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Rooftop gardening: A modern approach of production in urban areas

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Abstract

Rooftop gardening, commonly referred to as rooftop farming or green roofs, is a sustainable practice that entails growing plants on building rooftops. This review gives an in-depth analysis of rooftop gardening, highlighting its advantages, difficulties, and implementation approaches. Due to its ability to boost resource efficiency, contribute to food security in cities, and improve linked environmental and social services, urban horticulture is becoming more and more relevant in our urbanizing society. However, due to the limited amount of land that can be used for cultivation in cities, there is a need to investigate cutting-edge growth techniques, such as planting vegetation on top of structures. Rooftop horticultural activities are "sprouting" all over the world, and scientific knowledge on the best growing practices, regulations, and potential advantages is expanding. The main characteristics of rooftop horticulture will be covered in this review, which will also provide an interdisciplinary assessment of various development strategies and the many forms that rooftop horticulture may take in various contexts. It will bring together past successes and planning ideas for sustainable city development. Mineral fertilizers and pesticides are sometimes utilized in urban rooftop gardens. This essay will aid in understanding rooftop gardening and future study on rooftop gardens.

Keywords: Rooftop gardening, sustainable practice, urban horticulture, green roofs, resource efficiency, food security, development strategies, scientific knowledge

Introduction

Numerous issues affect urban regions, such as a lack of available space, environmental damage, and food instability. As a result, cutting-edge methods like rooftop gardening have come to light as a contemporary response to these problems that also encourages sustainable production in urban settings. By growing plants on building rooftops, rooftop gardening turns unused space into useful green space. This review study addresses the significance of rooftop gardening, its advantages, and its application methods in urban contexts. It is difficult to supply the food needs of urban populations due to the tendency towards increased urbanisation, which has resulted in the loss of agricultural land and green spaces. In order to close the gap between food supply and consumption, rooftop gardening offers a possible alternative. Rooftop gardening offers advantages beyond just growing food. It is essential for reducing the urban heat island effect, which causes cities to heat up more because of the abundance of concrete and lack of flora. Rooftop gardens serve as organic insulation, minimizing heat absorption and radiation, reducing energy use, and improving urban microclimates. Another benefit of green roofs is the potential to convert private, semi-public, or even entirely public recreation facilities onto roofs in high urban-density neighborhoods. (Manfred Kohler, Michael Laar, Marco Schmidt, 2004) ^[1].

Objectives of the review

1. Investigate the importance of rooftop gardening in the context of urban agriculture and its contribution to solving problems in urban settings.
2. Describe and debate the merits of urban rooftop gardening, including the environmental, social, and financial advantages.
3. Consider the difficulties and restrictions associated with adopting rooftop gardening in metropolitan locations.
4. Examine the methods and recommendations for implementing rooftop gardening successfully.

By attaining these goals, this review paper hopes to add to the body of knowledge on rooftop gardening and offer insightful information to practitioners, researchers, policymakers, and others who are interested in sustainable urban agriculture and food production.

Media used for production of rooftop farming

Rooftop farming uses a variety of media types to provide a substrate for plant development and nutrient uptake. The selection of medium is influenced by elements like weight, drainage, water retention, nutrient accessibility, and sustainability. The following are some popular media for rooftop farming:

1. **Lightweight Aggregate-based Media:** Rooftop farming systems frequently use lightweight aggregates such as expanded clay pellets, perlite, and vermiculite. These components support healthy plant growth by being lightweight, offering sufficient drainage, and allowing air to circulate around the roots. Additionally, they have strong water retention qualities, which ensure that plant roots receive enough moisture.
2. **Soil based media:** Traditional soil-based media can be utilised for rooftop farming; it consists of a mixture of topsoil, compost, and organic materials. This medium supports plant growth and offers a rich source of nutrients. However, it is crucial to take into account the soil's weight and guarantee adequate structural support for the rooftop.
3. **Soilless Mixes:** Lightweight substitutes for conventional soil-based media include soilless mixes like coco coir, peat moss, and decomposed bark. These mixtures can be altered with additional fertilizers to match the needs of the plants and have strong water retention and drainage qualities.
4. **Hydroponic Systems:** Without the use of soil or other conventional media, plants are grown in nutrient-rich water solutions in hydroponic rooftop farming. As a substitute, materials like coconut coir, rockwool, or expanded clay can be used to support plant roots. Precision control over nutrient supply and water management is possible with hydroponic systems.

Utilization of rooftop farming

Gardening on rooftops is practiced. Growing vegetables on rooftops has become more popular in recent years in an effort to support urban agriculture's sustainability. Urban areas can increase their resource sustainability through rooftop agriculture, which also helps locals access to food security. Rooftop gardens are an increasingly significant component of the recent revival of urban agriculture and offer an alternative setting for the production of vegetables for urban markets (Ouellette *et al.*, 2013) [3]. The growing of vegetables on rooftops should not be seen as a replacement for the large-scale vegetable production that takes place in rural areas rather, it should be seen as a way to strengthen the urban food movement by adding another source of fresh, local foods (Tomalty and Komorowski, 2010) [4]. More than 20% of the vegetable demands in many urban areas are currently met by production within the city limits. Urban agriculture is frequently practiced in developing nations, although some developed-nation cities globally make an effort to supply at least some of their food needs locally (MacRae *et al.*, 2010) [5]. In order for urban agriculture to be most effective, there

needs to be a greater emphasis on growing vegetables within city limits. However, urban land that has historically been utilized for agriculture, such as vacant lots, is susceptible to prospective development. As a result, urban agriculture faces difficulties in meeting the current demand for locally produced foods due to a lack of space in cities. In this way, green roofs can efficiently restore any lost green area due to construction. In order to expand localized urban agriculture, rooftop agriculture—especially green roof production systems—has grown to be an appealing option (Ouellette *et al.*, 2013) [3].

Nowadays, rooftop gardening is gaining popularity, especially in urban areas. Many people have previously made money out of their passion. Former employees of the public and private sectors, as well as businesspeople and industrialists, have engaged in rooftop agriculture as a way to pass the time. Despite the shortage of arable land, their efforts are making the cities greener. Some even hire other people's roofs for the purpose. People always favor chemical-free organic vegetables and fruits, which is another reason why it's growing.

The rooftop gardens provide them with simple access to fresh, organic food. These individuals are also assisting in fostering a healthy environment in metropolitan areas by spreading vegetation on the rooftop (The Daily Star, 2019). In Bangladesh, there are roughly 25 different vegetables grown on rooftops. According to estimates, rooftop farming in Dhaka City produces gourds (25%) and brinjal (61%), Indian spinach (47.8%), and chilies (45.3%). According to estimates made by Uddin *et al.* (2016) [7], Chattogram City also produces brinjal (48%), Indian spinach (35.7%), gourds (35.6%), lady's fingers (31%), tomatoes (23.7%), red amaranth (23%), beans (18%), cabbage, and cauliflower (7%). For roof gardening and horticultural development, the Agricultural Extension Division offers the required training and supplies to individuals. The "Green Roof Movement" is being led by Bangladesh's Roof Garden Association (RGA), which focuses on the practical and economical aspects of roof gardening (Uddin *et al.*, 2016) [7]. Rooftop vegetable production is growing in popularity, which is undoubtedly good news for the country, but more research is required to determine how to use waste on agricultural lands so that we can address the issue of waste management in the nation. To feed the population, similar rooftop gardening techniques can be used in India.

Rooftop gardening advantages

Urban regions can benefit from rooftop gardening in many ways, including the economic, social, and environmental aspects. These advantages help build resilient and sustainable cities. Here are a few of the main advantages of rooftop gardening:

1. **Urban Heat Island Reduction:** Rooftop gardens provide insulation and lessen heat absorption and radiation from buildings, which helps to reduce the urban heat island effect. In metropolitan locations, vegetation and green spaces on rooftops can dramatically reduce surface and air temperatures, resulting in a more pleasant and cooler microclimate (Akbari *et al.*, 2009) [8].
2. **Stormwater Management:** By catching and absorbing rainwater, rooftop plants serve as organic stormwater management solutions. They lessen the quantity and intensity of stormwater runoff, relieving pressure on

drainage systems and lowering the likelihood of floods (Wong *et al.*, 2003) ^[12].

3. **Improved Air Quality:** Plants in rooftop gardens help filter and collect airborne contaminants, such as gases and particulates, which improves the air quality in urban areas. In order to provide cleaner and healthier air, plants produce oxygen while absorbing carbon dioxide (Nowak *et al.*, 2000) ^[11].
4. **Community Engagement:** Rooftop gardens offer chances for socializing and participating in the local community. They act as social hubs, educational platforms, and mobilizers of neighborhood participation and power (Lohr *et al.*, 2004) ^[10].
5. **Local Food Production:** Urban rooftop gardens make it possible to produce food close to home, enhancing food security and lowering reliance on long-distance travel. They enable city dwellers to cultivate fresh produce, promoting a bond with nature and sustainable food systems (Blanchard *et al.*, 2019) ^[9].

These advantages underscore the value of rooftop gardening as a sustainable urban practice, enhancing resource efficiency, community well-being, and environmental resilience.

Challenges in rooftop gardening

Rooftop gardening has many advantages, but it also has a number of obstacles that must be overcome if it is to be successfully implemented. The sustainable and successful practice of rooftop gardening in urban areas depends on recognizing and overcoming these obstacles. These are some of the main difficulties that rooftop gardening faces:

1. **Structure limitation:** Rooftops may only be able to support a certain amount of weight, thus the soil, plants, containers, and water weight of the garden infrastructure must be carefully taken into account. To maintain the building's stability and safety, structural evaluations and reinforcements may be required (Oberndorfer *et al.*, 2007) ^[14].
2. **Maintenance requirements:** Rooftop gardens need frequent maintenance, including watering, fertilizing, pruning, pest control, and soil management. Access to the rooftop, particularly in multi-story structures, might present logistical issues for maintenance tasks (Snodgrass and Snodgrass, 2010) ^[17].
3. **Resource limitations:** Rooftop gardens frequently experience problems with water accessibility and soil fertility. To ensure effective water utilisation, adequate irrigation systems are necessary. To boost nutrient levels and encourage plant growth, suitable soil amendments or organic matter may also be needed (Rowe, 2011) ^[15].
4. **Environmental conditions:** Rooftops can be exposed to a variety of adverse climatic factors, including strong winds, chilly temperatures, and direct sunshine. Rooftop gardens call for carefully selecting the right species and cultivars of plants that can endure these conditions (Emmanuel *et al.*, 2007) ^[13].

Obstacles posed by legislation and policies: In some metropolitan locations, it is possible that rooftop gardening is not supported or encouraged to its full potential. Rooftop gardens may have difficulty starting or growing due to building laws, zoning regulations, and permission requirements. To remove these obstacles, advocacy and

encouraging policies are necessary (Scholz-Barth, 2013) ^[16]. In order to ensure the long-term viability and success of rooftop gardening efforts in urban locations, addressing these problems calls for careful planning, stakeholder participation, and creative solutions.

Techniques for Effective Implementation of roof gardening

Several tactics can be used to make sure rooftop gardening in cities is successfully implemented. These tactics cover important topics like planning, design, community involvement, and continuing upkeep. Here are some tactics for putting rooftop gardening into practise successfully:

1. **Engineering and Structural Assessment:** Perform a complete structural analysis of the building to ascertain its load-bearing capacity and make sure it can handle the weight of the garden infrastructure. Work with structural experts to put in place any reinforcements that are required (Oberndorfer *et al.*, 2007) ^[14].
2. **Planning and Design:** Create a thorough design for the rooftop garden, taking into account elements like plant choices, wind patterns, sunshine exposure, and water accessibility. Utilise effective irrigation techniques, suitable drainage, and suitable growing medium to enhance plant development and water management (Cameron and Oleksak, 2011) ^[18].
3. **Community Engagement and Stakeholder Involvement:** In order to promote a sense of ownership and teamwork, involve the community and pertinent stakeholders from the planning stage onward. Promote community resilience and social cohesion by encouraging participation through educational sessions, volunteer opportunities, and communal gardening areas (Blanchard *et al.*, 2019) ^[9].
4. **Maintenance and ongoing care:** Establish a maintenance schedule for the rooftop garden, which should cover routine fertilisation, insect control, and plant upkeep. Ensure rooftop access for maintenance tasks, and think about integrating intelligent technologies, like automatic irrigation systems, to simplify maintenance (Snodgrass and Snodgrass, 2010) ^[17].
5. **Collaboration with Policy Makers:** Speak out in favour of laws and policies that encourage the launch and growth of programmes for rooftop gardening. Incorporate rooftop gardening into urban planning frameworks and work closely with local government authorities to remove any regulatory obstacles, offer incentives, and do so (Scholz-Barth, 2013) ^[16].

By putting these tactics into practice, rooftop gardening initiatives can be sustained over the long term and have a good impact on urban environments.

Future Directions and Research Opportunities

Rooftop gardening offers a viable route for sustainable urban agriculture, and there are numerous future possibilities and research opportunities that can improve its use and impact. These directions for future study can help with addressing current issues, improving procedures, and increasing the advantages of rooftop gardening. The following are important issues for future research:

1. **Plant selection and adaptation:** Research might concentrate on determining the plant species and cultivars that are most suitable for rooftop gardening in various

climatic and environmental circumstances. Studying how different plants adapt to rooftop settings, such as their susceptibility to heat, wind, and shallow soil, might offer important tips for productive rooftop gardening (Cameron and Oleksak, 2011)^[18].

2. Optimization of growth Media: Researching different growth media and substrate formulations might enhance the effectiveness of rooftop gardens by increasing their ability to hold water and nutrients. Research can examine the application of cutting-edge materials, like biochar, for promoting plant growth and improving soil fertility in rooftop situations (Getter *et al.*, 2019)^[20].
3. Water Management and Irrigation Strategies: Improving water management and irrigation methods will assist rooftop gardens deal with water scarcity issues. To maximise water utilisation and lessen reliance on outside water sources, research can examine the use of rainwater gathering, graywater recycling, and smart irrigation systems (Berardi, 2015)^[19].
4. Ecological Impact and Biodiversity: Analyzing how rooftop gardens affect the surrounding fauna, such as birds, insects, and pollinators, can help to create environmentally friendly rooftop gardening techniques. Research can look into how rooftop gardens might help preserve biodiversity and maintain urban wildlife habitats (Oberndorfer *et al.*, 2007)^[14].
5. Economic feasibility and social equity: Assessing rooftop gardening projects' economic viability and looking at how they might affect local economies might give important insights for expanding these practises. In order to ensure that access and benefits are distributed fairly throughout varied urban areas, research can also examine methods for fostering social equality in rooftop gardening (Blanchard *et al.*, 2019)^[9].

The knowledge and practice of rooftop gardening can be advanced by concentrating on these research directions, making it more effective, sustainable, and available for urban settings.

Conclusion

In conclusion, rooftop gardening offers a cutting-edge strategy for food production in cities, solving a variety of issues and offering several advantages. This sustainable method helps to build cities that are healthier, greener, and more resilient. Rooftop gardens can be effectively installed and maintained with careful planning, community involvement, and creative design. The review study emphasised the advantages of rooftop gardening for the environment, such as the elimination of urban heat islands, stormwater management, enhanced air quality, and local food production. These advantages not only improve the standard of living for city dwellers but also aid in reducing the negative effects of climate change and encouraging sustainability. In addition, difficulties with rooftop gardening were examined, including structural restrictions, upkeep requirements, resource constraints, environmental issues, and policy obstacles. Initiatives to grow food on rooftops can succeed by addressing these issues through structural studies, careful planning, community involvement, and cooperation with legislators. The assessment also indicated potential research paths and opportunities, highlighting the significance of plant selection, growing media optimisation, water management techniques, ecological impact, and socioeconomic factors. In

these regions, more investigation is needed to improve the effectiveness, efficiency, and economic sustainability of rooftop gardening, assuring its long-term success and favorable effects on urban settings.

Overall, rooftop gardening offers a viable option for sustainable urban agriculture, and its adoption can help build the thriving, resilient, and sustainable cities of the future. Urban places can harness the power of rooftops to nurture green areas, advance food security, and enhance the wellbeing of urban residents by adopting this contemporary method of production.

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