Review Article

URBAN HORTICULTURE- AN INNOVATIVE APPROACH AND A NECESSITY FOR FUTURE

ABSTRACT

Urban Horticulture is a key solution to rapid population growth, urbanization, food crisis and climate change. According to FAO reports, projections indicate that by 2050, the global urban population will exceed 9.7 billion, nearly doubling the current 3.5 billion. In the case of India, UN World Population Prospects foresee that by 2050, 40.76% of the country's population will inhabit urban areas. Considering the above statistics, we can estimate the burden on rural production system to meet increasing demands of fruits and vegetables in urban markets. So, urban agriculture could be the saviour to avoid food crisis and inflation of market. Urban agriculture, with its roots dating back to the mid-19th century, has gained momentum worldwide and can potentially mitigate the looming threats of food crises and market inflation. There are various types of urban agriculture like, kitchen gardening, rooftop gardening, vertical farming, container gardening, *etc*. Multiple auras of crops can be cultivated in the minimal available space, right from herbs, vegetables and fruits to aromatic and medicinal plants. There are large number of advantages of urban farming, like, providing employment and daily wages to poor farmers, educating children, strengthening the community, improving social and emotional wellbeing and environmental justice to tackle climate change. Many cities across the world are practicing urban farming and have achieved success in production, marketing and educating people. While numerous cities globally have embraced urban farming, achieving success in production, marketing, and education, India is still in the nascent stages of this practice. It is imperative for both governmental and private entities to accord greater importance to and invest in the promotion and harnessing of the profitability of urban agriculture in the country.

KEY WORDS: Urban Horticulture, Plant factories, Community gardens, Sustainability, Food security

ABBREVIATIONS:

UA- Urban agriculture

PUA- Peri Urban Agriculture

UNDESA- United Nations Department of Economic and Social Affairs

WHO- World Health Organisation

FAO- Food and Agricultural Organisation

NAAS- National Academy of Agricultural Sciences

SDG- Sustainable Development Goals

PM- Particulate Matter

IOT- Internet of Things

SPFT- Smart Plant Factory Technology

INTRODUCTION

As per the UNDESA, World population prospects reports of 2022 from the United Nations the present global population, which stands at 7.3 billion, is projected to increase to 8.5 billion by 2030, followed by an estimated 9.7 billion by 2050 and a forecasted 11.2 billion by the year 2100, with an estimated 70 per cent of the population residing in urban areas. Considering the populous country like India with 1.43 billion inhabitants a significant demographic shift is anticipated, with nearly 60 percent of the population equivalent to almost 1 billion individuals, transitioning to urban living, primarily as a result of rural migration (NAAS, 2013).This rapid urbanization trend is poised to intensify the demand for a greater quantity of high-quality food, particularly in the form of high-value items such as fruits, vegetables, milk, meat, and eggs. This heightened demand for food resources will place additional pressure on the already diminishing land, water, and biodiversity reserves. Moreover, the expanding urban areas and their surrounding regions are expected to grapple with elevated levels of pollution and increased temperatures, further complicating the challenges associated with sustainable urban development. In this framework, urban and peri urban horticulture plays a significant role.

Urban horticulture is often associated with the term 'Urban Agriculture'. Urban agriculture (UA) involves activities aimed at ensuring the production of agricultural and livestock products within urban and peri-urban regions, while minimizing the environmental impact associated with traditional agricultural practices, as discussed by Hara *et al*. (2018), McDougall *et al*. (2019), and Nicholls *et al*. (2020). Urban agriculture as a strategic approach to enhance the quality of life (social, physical, psychological and functional) for residents, foster agricultural self-sufficiency, stimulate economic development through community markets, and encourage civic engagement, especially in areas where essential needs remain largely unaddressed (McDougall *et al*., 2019; Nicholls *et al*., 2020; Walsh *et al*., 2022). The term, "Urban horticulture" not only recognizes the contribution of plants as a source of food to urban environment but also emphasizes their positive impacts on the wellbeing of the individuals residing in these areas. Moreover, urban farms have a potentially important role to play in achieving several sustainable development goals including reduction of urban poverty (SDG1), health and wellbeing (SDG3), sustainable cities and communities (SDG11), climate change mitigation (SGG13), life on land (SDG15), and partnership with different stakeholders (SDG17).

COP28 UAE Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action 2023 is designed to tackle global emissions, protect the well-being and livelihoods of farmers, and specifically address the impact of climate change on vulnerable communities. The participating countries, representing a population of over 5.7 billion people, have pledged to enhance food systems, bolster climate resilience, and decrease emissions. Urban horticulture is posited as a viable solution to address this impeding challenge. As traditional agricultural spaces diminish, incorporating horticulture into urban planning becomes imperative for securing food sources, enhancing urban resilience, and promoting the well-being of urban residents.Many countries are now delving into implementing the urban horticulture in these areas. The main objective of this article is to focus urban horticulture as an innovative approach which will be the necessity in the future.

Subsequently, this article will discuss and explore the essential components of urban horticulture systems that will address the following questions such as how does urban horticulture contribute to food security in densely populated urban areas?How can urban horticulture be effectively integrated into urban planning policies to promote sustainable and resilient cities?How can urban horticulture address climate change challenges and contribute to urban resilience?"

MATERIALS AND METHODS

In order to address the aforementioned challenges and meet the research objective data from peer-reviewed articles published over the past two decades, spanning from 2000 to 2020 were collected. These articles were sourced from reputable journals accessible in databases such as Scopus, Web of Science, ResearchGate, and Google Scholar with the search terms such as " Urban horticulture", " vertical farming", " Urban heat island mitigation", "food insecurity", "population expansion", "resource efficiency", "benefits of urban horticulture", " Internet Of Things (IOT), "Technology intervention", "smart plant factory technology (SPFT)", "Plant factories", "Community gardens", "Urban framing", " Urban and Peri urban agriculture", "Sustainable development goals" and " Mitigating climate change"

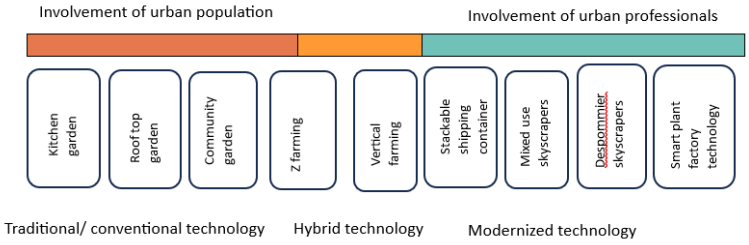

Figure1: Schematic diagram of technology and individual involvement in Urban and Peri urban agriculture

NEED FOR URBAN HORTICULTURE

FOOD INSECURITY

With the global population expected to experience a significant increase, it is anticipated that by 2030, there will be a substantial surge in world food demand—estimated to rise by 43%, as outlined in the FAO 2011 report. Additionally, the widespread lockdown measures, implemented in response to the global novel coronavirus outbreak, have caused disruptions in transportation, labor shortages, and constraints on market access (Beltrami, 2020)

This situation has prompted urban dwellers to turn towards home-based cultivation of fruits and vegetables, presenting an opportunity to strengthen urban horticulture. In the face of these challenges, the concept of 'Urban Horticulture' has emerged as an exemplary solution, aiming to ensure a steady supply of fresh and safe food in urban areas. This contributes to sustainable food supplies and enhances overall food security (Khan *et al.*, 2020)

POVERTY ALLEVIATION

Poverty stands out as a major challenge in global development (Lucci, Bhatkal, and Khan, 2017). The WHO Millennium Development Goals Report in 2015 highlighted that approximately 800 million individuals continue to suffer from extreme poverty and face the scourge of hunger. A staggering estimate reveals that over 836 million people subsist on less than $1.0 per day, with an additional one billion unable to fulfill their basic necessities (WHO, 2015).The researchesby Bishoge*et al.,* 2018, Kontothanasis (2017), Rezai et al. (2016) suggested that cultivating urban vegetables and ornamental flowers plays a crucial and beneficial role in enhancing the availability and accessibility of food security, nutrients, and income. This, in turn, contributes positively to the improvement of essential social services like water, electricity, health, and education. This provides empirical evidence regarding the impact of urban agriculture on poverty alleviation.

RESOURCE EFFICIENCY

Given the scarcity and high cost of urban land, cities worldwide are actively exploring diverse strategies to intensify agricultural and horticultural production, along with optimizing value chain processes. The overarching goal is to maximize resource utilization, encompassing water, energy, and space, while simultaneously minimizing waste.

Various innovative approaches are being adopted, such as rooftop gardening and Zero Acreage Farming (Z farming), involving cultivation in unused spaces within buildings. Additionally, there is a growing trend of promoting high-tech and commercial rooftop gardens on supermarkets, restaurants, or office buildings, particularly observed in places like China (Orsinie*et al*., 2016).

Several strategies and practices that contribute to resource efficiency in urban horticulture are

HYDROPONICS AND AQUAPONICS

Hydroponics and aquaponics system enable soil-less cultivation, fostering plant growth in nutrient-rich water solutions. These methods provide a resource-efficient, sustainable, and consistent year-round cultivation platform within controlled environments in comparison to traditional soil-based methods. (Chena*et al.,*2020)

VERTICAL FARMING

Vertical farming is the practice of cultivating crops in stacked layers or on inclined surfaces (Al-Kodmany, 2018). This innovative approach maximizes space efficiency, enabling the cultivation of a greater quantity of crops within a smaller area. While vertical farming systems were initially considered futuristic, the disruptions in the supply chain caused by the COVID-19 pandemic spurred the rapid development of urban farming, with a primary focus on ensuring global food security (Ng and Mahkeswaran, 2021; Shahda and Megahed, 2022).

However, the feasibility of vertical farming remains a subject of debate, with numerous reports advocating for a model-based approach to integrate systems (Ondruška et al., 2022). For instance, studies by Al-Kodmany (2018) and Cowan *et al*., (2022) proposed the integrate natural ecosystems, where the waste from certain subsystems or units serves as raw material for others. Goddek*et al*, (2019) put forth the idea that a prevalent model for organic waste recycling involves aquaponics, wherein nutrient-rich water from a fish tank is circulated back to hydroponically grown plants.

DRIP IRRIGATION AND WATER RECYCLING

Drip irrigation directs water precisely to the plant base, minimizing water wastage in contrast to conventional overhead watering methods.Cities often discharge untreated or partially treated wastewater into the environment, leading to pollution in traditional irrigation water sources (Raschid-Sally &Jayacody, 2008). Addressing this challenge, the "source replacement" concept (Hespanhol, 2002) emerges as an effective alternative to meet water demands. The use of treated sewage water in irrigation proves to be an effective strategy in reutilizing water, thereby augumeting water efficiency in agriculture. Sousa *et al*., (2006) observed that pepper cultivation with water from Upflow Anaerobic Sludge Blanket (UASB) resulted in similar fruit quality to plants irrigated with water from an artesian well, despite slightly lower yields. In the case of hydroponic lettuce grown with recycled water, Cuba *et al.,* (2015) discovered no thermotolerant microorganisms in plants.Though all samples tested positive for total coliforms, the counts were recorded to be low. Additionally, the adoption of recycled water holds the potential to embody the three pillars of sustainability: economic development, social progress, and environmental preservation.

COMPOSTING AND ORGANIC WASTE RECYCLING

According to Dubbeling and Santandreu (2003), the production of solid organic waste in urban areas of Latin America ranged from 30% to 60%, and only 2% of this waste is adequately treated. The conversion of organic solid waste into nutrient-rich compost can be achieved through composting and vermiculture techniques. The study conducted by Bonito *et al*., in 2018 demonstrated that incorporating compost and biochar as a growing medium led to an increase in the size of tomatoes and the biomass of leafy vegetables. Further, the implementation of low-cost composting systems diminishes the reliance on synthetic fertilizers. This closed-loop process effectively reduces waste and enriches the soil in urban gardens. Local food production coupled with waste composting holds promise in curtailing overall food waste and mitigating emissions linked to food spoilage during transportation. In Tomé, Chile, an initiative was launched to efficiently manage household organic waste. The resulting compost served as a valuable fertilizer in urban agriculture. The municipal government actively distributed the compost to assist low-income families in cultivating their own fresh vegetables (Dubbeling and Santandreu, 2003).

ENERGY-EFFICIENT LIGHTING

As per FAO's findings in 2012, the food system is estimated to contribute up to 30% of total energy consumption and generate around one-fifth of global greenhouse gas (GHG) emissions. Additionally, over one-third of the produced food is lost or wasted, resulting in the squandering of about 38% of the energy consumed within the food chain.

Engaging in urban horticulture offers a solution by significantly reducing the reliance on fuel and electricity. This is accomplished through the local cultivation of food, eliminating the necessity for extensive transportation. Furthermore, urban horticulture practices, such as nutrient management through composting and precision farming utilizing hydroponics technology, contribute to enhanced efficiency in nutrient, water, and waste management.

In summary, urban horticulture not only diminishes energy-use costs but also plays a role in curbing greenhouse gas emissions associated with various inputs in the food production chain.

LOCALIZED FOOD SYSTEMS

Establishing localized food systems, such as farmers' markets and community-supported agriculture (CSA), serves to diminish the carbon footprint associated with the transportation of food. Additionally, it encourages the consumption of fresh, locally grown produce. For instance, if all available land within a developed city were cultivated, urban horticulture could potentially meet between 15% and up to 122% of the demand for fruit and vegetables within the city's population (McDougall *et al.*,2020)

Home gardening is acknowledged as one of the most impactful interventions for enhancing nutrition (Berti *et al*., 2004). Households engaged in gardening tend to enjoy better access to food, maintain a more diverse diet, and consume more vegetables than those not involved in gardening (Zezza and Tasciotti, 2010). Despite the small-scale nature of individual gardens in or near cities, the collective food production from these gardens can be significant, with yields comparable to or even surpassing those of large-scale conventional farms in rural areas (Nicholls *et al*., 2020).Research on home and community gardeners reveals that they highly value their produce for its freshness, taste, and quality (Pouria*set al*., 2016). Moreover, studies indicate a positive correlation between gardening and increased fruit and vegetable consumption (Algert *et al*., 2016).

Thus, by integrating these systems, urban horticulture can contribute to a more sustainable and resilient urban environment, ensuring the responsible use of resources for food production and green space development

ENVIRONMENTAL BENEFITS

Urban horticulture provides various environmental advantages that enhance the overall health of urban ecosystems. Here are some primary environmental benefits of incorporating horticulture into urban areas.

AIR QUALITY IMPROVEMENT

Fine particulate matter (PM2.5) stands as a prevalent air pollutant, posing a significant threat to public health. A study conducted in Dublin by Riondato*et al.,* 2020 utilized the i-Tree Eco (UFORE) deposition model to evaluate the impact of urban trees on PM2.5 removal during both rush and non-rush hours. The findings suggest that a tree-lined pathway could annually eliminate approximately 3 kg of PM2.5, leading to a remarkable 126% improvement in air quality. Therefore, we can infer from the above study that the plants play a vital role in air purification by absorbing pollutants and releasing oxygen through photosynthesis. Urban horticulture, encompassing elements such as street trees, green spaces, and gardens, contributes significantly to alleviating air pollution and enhancing overall air quality (Koski, 2013).

CARBON SEQUESTRATION

Urban agriculture serves multiple functions. Trees and plants in urban areas act as carbon sinks, absorbing carbon dioxide during photosynthesis and storing carbon in their biomass. This not only helps mitigate the impact of greenhouse gas emissions but also contributes to the broader effort against climate change. Notably, food crops exhibit better carbon sequestration capabilities compared to vegetable crops, and within the same crop, there is a greater amount of carbon sequestration in farmland compared to non-farmland. From an

economic perspective, effectively managing this carbon sequestration, particularly through urban spatial planning, can yield substantial economic value.(Hastuti*et al*., 2022)

URBAN HEAT ISLAND MITIGATION

The concept of the "urban heat island" characterizes the occurrence of higher air temperatures in urban areas when compared to their rural counterparts (Ishola et al., 2016).The diminished presence of vegetation in urban areas compared to the surrounding regions leads to a decline in evapotranspiration (ET). This reduction in ET results in a decrease in latent heat consumption, leaving more energy available as sensible heat, consequently leading to higher land surface temperatures. Vegetation, such as trees, green roofs, and green walls, plays a crucial role in mitigating the urban heat island effect by providing shade and releasing moisture through transpiration, thereby cooling the environment (Humaida *et al*., 2023).A case study conducted in London and Beirut indicated that larger green spaces were associated with a temperature decrease of approximately 4 to 6 ℃ compared to the surrounding areas.

BIODIVERSITY CONSERVATION

Urban areas exhibit a significant reduction in the diversity of plants and animals compared to rural regions (Aronson *et al*., 2014). However, studies focused on urban agriculture highlight the potential of cities to foster biodiversity and contribute to the conservation of endangered and threatened species (Ives *et al*., 2016). Green spaces within urban environments serve as sanctuaries and natural habitats. Urban horticulture plays a crucial role in establishing habitats and food supplies for various wildlife, encompassing birds, insects, and small mammals. The inclusion of a variety of plant species in urban green spaces actively supports local biodiversity, thus playing a part in the conservation efforts for urban wildlife (Tresch *et al*., 2019).

NOISE REDUCTION

An increase in population has been observed in areas with increased pollution and less vegetation due to the urbanization phenomenon (Bloemsma *et al.*,2019). Consequently, there has been a notable surge in environmental impacts, particularly linked to thermal discomfort, deteriorating air quality, and heightened noise pollution, primarily originating from urban road traffic (Cohen *et al.*,2014). Green spaces and plant life function as natural buffers, effectively absorbing and mitigating noise generated by urban activities and traffic. Research has demonstrated the efficacy of vegetation in reducing noise pollution. The density and quantity of trees possess a strong correlation with the noise reduction. Dense trees contributed about 4 dBA while dense shrubs contributed about 2 dBA additional noise reduction according to the study by Papafotiou*et al.*,2004. This not only fosters a quieter and more enjoyable urban environment but also benefits both residents and wildlife (Piedrahita *et al.*,2020)

Besides, it reduces energy and water consumption while urban horticulture projects, such as community gardens and educational programs, raise awareness about the importance of environmental stewardship.Overall, urban horticulture contributes to creating healthier, more sustainable, and resilient urban environments by addressing various environmental challenges and enhancing the overall quality of life for urban residents.

COMMUNITY ENGAGEMENT AND WELL-BEING

Numerous unstructured agricultural sites continue to exist in urban areas. These sites can be effectively utilized for urban farming to enhance efficiency and sustainability. A case study conducted by Wulandari et al., 2021 in Yogyakarta City showed that the community has taken proactive steps by forming an organization known as 'Kampung Sayur Bausasran.' This initiative involves the establishment of nursery gardens, group gardens, and vegetable aisles, along with active engagement in the cultivation of medicinal plants, horticultural crops, and catfish farming.

The outcomes of these efforts have been multifaceted, contributing not only to the community's self-sufficiency in food and nutrition but also to the improvement of family income. Additionally, these endeavors have enhanced the aesthetic appeal and comfort of their living spaces by creating a beautiful and picturesque home environment.

Community gardens represent open areas managed by local community members where they cultivate food or flowers. These spaces serve as alternatives for individuals without personal terraces or outdoor spaces for gardening. For instance, the Brindavan community garden in Bangalore serves as a notable example, where a designated gardener is employed for weekday maintenance, with community members actively participating during weekends.

The primary benefits of these gardens encompass access to pesticide-free organic produce, fostering a connection with nature, and providing opportunities for quality time spent with loved ones. Additionally, participants often experience cultural and spiritual benefits from their involvement in these communal gardening spaces (Wikström, 2015).

EDUCATIONAL OPPORTUNITIES

Urban horticulture presents abundant educational opportunities for people of all ages, extending beyond conventional classrooms to provide hands-on learning experiences that foster a deeper comprehension of plant biology, ecology, sustainability, and environmental stewardship.While there is a growing interest in self-growing food in urban settings, it often lacks in-depth learning. Report from a study conducted by Duda and Korwin-Szymanowska, 2023 revealed that food is grown as a necessity or routine and thatpassing on knowledge was not a priority. Deikmann (2020) suggested that the educational experiences within gardens can act as a precursor to heightened food advocacy and democratic engagement with the food system, contributing to social cohesion. Kumari (2021) repoted that to motivate urbanites in urban farming more training programs that impart technical skills and knowledge should be conducted. Besides, School-based community gardens, known as 'Community Food Hubs,' play a crucial role in transmitting traditions and cultural practices related to food production and consumption to the next generation

AESTHETIC AND CULTURAL VALUE

Currently, urban gardening is undergoing a renaissance, spurred by a heightened environmental consciousness and counter-culture movements opposing consumerism, conformity, industry, inflation, and unemployment (Mok et al., 2014). Urban gardening contributes to the enhancement of aesthetic appeal in urban areas through green spaces and well-maintained gardens

A study conducted by Lindemann-Matthiesand Brieger in 2016 explored the incorporation of vegetable pots alongside flowerbeds in urban gardening. The study suggested that though the preference of individuals is over the flowerbeds or flower meadows over vegetable plots the combination of both might be advisable in urban gardening sites. This approach not only augments overall diversity, providing aesthetic benefits, but also proves advantageous from an ecological standpoint.

JOB CREATION AND ECONOMIC OPPORTUNITIES

Food insecurity and unemployment have and still remain one of the critical problems in many parts of developing countries, especially in and around the major urban centres(Mougeot, 2005). Urban farming yields direct income by handling of day-to-day operations like planting, harvesting, irrigation, and maintenance while indirectly by need for transportation, logistics, packaging, marketing, and sales(Thornton, A. 2011.)Sustainable and cutting-edge techniques including hydroponics, aquaponics, and vertical farming are frequently used by urban agricultural enterprises. Because these technologies call for certain expertise and abilities, the green technology industry will see job growth.

TECHNOLOGY INTEGRATION

PLANT FACTORIES

The integration of technology in urban horticulture involves incorporating various technological tools and solutions to enhance and optimize plant cultivation in urban environments. Plant factories, for example, strive for fully controlled environment agriculture (CEA), applying a closed-loop production principle to operate all processes of advanced crop cultivation in an optimized manner (Institute of Space Systems, 2015).

However, real-time monitoring of plant health, optimal control of the growing environment, and predictive and adaptive maintenance of cropping systems present significant challenges in terms of industrial communications and flexible computing architectures. Industrial artificial intelligence (AI) is recognized as a driving force in addressing these challenges within smart plant factories (Wan*et al.*, 2018).

This technology integration aims to overcome challenges such as limited space, environmental constraints, and the need for efficient resource utilization. Several adapted integrated technologies in smart plant factories include:

• Vertical Farming and Hydroponics

• Smart Sensors and Monitoring

• Precision farming (Drones and UAVs)

• Internet of Things (IoT) - Smart Irrigation Systems and Automated Greenhouse Systems

• Robotics and Automation - Robotic Harvesting and Weeding Robots

• Crop Modeling and Decision Support Systems

• Aquaponics - Combining Fish Farming with Horticulture

By leveraging these technological advancements, urban horticulture can enhance productivity, resource efficiency, and sustainability while addressing the unique challenges presented by urban environments.

POLICIES

The FAO Committee on Agriculture has directed the FAO to recognize Urban and Peri-Urban Agriculture (UPA) as an integral component of the agricultural system, acknowledging its significant role in feeding and greening cities while prioritizing health and safety requirements (FAO, 2009). In alignment with this, the government has formulated policies to promote the adoption of urban horticulture, emphasizing technology-led development through initiatives like contract and cooperative farming in peri-urban areas.

To support the sustainable growth of UPA, urban development authorities are urged to take measures for recycling water and ensuring the availability of safe inputs. Safety procedures should be implemented, recognizing and reinforcing the vital role of women in UPA, advocating for their leadership in food distribution, processing, and production. Decision support systems for urban development authorities should incorporate regular updates derived from remote sensing data.

Mapping UPA typologies and facilitating technology transfer based on climatic and agro-economic similarities is recommended for effective urban planning. The government's efforts to connect farmers with urban horticulture include providing quality seeds suitable for Urban Peri-Urban Horticulture (UPH), promoting year-round cultivation of fruits and vegetables, and building professional skills among urban youth related to UPH activities.

Many government initiatives have been launched in India. Considering Kerala, which was once food-dependent, implemented a vegetable development program in 2012, encouraging gardening in various settings. The government provided subsidies and support for eco-friendly inputs, irrigation, compost, and biogas plants, resulting in a substantial increase in vegetable production. In Tamil Nadu, a "do-it-yourself" kit was introduced in 2014 under the Urban Horticulture Development Scheme to facilitate vegetable cultivation on rooftops, houses, and apartment buildings. Since 2021, Bihar has been actively promoting terrace gardening in five smart cities through subsidies for input costs.

In Pune, a city farming project was launched in 2008 to encourage people to take up farming on allocated land. Similarly, in Delhi, the ShahriBagwani initiative by the government promotes urban farming, encompassing various methods such as vertical production, warehouse farms, community gardens, and innovative hydroponic, aeroponic, and aquaponic facilities. This initiative aims to ensure food and nutrition security, foster social and political inclusion, promote sustainability and environmental health, drive economic progress, and enhance educational awareness about nutrition and food systems. The Delhi Government envisions increasing green spaces across the city to mitigate air pollution.

CONCLUSION

In conclusion, urban farming emerges as both an innovative approach and an imperative for the future of sustainable urban development. The projected increase in urban populations, driven by escalating global urbanization, population growth, and environmental

concerns, emphasizes the urgency of localizing food production to meet the rising demand for fresh, nutritious produce. Urban farming not only provides a solution to food security challenges but also contributes to improved public health by promoting access to locally grown, organic produce.

The environmental benefits of urban farming, which include reduced carbon emissions from transportation, enhanced biodiversity, and improved air quality, position it as a critical component of sustainable urban planning. Additionally, community engagement in urban farming fosters social cohesion, promotes education on sustainable practices, and addresses issues related to urban poverty and inequality. The multifaceted benefits of urban farming underscore its pivotal role in addressing contemporary challenges and shaping resilient, livable cities.

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