

2. Varietal selection and other considerations for successful indoor fruit culture

For effective indoor fruit growing, choosing the right fruit crop variety is crucial. Suitable fruit crops for indoor cultivation furnished in Table 2. The size of the tree is the most important factor to consider, as dwarf trees are preferred. And understanding the temperature requirements is necessary to assure their indoor adaptation. It's best to choose types that can thrive at room temperature. Recommendations for varietal selection of different fruit crops given in Table 3.

3. Special operations in indoor fruit cultivation

Media

Containerized plants need different potting soil of different physical properties. So, it is wise to avoid garden soil as they may act as source for some soil-borne disease. Best potting mixture will be peat moss: bagged topsoil or potting soil at 1:1 ratio, some weed-free compost. While potting leave 2 inches gap on the top for an organic mulch. Plants may need repotting for every 3-5 years in order to cope up with nutrient depletion in media.²⁴

Optimum irrigation

Appropriate and sufficient irrigation is required to obtain appropriate yields and healthy products.⁹ The amount of water required and how often it is watered are determined by the kind and size of the plant, the type and size of the container, the temperature, humidity, potting media, and other factors. Before watering most plants, let the upper surface of the soil to become dry to the touch. Then, carefully fill the container with water to completely wet it. The ability to remove surplus water from the containers is critical.

Plastic, metal, and ceramic containers keep the soil moist for longer than wood or clay containers, which allow water to evaporate through the sides. Because chilly weather slows plant development and so lowers the demand for moisture, watering should be done less often during this time.²⁴

Rain, collected water, tap water, or wastewater can all be used as a source of water. Untreated wastewater poses a significant risk to human health, and modern treatment equipment is still too costly.⁹

Despite the fact that using wastewater for fertilizer and irrigation in UA is considered a positive wastewater treatment²⁵, it has been linked to a rise in health problems.⁸ Eating contaminated food can create epidemics if it is used improperly or insufficiently handled.²⁶ As a result, using high-quality water for irrigation is critical.

Nutrition

Organic waste, such as animal manure, plant leftovers, or waste from the food industry or homes, can be utilized for nutrition and fertilization.

Commercial hydroponics is a contemporary technology that involves plant development in nutrient solution without the need of soil as a rooting media (suitable for specific fruit crops such as strawberries, grapes, raspberry, blackberry, and blueberry). This technique uses irrigation water to apply inorganic fertilizers and then recirculates the nutrient solution to prevent leaching and waste.²⁷

Excess fertilization and/or water containing significant soluble salts can occasionally cause salt buildup, which is fre-

quently indicated by a white crust on the soil or container. By carefully flowing water through the container for many minutes, the container should be thoroughly leached. Excess salts will be carried down through the soil and out the drainage holes.^{28,24}

Light requirement

Plants growing outdoors will meet their light requirement from solar radiation. But plants growing under controlled condition or closed environment sometimes need light source to carryout photosynthesis in an effective manner.

Traditional light sources, such as high-pressure sodium and metal halide lamps, produce a lot of heat and aren't very energy efficient or cost-effective for plant development. To address these issues and improve the quality of the product, solid-state light-emitting diode (LED) lights have been created. LED lights are energy-efficient, low-maintenance, and long-lasting.²⁹ Three light characteristics should be considered: intensity, quality, and duration, all of which have varied effects on crop development and product quality.³⁰ In an experiment on the indoor cultivation of basil and strawberry, it was discovered that when the plants were treated with LEDs with the highest energy use efficiency than traditional fluorescent lamps, the plants produced more biomass, fruit yield, antioxidant content, and reduced nitrate content, and that a spectral red: blue ratio of 0.7 was required for proper plant growth with enhanced nutraceutical properties.³¹

Grooming

Grooming refers to cleaning and pruning of indoor plants periodically to remove dust, keep them at peak of their productivity since the dust deposition on leaves will affect the photosynthetic capacity of the plant. Indoor plants' leaves, on the other hand, can quickly become covered in a thick coating of dust. These dust particles block stomata, impairing gas exchange. As a result, grooming is critical.

Different techniques of grooming,

- Clean glabrous leaves with a soft, damp towel; clean pubescent leaves with a make-up or soft painters brush; place plants in the shower to wash away dust
- If it's warm outside, rinse them with a garden hose.
- Use warm water between 60° and 75°F to avoid harming the plant's development by exposing it to overly hot or cold conditions.²⁴

Training and pruning

Pruning is highly essential to maintain optimum plant height. Training the plants into well-defined structure wisely reduce their space requirement. If the space availability is very less than training them into vertical or columnar shape (in case of apple and peaches) will be ideal.²⁴

Rootstock selection

While focusing on growing plants in containers, it is wise to choose dwarf varieties (Table 4) that made keeping plants height optimum with less care. The size of the plants is determined either by nursery pruning or plant genetics. But the role of rootstock is highly significant in inducing dwarfness. Dwarfing rootstocks enlisted in Table 5.

Plant protection

As per the report presented by Lada et al.³² there is no or very less incidence of pest and disease in indoor cultivation which doesn't require application of pesticide.

DISCUSSION

Fruits certainly play vital role in achieving food and nutritional security. By standardizing techniques for growing them indoor we can surely ensure food and nutritional security of each and every individual. It provides the city dwellers with nutritious food along with aesthetic recreation and its socio-economic importance will develop further as the overall advancement of society is progressing at rapid pace. It will also become a more significant aspect of horticulture business entrepreneurship.

The significant issue for indoor fruit cultivation is tree size. As most of the fruit crops are tends to grow much larger, it is essential to control tree size. This can be done by using dwarfing rootstock, dwarfing scion, proper training and pruning and by usage of growth retardants.

Apart from these tree size reducing approaches, indoor fruit crops require mere attention towards light availability, ventilation, optimum temperature and relative humidity. To ensure these requirements it is advisable to place the plants near the windows or any other light source. Water can be provided based on the media dryness. Root pruning and changing depleted media have to be done once in a long while to ensure proper growth and development.

CONCLUSION

Indoor fruit culture's full potential as a food and livelihood provider, on the other hand, can only be realized if it is integrated into urban land use planning and policy making, addressing both potential advantages and hazards for nutritional benefits and nutritional empowerment. In many developing country cities, well-managed urban horticulture will be an essential tool for reducing poverty, improving environmental management, and advancing economic growth. When these ideas are turned into practical norms and activities, urban horticulture may help with food security, food safety, and livelihoods while also providing a lot of room for creativity.

Overall, it is evident that indoor fruit culture is a viable option for providing healthy, fresh, and safe food to the globe in the twenty-first century.

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- S. Senthilkumar given this ideology, analysed and reviewed the article.
- Vijayalakshmi K collected and analyzed the information and prepared the report.
- U.S. Akshara Govind reviewed the article.
- S. Manivannan analysed and reviewed the article.

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Table 1: Container size required for some fruit crops

Apple	20–25 gallon
Blueberries	2 feet x 2 feet x 2 feet
Figs	10 gallons
Grapes	15 gallons
Citrus	15 gallons
Peaches	20–25 gallon
Strawberries	8-inch-deep container

Source: Williamson (2020).²⁴

Table 2: Suitable fruit crops for indoor cultivation

Tropical fruits & subtropical fruits	Temperate fruits
Banana	Apple
Kagzi lime	Blackberry
Kumquat	Blueberry
Lemon	Strawberry
Tahiti lime	Raspberry
Papaya	Peach
Guava	
Pineapple	
Passion fruit	
Avocado	
Barbados cherry	
Carissa	
Fig	
Pomegranate	

Source: Williamson (2020).²⁴

Table 3: Varietal selection for indoor fruit cultivation

Fruits	Recommendations
Apple	Select disease-resistant and dwarf rootstocks. To ensure Cross-pollination growing different varieties is also essential.
Blueberry	Soil with the pH value of 4.5 – 5.3 is suitable.
Citrus	<i>Satsuma</i> or <i>Kishu</i> mandarins, calamondins, lemons and limes found to be successful under indoor condition. Lemons and limes do not withstand freezing temperatures, so bring the plant inside if the temperature drops below 45°F; mandarins grow well in colder climates when they grafted on <i>Poncirus trifoliata</i> semi-dwarfing rootstock. Calamondins can withstand temperatures as low as 25°F. Select dwarfing root-stock such as flying dragon to control the plant size.
Fig	Roots system of fig crop will withstand temperatures to about 15° F. Proper training and regular pruning is essential to maintain plant size as small.
Strawberry	Day-neutral or ever-bearing cultivars are preferred since they yield fruit regardless of the length of the day.

Source: Richter et al.(2011)³³**Table 4: Dwarf cultivars/variety/hybrid of different fruit crops**

Crop	Dwarf cultivars/variety/hybrid	Reference
Banana	Dwarf Cavendish	(Salaria, 2015) ³⁵
Papaya	Pusa Nanha	(Salaria, 2015) ³⁵

Table 5: Dwarfing Rootstocks

Crop	Dwarfing rootstocks	Reference
Apple	M 27 (Ultra Dwarfing) M 20 M 9 M 26	(Goswami et al., 2017) ³⁴
Pear	Quince – C	(Goswami et al., 2017) ³⁴
Cherry	Colt	(Goswami et al., 2017) ³⁴