Nepalese Journal of Agricultural Sciences, January, 2025, Volume 28
eISSN 2091-0428; pISSN 2091-041X; esjindex ID = 6279

ENVIRONMENTAL, SOCIAL, AND ECONOMIC BENEFITS OF ROOFTOP FARMING

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ABSTRACT

Rooftop farming has emerged as a transformative solution to address pressing urban challenges in Kathmandu, Nepal, amidst rapid urbanization and population growth. This paper explores the historical roots, types, benefits, and economic insights of rooftop farming, focusing on its significance in Kathmandu's urban landscape. Drawing on historical examples and contemporary initiatives, the study highlights the multifaceted benefits of rooftop farming, including environmental sustainability, food security, community resilience, and economic empowerment. By examining the successes and challenges of rooftop farming in Kathmandu, this paper underscores its potential as a sustainable urban agricultural practice and calls for concerted efforts to mainstream and scale up rooftop farming initiatives in Kathmandu and beyond.

Key Words: Community resilience, Environmental Conservation, Green roofs, Urban agriculture

INTRODUCTION

The burgeoning population and rapid urbanization worldwide have compounded existing challenges, particularly in developing countries where urban populations are swelling. As cities burgeon, so does the number of low-income consumers, amplifying the strain on resources. Projections indicate that urbanization will surge to 69% by 2050, with urban residents comprising 86% of the population in more developed regions and 66% in less developed ones (Deelstra and Girardet, 1999). This demographic shift disrupts ecological equilibrium, deepening the interplay between nature and human society. Unprecedented urbanization and population growth have thrust the world's cities into the spotlight, confronting them with critical issues like food security and climate change. Studies suggest that urban populations will nearly double from 2010 to 2050, exacerbating the demand for essential resources, including food and supplies (Swilling *et al.*, 2018).

According to the Central Bureau Statistics (2024) Nepal consumer spending has been persistently increasing (Table 1). During the Last one decade the consumer spending has increased by two-times. Consumers preferences have been increasing towards fresh and organic vegetables and fruits. That may be one reason that rooftop gardening has been increasing in the urban areas.

Table 1. Nepal Consumer Spending - Historical Data (CBS, 2024)

Year	Spending	Per Capita	Growth Rate
2023	$35.16B	$956	0.70%
2022	$35.01B	$960	6.83%
2021	$31.52B	$914	7.97%
2020	$28.49B	$866	3.60%
2019	$26.18B	$851	8.14%
2018	$25.54B	$796	6.17%
2017	$22.74B	$758	0.79%
2016	$21.69B	$761	4.16%
2015	$20.36B	$737	2.58%
2014	$18.78B	$723	3.04%
2013	$18.68B	$703	2.65%

Many urban cities in the world are trying to enhance sustainability by improving greenery and promoting urban farming. Following a promotional "Go Green" campaign, rooftop farming has become an important factor in urban planning. An investigation based on an urban ecological assessment proved the significance of green roofs for modern town planning strategies, it showed that the extent of the area with a high environmental load could be reduced. Innovative forms of green urban architecture aim to combine food, production, and design to produce food on a larger scale and promise environmental benefits resulting from the saving and recycling of resources and reduced food miles. Social advantages include improving community food security, the provision of educational facilities, linking consumers to food production, and serving as a design inspiration. In economic terms, it provides potential public benefits and commodity outputs.

As worries about food security become more pressing, rooftop gardening has become a practical alternative in urban areas, providing fresh crop production and

supporting sustainable farming methods at the same time. Rooftop gardens are located atop buildings and offer a multitude of functional benefits, such as temperature regulation, food provisioning, hydrological management, architectural enhancement, and the creation of wildlife habitats or corridors that support biodiversity conservation within urban landscapes. Rooftop gardens are also visually pleasing.

In burgeoning cities like Kathmandu Valley, rooftop farming emerges as a creative solution to utilize wasted spaces. Known as "*Kausi Kheti*," this initiative promotes greening the city and addresses the rising vegetable prices and concerns over produce quality. The growing interest in rooftop gardening reflects a modern commitment to sustainability, community resilience, and food self-sufficiency. It embodies an effort to align human living with natural ecosystems, emphasizing the interconnectedness of sustainability, community well-being, and food security. Examining the historical roots of rooftop farming provides insights into its contemporary relevance in tackling urban challenges.

HISTORICAL NOTE OF ROOFTOP FARMING

Rooftop farming has a rich history that spans centuries and continents, showcasing humanity's ingenuity in utilizing elevated spaces for agricultural purposes. Ancient Mesopotamia provides some of the earliest documented instances of rooftop gardens, with the legendary Hanging Gardens of Babylon believed to have been constructed around 600 BCE. These gardens, though debated among historians, are often cited as early examples of rooftop farming. During medieval Europe, rooftop gardens flourished in monasteries and convents, where monks and nuns cultivated herbs, vegetables, and medicinal plants for sustenance and healing. The Victorian era witnessed a resurgence of rooftop gardens, particularly in urban centers like London and New York City, where ornamental rooftop gardens adorned buildings, adding to the aesthetic appeal of the skyline. World War II saw rooftop gardening gain prominence as part of the war effort, with citizens urged to grow their food on rooftops to supplement rationed supplies. This initiative, known as "victory gardens," played a pivotal role in ensuring food security during the times of scarcity. In more recent decades, rooftop farming has experienced a modern revival driven by urbanization, environmental concerns, and a focus on sustainable agriculture. Germany emerged as a pioneer in modern green roof technology, with the concept of "Begriming" originating in the early 20th century. The Saxon State Chancellery building in Dresden, Germany, constructed with a green roof in 1915, is often credited as the first modern green roof. Switzerland also played a significant role

in advancing green roof development and adoption, with a notable portion of apartment roofs being greened by the mid-1990s. These early innovations underscore the role of Germany and Switzerland as leaders in sustainable urban development strategies, with green roofs serving as a tangible manifestation of their commitment to environmental stewardship (Bertschinger *et al.*, 1996).

BENEFITS OF ROOF-TOP FARMING

Rooftops, often considered spaces of fantasy and imagination, offer unique opportunities for agricultural innovation and ecological engagement. With three primary options for rooftop farming - container gardening, intensive rooftop planting, and hydroponics - each approach presents distinct advantages and considerations. Container gardening, characterized by its simplicity and affordability, involves minimal modifications to existing roof structures, making it accessible to many urban dwellers. Conversely, intensive rooftop planting, where the rooftop serves as the planting medium, requires more substantial investments but offers benefits such as enhanced storm-water retention, building insulation, and the creation of urban ecosystems that facilitate biodiversity conservation and ecological resilience.

Benefits of Roof-Top Farming

Environmental benefits

Rooftop farming offers a plethora of benefits, aligning with the growing global momentum towards sustainable living. Amidst the rapid urbanization and modernization in Kathmandu Valley, Nepal, traditional agricultural practices have faced significant challenges due to the conversion of arable land into urban infrastructure. This transition has heightened concerns over food security, environmental degradation, and sustainable development, necessitating innovative solutions (Sharma and Nepal, 2020).

Rooftop farming has emerged as a promising avenue to address various challenges including food security, environmental sustainability, and community resilience. By utilizing underutilized rooftop spaces, urban dwellers can cultivate fresh and organic produce, thereby reducing dependency on imported food items and mitigating the environmental impact associated with long-distance food transportation (Shrestha, 2023). The environmental benefits of rooftop farming are substantial. Rooftop farms act as natural filters, absorbing rainwater and reducing storm runoff, thus mitigating the risk of flooding and soil erosion. Additionally, the vegetation on rooftops helps cool buildings, counteracting the

urban heat island effect and improving overall air quality. Organic farming practices further contribute to healthy soil and biodiversity, fostering a harmonious ecosystem that supports pollinators like bees and butterflies (Sharma and Nepal, 2020).

Social Benefits

Beyond environmental advantages, rooftop farming brings significant social benefits to urban communities. By engaging residents in rooftop gardening, it fosters a sense of community and connection to nature. Participants can grow fresh, nutritious produce for themselves and their families, thereby improving access to healthy food options, particularly in underserved areas. Moreover, rooftop farming initiatives create local job opportunities, especially in urban regions with high unemployment rates, and educational programs can be integrated to educate children about sustainable food production and environmental stewardship (Gurung, 2019). Furthermore, rooftop farming initiatives demonstrate a commitment to environmental, social, and governance (ESG) principles, which are increasingly valued by cities worldwide. Cities with robust rooftop farming programs showcase their dedication to environmental responsibility and social well-being, attracting environmentally conscious businesses and residents. Through incentives and streamlined regulations, local governments can further encourage the development of rooftop farms, fostering collaboration between public and private entities to ensure their success (Thapa and Subedi, 2021). Despite facing challenges such as limited awareness, technical knowledge, and logistical constraints, the future of rooftop farming is bright. Technological advancements, such as lightweight growing mediums and automated irrigation systems, are making rooftop farming more accessible and efficient. With growing public awareness of sustainability issues and government support, rooftop farming is poised to become a mainstream practice, contributing to a more sustainable and resilient urban future (Khan and Akram, 2020).

Economic Benefits

One compelling example of the economic importance of rooftop farming in Kathmandu lies in its role in providing supplementary income for urban residents. Consider a family residing in an apartment building in the heart of Kathmandu, where traditional agricultural pursuits are constrained by limited space. Turning to their rooftop as a fertile ground for cultivation, they meticulously plan and employ innovative techniques to establish a garden abundant with high-value crops such as tomatoes, bell peppers, and herbs.

As their rooftop garden flourishes, the family begins harvesting a bountiful yield of fresh produce. Not only do they satisfy their own dietary needs with homegrown vegetables, but they also find themselves with surplus crops to sell at local markets or directly to neighbors and restaurants. The premium quality and organic nature of their rooftop-grown produce command a higher price compared to mass-produced, commercially available alternatives. The income generated from the sale of rooftop-farmed produce serves as a valuable supplement to the family's finances, easing financial strain and enhancing their overall economic well-being. Furthermore, as the demand for locally sourced, organic produce continues to rise in Kathmandu, the economic viability of rooftop farming becomes increasingly apparent.

An economic analysis of rooftop gardening in Kathmandu Valley (Wasti and Bhusal, 2019) provides intriguing insights into its financial viability. The total cost of operation averaged NRs. 35,519.40, with expenses varying across different inputs, notably higher expenditure on manure compared to oil cake. Conversely, the total income from rooftop gardening amounted to NRs. 44,032.17, with green leaves emerging as the primary income generator among all garden components. The benefit-cost ratio (B/C ratio) further underscores the economic prospects, with the average B/C ratio per household calculated at 1.24. This suggests that for every unit invested in rooftop vegetable production, the return was approximately 1.24 times, affirming rooftop gardening as a profitable venture worth pursuing.

SUITABLE CROPS FOR ROOF TOP FARMING

In the vibrant landscape of rooftop farming in Kathmandu, an array of crops thrives under the open sky, transforming urban rooftops into verdant oases. From the familiar solanaceous delights of tomatoes and bell peppers to the robust brassicas of cabbage and broccoli, the diversity of cultivars mirrors the rich tapestry of Kathmandu's culinary heritage. Yet, within this mosaic of greenery, variation abounds as rooftop farmers tailor their crops to the unique capabilities of their rooftop spaces. Some opt for the delicate allure of herbs like parsley and dill, infusing their dishes with aromatic freshness, while others venture into the realm of woody plants, nurturing fruit-bearing trees like apples and pears. This dynamic spectrum of cultivation reflects not only the ingenuity of urban farmers but also the adaptability of rooftop farming to meet the diverse needs and preferences of Kathmandu's inhabitants. Reasons for adapting rooftop gardening: The major reasons for adapting the rooftop gardening were for the sustainable production with 0.54 index value followed by minimize side effects of health,

healthy soil and environments with rank value 0.48 and 0.44, respectively (Wasti and Bhusal, 2019).

Unveiling Kathmandu's Rooftop Eden: A Paradigm Shift in Urban Agriculture

In today's global landscape, rooftops are transforming into multifunctional spaces, heralding a new era of sustainability and innovation. From Singapore's cooling rooftops to Berlin's urban greenhouses, cities worldwide are harnessing the potential of elevated spaces for environmental, social, and economic benefits (Khan and Akram, 2020). In Kathmandu, a city grappling with rapid urbanization and a surge in rural migrants seeking better prospects, rooftops offer a promising solution to address pressing challenges while nurturing a greener future.

With over 3 million residents in Kathmandu Valley alone, the burgeoning population density strains the city's resources and infrastructure. Rooftop gardens emerge as a beacon of hope, promising to alleviate urban pressures and enhance the quality of life for its inhabitants. These elevated sanctuaries not only contribute to ambient and home temperature regulation but also reduce heating and cooling requirements, thereby curbing emissions and cutting costs (Shakya and Shrestha, 2017).

Rooftop farming (RTF) emerged as a transformative practice, pioneered by the Kathmandu Metropolitan City (KMC) with support from development agencies like the Environment and Public Health Organization (ENPHO) and the Institute for Social and Environmental Transformation Nepal (ISET Nepal). Encouraged by its success, the KMC envisions RTF as a cornerstone of urban waste management, utilizing organic waste and greywater to nurture thriving ecosystems above the concrete jungle (Shakya and Shrestha, 2017).

The exponential growth of Kathmandu's urban landscape underscores the urgency of sustainable urban agriculture initiatives. With an estimated one million new houses added to the capital in recent years, the KMC recognizes the pivotal role of rooftop farming in ensuring food security and fostering self-reliance (CBS, 2017). Empowering residents to embrace rooftop gardening, the KMC initiates training programs and provides support to 500 households annually, aiming to cultivate a culture of self-sufficiency and environmental stewardship (CBS,2017). The integration of rooftop farming into government policies reflects a concerted effort to mainstream sustainable agricultural practices. While challenges persist in defining and implementing rooftop farming initiatives, governmental support

and grassroots enthusiasm pave the way for a greener, more resilient Kathmandu. As the Ministry of Agriculture and Livestock Development prepares to formalize the concept of rooftop farming, the stage is set for Kathmandu to emerge as a beacon of urban agricultural innovation, inspiring cities worldwide to cultivate their rooftops and harvest the sky.

Table 2. Species and families of vegetables grown on roof top gardens at Kathmandu

Solanaceae	Brassicaceae	Cucurbitaceae
• Tomato • Bell Pepper • Chili • Eggplant • Potato	• Mustard • Turnip • Radish • Cabbage • Cauliflower • Broccoli • Kale	• Zucchini • Bottle gourd • Bitter Gourd • Cucumber • Squash • Pumpkin • Melons
Fabaceae	Poaceae	Apiaceae
• Lentils • Chickpeas • Beans • Peas	• Corn • Wheat • Barley • Oats • Lemon grass	• Carrots • Celery • Parsley • Dill
Amaranthaceae	Amaryllidaceae	Rosaceae
• Spinach • Swiss Chard • Beetroot • Quinoa	• Onion • Garlic • Leeks Chives	• Raspberry • Blackberry
Asteraceae	Lamiaceae	Rutaceae
• Lettuce • Arugula • Chicory • Sunflower	• Mint • Basil • Lavender • Oregano • Rosemary	• Grapefruit • Tangerine • Citrus (e.g., Lemon, Orange, mandarin)
Rosaceae	Others	
• Strawberries • Apples • Pears • Cherries	• Herbs (e.g., Thyme, Cilantro), Flowers	

Source: Observation of various rooftop gardens, 2024

CONCLUSION

Rooftop farming in Kathmandu is not merely a horticultural endeavor; it represents a transformative shift towards sustainable urban development. As Kathmandu grapples with the challenges of rapid urbanization and burgeoning population growth, rooftop farming offers a beacon of hope, addressing critical issues such as food security, environmental sustainability, and community

resilience. Through innovative approaches and collaborative efforts between government bodies, development agencies, and local communities, rooftop farming has emerged as a viable solution to utilize underutilized spaces and promote self-sufficiency.

The historical roots of rooftop farming, spanning centuries and continents, underscore its resilience and adaptability to diverse urban landscapes. From ancient Mesopotamia to modern-day Kathmandu, rooftop farming has evolved to meet the changing needs of urban dwellers, reflecting humanity's ingenuity in harnessing elevated spaces for agricultural purposes. Today, Kathmandu's rooftop gardens not only provide fresh produce but also contribute to environmental conservation, social cohesion, and economic empowerment.

As rooftop farming gains momentum in Kathmandu, it is imperative to address challenges such as limited awareness, technical knowledge, and logistical constraints. By leveraging technological advancements, government support, and community engagement, Kathmandu can unlock the full potential of rooftop farming, paving the way for a more sustainable and resilient urban future. With concerted efforts and collective action, Kathmandu has the opportunity to emerge as a global leader in urban agricultural innovation, inspiring cities worldwide to cultivate their rooftops and harvest the sky.

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