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RESEARCH ARTICLE

ROOFTOP FARMING: AN ALTERNATIVE TO CONVENTIONAL FARMING FOR URBAN SUSTAINABILITY

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ABSTRACT

In ecological terms, modern cities consume 75% of world resources with 2% of global land area and have become a parasite and a resource sink. Unmanaged planning and rapid development often result in the destruction of natural resources and loss of greenery. Pokhara is rapidly urbanizing into a megacity in Nepal and climate change caused by global warming is a great menace here. To support the rising requirement of quality food for the skyrocketing population, the main consumption centre should be mobilized for food production. Rooftop gardens are gaining relevance as they have the potential to meet the growing demand for food in cities and enhance the ecosystem along with the conservation of biodiversity. Thus, the addition of greenery element such as a green roof is becoming a trend to solve this problem in Pokhara. Establishment of green roofs in Pokhara city is arousing the interest of the government and public due to their demonstrated environmental benefits. The objective of this research is to inspect the existing practice and obstacles in rooftop farming that is faced by practitioners. Nagdhungha and Birauta are the areas of research here. Two practitioners are interviewed and sixty nonpractitioners are surveyed. The result shows that rooftop farming can benefit the environment by greatly reducing carbon in the atmosphere and can assist urban areas by reducing stormwater management cost. Furthermore, the paper demonstrates that the willingness to practice rooftop farming is high among urban dwellers and for future scope, some recommendations are provided in this research.

KEYWORDS

Benefit, Rooftop, Urban

1. INTRODUCTION

In the Meantime, Urbanization and Human Activities induced climate change impacts are two distinct hot topics that are worth discussion. Urbanization brings various challenges like greater ambient noises, increased environmental stressors and massive demand for food. 54% of the total world population is urbanized, the share is expected to reach up to 66% in less developed regions and 86% in most developed regions by 2050 [1]. Moreover, many urban residents are facing problems due to lack of space for vegetation. The pensive problem of urbanization and destruction of fertile soils cordially invites the solution of rooftop gardening. Where the lives of people are obstructed and there is a scarcity of soil and land to cultivate plants, Rooftop gardening is itself a prodigious idea for pitching a road towards sustainability. Some cities are trying to boost sustainability through urban farming as a possible remedy to these problems [2]. Though it may look a stressful and energy draining job to get engaged in gardening or either to fill our own plates of vegetables from our own free spaces of the roof, it doesn't take much time. Side by side rooftop gardening is itself a better way of utilizing free family time. There is a Chinese Proverb "We all are Farmers by birth" The time we spend in growing vegetables and plants for ourselves we mend our own souls.

In the modern times of massive misuse of pesticide and degrading soil fertility, the fright of health hazards while consuming the market

vegetables are inside the minds of people somewhere. Roof Top Gardening may seem a small step but it is a leap ahead for sustainability and combating the havoc of climate change hazards. Microclimate can be modified by rooftop farming because of its contribution to mitigate the ecological problems and promotion of metropolitan food system. Rooftop garden regulates the temperature on the roof as well as the room below the roof garden [3]. 60% of heat gain can be prevented from the vegetation of the green roof system. This result to decrease in temperature as compared to other buildings which lack the rooftop garden [4]. Moreover, green roofs provide insulation by decreasing transport heat which leads to a reduction in electricity as well as natural gas consumption. Green roof cut off 30% of all CO₂ emissions for heating or cooling the building in many developed nations.

Various environmental issues like massive pollution, waste generation, the rapid growth of population, high consumption and unsustainable use of natural resources challenge the urban centre in developing countries. The rooftop garden captures rainwater through absorption by the vegetation and minimizes overflowing impact on roads [5]. Carbon emitted at the local level and various infrastructures are absorbed by plants in the rooftop garden and used as a source for photosynthesis. Green roof on top of the building reduces air pollution by removing particulate matter and pollutant gases like nitrous oxide, sulfur dioxide and carbon monoxide, in turn, cut off greenhouse gas emissions [6,7].

Besides, the benefit of recreation, fresh air and good ambience is an added bonus. By 2050, the food production will drop by more than 50% whereas, the population is estimated to reach 9 billion [8]. If we take some hours off from our robotic lives in our roofs, we will be able to discover the panacea for many big problems like food insecurity and hunger. The vegetables which are grown in roofs are far better than those in fields as we can easily modify the microclimate of kitchen gardens according to our will and we can deny using harmful pesticides. We can use locally available resources including local varieties of vegetables which are prolific but less in use, we can use abandoned bins, drums, plastic bags as pots for the vegetables, local ropes as staking, rainwater as irrigation [9]. Roof Top gardening certainly considers some important points to note. We must be well aware of the load-bearing ability of the roofs; we can in the other hand modify the engineering of the roof for cultivation taking help of engineers and technicians too. The problem of wind and direct rainfall can be an issue but on the other hand, we can develop sustainable infrastructure which will be suitable for carrying out this eminently beneficial process in our roofs. For controlling pests and insects we can also use the concepts of Integrated Pest Management.

On the basis of the above consideration, a need to study rooftop gardening in Pokhara is realized. This study was conducted for the evaluation of quantifying soft benefits of the rooftop garden in Pokhara. Besides this, the study discusses future prospects and the potential benefits of a rooftop garden. The important things are objectives, value and sustainability. If rooftop gardening comes with a plethora of advantages like sustainable production, decreasing family monthly costs, improving the quality of air in roofs and providing healthy nutritious vegetables straight from roofs to plates, it certainly deserves some efforts. We can't deny rooftop gardening is the bright solution for dozens of urban problems.

2. STUDY METHODS

2.1 Study vicinity

This research was conducted in an urban corridor of Pokhara city. In 2018, Pokhara metropolitan city started promoting rooftop farming by providing training and subsidies on Rooftop farming. For the purpose of this study, Nagdhungha and Birauta areas have been chosen as a study site as there was the highest number of enlisted practitioners according to the database of Pokhara metropolitan city. Most of the buildings where the practitioners did urban farming in the selected areas were two to three storey high.

2.2 Data collection

Two practitioners were selected from each of the selected sites and were interviewed to discover the existing situation as well as the opportunities and obstacles of rooftop farming. Again 30 practitioners from each site were surveyed with a semi-structured questionnaire to perceive their point of view regarding rooftop gardening.

Table 1: Basic Description of two practitioners' of Birauta and Nagdhunga Areas

Practitioner	Gayatri Aryal	Damar Subedi
Address	Birauta	Nagdhungha
Type of Building	Private	Private
Storey number in Building	2 and half	3 and half
Tenure Type	Building Owner	Building Owner
Roof Area of Building	4 Aana	5 Aana
Gardening Area	1.9336 Aana	2.56 Aana
Starting Time of Garden	2068 BS	2074 BS
Satisfaction status	High	High

3. DETAIL ABOUT TWO ROOF GARDEN OWNERS

3.1 Basic information on practitioners

Miss Gayatri Aryal is a Housewife. She lives in Birauta Pokhara, Kaski. Inspired from Rooftop gardening she started growing vegetables on her roof from 2068 BS. She began gardening with the basic knowledge she had within herself with Rs. 2000 (18\$ Approx.) At first, she started the roof gardening with basic plants like onions, garlic, coriander. Two years later after getting support from District Agriculture Office, she got knowledge

about cultivation practice of other vegetables like brinjals, tomato, chillies etc. She has now become a role model in her community as a rooftop gardener and her roof is nowadays crowded with the local enthusiasts who are inclined in rooftop gardening.

In the other hand, Damar Subedi from Nagdhungha Pokhara is the president of a community cooperative. He started the practice from 2074 BS. His initial cost of the Rooftop gardening was Rs1500 (13\$ Approx.) Although he started as a capricious practitioner, the level of satisfaction is high in himself now. He started with the early growing species and flowers like petunias and marigold. Later he started to thrive on the rooftop garden for the consumption of vegetables. As a cooperative leader, his work has impressed the society and many are following him now.

3.2 Cultivation Methodology

The cultivation practices in both cases of practices are more influenced by conventional technology. The use of soil in abandoned pots, tubes, utensils has been practised. Side by side use of modern clay pots and plastic bags are also been used. The leafy vegetables can be seen in both pots and beds too.

3.3 Plants and Production at the existing stage

At the present moment tomatoes, coriander, onions, garlic, eggplant, peas, leafy vegetables, cabbages, cauliflower, lady's finger and gourds are the dominant vegetables covering the gardens. Some plants of citrus, lime, mint and beans are also seen. The rotation of vegetables is practised in the gardens according to seasons. Offseason practise is not being adopted though.

The winter vegetables like brinjal, cabbage, cauliflower, tomatoes are seen more in the garden in the cold season and the summer crops include gourds. Lime and citrus are also grown in dominant form. The production of tomatoes, brinjal, cabbage and many other vegetables are satisfactory and adequate enough to fill the plates and stomach of Aryal and Subedi families.

In Recent years, Damar Subedi has been assisted from various agriculture cooperatives and has been enthusiastically growing fruit trees like guava and pomegranate. On the other hand in the garden of Gayatri Aryal leafy vegetables are the most grown plants which have been keeping the roof busy and green.

3.4 Maintenance and Reclamation

In both cases, the use of organic fertilizers and organic way of pests control are being adopted. The use of the chemical is very low. An additional gardener is not hired. The use of compost manure and eco prangarik mal has been practised. Use of drums, bricks, pots have been done. In the case of soil loss and leaching, new nutrition mixed soil is refilled and a proper drainage system is maintained to avoid damping and water stagnation in the roof.

4. ESTIMATION OF SOFT BENEFITS OF THE ROOFTOP GARDEN

No, any work has been carried out yet in Nepal for the quantifying roof garden benefits, the methodologies and standard values for quantifying these benefits are in accordance with [10]. Five perspectives (i.e. property value amplification, food production, stormwater retention, air quality enhancement, carbon sequestration) are used to calculate the pecuniary worth of the soft benefit of rooftop farming.

4.1 Social benefits

The natural character of the green roof provides solace from concrete construction in busy and noisy urban areas. Presence of greenery in roof generate the feeling of safety, calm psychological effect, helps to reduce blood pressure and maintain heartbeat. The green ambience and lively environment created by the plants also counts in social benefit. Additionally, it also adds aesthetic value and can be a perfect place for gatherings and informal meetings and foster the social relationship.

We asked two practitioners from Nagdhunga and Birauta of Pokhara. Mrs Gayatri Aryal of Birauta stated that the opinions and perspective of her

neighbours have been changed since she started to adopt rooftop gardens. They ask her about the techniques and quite often they also visit her roof. She herself admits that she has been in limelight and a focal person in her community regarding gardening and rooftop practice.

Mr Dambar raj subedi of Nagdhungha have also resembling experiences. In the scarce time of vegetables in the market and the time when there is havoc of chemically sprayed vegetables in the market, the rooftop garden comes to great advantage. His family of 4 members are sustainably consuming vegetables from their roof and they spend their family time together in the roof. People also come to his house and ask about the way to start rooftop gardening and they are in other words lured by his practice.

4.2 Financial and Ecological benefits – the pecuniary value of soft benefits

4.2.1 Property value

Green infrastructure increases the property value as well as increases the marketability of nearby real estate. Thus, the rooftop garden favours both to owner and surrounding. The green roof on the building increases the property value by 7% if it is productive and by 11% if it is recreational. The formula widely used to assess the property value is,

$$b = 0.07 \cdot v$$

In the above-mentioned formula, "b" means the benefit value and "v" represents the \ roof garden value of owning property. Both prices of land and building price are important to calculate the property value. On an average range, the present price of land per ropani in Birauta area is approximately found to be Nrs. 2,50,00,000. The building price per square feet is Nrs. 1600. The area in which the building is constructed is approximately found to be 4.5 anna, the area of the building was recorded as 127.185 square meters and the building is 2 and a half storeyed, so the final price of the land comes to be Nrs. 70,03,125 and the building is Nrs. 54,76,000. Thus, the value of the owner's roof garden property is Nrs. 1,24,79,725.

Therefore, value of benefit, $b = 0.07 * 1,24,79,725 = \text{Nrs. } 8,73,580.75$
i.e. US\$7769.30

On the other hand, the average price of land per ropani in Nagdhungha area is Nrs. 3,20,00,000. The price of the building per square feet is Nrs. 2200. The plot of the building is over 7 annas, the building area is approximately 5 annas and the structure is 3 and a half storeyed, So the price of land in all total is Nrs. 1,40,00,000.00 and that of the building is Nrs. 1,31,76,625. Thus, the value of the roof garden of the owner is Nrs. 2,71,76,625.

Hence, value of benefit, $b = 0.07 * 2,71,76,625 = \text{Nrs. } 19,02,363.75 =$
US\$16918.92

4.2.2 Stormwater retention

Green roofs retain stormwater which mainly is dependent primarily over the components like which plants are used, what is the depth of the planting media used and its formation and the environmental effects can be caused to lessen the effects of impervious runoff. However, when the media used in green roof become saturated, the runoff will occur but it takes some time. This delay in the runoff can control the overflow of stormwater This delay can prevent overflowing of stormwater in the system and the intensity of rainwater leaving the roof is pretty slower than in case of concrete floor which reduces the erosive power of runoff. The rooftop garden also reduces diurnal fluctuations of temperature at membranes of the roof that prevents the pressure of per day expanding and contractions and can increase the life of membrane life by three or two times. In Washington DC, if all roofs in the city are replaced with the green roof, the air pollutants that can be removed would be accountable with the figure of 58 metric tons. If we use a combination of 80% extensive and 20% intensive ratio in the green roof, it is possible to reduce runoff volume by 69% as compared to conventional roofs [11].

The formula widely used to calculate stormwater retention benefit is,

$$b = (R+E) \cdot C \cdot d$$

In this formula, the value 'b' denotes the yearly value of benefit and 'a' denotes the garden area of the roof in square meters. Value of erosion mitigation, E is worth of \$13.66/m³ i.e. Nrs. 1535.93 /m³ (Tomalty & Komorowski, 2010). The lowest value for retention of stormwater services is \$20.13/m³ (R) signifies retention pond and the highest value found to be \$1059.44/m³ (R) denotes retention basin. The capacity of retention was 42.7 L/m²roof (C) as used by (Carter & Keeler, 2008) has been adopted for the calculation purpose.

In this research study, the stormwater management benefit gained from rooftop farming of the Birauta practitioner is estimated to be in the range of Nrs. 9972.30 and Nrs. 3,16,703 i.e. US\$ 88.69 and US\$ 2816.64 and in case of the practitioner from Nagdhungha area is estimably found to be in the range of Nrs.13201.58 and Nrs.419282 i.e. US\$ 117.41 and US\$3728.94. As these two buildings reside in a city environment where there is significantly high urbanization with very high values of land, low-cost solutions for managing stormwater cannot be an option. For all of these reasons, the values of the benefits are likely to be high (around Nrs.3,16,703 i.e. US\$ 2816.64 and around Nrs. 4,19,282 i.e. US\$3728.94).

4.2.3 Air quality

Green roof on top of the building reduces air pollution by removing particulate matter and pollutant gases like nitrous oxide, sulfur dioxide and carbon monoxide as well as reduces energy demand for regulating housing temperature which in turn cut off greenhouse gas emissions. Furthermore, green roof increases air quality through carbon sequestration which mainly depends upon the size of the plant and thickness of substrate used in green roofs [12]. In Singapore, Sulphur dioxide and particles level after installation of the green roof on a 4000 square metre roof was reduced by 6% and 37% respectively above the green roof in the air [13]. In Bologna, Italy, Rooftop top garden could capture an estimated 624 tons of CO₂ every year and meet 77% of residents need for vegetables in the city if all suitable flat roof space can be used for urban agriculture.

The formula widely used to calculate air quality benefit is,

$$b = (g/12\text{months}) \cdot [H_{sg} \cdot a_{sg} + H_{tg} \cdot a_{tg} + H_d \cdot a_d]$$

In this formula, b denotes the yearly value of benefit whereas g means the growing period in months; H_{sg}, H_{tg} and H_d simultaneously denotes the health benefit for short grass pollution absorption, for tall herbaceous plant pollution absorption and deciduous plant pollution absorption in \$/m²*year respectively and a_{sg}, a_{tg} and a_d turn by turn denotes the area covered with short grass, with tall herbaceous plant and with deciduous plants in m² respectively. Duration of the growing period i.e. in months (g) of fruits, vegetables and other plants is 12 months because in Nepal crops are grown all year round. The annual pollutant removal health benefit value for different types of vegetation has been used as 0.0521 US\$/m² for short grass, 0.0673 US\$/m² for tall herbaceous plants and 0.0839 US\$/m² for deciduous trees. Therefore, along with this study, the benefit in air quality from rooftop farming for the practitioner of Birauta area is found to be of worth Nrs. 469.45 i.e. US\$ 4.175 and for the case of the practitioner of Nagdhungha area is found to be of worth Nrs. 761.15 i.e. US\$ 6.77.

4.2.4 Food value

Pokhara is a Metropolitan City. It is the second most urbanized city in Nepal. The prime occupation of people here in Pokhara is business including hotel, restaurants, tourism industry and others but not agriculture. The shifting occupation of people from agriculture to non-agriculture is significantly prevalent here. People generally buy vegetables from the market. Here the trend of supermarkets and shopping complexes is massive now. For increasing the post-harvest life and shelf life of vegetables, the use of chemicals is not that uncommon. Rooftop gardeners/practitioners are completely away from these problems. They are also non-agriculture occupants but they spend their fixed time of day hours in the rooftop for growing vegetables and plants and this culture seems to be impactful here. The spaces of house which are generally abandoned in other cases are utilized well in Rooftop gardening for food production. Singapore imports a large number of vegetables to meet present-day needs and after implementation of rooftop farming across

public housing estates, the production can meet 35.5% of food demand [14-15].

The formula widely used to calculate food production benefit is,

$$b = P * g * a$$

In the above formula, "b" denotes the yearly value of the benefit and "a" denotes the roof garden area in meter square. The period of duration(g) of fruits, vegetable and any other plants is 12 months in Nepal because the crop is grown year around in the country. In the case of mixed fruit and vegetables (low case scenario), productivity (P) is found to be Nrs. 224.88 or \$2 per square meter per month and for lettuces, herbs and flowers (high case scenario) like plants, productivity (P) is found as Nrs. 2248.8 or \$20 per square meter per month. Therefore, for this study, the food production value from rooftop farming of the practitioner of Birauta area is estimated to be between the range of Nrs.1,65,880.48 and Nrs. 16,58,804.83 i.e. US\$ 1475.28 and US\$ 14752.8. We found that the garden generally produces mixed fruits and vegetables, so the total value of production is likely to be at the lower end of this range (around Nrs. 1,65,880.48 i.e. US\$ 1475.28). Here again, the food production value from rooftop farming of the practitioner of Nagdhungha area is estimated to be in between the range of Nrs.2,19,608.81 and Nrs.21,96,088 i.e. US\$ 1953.12 and US\$ 19531.2. This garden also produces mixed fruits and vegetables, so the total value of production is likely to be at the lower end of this range (around Nrs.2,19,608.81 i.e. US\$1953.12).

4.2.5 Carbon sequestration

Rapidly developing cities like Pokhara are dealing with population growth, poor resource endowments, pollution and environmental degradation. Globally warming climate could have detrimental effects on the environment. Employing vegetation in highly populated areas as a carbon capture and storage system encase an engineering strategy that can be easily installed by the urbanites. Rooftop farming on an urban fringe could potentially reduce greenhouse gas emissions and is one of the potential ways of mitigating climate change.

The formula widely used to calculate carbon sequestration benefit is,

$$b = S_d * a_d + S_g * a_g + S_r * a_r$$

In this formula "b" means the value of benefit in \$/year; S_d, S_g and S_r represents the value of carbon sequestration by deciduous plants, by grasses and by productive agriculture in \$/ha*year respectively and a_d, a_g and a_r denotes the area of roof garden covered by deciduous plants (ha), covered by grasses and covered by productive crops in hectare respectively. The total value of carbon sequestration by deciduous plants, by grasses and by productive agriculture has been estimated to be worth of \$ 39.11/ha, \$ 28.46/ha and \$28.59 /ha respectively. For this study, the carbon sequestration benefit from rooftop farming of the practitioner of Birauta area is found as the worth of Nrs. 20.70 i.e. US\$ 0.184 and the practitioner of Nagdhungha area is found to be worth of Nrs. 27.84 i.e. US\$ 0.248.

5. OBSTACLES ON ROOFTOP GARDEN

5.1 For Practitioners

The availability of true to type plant varieties is one of the major problems faced as there is no quality assurance by any of the nursery providing the seedlings. Generally, People cultivate locally available and inferior plant varieties instead of improved varieties. Another big problem is the lack of help from the government sector. If little more assisted, the productivity can get raised. The shadow of other buildings and structures is also the problem.

5.2 For Non-Practitioners

One of the problems for non-practitioners for not establishing Roof-Top Gardening has been observed that a Roof is a vital place for recreation of children and families. If Roof Top gardening is practiced the Children become dependent on technology; it is the fear of most of the householders In Pokhara most of them are tenants and it is very difficult to convince landlords to allow them to Practice Roof Top Gardens because of several

fears high load and damping.

6. OPPORTUNITIES FOR ROOFTOP GARDENING IN POKHARA KASKI

6.1 Household demand thrives and supply

The production of different vegetables according to seasons and appropriate conditions are of great benefit for supplying the family demand for vegetables. They are being able to cut off the cost of vegetables which was prevalent before adopting rooftop gardening. When the scarcity of vegetables and the supply chain of vegetables get distorted in the market, householders are okay to stay calm because the rooftop garden is their back support. It has also been found the householders who want to consume more vegetables are involved in managing their rooftop garden in a more efficient way.

The rooftop gardening is certainly serving the demand of households and saving a major portion of household expense very decently.

6.2 Scope and Support of Roof Top Gardening

There are certain conditions and requirements for operating a rooftop gardening. Every person cannot adopt rooftop gardening because there are limitations too. A portion of space is very preliminary for Rooftop gardening. The house owners with small houses cannot adopt rooftop gardens. The difficulty in management occurs if the roof is too small. If the roof is too large, the management cost of rooftop gardening can be overtiring. If rooftop gardening has to be adopted the previously used space for sports, recreation, family time and cloth drying must be forgotten. Rooftop gardening involves extra costs, doesn't matter it might be of a small amount. The owner must spend extra and the only rooftop garden is possible to say the truth.

7. THREATS TO ROOFTOP FARMING IN POKHARA

This study figures out why non-practitioners are yet not involved in rooftop farming. Majority of them answered that they did not have technical knowledge about farming on the roof. 31.66% of people stated that they are afraid of using soil as the media on their roof because it leads to heavy load which may create the problem of seepages in the roof. Lack of leisure time is also a constraint for not practicing.

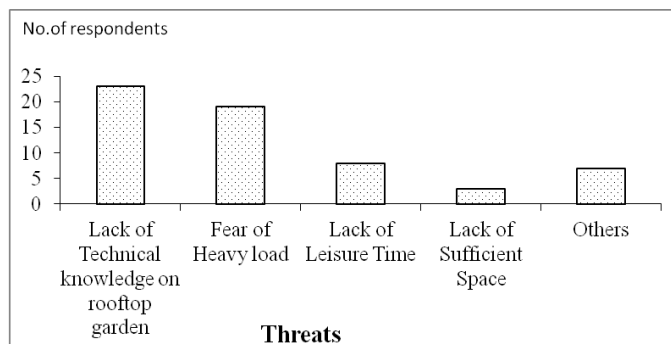


Figure 1: Reasons behind not willing to practice Rooftop Farming

8. RECOMMENDATIONS

- Most of the urban pedestrians are aware and well conscious about Roof Top Gardening, at least they have heard about it once but the fear of extra load to be thrived due to the soil and the hefty containers remain a major problem. However, If the design of the building and roof are modified in such a way that it can hold and thrive certain load of vegetations, growing media and containers, these problems can be solved. Use of light rooting media other than soil like coco peat, clay balls, can also be practised. Durable grow bags can be used instead of heavy clay pots.
- Ceiling dampness/Roof dampness is also a great fear and a threat to the householders. Placing the containers, drums, pots above brick or any firm substance can help to avoid this problem.

- Although being a Metropolitan City, the extension of the education of rooftop farming and the proper way to carry it out still remain in the dark corners. The government sectors should make people aware of the probable good impact of training and seminars about rooftop gardening in growers/residents through training.
- Choice of crops is also another important point to consider. Instead of harvesting in bulk and once, multiple picking can be of great advantage. For this advantage, the crop which can grow moderately for a longer period with multiple picking can be selected. On an important note, they can be of great advantage for evergreen freshness and ambience in the roof if done so.
- The problem of the scorching sun is prevalent on the roof which reduces the moisture level in the growing substrate and leads to volatilization of nutrients. For avoiding this problem, continuous moisture should be maintained by installing a drip irrigation system.
- Hailstones and strong wind prevalence in monsoon are the problems of concern in Pokhara. For avoiding all these we can use roof boundary wall, hail nets to avoid hail problem and good staking must be maintained to make plants more stable.

9. CONCLUSION

Thus, this study concludes that green roofs can be a potential way to meet the growing demand of fresh food and also make a major improvement in the quality life of urban people by contributing to the various environmental benefits such as purifying the air by acting as a reservoir of carbon dioxide and place for stormwater management. It also has benefits at the societal level as it can be a perfect place for gatherings and relaxing and also helps to increase the property value of the rooftop garden host property as well as the surrounding. Being the rapidly developing city the population of Pokhara is skyrocketing day by day resulting in the higher demand for quality food and fresh air. If the government, as well as the other responsible organizations, step forward to foster rooftop gardening, a sustainable and beautiful city with plenty of quality and fresh food can be maintained. It is hoped that this study will be beneficial to the ongoing research on environmental, economic and social benefits of green roof as well as support the Pokhara Metropolitan city to develop the policy for promotion of rooftop farming in the beautiful city of lakes.

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