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# Importance of Vegetables in Home Food Gardening in Modern Cities: Advances and Future Perspectives

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## Abstract

The practice of home food gardening (HFG) has gained enormous importance in modern cities due to decreasing availability of agricultural land, rapid urbanisation and increased concern for food safety, nutrition and sustainability. The COVID-19 pandemic has revealed the vulnerability of global food supply systems and the value of local food production. The review assesses the importance of vegetables in Home Food Gardening in modern cities. Vegetables are a major part of HFG since they are rapidly produced, easy to maintain, high-yielding in small spaces, and bring high nutritional benefits. Some of the common types of gardening practices seen in modern cities are: yard garden, rooftop garden, balcony garden, community garden and street/plot garden. Newer innovations such as better crop varieties, hydroponics, aquaponics and smarter monitoring systems have raised productivity. But there are still issues like space constraints, expensive setup costs, lack of knowledge, poor soil, and insufficient light. These problems can be addressed through better urban design, affordable technologies, training and sustainable behaviours. Furthermore, HFG helps to improve urban life, healthier diets and environmental sustainability in general.

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*Keywords: Vegetables; home Food Gardening; modern cities; COVID-19 pandemic.*

## 1. Introduction

Urban populations are growing rapidly across the world. Estimates suggest that by 2030, nearly two out of every three people, i.e. around 5 billion individuals, will be living in urban areas. The urban population is projected to reach about 68 per cent of the global population, or nearly 6.7 billion people, by 2050 (Lal, 2020; Richardson & Arlotta, 2022). Food supply systems are essential for ensuring proper nutrition in any country, but their value became fully noticeable during the lockdowns of 2020 due to the COVID-19 pandemic. Movement restrictions, quarantine rules, and the suspension of transport services interrupted the smooth flow of food supplies (Workie *et al*., 2020; Mead et al., 2021). As a result, food availability declined in many places, creating concerns about food security (Reardon *et al*., 2020). Home food gardens have assumed increased significance during this period owing to their accessibility under movement restrictions and their potential to support the supply of fresh produce. Furthermore, they have been associated with stress alleviation, enhanced physical activity, and the strengthening of social relationships (Cerda et al., 2022).

People living in urban areas have very limited or no control over the supply and quality of food; thus, in this case, growing their own food or going for home food gardening can be a possible solution to this problem. Home food gardening (HFG), alternatively referred to as residential or household food gardening, entails the cultivation of edible plants, often possessing ornamental characteristics, within small-scale agricultural spaces located in and around private residences. Such cultivation may occur in backyards, front gardens, balconies, kitchen windowsills, bay windows, patios, terraces, rooftops, and other underutilised areas adjacent to the home (Aditya & Zakiah, 2022; Xu et al., 2024). They play a role in supplying food, nutritional support, medicinal resources, and other valuable products, while also addressing social and cultural requirements as integral components of traditional knowledge systems and practices. In addition, they provide a range of ecosystem services, assist in mitigating the impacts of climate change, and contribute to economic needs as well as the development of sustainable livelihoods (Korpelainen, 2023).Growing vegetables at home itself is a self-sustainable approach, especially for people living in modern cities where they have limited access to fresh produce. Due to their quick harvest cycle and high nutritional quality, vegetables play an important role in home gardens by improving diet quality and reducing dependency on purchased food (Kaur *et al*., 2024)

## 2. Methodology

Relevant studies were identified through systematic searches of online databases, including Google Scholar and Scopus, using combinations of keywords such as *home food garden*, *urban gardening*, *vegetable gardening*, *sustainable farming, urban sustainability, smart gardening technologies,* and *food nutrition and security*. Resulting articles were screened first using their titles and abstracts (written in English), and then full evaluation of the text and a re-reading process. The primary focus of this review is to compile and analyse the most recent findings on home food gardening-related issues and advancements from the scientific literature. Greater emphasis was placed on studies presenting intervention outcomes published in peer-reviewed academic journals over a 20-year period from 2005-2025. The inclusion of peer-reviewed literature ensured that the evidence used in this review had undergone scientific assessment and was considered reliable within the relevant field of study.

## 3. Significance of Home Food Garden After COVID-19

Lin *et al*. (2021) noted global trends suggesting that home gardening peaked during the initial year of the pandemic. The COVID-19 pandemic was a historic event that exposed the vulnerability of global food supply chains and made us think about how to prevent this disruption of such food supply chains in future (O'Hara & Toussaint, 2021). Realising this and also the need to get local supply, Mr Narendra Modi, the Prime Minister of India, in his address to the nation on May 13, 2020, made an appeal for vocal-for-local (Chakraborty, 2020). To ensure the local supply of fresh vegetables, many people started adopting kitchen gardening by themselves. It includes gardening for consumption in one's own house, especially the growing of vegetables and fruits, etc., in the house premises, like a backyard, rooftop or a small garden within the boundary of the house. It not only promotes self-reliance in the production of fresh vegetables but also encourages the engagement of urban households in urban gardening practices (Mohsin *et al*., 2017). This approach not only ensures a degree of self-sufficiency in vegetable production but also contributes to improved human health by reducing household food expenditure and enhancing nutritional intake.

## 4. Importance of Vegetables in Home Food Gardening

India is the second largest producer of vegetable crops after China. The vegetable production in India is estimated at about 217.8 million tonnes during 2024-25 from nearly 11.2 million hectares of area (Department of Agriculture & Farmers Welfare, 2025). The present production of vegetable crops is not sufficient to meet the requirement of 300g of vegetables, on average, per capita per day as recommended by ICMR (Indian Council of Medical Research, 2020). A recent assessment based on the nationally representative National Sample Survey (2011–2012) reported that per capita household consumption of fruits and vegetables is 160 g/person/day in rural India and 184 g/person/day in urban India (Minocha et al., 2018), which remains considerably below the World Health Organization's recommended intake of 400 g/person/day. In addition, Prathiba and Rani (2012) suggest that a healthy vegetarian diet should include 125 g of leafy vegetables, 100 g of root vegetables, 75 g of other vegetables, and 85 g of fruits daily, alongside 475 g of cereals and 85 g of pulses. An average individual requires a daily diet supplying approximately 2,800 calories, 55 g of protein, 450 mg of C, 20 mg of Fe, 3,000 mg of β-carotene, 50 mg of vitamin C, 100 mg of folic acid, 1.0 mg of vitamin B, 1.4 mg of thiamine, 1.5 mg of riboflavin, 19 mg of niacin, and 5 mg of vitamin D. Vegetables constitute a rich source of these essential nutrients. Moreover, vegetable crops generally produce higher yields per unit area compared with other crops, and there is considerable potential to further enhance productivity through the adoption of high-yielding varieties or hybrids alongside improved production technologies. This will ensure a balanced diet to the common man and income generation from sales of harvested crops to improve household income.

## 5. Key Steps to Follow while Implementing a Home Vegetable Garden

Oebker and Call (2008) stated that good care and appropriate cultural practices play an important role in achieving healthy plant development and better yield in home vegetable gardens. Some of the key steps to be followed while implementing a home vegetable garden are mentioned below:

a) Selection of location-A suitable site with adequate sunlight, proper drainage, and a nearby water source should be selected for establishing a home vegetable garden.
b) Planning of garden layout-The garden should be planned carefully by considering the available space, choice of vegetables, spacing requirements, and seasonal planting schedule.
c) Selection of suitable vegetables-Vegetable crops should be chosen based on climatic conditions, household requirements, and the space available for cultivation.
d) Use of healthy planting materials- Good quality seeds and healthy seedlings should be used to ensure better germination, growth, and yield.
e) Soil preparation and improvement-The soil should be made fertile and porous by incorporating compost, organic manure, and other soil amendments before planting.
f) Adoption of appropriate gardening methods-Methods such as container gardening, raised bed gardening, rooftop gardening, and vertical gardening can be adopted according to space availability.
g) Proper sowing and transplanting practices-Seeds should be sown at the recommended depth and spacing, while seedlings should be transplanted carefully to avoid damage to roots.
h) Irrigation management-Regular watering should be provided to maintain adequate soil moisture without causing waterlogging.
i) Management of weeds and pests-Weeds should be removed regularly, and eco-friendly methods should be followed for controlling insects and diseases.
j) Harvesting at the proper stage-Vegetables should be harvested at the correct stage of maturity to obtain better quality, taste, and nutritional value.

## 6. Types of Home Food Gardens Seen Mostly in Modern Cities

The home gardens were classified into five garden types based on their location in and around the residents (Bhaskaran & Nilon, 2024).

a. Yard Garden-Garden space in front of the residential building or behind the residential building, within the compound walls of the plot.
b. Rooftop Garden- Garden on the rooftop of the residential building.

c. Balcony garden -Garden/Plants located in the balcony, patio, or any other extended part of the main residential building.
d. Community garden- A common garden space usually located adjacent to the residential building but maintained collectively by the residents of the neighbourhood
e. Plot garden/Street garden-Garden maintained on a vacant plot usually adjacent to the residential building or outside the compound wall of the residential building on the street. These types of gardens are usually developed in plots not owned by the homeowner.

## 7. Benefits of Home Vegetable Garden

### 7.1 Provides Fresh Produce

Home gardens are cultivated to ensure convenient access to fresh plant resources in both rural and urban settings. They facilitate the regular availability of a diverse range of fresh and nutritious foods for household consumption, with evidence indicating that such households may obtain more than 50% of their vegetables, fruits, tubers, and yams from home garden production (Marsh, 1998).

### 7.2 Enhances Nutrition and Immunity

A home vegetable garden represents a low-cost and environmentally sustainable approach to mitigating malnutrition. By utilising locally available and existing resources, it ensures a direct farm-to-plate supply of nutritious vegetables, thereby supporting improved health outcomes (Lieske, 2010).

### 7.3 Improves Mental Health and Well-being

Urban home gardens act as personal green spaces for owners and provide multiple benefits ranging from health and well-being to nature connectedness (Calvet-Mir *et al*., 2012; Cameron *et al*., 2012; Hanson *et al*., 2021). It was seen that home gardening beneficiaries not only enjoyed gardening but also formed emotional and spiritual connections with the process of growing their own food, which in turn can influence their food values and dietary choices (Strout *et al*., 2017; Zimpita *et al.,* 2015). Also, gardening interventions often encourage or strengthen community and family integration and a sense of belonging or unity in the participants (Hartwig & Mason, 2016; Waliczek *et al.,* 1996). In a study from India, respondents linked spending more time in home gardens with reduced stress and anxiety during the lockdown (*Basu et al*., 2021).

### 7.4 Supports Sustainable Urban Living

Home food gardening effectively reduces food miles and lowers reliance on complex logistical systems, thereby conserving fossil fuels and decreasing greenhouse gas emissions associated with transportation. It also minimises post-harvest losses of perishable goods during transit and contributes partially to strengthening food sovereignty. In addition, it helps to address risks of starvation and malnutrition arising from delays in the long-distance transport of fresh produce, particularly during pandemics and other forms of traffic congestion or major systemic disruptions (Richardson & Arlotta, 2022; Li et al., 2023; Ma et al., 2023).

### 7.5 Small Economic Benefits

Home gardens are extensively promoted across many countries as a strategy for alleviating poverty and as a source of income for subsistence households in developing contexts. Although they are often regarded as low-input subsistence production systems, they can be reorganised into more efficient commercial enterprises through the cultivation of high-value crops and the integration of livestock rearing (Ranasinghe, 2009).

## 8. Advances of Home Food Gardening

Home food gardening (HFG) has come a long way due to technological innovations, better crop selection, and changing urban lifestyles. Below are outlined major advances:

## 8.1 Important Cultivated Species

Growing vegetables that are suitable for the local climate is essential to climate-resilient gardening. Climate-appropriate cultivars are more resistant to drought, extreme temperatures, and high humidity, and they typically require less water and pest control (Dhruve *et al*., 2024). By selecting vegetable varieties that are climate-adapted, gardeners can reduce resource consumption and improve the sustainability of their gardening practices (Kirkpatrick & Davison, 2018). The selection of HFG types is influenced by a number of factors, including available space, seasons, and climate (Baliki *et al*., 2023; Cruz *et al*., 2023). Some heat-tolerant crops include water spinach (*Ipomoea aquatica* Forssk.) and okra (*Abelmoschus esculentus* L.) (Khan *et al*., 2022), which can be grown in the summer (Khosa *et al*., 2023). Winter is a good time to harvest hardy vegetables such as Chinese chives (*Allium tuberosum* Rottl. ex Spr.) (Wang *et al*., 2024) and spinach (*Spinacia oleracea* L.) (Yoon *et al*., 2017). The poor light-tolerant vegetables like Chinese chives (*Allium tuberosum* Rottl. ex Spr.) (Wang *et al*., 2024) and other sprouts are more suitable for HFG in areas with inadequate lighting, like low-rise balconies (Le *et al*., 2021).

**HFG is applicable to a variety of crops, some of them are mentioned below:**

i. **Solanaceous vegetables:** Solanaceous vegetables: The Solanaceae family comprises around 80 genera and 3000 species and includes some of the most important economic vegetables, such as chilli, potato, tomato, eggplant (He *et al*., 2019). Tomato is the most popular HFG crop, particularly dwarf and miniature varieties that take less space, need little pruning and give good yield. Varieties: Pusa Early Dwarf, Hs 101, Micro Gold, Micro Tom, Red Robin, Tiny Tim, etc. Non-miniature tomatoes with indeterminate growth characteristics need the application of plant growth regulators (e.g. paclobutrazol) to produce compact potted plants for HFG (Melo *et al*., 2018; Cruz & Gómez, 2022). Potato (*Solanum tuberosum* L.) is regarded as one of the ideal staple foods for HFG because of its multifarious merits. These include: (1) high harvest index, (2) high tuber yield, (3) starchy tubers that provide a lot of nutritious food, (4) easy growing requirements, (5) adaptation to environmental stresses and low soil fertility, (6) relatively long shelf life, (7) simple food processing requirements and (8) asexual propagation through tubers to consistently regenerate nutritional components (Wiersema & Booth, 1987; Coffin et al., 1993; Boivin et al., 2020; Devaux *et al*., 2021; Liu *et al*., 2021). Sweet and Hot Peppers come in a lovely variety of colours and shapes. They add flavour, colour and crunch to many low-calorie dishes. All fresh peppers are very good sources of vitamin C, vitamin K, carotenoids and flavonoids. Eggplant is also a good source of bone-building vitamin K, magnesium, and heart-healthy copper, vitamin C, vitamin B6, folate, and niacin (Dias, 2012)

ii. **Crucifers:** Cruciferous vegetables (family Brassicaceae or Cruciferae), including cabbage, broccoli, cauliflower, Brussels sprouts, kale, kailan, Chinese cabbage, turnip, rutabaga, radish, horseradish, rocket, watercress, mustard and related species, constitute the primary dietary sources of glucosinolates in the human diet. Members of this family are also able to accumulate considerable quantities of selenium when cultivated in selenium-rich soils. Banuelos and Meek (1989) reported that broccoli grown under selenium-enriched conditions accumulated approximately seven times more selenium than cabbage, collards, and Swiss chard (Dias, 2012).

iii. **Leafy vegetables and herbs**: Leafy indigenous vegetables constitute important sources of dietary fibre, vitamins, and minerals, while also contributing to greater dietary diversity. In addition, they have traditionally formed part of cropping systems, particularly within home garden cultivation practices (Midmore *et al.,* 1991). Example: lettuce, spinach, basil, rosemary, coriander

iv. **Sprouts**: Microgreens, a new class of edible veggies that are picked and consumed at an immature stage (Teng *et al*., 2023). Besides, sprouts are green foods that are non-polluting and obtained directly from seeds without complicated cultivation requirements, which can be grown in the soil or hydroponically under light or dark conditions (Reed *et al*., 2018; Le *et al*., 2021; Xiao *et al*., 2022). Sprouts are ideal for small spaces, grow quickly, require few inputs, and are high in health-promoting compounds, making them valuable in food supply disruptions. Common varieties include mung bean, soybean, pea, broccoli, coriander and rapeseed sprouts.

## 8.2 Technologies Available for Home Food Gardening

Urban indoor systems allow production all year round, reducing dependency on seasonal and long-haul supply chains and helping to reduce the carbon footprint of food. Sodikova, (2026) suggested some key technologies available for smart home food gardening:

i. **Sensors and IoT**: Smart Garden devices utilise soil-moisture, temperature, pH, nutrient, and light sensors to track plant conditions in real-time. These sensors generate continuous flows of data that inform adaptive watering, nutrient and lighting schedules. You can monitor it remotely and integrate it with your smart home assistant through wireless communication via Bluetooth or Wi-Fi. Data analytics can take these inputs and give you tailored recommendations and predictive plant care.

ii. **Hydroponics and automation**: Hydroponics is a way to grow plants without soil, instead using nutrient solutions and controlled lighting. This method can yield high yields in a small area and reduce the risk of pests. Automation of watering and feeding reduces the amount of labour and provides uniform growth conditions. Compact modular systems are gaining popularity with urban consumers, and novel devices such as vertical towers, wall-mounted gardens and self-watering planters allow users to expand their gardens as they need.

iii. **Artificial Intelligence and Machine Vision**: AI-enabled sophisticated platforms analyse the environmental data and plant growth patterns. In machine-vision applications, smartphone cameras can be used to diagnose the health of plants, while AI algorithms can be used to adapt lighting and irrigation schedules to users' consumption habits and to adapt cultivation cycles. These characteristics ease maintenance and make horticultural knowledge more accessible.

iv. **Eco-friendly materials and energy efficiency**: Consumers with a strong orientation towards sustainability are increasingly driving demand for biodegradable seed pods, recyclable components for hydroponic systems, and energy-efficient LED lighting. In addition, solar-powered sensors and biodegradable growing media are gaining wider adoption, reflecting a broader rise in environmental awareness.

## 9. Conclusion

Rising urbanisation, climate challenges and food costs are driving more and more people to home gardening for food as a simple, effective way to contribute to sustainable living. Gardening vegetables, fruits and herbs in small spaces such as balconies or rooftops helps households get fresh, safe and nutritious food and improve the overall diet quality. It benefits the environment by utilising unused spaces, encouraging biodiversity, mitigating urban heat and transforming household waste into valuable compost. Furthermore, gardening is a way to relax mentally, build self-dependence, and was especially useful during disruptions such as the COVID-19 period**.** Factors such as space constraints, lack of technical know-how, and input costs can hamper its growth, but better awareness, training and policy support can make home gardening a key ingredient of sustainable and resilient urban living.

## 10 Limitation of Home Food Gardening

### 10.1 Space Constraints

Hoogerbrugge and Fresco (1993), together with Mitchell and Hanstad (2004), provide a review of the principal constraints affecting home gardening. Among these, they identify access to adequate and suitable land for establishing home gardens, as well as the absence of secure ownership or usage rights, as the most significant limiting factors.

### 10.2 High Input Cost

Modern home gardening technologies such as smart planters, hydroponic systems, LED grow lights, quality potting media, seeds, fertilisers, and pest control tools can be expensive. Building raised beds, purchasing quality soil, composting materials, organic seeds, and water-efficient irrigation systems can be costly, particularly for those starting from scratch (Sullivan *et al.,* 2015).

### 10.3 Lack of Planting Experience

Many urban beginners have little knowledge of irrigation, fertilisation, pest control and plant spacing, and this results in poor yields and loss of plants. Urban horticultural neophytes generally have little knowledge of how to perform HFG in an appropriate approach (Oberholtzer *et al*., 2014; Kunszabó *et al*., 2022).

### 10.4 Seed Quality Problem

Poor germination, mixed varieties, low resistance to diseases and inconsistent crop performance may occur with seeds from unknown or unreliable sources. There is a lack of specialised varieties for HFG, which hampers its widespread adoption and application (Sykes *et al*., 2021).

### 10.5 Poor Quality of Urban Soils

Soil contamination with heavy metals, including lead (Pb), arsenic (As), and cadmium (Cd), as well as organic pollutants such as polycyclic aromatic hydrocarbons (PAHs), antibiotics, and petroleum-derived compounds, constitutes a significant constraint on the utilisation of urban soils for food production (Menefee & Hettiarachichi, 2017).I n order to produce healthy and safe food, these problems must be resolved. In fact, the pathway from contaminated soil to humans through food can be minimised with sound management and bioremediation, and high yield can be obtained with judicious management of inputs (McDougall *et al*., 2019).

## 11. Future Perspectives of Home Food Gardening

Home food gardening (HFG) is expected to play an important role in ensuring food and nutritional security, especially in urban areas. Several future directions are emerging to overcome current limitations and improve productivity, sustainability and accessibility. Some of them are discussed below:

### 11.1 Integration into Building Design

For the encroachment on HFG spaces as well as omission of HFG spaces by property development, spaces available for HFG should be embedded in housing estates along with other systems in building planning design, which requires valid government policy development (Xu *et al.,* 2024). Landscape architecture, an intricate blend of artistic design and harmonious integration with the natural world, has increasingly come to appreciate the pivotal role of plant physiology in the creation of sustainable and visually captivating gardens (Wang, 2024).

### 11.2 Space-efficient Cultivation Systems

Vertical gardening, wall-mounted systems, stacked containers and compact hydroponic units are alternatives to limited space in cities. These systems provide maximum food production per unit area and can be used on balconies, rooftops and for indoor environments. Vertical gardening is a design idea that adds climbing plants and upright structures to a garden, giving a garden design a new dimension. Successful vertical gardening requires a good understanding of the growth habits and structural requirements of climbing plants (Wang, 2024).

### 11.3 Training and Skill Development

There is some evidence that one of the solutions – the lack of planting experience and techniques – may be relatively easy to resolve through hands-on training in garden management. So, neighbourhood committees of residential compounds, apartments and townhouses may ask agricultural experts to give talks to HFG greenhorns (Xu *et al.*, 2024).

### 11.4 Affordable Smart Technologies

By using artificial lighting fixtures such as LED grow lights or concealed garden lighting, gardeners can grow a wider range of plant species that may not thrive in low-light conditions. This method also provides the opportunity to create stunning nocturnal garden displays, highlighting the garden's aesthetic value even after the sun has gone down (Elomaa *et al*., 2020). The use of solar-powered sensors, automated irrigation systems and low-cost monitoring devices will reduce labour and resource wastage while providing optimal growing conditions.

### 11.5 Development of Special Cultivars

When designing gardens, it is important to consider the local environmental conditions and choose plant species that naturally exhibit resilience to these stressors (Pessarakli, 2014). This not only reduces the maintenance requirements, but also improves the overall sustainability of the garden.

### 11.6 Improved Hygiene and Compost Management

Composting, mulching and organic pest control methods are multi-benefit. Composting is a recycling process for organic matter that also enriches the soil with nutrients necessary for plant growth. Mulching, by contrast, helps to retain moisture, control soil temperatures and limit weed growth, all of which contribute to increased plant resilience. Additionally, the use of organic pest control methods can reduce the use of hazardous chemicals, thus preserving the biodiversity of the garden, as well as the well-being of beneficial insects and organisms that play a significant role in the ecosystem (Coisnon *et al*.,2019)

### 11.7 Safe Aquaponics and Hydroponics

Hydroponic and aquaponic systems will become safer and more efficient through real-time sensor monitoring of nutrients, dissolved oxygen, and water quality (Xu *et al*., 2024). Aquaponics is a bio-integrated system that mimics a complex ecosystem and consists of beneficial bacteria (e.g. heterotrophic bacteria and nitrifying bacteria), recirculating aquaculture and hydroponic cultivation (Wongkiew *et al*., 2017)

## Competing Interests

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

## Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

## Competing Interests

Authors have declared that no competing interests exist.

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