Growing Sustainably: Navigating Challenges and Opportunities in Urban Horticulture in India

Comment [U1]: Names and affiliation of authors are not included

ABSTRACT

In India's bustling terrain, peri-urban areas face neglect, unplanned growth, and environmental damage. As urbanisation encroaches on agricultural land, the competition for resources grows. This article delves into the complex tapestry of challenges and opportunities in urban and peri-urban horticulture, offering light on topics such as land-use disputes, food security, and environmental sustainability. The article also explores the durability of conventional growing methods such as home gardening and community gardens, as well as novel alternatives such as soilless cultures and indoor farming systems. Amidst the challenges, there are chances for revitalising urban settings with continuous productive landscapes, developing sustainable food sources, and improving general urban well-being. From the complicated dance of people, places, and food products to managing market dynamics, this research reveals urban horticulture's brilliant promise for crafting a healthier, more sustainable future for India's changing urban fabric.

Keywords: Urban horticulture, sustainable city, food security, indoor farming, land use planning.

Comment [U2]: Use maximum of 5 key words arrange in alphabetical order

1. INTRODUCTION

Peri-urban areas are frequently overlooked in India. They are riddled with institutional ambiguity, uncontrolled expansion, inadequate infrastructure, and environmental deterioration. India's population accounts for 16.7 per cent of the global population and constitutes 2.4 per cent of the world's land area (Singh et al., 2021). Furthermore, the available area for farming in India was shrinking year after year. Land has long been an important natural resource for producing agricultural livelihoods in rural India.However, land is increasingly demanded for industrial, residential, and commercial purposes, causing real estate to expand on the outskirts of cities. People lost their agriculture, their source of food and fodder, as well as all of the advancements accumulated over generations (Levien, 2012). However, the question remains whether the lands acquired by private parties were used to accomplish the goal for which they had been purchased, or if they are retaining the property as unfinished plots in order to make a large profit after obtaining it from farmers at a low cost. Demographic change without consideration of crucial environmental components will be disastrous in coming years, as global washing causes havoc around the world.Poverty is a significant factor influencing food security and also a major cause of malnutrition and undernourishment (Prerak, 2019). Migration from rural areas to the urban, and also urban expansion, contribute to urban poverty while also increasing the distance between traditional food production sites, i.e. rural areas, and consumption. Furthermore, environmental degradation caused by global climate change reduces crop production space, which feeds rising urban and peri-urban populations. Land use conflict, another barrier to the food security, specifically between food crops and energy crops. These circumstances may differ in different places of the world.Growing urban reliance on rural food sources, along with agricultural food production in the urban areas, are key components of lifestyles that exist on an urban-rural continuum (Foeken and Uwuour, 2008; Tacoli, 2006).

Vegetables and fruits are essential components of a balanced diet; horticulture food is high in fibre, minerals, and bioactive substances. Diets containing staple foods such as cassava, maize, and rice must be balanced with fruits and vegetables to minimise chronic illnesses among the population caused by deficiencies. Micronutrient deficiencies, such as vitamin A, iron, zinc, and iodine, are highly

common in metropolitan populations.Horticulture is appropriate for urban environments because it has a high turnover, great resource efficacy, high yield and quality, flexible land use, and the ability to produce multiple crops in a single season. Horticultural agriculture makes better use of land by allowing for large crops in small spaces using efficient low-tech production technologies such as vertical cropping. For example, bag garden production (growing in hanging bags packed using soil and manure) is rising in popularity, contributing to household food security and also eco-social capital. Horticulture in urban neighbourhoods is an oasis of hope neutralized security and a sustainable atmosphere. Urban horticulture not only produces plant-based food with excellent nutritional and health value, but also provides secure livelihoods.However, most urban and peri-urban horticultural output takes place without official acknowledgement. Without government backing and restrictions, there is a risk that optimising economic returns may result in unsustainable conditions through unregulated pesticide use and dirty effluent. Urban horticulture provides well-managed vegetative cover, which benefits urban areas.

2. CHALLENGES AND OBSTACLES

Growing food through urban horticulture highlights challenges at various societal levels and is inextricably linked. It is an ideal instance of the prudent use of collective pool resources, which are often combined with an uncertain land use situation.Due to a scarcity of institutional structure as well as permits governing land use, there is less emphasis on strategies for the future for administering and upholding public or common locations used for cultivating crops for consumption in urban areas; as a result, sustainability suffers significantly, both for urban areas and crops. However, sustainability is affected not just by land use for urban horticulture, but also by the country's overall institutional structure for sustainable development, as common pool resources such as water, soil, or air may be signed while taking environmental pollution into account. This jeopardises food safety, and by extension, public health and food security. Such challenges must be addressed severely with workable solutions (Congresves, 2022).

3. OPPORTUNITIES

Food security is measured using a variety of indicators based on static and dynamic variables that describe availability, physical and economic access, utilisation, vulnerability, and access and utilisation outcomes. The existence of infrastructure leads to the production of fruits and vegetables in urban areas, increasing the availability of fresh food with high nutritional content; this has an impact on diet quality and, as a result, promotes the fight against malnutrition. In underdeveloped nations, urban horticulture provides an additional dimension to food security by contributing to livelihoods (Parrot et al., 2008). Furthermore, limiting resource flows within metropolitan regions may be an appealing strategy for sustainable city ecosystems.Horticultural cropping techniques in urban areas may also be linked to the production of animal-based proteins in aquaculture by the use of aquaponics, which links fish production to horticultural crop production. Urban horticulture fosters ecosystem services in addition to food provisioning by influencing ecological cycles and aspects in cities, particularly climatic elements like air quality, biodiversity, and water management. Energy provision is also influenced by cropping strategy and location selection. However, the multi-complex nature of synergy achieved by urban horticulture does not necessarily result in good food quality and resource efficiency. It necessitates action on a local, national, and worldwide scale.Fruit trees that require few inputs have a dual purpose: they enrich the environment while also providing money to the inhabitants.

Horticultural production is one of the most significant advantages of city or urban agriculture around the world. Orsini et al. (2013) says, urban horticulture is a highly competitive form of city or urban farming. Due to the expensive nature of urban land, vegetables with high fertilizer and water efficiency tend to be more profitable to grow than other crops. They also have the benefit of having a unique nutritional value, a short life period, and no additional processing required after harvest. Vegetables have a fairly short cycle, so they can meet expanding demand fast.For instance, after a disaster, certain vegetable species may be harvested only 60-90 days after sowing, and even shorter when grown using seedlings (Dubbeling et al., 2010). Dubbeling et al., (2010) indicate that fruit and vegetable growing can produce up to 50 kg per year on just 1 m^2. Compared to other horticultural products, this yield is extremely high. According to Hamilton et al. (2013), the quantity of land presently utilised for worldwide cereal production in developing nations is almost 10 times that occupied by cities globally, but global fruit and vegetable

production covers an area similar to that of cities.This contributes to the presumption that vegetables are appropriate for urban cultivation, requiring high-tech equipment and for the self-sufficiency of underprivileged urban residents, indicating that urban horticulture has the ability to provide a certain level of nutritional self-sufficiency for residents.

4. TRADITIONAL SYSTEMS

Globally, there are numerous ways to urban and peri-urban horticulture, including allotments for self-consumption, community gardens, huge-scale commercial farms, as well as edible landscapes. There are numerous unoccupied sites available for urban horticulture, including roofs, fallow ground, and smaller areas such as roadsides or balcony spaces. The availability of fresh, healthful, nutritious, and inexpensive food is a primary reason to participate in urban horticulture.Locally grown food is typically fresher, more readily available, and more nourishing than imported food, and hence has the ability to boost overall consumption and enhance nutrition. This is especially important for family members who have specific nutritional requirements.

4.1. Home Gardening

The traditional food production approach of home gardening can help to meet future dietary demands in addition to hidden hunger. This food production method was largely disregarded during the Industrial Revolution of agriculture & the Green Revolution, however, it has received renewed interest from development organisations since the 1980s. Home gardens offer diversified cropping of vegetables, fruits, trees, and condiments to complement food and revenue.Home gardens range in size and intricacy, from an insignificant creeper climbing on a fence to big, organised agricultural plots. The distance between a residence and its garden might range from nearby to several kilometres. Small plots can supply food and enhance nutrition for rural people, in addition to boosting income-generating opportunities and elevating a household's prestige in the community.

Home gardening is a globally popular phenomenon that is perceived at all levels of society, and it is the most widespread type of urban agriculture. Proximity to the producers' homes, the cultivation of varied vegetables, and the utilisation of low-cost inputs are widely regarded as fundamental aspects of home gardens.Galhena, Freed, and Maredia (2013) state that production is frequently supplementary rather than the primary source of consumption. Many individuals regard this form of urban horticulture as a hobby as well as an opportunity to devote time outside for aesthetic beauty and potpourrie production (Lovell, 2010). Enabling the urban poor to grow their food would save them a lot of money and improve their happiness index. To get acceptable yields and healthy produce, enough irrigation is required. This can be derived from rain, harvested water, tap water, or wastewater. Using wastewater that is not treated can endanger human health, yet contemporary treatment equipment is still prohibitively expensive for low-income farmers(Hamilton, et al., 2013). Eating contaminated food might trigger epidemics if it is not managed properly or at all (Mbaye 2000). Rooftop gardening is another new option for urban inhabitants with little land space, which is primarily utilised for food cultivation.

4.2. Community Gardening

Community gardening is the collaborative growing of plants by many individuals in a common location. Garden organisations range from extremely close-knit societies with engaging mutual activities to loosely organised ones that just share facilities (De Neergard, Drescher, &Kouame, 2009). Close-knit societies that operate on a bigger scale frequently include modest stores or cafes where self-grown items are offered. The methods used to cultivate community gardens vary as well.Some gardens have no private vegetable plots and are entirely produced on a collective scale. The common areas of community gardens comprise mainly urban open spaces. Rooftops along with other fallow land in cities can include small plots as well as bigger regions. According to Lovell, (2010) some of the key constraints of urban horticulture are limited access to land, a lack of property tenure, and inadequate services and infrastructure for urban farmers. Community gardens are supported by non-governmental organisations, municipalities, individual sponsors, or a variety of benefactors.In some gardens, people or groups possess or lease a private plot and share amenities with their fellow gardeners. This allows for the exploitation of uncommon regions while avoiding the possibility of plant contamination from filthy soil. This is a simple kind of plant cultivation in "growing media" that could theoretically be applied anywhere. This includes closed-off or cemented sections of

the city, including city squares, shrubs, walls, and terraces. There are community gardens in both developing and industrialised countries around the world. Food security is a major issue in developing nations, and community gardens are frequently formed as a result of poverty and the need to provide jobs.Community gardens allow residents to use pooled or subsidised land to improve their diet while also being nourished through aesthetic features and gardens with crop cafes.

4.3. Edible Cities or Continuous Productive Urban Landscapes

Continuous Productive Urban Landscapes, sometimes known as "edible cities," are holistic ways to make city infrastructure more sustainable by incorporating urban horticulture, green avenues, and outdoor recreation areas as vital features. Within edible cities, cultivation strategies usually vary from smaller-scale gardening to high-yielding commercial gardening (Bohn &Viljoen, 2011). This would increase the city's environmental sustainability while simultaneously improving its socioeconomic performance. The goal is to improve the city's overall dimensions while also connecting it with the rural area in order to strengthen agricultural supply chains(Lovell, 2010). To accomplish it in towns with limited unoccupied land, infrequently used highways might be transformed into a continuous productive urban landscape green area with adequate room for a pedestrian and cycling route to nourish nature. Military units within the cantonment region maintain farms to produce fruits and vegetables for soldiers.

5. INNOVATIVE SYSTEMS

Horticultural production continues to face challenges such as low quality of soil and water availability, the desire to maximise yields, and reducing environmental impact. Newer cropping technologies were developed to address these concerns and improve horticulture's sustainability. These systems of cultivation are highly intense and are typically found in metropolitan settings that lack cultivation space.People living in canal-commanding areas have the possibility to grow horticulture due to the abundance of available water.

5.1. Soilless Cultures

The term "soilless culture" refers to the "in situ" growing of plants in systems without soil. In recent years, a plethora of novel growth techniques utilising bags, mats, and containers, as well as fertiliser solutions, have been created. These growing methods include both systems without a solid medium and aggregate systems that use organic or inorganic substrates and additives. Furthermore, adapting cultural management for the particular cultural system of soilless culture, in addition to crop needs, might result in improved horticulture product quality.With the constant growth in soil erosion and the depletion of arable land, the significance of soilless cultures is projected to grow in the near future. Soilless systems are particularly well-suited for urban environments due to their lightweight design and resource efficiency. In hydroponic systems, vegetables are produced in water that contains minerals and nutrients required by the plants. This allows for accurate nutrient dose and application. This method is suitable for growing high-value vegetables such as tomato, capsicum, lettuce, watermelon, muskmelon, and strawberries. Countries such as Israel and the Netherlands have effectively implemented this technology.

6. INDOOR SYSTEMS

Concerns about pollution dangers, some metropolitan regions, if not entire cities, are unsuitable for large-scale urban horticulture. Indoor farming systems combine the efforts of agricultural production and construction to create a cohesive unit inside the protected surroundings of a building. They can be set up as levelled indoor farms in multistorey buildings or as storefront greenhouses using similar technologies. There are numerous options for integrating indoor agricultural systems in metropolitan environments. Important visitors must integrate architectural and landscaping components.

6.1. Building Integrated Agriculture

The primary motivators for incorporating the cultivation of vegetables into existing structures are resource conservation and increased resource efficiency. Caplow (2009) believes that rooftops of schools, hotels, hospitals, prisons, supermarkets, & shopping malls are good locations for developing integrated agriculture. These rooftops are suitable for the setup of greenhouses. Hydroponic systems, which are lighter in weight than conventional greenhouses, may be suitable for rooftop placement. To achieve long-term efficiency, it is critical to incorporate efficient management

cycles. Efficiency can be accomplished by a variety of methods, including proper resource management, energy use, fertiliser delivery, waste management, and, of course, sustainable cropping patterns.In modern times, a wide range of extremely effective greenhouse systems are employed all over the world. By connecting these greenhouses to building energy cycles, emitted energy, including waste heat from air conditioners and refrigerators, may be reused and recycled. This is especially beneficial in temperate climates since it ensures proper heating of greenhouses during the colder months (Caplow 2009). Additionally, it is possible that a number of greenhouses' water requirements can be met through the use of recycled or captured rainwater. In regards to nutrition and fertilisation, organic waste such as animal manure, plant leftovers, or trash from food production facilities or households can be used.When installing greenhouses atop rooftops, it is critical to consider the building's weight-carrying capabilities. As a result, greenhouse materials like roof coverings must be lightweight. Another static component is wind, which is especially critical in taller buildings. Greenhouse materials must consequently meet a number of specifications. They must be energy efficient, acceptable for high-quality goods, and suited for static recycling purposes. Finding a suitable substance that combines all of these properties with regard to of optimal output is a significant task.

7. URBAN HORTICULTURE AND ITS FACTORS

7.1. People

The urban poor make up a large proportion of those involved in urban horticulture. In many cities, lower and intermediate government officials, school teachers, and others are interested in agriculture, as are wealthy individuals looking for a solid return on their investment. Women have a key role in urban farming since agriculture, as well as related processing and marketing operations, may often be merged with their other household responsibilities. Women outperform males in important agricultural operations.

7.2. Location

Urban horticulture can take place either within cities (intra-urban) or in peri-urban settings. The operations may occur on the homestead (on-plot), away from the place of residence (off-plot), on private property (owned or leased), on public property (parks, conservation areas, along highways, streams, and railways), and semi-public land (school campuses, and hospitals). Proper linkage to the main line is required for efficient transport and handling of crops.

7.3. Food Products

Food products from various crops (grains, vegetables, root crops, fruits, mushrooms, etc.) and animals (poultry, goats, sheep, pigs, fish, etc.) along with non-food products (such as aromatic and medicinal herbs, tree products, ornamental plants, etc.) or combinations of these are produced in areas that are both urban and peri-urban. Often, the more perishable and comparatively high-valued vegetables, animal products, and by-products are preferred. Urban agriculture production units are typically more specialised than rural companies, necessitating cross-unit exchanges. Consumer acceptability is the key to popularising any food product in the municipal domain.

7.4. Product Market

Urban horticulture encompasses horticultural production, and all related processing and marketing operations, as well as inputs (e.g., compost) and service delivery (e.g., animal health services) provided by specialised micro-enterprises or non-governmental organisations (NGOs). The majority of cities in developing countries employ a significant portion of their agricultural products for personal consumption, with surpluses exchanged. However, the importance of market-driven urban agriculture, in terms of volume and economic value, cannot be overlooked. Goods are sold at farm gates, by cart in the same or different neighbourhoods, in local shops, at local (farmers) markets, or through middlemen and supermarkets.The majority of the products sold are fresh, however, some are processed for personal use, cooked to be sold on the streets, or processed & packaged for sale at one of the stores mentioned above.

Comment [U3]: There is a need to add contributions to literature before conclusion

8. CONCLUSION

Urban and peri-urban horticulture in India is at a critical juncture, facing multiple obstacles yet holding enormous promise for transformational change. The concerns of land-use conflict, institutional ambiguity, and environmental deterioration highlight the need for comprehensive policies and sustainable

practices. Traditional methods of home gardening and communal gardens, which are firmly ingrained in the cultural fabric, provide opportunities for decentralised and sustainable food production. Adopting new cropping methods, such as soilless cultures and indoor farming, indicates a dedication to resource efficiency and sustainability regardless of urban limitations.Continuous Productive Urban Landscapes, or "edible cities," emerge as comprehensive solutions that encourage a mutually beneficial link between urban infrastructure and horticulture techniques. The involvement of a wide range of stakeholders, from the urban poor to government officials and corporate investors, demonstrates a shared responsibility for directing urban agriculture towards a more sustainable future.
Addressing issues needs a collaborative effort at the local, national, and international levels, including legislative frameworks, infrastructure development, and awareness campaigns. By capitalising on the potential provided by urban gardening, India cannot just secure food sources but also reduce environmental impact and improve the well-being of its urban population. The transition to sustainable urban and peri-urban horticulture is both a practical requirement and an investment in a healthier, more resilient, and sustainable urban future.

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