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URBAN FARMING- TRANSFORMING THE EMPTY SPACES INTO THE VALUABLE SPACES: A REVIEW

Kashish Rawat, Santosh Kumari*, Akhilesh Sharma and Anupriya
Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur
Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP, India
*Corresponding author E-mail: santoshstpc@gmail.com
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ABSTRACT

Urban farming has emerged as an innovative and sustainable approach to tackle the pressing issues of food security, resource limitations, and environmental challenges, particularly in urbanized areas. This review examines the potential of urban agriculture for vegetable crop production, focusing on systems such as vertical farming, green roof gardening and balcony gardening. These methods maximize the use of urban spaces while promoting ecological harmony and reducing reliance on conventional rural farming. The paper outlines the advantages of urban farming, including improved food availability, environmental conservation, economic development, and community involvement. The shift from the rural land to city life is adding more populationeffecting the environment and lack of availability of fresh produce. To overcome these challenges, urban farming is a suitable opportunity. This review explores future directions, highlighting the role of technological progress and policy integration in expanding urban farming initiatives. With its diverse benefits, urban farming has the potential to transform vegetable production and establish self-sufficient and sustainable urban ecosystems.
***Keywords*:** Hydroponics, Urban farming, green roofs, Sustainable.

Introduction

A pressing global challenge is finding effective ways to fulfil the nutritional requirements of the human population, which is projected to reach 10 billion by the year 2050. It is as suggested there should be 30% rise in the food production to meet the needs of our upcoming future generation (FAO, 2017). Urban farming has evolved as a forward-thinking and sustainable approach to tackle pressing issues related to food security, resource scarcity, and environmental challenges in rapidly urbanizing regions. Urban agriculture addresses these challenges by utilizing rooftops, balconies, community areas and indoor area. Vegetable crops play a vital role in urban farming due to their high nutritional value, quick growth cycles, and adaptability to confined and controlled environments. Advanced systems like aquaponics, vertical farming, and green roof agriculture are present innovative methods for cultivating fresh vegetables within urban settings, while maximizing efficiency in water, space and nutrient usage. These practices not only decrease the carbon emissions linked to transporting produce but also provide consistent, pesticide-free vegetables throughout the year, promoting healthier eating habits and lifestyles for city residents.In addition, urban farming reclaims neglected spaces and converts into productive agricultural zones, contributing to ecological balance, enhancing air quality, and fostering sustainable practices in urban areas. It also strengthens social bonds, stimulates local economies, and generates employment opportunities. As urbanization progresses, integrating advanced technologies and sustainable strategies into urban farming will be critical for creating robust and sustainable food systems in the future. As of now, people get settled from the rural areas to the urban areas for the sake of better livelihood, and land in the rural areas are left abandoned. As a result of this, the population and youth too are increasing day by day in the urban areas which is leading to the shortening of the produce,

increased transportation, leading to more emission of carbon dioxide and is indirectly affecting and contributing to the global warming. With increasing global warming, there is increase in the health risk. People in the cities are living in the polluted environment and consuming the unhealthy produce which have negative effect on their health. Urban farming has overcome these problems by providing fresh and healthy produce. Merits and attributes of urban farming has been illustrated in the table 1.

Types of Urban Farming

Urban farming encompasses a variety of innovative techniques designed to make the best use of space, resources, and sustainable practices in urban environments. Below are the key types of urban farming, with a specific emphasis on vegetable cultivation:

1. Vertical farming

Vertical farming system refers to growing of the vegetables in the layers which are vertically arranged by using different techniques such as aquaponics, hydroponics and aeroponics. Smart approach to introduce greenery in heavily populated city area is through the use of the vertical gardens (Waldron, 2018**).** This system is widely used, where is limited space. This system helps to grow the vegetables year round in the controlled environment. Usage of water is also minimum compared to the traditional farming syetem. Pesticide usage is also minimum. The vertical farming approach seeks to enhance efficiency. A "vertical farm" refers to a well-organized indoor system for growing plants that delivers high quantities of top-quality fresh produce throughout the year, independent of external factors like sunlight (Januszkiewicz and Jarmusz 2017). The aim of the urban farming is to give more food assurance and increased yields. Modern farming methods have the potential to produce greater yields while utilizing significantly less water. Smart plant care system allows people to enjoy the green spaces without any worries, as it manages and upkeep the operation of the irrigation system on your behalf (Kumar et al. 2020). Vertical farming is of following types

Hydroponics

The term "hydroponics" originates from two Greek words: "hydro," meaning water, and "ponos," meaning labor. Together, the term translates to "water labor" or "water work. "Hydroponics was introduced by the English scientist W.J. Shalto Duglas. Hydroponic methods cultivate healthy, high-yield crops without the risk of soil-borne pests and diseases. This system promotes organic food production, eliminating the need for harmful pesticides or toxins. Hydroponics requires significantly less space than traditional soil gardening, as plants with small root systems can be grown closely together. Crops cultivated hydroponically grow at twice the speed of conventional methods, doubling yields and enhancing production from the same land area. This technique minimizes water wastage by reusing and recycling water, utilizing only one-twentieth of the water required in conventional farming. Hydroponics requires significantly less labour compared to conventional farming, as it eliminates the need for several traditional agricultural practices such as spraying, weeding, watering, and tilling. Crops can be cultivated year-round without being influenced by changing climatic conditions. (Schiavon *et al*., 2013). Hydroponics is an eco-friendly farming method that eliminates abiotic stress, providing a sustainable and efficient approach to agriculture.

Hydroponics is a soil-free farming method where plants are cultivated on either natural or artificial substrates. This approach enables roots to efficiently absorb nutrients from a specially prepared nutrient solution. Various hydroponic methods exist, and their suitability depends on factors such as the type of crop, regional climate conditions, and budget. Typically, hydroponic systems include a nutrient solution reservoir and an aerator to ensure optimal plant growth. This method involves growing plants without soil, using nutrient-rich water instead. Hydroponics is especially suitable for leafy greens, herbs, and vegetables, offering efficient water utilization, accelerated growth, and the ability to produce crops year-round in small urban spaces. Vegetables like tomato, lettuce, spinach, capsicum, cabbage, French bean and palak etc. are grown under this system.

https://media.gettyimages.com/id/1350214543/photo/hydropronics-farm-close-up-of-asian-worker-working-in-organic-hydropronics-farm.jpg?s=612x612&w=0&k=20&c=v9g0Qm0YOsspNgE1J4LJ2OohBPyXeeAtV_j2uKnUgM0=

https://www.gettyimages.in/detail/photo/lettuce-farming-in-a-hydroponic-farm-royalty-free-image/1498664599

Fig. 1: Hydroponics

Aquaponics

Aquaponics integrates recirculating aquaculture systems with soilless hydroponic methods to enable the simultaneous production of fish and plants within a closed-loop system. Essentially, it involves cultivating fish and crops in a shared, recirculating environment. Recirculating aquaculture systems are specifically designed to support high fish production in minimal water volumes by filtering out harmful waste and reusing the purified water for fish. Nitrifying bacteria are essential in converting harmful ammonia and nitrite into less toxic nitrate within specialized filtration systems, referred to as biofilters. However, disruptions to the biofilter or excessive ammonia production can lead to challenges. In most aquaponic systems, fish and plants absorb approximately 70% of the nutrients, while the leftover solid waste can be repurposed to cultivate fruit trees or traditional horticultural crops. Despite these potential limitations, the approach is increasingly recognized as a bio-integrated model for sustainable food production. An aquaponics system not only removes nitrates from the water but also recycles fish waste, transforming potentially harmful nitrogenous compounds into plant-usable nutrients. This nutrient-rich water supports the growth of vegetables, providing an eco-friendly alternative to discarding waste into the ocean. The closed-loop system ensures efficient water reuse, significantly reducing overall consumption. Those interested in combining fish cultivation with vegetable gardening, starting with a simple DIY aquaponics setup is a great way to explore its functionality. According to (Tyson et al. 2011) enhancing plant to fish ratio has been a debate among the scientist.Vegetables suitable for cultivation in aquaponic systems are lettuce, beans, peppers, squash, zucchini, cucumbers, broccoli, peas and spinach.

https://t3.ftcdn.net/jpg/13/42/17/02/240_F_1342170298_pSsj6zATEq3b17SkNgRbKVmrm5cwrTkB.jpg

Fig. 2: Aquaponics

Aeroponics

Aeroponics refers to the method of cultivating plants in an air or mist environment, avoiding the use of soil or aggregate media. The term "aeroponic" originates from the Latin word "aero," meaning air, and "ponic," which translates to labour or work (Farran and Mingo-Castel 2006).This term refers to cultivation of the plants in air or mist based setting without the use of soil and utilizing minimal water. NASA has also explored this technique to be efficient to grow plants in the space (Lee *et al*., 2006). It has been seen that the plants which are produced by this system are able to absorb more quantity of minerals and vitamins, which resulted in the plants being healthier (Hosseinzadeh, 2017). It could be an effective method for altering nutrient supply to cultivate potato minitubers. The restricted stolon growth during the stolon phase notably enhances root activity. Additionally, this approach proves advantageous in overcoming challenges like high temperatures and late-season varieties, which are non-tuber conditions, thereby optimizing the nutrient disruption technique. The trench or trough technique involves growing crops in

narrow channels within above-ground or ground troughs constructed using blocks or solid squares. Waterproof materials are applied to seal the channels and troughs, separating the growing medium from the soil. To simplify operations, the width of the channels or troughs can be customized as needed. For planting two rows of crops, high-cost troughs or channels are utilized. The depth of the troughs may vary based on the plants being cultivated, with a minimum depth of 30 cm typically required. Growing media such as old coconut shell fiber residues, sand, or rocks can be employed for this system. Water and nutrients are provided through a drip irrigation system, although manual application is also straightforward to manage. Aeroponics is recognized for enhancing growth rates and producing potato tubers that are healthy, uniform, and robust. This method can achieve yields up to ten times greater than traditional production systems. Its efficiency has contributed to better potato cultivation while lowering costs tied to seed multiplication and improving initial field quality. (Barak et al. 1996) employed this system to check the rates of water and ions uptake in cranberries without causing any damage to the plants.

Fig. 3: Aeroponics

2. Roof top farming

Greeen roof farming has become more popular during the present days as people are moving to the urban areas for better lifestyle and livinghood. As gardening on the rooftops might contribute a little but it serves as a significant pathway towards promoting sustainability and addressing the destructive impacts of climate change (Kumar *et al*., 2019). It also contributes to address the food demand by providing fresh and healthy produce by lowering the costs of households spend on purchasing the fruits and vegetables (Alaimo *et al*., 2008). Many countries are facing limited availability of the farmable land, such as Bangladesh, can adopt the rooftop farming system to enhance the greenery and provide fresh food supplies (Altieri *et al*., 1999). Due to escalating use of land for the purpose for housing, business, or industrial purposes, its availability is steadily decreasing. This system of farming is an excellent illustration of the integrated farming practices, which with time has been advanced within urban farming system (Astee and Kishnani, 2010). Rooftop farming has been adopted across cities and towns throughout India (Block and Chavez, 2011).The rooftop farming system use minimal amounts of water and soil (Taylor and Lovell *et al*., 2013). When pandemic covid-19 hit our country rooftop gardens played a very important role in the food security (Despommier, 2010). As the name itself suggest rooftop farming the rooftop is covered with the greenery of variety of plants, including tress, shrubs, bushes, and grasses (Morgan and Sonnino *et al*., 2010).Green roofs are also known as roof gardens, living roofs, or eco-roofs on the building that features a growth substrate and are adorned with the vegetation.Rooftop farming is a small step which can help in the food and nutritional security of our country.

Vegetables on the rooftop can be grown in the plastic pots, concrete pots, plastic bottles and buckets. The advantage is that instead of using the harmful and toxic pesticidesleftover kitchen wastes is used. Kitchen waste included peels of vegetables, shells of egg and leftover food etc. Peels of vegetables and fruits are rich

in the nutrients like nitrogen and potassium. Shells of the eggs are rich in calcium and plays a major role by strengthening the cell walls of plant and prevent the physiological disorder in tomato such as blossom-end rot. As the leftover food decomposes into organic matter it enhances the soil fertility (Resh, 2012) Numerous companies produce a wide range of containers designed specifically for rooftop gardens. The key insights indicate that balcony and terrace gardens significantly contribute to urban agriculture while offering additional opportunities to improve food security, as highlighted in the title (Morris and Zidenberg-Cherr, 2002).

The vacant spaces of the rooftop can be utilized for the purpose of growing vegetables. Rooftop farming is a good option as there is availability of plenty of sunlight, water and pollinators. Rooftop garden will insulate the building by absorbing the solar radiations optimally and will reduce "urban heat island effect". Rooftop gardens provide opportunities for social interaction and involvement within the local community. They serve as gathering spaces, learning centers, and catalysts for fostering neighborhood engagement and empowerment (Lohr *et al*., 2004). Vegetables suitable to grow on the roof top gardens are eggplant, chilli, tomatoes, bell peppers, onions, okra, amaranth, gourds, radishes, carrots, beets, spinach, cabbage, cauliflower, broccoli and beans.

https://img-cdn.krishijagran.com/7339/terrace-vegetable-garden-2_mini.jpg

Fig. 4: Roof top farming

3. Balcony Gardening

Balcony gardening is best option when there are limited spaces in home and will also help in producing fresh and healthy produce. This can be seen as a good hobby. The cultivation of food on small patches of land near human dwellings is the most ancient and long lasting method of agriculture (Ninez, 1987). By utilizing the empty spaces in the balcony variety of vegetables can be grown. Temperature is maintained and promotes more greenery adding to the asthetic view of the surroundings. The gardening develop a self-sufficient system that effectively recycles nutrients, minimizes waste, and produces premium-quality vegetables while safeguarding environmental well-being. Recognizing and accommodating cultural beliefs, social practices, and local dietary preferences is crucial for ensuring the success of these interventions. Under this gardening choose the vegetables which utilize the less space for growing, the location where adequate sunlight is available to the plants and containers with good drainage system. Tomato, lettuce, peppers, cucumber, carrot, radish, brinjal, garlic, peas and beet are suitable for cultivation in balcony.

https://cdn.mos.cms.futurecdn.net/Jmc7gKwau79tgQnykJY5EU.jpg

Fig. 5: Balcony gardening

Table 1 : Merits and Attributes of urban farming

Merits	Attributes
Broadened food access	Increased food supply to the people in cities
Utilization of empty spaces	Transforming the empty spaces into the productive ones
Good for the environment	Produce will be available at home and will reduce the need of transportation
Less use of water	Urban farming utilizes less water
Year round production	Year round production under controlled environment
Increased social interaction	It leads to increased social interaction among people
Economically beneficial	Provides job opportunities for the local people
Kitchen-organic waste	Waste in the kitchen can be utilized for growing produce
Health benefits	Local fresh produce will have several health benefits
Conservation of water	Rainwater can be utilized
Great hobby	Utilizing free time in a productive manner
Healthy habits	Encourages city people to have good healthy habits by good nutritious food

Conclusion

Urban farming, especially with vegetable cultivation, provides a forward-thinking and eco-friendly solution to tackle pressing issues such as food security, climate change, and urban sprawl. By making use of spaces like rooftops, balconies, and community gardens, it encourages localized food production, cuts down on emissions linked to long-distance food transport, and promotes a healthier lifestyle with access to fresh produce, all while strengthening community bonds. Furthermore, modern techniques like vertical farming, hydroponics, and aquaponics have unlocked the potential for growing diverse vegetable crops in urban environments, even in space-constrained areas. Urban farming has the power to inspire environmental consciousness, uplift economies, and promote social inclusivity. As urban areas continue to expand, incorporating urban farming into city planning can help establish greener, self-sustaining ecosystems where vegetable crops flourish alongside urban residents. It offers a vital step toward creating robust and sustainable cities for the future.

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References

Alaimo, K., Packnett, E., Miles, R.A., and Kruger, D.J. (2008). Fruit and Vegetable Intake among Urban Community Gardeners. *J. Nutr. Educ. Behav.,* **(40) 2:** 94–101.

Altieri, M.A., Companioni, N., Kristina, C., Catherine, M., Peter, R., Martin, B., and Nicholls, C.I. (1999). The greening of the "barrios": Urban agriculture for food security in Cuba. *Agric. Hum. Values.,* **16:** 131–140.

Astee, L., and Kishnani, N. (2010). Building Integrated Agriculture: Utilizing Rooftops for Sustainable Food Crop Cultivation in Singapore. *J. Green Build.,* **5(2):** 105–113.

Barak, P., Smith, J.D., Krueger, A.R., and Peterson, L.A. (1996). Measurement of Short-Term Nutrient Uptake Rates in Cranberry by Aeroponics. *Plant Cell Environ.,* **19(2)**: 237–242.

Block, D.R., and Chavez. (2011). Food Sovereignty, Urban Food Access, and Food Activities: Contemplating the Connections through Examples from Chicago. *Agric. Hum. Values.,* **29:** 203–215.

Despommier, D. (2010). The Vertical Farm: Controlled Environmental Agriculture Carried Out in Tall Buildings Would Create Greater Food Safety and Security for a Large Urban Population. *J. Verbrauchersch. Lebensm.,* **6:** 233–236.

FAO (Food and Agriculture Organisation of the United Nations). 2017. *The Future of Food and Agriculture: Trends and Challenges.* Rome: FAO.

Farran, I., and Mingo-Castel, A.M. (2006). Potato minituber production using aeroponics: Effects of density and harvest intervals. *Am. J. Potato Res.,* **83:** 47–53.

Hosseinzadeh, S., Verheust, Y., Bonarrigo, G., and Van Hulle, S. (2017). Closed hydroponic systems: Operational parameters, root exudates occurrence and related water treatment. *Rev. Environ. Sci. Biotechnol.,* **16:** 59–79.

Januszkiewicz, K., and Jarmusz, M. (2017). Envisioning urban farming for food security during the climate change era: Vertical farming within highly urbanized areas. *IOP Conf. Ser. Mater. Sci. Eng.,* **245(5):** 052094.

Kumar, J.R., Natasha, B., Suraj, K., Kumar, S.A., and Manahar, K. (2019). Rooftop farming: An alternative to conventional farming for urban sustainability. *Malays. J. Sustain. Agric.,* **3:** 39–43.

Kumar, S.M., Heuvelink, E., and Marcelis, L.F.M. (2020). Vertical farming: Moving from genetic to environmental modification. *Trends Plant Sci.,* **25:** 724–727.

Lee, J.G., Lee, B.Y., and Lee, H.J. (2006). Accumulation of phytotoxic organic acids in reused nutrient solution during hydroponic cultivation of lettuce (*Lactuca sativa* L.). *Sci. Hortic.,* **110:** 119–128.

Lohr, V.I., Pearson-Mims, C.H., and Goodwin, G.K. (2004). Interior plants may improve worker productivity and reduce stress in a windowless environment. *J. Environ. Hortic.,* **22:** 97–100.

Morgan, K., and Sonnino, R. (2010). The urban foodscape: World cities and the new food equation. *Cambridge J. Reg. Econ. Soc.,* **3:** 213–221.

Morris, J.L., and Zidenberg-Cherr, S. (2002). Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrients and preferences for some vegetables. *J. Am. Diet. Assoc.,* **102(1):** 92–93.

Ninez, V.K. (1987). Household gardens: Theoretical and policy considerations. *Agric. Syst*., **23:** 167–186.

Resh, H. (2012). Hydroponic Food Productions: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower. In: CRC Press, New York, 7th ed.

Schiavon, M., Dall'Acqua, S., Mietto, A., Pilon-Smits, E.A., Sambo, P., Masi, A., and Malagoli, M. (2013). Selenium fertilization alters the chemical composition and antioxidant constituents of tomato (*Solanum lycopersicon* L.). *J. Agric. Food Chem.,* **61(44):** 10542–10554.

Taylor, J.R., and Lovell, S.T. (2013). Urban home food gardens in the global North: Research traditions and future directions. *Agric. Hum. Values.,* 31**:** 287–301.

Tyson, R.V., Treadwell, D.D., and Simonne, E.H. (2011). Opportunities and challenges to sustainability in aquaponic systems. *Hortic. Technol*., **12:** 22–27.

Waldron, D. (2018). Evolution of vertical farms and the development of a simulation methodology. *WIT Trans. Ecol. Environ.,* **217:** 975–986.

Zeigler, R. (2005). The vertical aeroponics system. Synergii International Inc.