Pak. J. Agri. Sci., Vol. 57(2), 333-337; 2020
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/2020.8746
http://www.pakjas.com.pk

ROOF TOP GARDENING, A SOLUTION FOR LANDSCAPE ENHANCEMENT IN URBAN AREAS: A CASE STUDY OF FAISALABAD, PAKISTAN

Adnan Younis[1], Faisal Zulfiqar[1,*], Fahad Ramzan[1], Ahsan Akram[1], Shawn R. Wright[2], Amjad Farooq[3], Muhammad Ahsan[4] and Akbar Hayat Sagu[5]

[1]Institute of Horticultural Sciences, Faculty of Agriculture, University of Agriculture Faisalabad, Pakistan; [2]Department of Horticulture, University of Kentucky, USA; [3]Department of Environmental Sciences, COMSATS University, Vehari; [4]Department of Horticultural Sciences, University College of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, Bahawalpur[5]Citrus Research Institute, Sargodha, Pakistan.
[*]Corresponding author's e-mail: adnanyounis@uaf.edu.pk

Rooftop gardening is a sustainable approach for mitigating the environment complexities of the urban world. This is a well established technology in many areas although in developing countries rooftop gardening often seems to be a novelty. The environmental benefits of rooftop gardening have been well reported however people's social and aesthetic perception have received less attention. This study is the first report on the survey within the Faisalabad (Pakistan) community assessing of the public perception and visual appeal (aesthetic reactions) of rooftop gardening. A rooftop garden was established on the roof of a single story building and a visitor survey was taken on the site, to assess the visitor's general attitude and visual aesthetic preferences in this concern. A questionnaire was designed and distributed to solicit opinions from the 387 visitors and the collected data were subjected to statistical analysis. The results illustrated visitor's positive response regarding auditioning technique. Moreover, 45% visitors felt that green roof gardening possess high value up to 50%. In conclusion, the majority of the respondents favored the adoption of the rooftop gardening technique. Insights obtained from this report may prove useful for future town planning with the focus on promoting rooftop gardening to ease environmental effects of urban areas.

Keywords: Sustainable urbanization, rooftop gardening, public perception, urban horticulture, case study, ornamental plants.

INTRODUCTION

Nature-based sustainable solutions for the changing climate are increasingly important especially in urban areas (Naumann *et al.*, 2011; Gómez-Baggethan *et al.*, 2013). Urbanization is encroaching on natural ecosystem sisolating people from their natural environment (Li *et al.*, 2005; Gupta, 2017). Various studies have examined the negative consequences of rapid urban sprawl including; poor air quality (Frank, 2000), fragmentation of natural habitat, social problems encompassing education in public spaces (Baþdooan and Çio, 2016) and community spirit among urban populations (Baþdooan and Çio, 2016). Additionally, rapid urban sprawl also increases various physical and mental ailments among the residents (Wilkinson and Orr, 2017). Urban green spaces in dense population areas are decreasing asa result of increased building (Rahman *et al.*, 2015). Ensuring the availability of urban green spaces as well as improving access to natural areas is a possible opportunity to offset these negative consequences (Baudoin *et al.*, 2017). The numerous benefits associated with the proximity of green spaces for people are well documented (Brethour *et al.*, 2007; Grinde and Patile, 2009). Gardens, parks, urban agriculture and urban forestry are the main sources of social, economic and ecological benefits in these congested areas (Baudoin *et al.*, 2017).

Space limitation within high population urban areas is a challenge and requires proper alternate solutions (Fernandez-Cañero *et al.*, 2013). In this regard, exterior surfaces, especially the roof area, provides plenty of space for planting (Yuen and Nyuk Hein, 2005) referred to as a "Rooftop garden" (Niekerk *et al.*, 2011). Benefits associated with roof gardening include mitigation of 'Heat Island' effect (Oberndorfer *et al.* , 2007; Malakar *et al.*, 2017), reduction in the energy requirements for air conditioning of the building (Wong *et al.*, 2010; Muñoz *et al.*, 2015), improvement in air quality (Malakar *et al.*, 2017), reduction in stormwater runoff (Stovin, 2010), an increase in biodiversity as well as habitat (Francis and Lorimer, 2011), property value enhancement (Ichihara and Cohen, 2010), emergence of technologic, economic and employment opportunities (Malakar *et al.*, 2017), and recreation (Dunnett and Kingsbury, 2004).

There is limited research data available on people's perception for the adoption of the rooftop gardens even though understanding people's behavior regarding the adoption of rooftop gardening is important for future urban planning (Cañero *et al.*, 2013; Jungels *et al.*, 2013). Smith

and Boyer (2007) emphasize this sort of research. The benefits of rooftop gardens cannot be attained if residents lack awareness and knowledge of it. Incorporation of rooftop gardening into urban design has received little attention in Pakistan either by layman or professionals. Peoples' perception depends upon their innate beliefs in order to acclimate with their environment (Rahman *et al.*, 2015).

Perception is termed as the process of identification, awareness and alertness regarding what happens in one's surrounding. Landscape perception is dependent on the individual's experiences, memory, culture, preferences and beliefs. Cañero *et al.* (2013) evaluated public preferences and attitudes for the adoption of rooftop gardens in Southern Spain. Rahman *et al.* (2012) reported positive aesthetic reactions attitudes towards rooftop garden implementation and exposed that background characteristics effect people's perception.

The current study was designed to evaluate peoples' perception regarding rooftop gardening in the Faisalabad city, Pakistan, the third most populous city in the country (Younis *et al.*, 2002). City population is growing daily because the city is a growing textile industrial hub so this issue is very important as there are not enough green spaces to fulfill aesthetic and environmental needs of the local inhabitants. Planning decisions made today will have an effect on the future environment so understanding peoples' perception of rooftop gardening will be of utmost importance for stake holders.

MATERIALS AND METHODS

***Study area, sampling and questionnaire design*:** A diverse ornamental roof garden of 2000 sq ft was created on the roof of a building in the district Faisalabad of province Punjab, Pakistan, and face-to-face survey was conducted among 387 people of rural or urban backgrounds to evaluate their perception and awareness. Responses were evaluated in term of percentage on gender, profession, background (rural or urban) basis. Respondents were evaluated for the garden in terms of percentage of respondents having any awareness about the rooftop garden, liking, disliking or neutral behavior, and ratio of willing or not willing to establish them. The respondents were also evaluated for the rooftop garden regarding their opinion towards; mental relaxation, maintenance of plants grown in rooftop, professional's performance of the roof garden, problems associated with the management, personal benefits, psychological benefits, plantation choice, growing media choice, plantation on gender basis, hardscape elements, irrigation system, pollution control, cost, energy cost saving, biodiversity, temperature reduction, property value enhancement, negative impacts, developmental limitation, increase in aesthetical value of the buildings.

Statistical analysis: Data were coded, arranged in standard form and analyzed statically through SPSS (Statistical Package for Social Sciences) IBM version 19. Chi-square test is used for means comparison at 5 % level of significance.

RESULTS AND DISCUSSION

***Respondents' demographic information*:** Demographic for the 387 respondents have been presented (Table 1). The questionnaire was related to socio-demographic characteristics of respondents including gender, occupation, and living place. Male and female respondents were 43% and 57%, respectively and both genders show a positive interest in rooftop gardens. Businessmen represented the largest group (30%)followed by students (25%), private sector employees (20%), government employees (15%) and farmers (10%). Most respondents had an urban background (77%) and showed significant interest with a roof top gardening initiative in the city while others having rural background (23%) showed less interest. Urbanites are more aware possibly due to education level or through the awareness of media and tv shows. Strategies for increasing awareness among rural people will be important as they continue to migrate to the urban areas.

Table 1. Respondents' demographic information.

Information	Response rate (%)
Gender	
Male	43
Female	57
Profession	
Businessmen	30
Private sector employees	20
Government employees	15
Farmers	10
Background	
Urban	77
Rural	23

***Respondents' perception regarding idea of roof garden*:** Respondents were asked whether they had any knowledge about rooftop gardens. Fifty-five percent said "no" while forty-five percent respondents said "yes". The majority of people are unaware because rooftop gardening is a new urban greening concept in Pakistan. The study relates with Yuen and Hein (2005) about roof gardens in Singapore. Researchers found an overall of low percentage of residents visiting the roof gardens. Among them is the higher percentage of males from neighborhoods or local residents who visited alone (43.8%) and mostly with children (52.2%). About 90% claimed that they are familiar with the existence of roof gardens yet 84% were willing to use roof gardens if it's in their own neighborhood. Low utilization

resulted from improper access to the roof and lack of knowledge about precise location.

***Respondents' perception regarding liking, disliking or neutral behavior for roof garden*:** The vast majority of respondents (90%) indicated a preference for rooftop gardens. This may be from the introduction of new concept of urban greening that requires no special space for establishment. Of the remaining 10%, 6% respondents showed neutral attitudes for the adoption of rooftop gardens and 4% respondents have no interest. Similar results were expressed by Kaplan and Kaplan (1989). Benefits expressed for having rooftop gardens included exercise, smoking, visiting with friends, and "taking a break". Approximately 65% wanted to have more amenities like barbeque pits or snack areas. When citizens were asked about more roof gardens, 80% responded positively mainly for aesthetic reasons like beautification of the environment and also for leisure and relaxation. A relatively small percentage, 8-15% did not show willingness for more roof gardens because of maintenance, insect, or safety concerns. Roof gardens are plant refuge areas as society becomes more vertical and there is less space left for parks and plantations in urban environments.

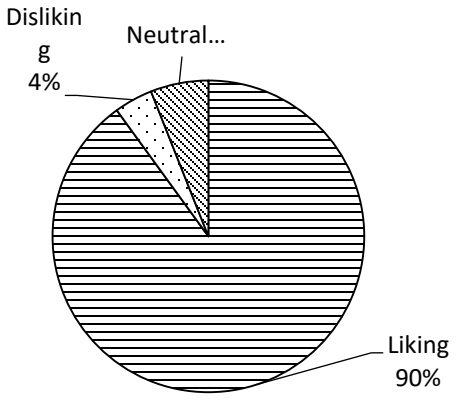

Figure 1. Respondent's perception regarding liking, disliking or neutral behavior for roof garden.

***Respondents' perception regarding better air quality through of roof garden concept*:** Eighty-five percent of respondents agree that a role for rooftop gardens is improving air quality, while 12% said that they did not believe air quality will improve as a result of rooftop garden establishment.

***Respondents' perception regarding mental relaxation by roof garden*:** The majority of respondents (90%) said "yes" when asked about whether they feel relaxed by rooftop gardens, while only a small number of respondents (5%) said "no". The reason given broadly support the results with Kalpan and Kalpan (1989) which perceive the benefits of roof gardens like recreation aesthetic pleasure, opportunities for children's play, peace and quiet moments. Approximately 90% claimed that they are familiar benefits of roof gardens like recreation and aesthetic pleasure. It was recorded that 84% were willing to use roof gardens in their houses as roof gardens are source of recreation and aesthetic pleasure as reported by Yuen and Hein (2005). When citizens were asked about more roof gardens, 80% responded positively for aesthetic reasons like beautification and also for leisure and relaxation. In present study it was also observed that 8-15% respondents did not show willingness for roof gardens because of high maintenance requirements and insects issues.

Table 2. Respondents perceptions for rooftop garden.

Idea about rooftop garden	Response rate (%)
Yes	45
No	55
Like or dislike	
Liking	90
Disliking	4
Neutral	6
Air quality improvement	
Agree	85
Disagree	12
No response	3
Mental relaxation	
Yes	90
No	5
No response	5

***Respondents' perception regarding their interest for maintaining and personal benefits associated with rooftop garden*:** Respondents interest for the maintenance of the rooftop garden plants is evaluated in this section. The results of survey reveal that majority (60%) of respondents was not interested in maintaining the plants in their rooftop garden while other respondents (40%) showed interest for plant maintenance. In this respect, the 45% respondents answer in term of energy saving benefit from rooftop garden. However, 30% respondents respond in term of property value enhancement. The 20% respondent's credit it in term of the mental relaxation benefit while 5% respondents said that there includes no personal benefit in the rooftop garden. Results cope with Yuen and Hein (2005) and Baudoin *et al.* (2017) that 80-84% people showed interest and willingness for maintaining it. Similarly, Alexandri and Jones (2008) suggests Australia has a lot to gain if the technology can be adapted. Once the substrate and plants required for successful Australian green roofs are identified and developed, the environmental benefits of green roofs in Australian conditions can be evaluated and policy incentives developed to increase uptake.

***Respondents' perception about the cost and energy cost saving through rooftop garden*:** A majority of respondents

(75%) thought that roof top gardens would be costly, while 10% respond that the cost is moderate followed by 15 % who had no idea about the installation costs. Ninety percent believe there are energy cost savings from an installation of rooftop garden while 6% did not think there would be energy cost savings. While cost savings are important Nicholas *et al.* (2010) found that people visit roof gardens 'to find peace and quiet' among respondents living away from the roof gardens and 'to take children out' among other households. Abdul Rahman *et al.* (2013) in Malaysia conducted an online survey among the different industry professionals for evaluating the use of green roofs in the light of green technology. The survey concluded that 80% of respondents were agreed the energy cost saving but only 10% were not agreed and 10% have no idea about rooftop garden.

Table 3. Respondents perception about the cost and energy cost saving through rooftop garden.

	Response rate (%)
Interest for plant maintenance	
Interested	40
Not interested	60
Personal benefits	
Energy saving benefits	45
Property value enhancement	30
Mental relaxation	20
No benefits	5
Installation cost	
Costly	75
Moderate cost	10
No idea	15
Energy cost saving	
Agree	90
Disagreed	6
No response	4

Table 4. Respondents perception regarding property value through rooftop garden.

	Response rate upto (%)
Property value perception by respondent % age	
15	60
45	50
30	40
Negative impacts	
Heavy weight at the roof	40
Roof leaking	30
No negative effect	10
No idea	20

***Respondents' perception regarding property value through rooftop garden*:** Respondents were asked about the property value enhancement. The 45% respondents said that rooftop garden can increase the property value upto 50%. While the 30% respondents were of the opinion of upto 40% followed by 15% that said property value enhancement about up to 60%. Ten percent did not believe that rooftop gardens increase property value. Similar results were reported by Yuen and Hein (2005). About70% claimed that they are familiar with the increased property value through rooftop and 60% were willing to use roof gardens if it's in their own neighborhood. The reasons for low utilization came out to be the improper access to the roof and also the lack of knowledge about the precise location.

***Respondents' perception regarding the possible negative impacts of rooftop garden*:** The leading negative impact expressed by respondents (40%) was a concern about the 'heavy weight of the roof' while 30% respondents' were concerned about the 'possibility of roof water leaking' from the garden. Twenty percent said they 'have no idea' about the possible negative effect of rooftop gardens and ten percent of the respondents, claimed 'no negative effect'. In Singapore Yuen and Hein (2005) found similar concerns and concerns about the extent of roof gardens usage.

***Conclusion*:** People believe that rooftop gardens can improve the urban habitat and express a generally positive attitude towards them for aesthetic and personal reasons. Rooftop gardens also would increase ecosystem diversity in the city as well as improve and the comfort and health of the urban dwellers, and may lessen urban environmental impacts. The production of edible and medicinal crops would be a good incentive to increase awareness and sustainability of these roof top gardens. The financial costs must be clearly determined and compared to potential savings on energy and food purchases to increase public acceptance. Also rooftop gardens must be well-designed so that they do not cause structural problems with the building from increased weight or from water issues.

REFERENCES

Abdul Rahman, S.R., H. Ahmed and M.S.F. Rosley. 2013. Green Roof: Its awareness among professionals and potential in Malaysian market. Proc. - Soc. Behavioral Sci., Malaysia 85:443-453.

Alexander, E. and P. Jones. 2008. Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates. Build Environ. 43:480-493.

Baudoin W., Y. Desjardins, M. Dorais, U. R. Charrondière, L. Herzigova, U. El-Behairy, N. C. Metwaly, and Marulanda, N. Ba. 2017. Roof top Gardening for Improved Food and Nutrition Security in the Urban Environment. In: Orsini, F., M. Dubbeling, de H. Zeeuw, G. Gianquinto (eds) Rooftop Urban Agriculture. Urban Agric. Springer, Switzerland.

Baþdooan, G. and A. Çio, 2016. Ecological-social economical impacts of vertical gardens in the sustainable city model. Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi 26:430-38.

Brethour, C., B. Delia, M. Terri-Lyn, B. Sparling and G. Watson. 2007. Literature review of documented health and environmental benefits derived from ornamental horticulture products. Agric and Agri-food Canada Markets and Trade. Ottawa http: //www.agrireseau.qc.ca/horticulturearbresdenoel/documents/Reports.

Carvajal Muñoz, J.S. and C.E. Carmona García. 2015. Global research trends in green roofs: benefits, main developments and future needs. Prod. Limpia 10:173-185.

Dunnett, N.P. and N. Kingsbury. 2008. Planting green roofs and living walls. Timber Press, Portland.

Fernandez-Cañero, R., T. Emilsson, C. Fernandez-Barba M.A. and Herrera Machuca. 2013. Green roof systems: a study of public attitudes and preferences in southern Spain. J. Environ. Manage. 128:106-15.

Francis, R. and J. Lorimer. 2011. Urban reconciliation ecology: the potential of living roofs and walls. J. Environ. Manag. 92:1429-1437.

Frank, L. D. 2000. Land use and transportation interaction implications on public health and quality of life. J. Plan. Educ. Res. 20:6-22.

Gómez-Baggethun, E., A Gren, D.N. Barton, J. Langemeyer, T. McPhearson, P. O'Farrell and P. Kremer. 2013. Urban ecosystem services. In: Elmqvist, T., M. Fragkias, J. Goodness, B. Güneralp, P.J. Marcotullio, R.J. McDonald and C. Wilkinson. (Eds.), Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. A Global Assessment. Springer, pp. 175-251.

Grinde, B. and G.G. Patil. 2009. Biophilia: does visual contact with nature impact on health and well-being? Int. J. Environ. Res. Public Health 6:2332-2343.

Gupta. A. 2017. Building a green home using local resources and sustainable technology in Jammu region - a case study. Energ. Procedia115:59-69.

Wilkinson, S. and F. Orr. 2017. The impact of horticulture therapy on mental health care consumers on a retrofitted roof. 23rd annual Pacific Rim real estate society conference Sydney, New South Wales, Australia.

Ichihara, K and J. Cohen. 2010. New York city property values: what is the impact of green roofs on rental pricing? Lett. Spat. Resour. Sci.4:21-30.

Jungels, J., D. A. Rakow, S. B.Allred, S. M. Skelly. 2013. Attitudes and aesthetic reactions toward green roofs in the Northeastern United States. Landsc. Urban. Plan 117:13-21.

Kaplan, R and S. Kaplan. 1989. The Experience of Nature. Cambridge University Press, Cambridge.

Li, F., R.Wang, J. Paulussen and X. Liu. 2005. Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China. Landsc. Urban. Plan 72:325-336.

Malakar, M., P. Acharyya and S. Biswas. 2017. Vertical gardening for enlivening the ambiance. J. Crop Weed 13:89-93.

Naumann, S., G. Anzaldua, P. Berry, S. Burch, M. Davies, A. Frelih-Larsen, M. Davis, P. Berry, S. Burch, M. Sanders. 2011. Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe. Final report to the European Commission, DG Environment.

Nicholas, S.G.W., J.P. Rayner and K.J. Raynor. 2010. Green roofs for a wide brown land: Opportunities and barriers for rooftop greening in Australia. Urban. For. Urban. Green. Aus. 9:245-254.

Niekerk, M.C., V. Greenstone andM. Hickman. 2011. Guideline for designing green roof habitats. pp. 52-??.

Oberndorfer, E., J. Lundholm, B. Bass, M.Connelly, R.Coffman, H. Doshi. 2007. Green roofs as urban ecosystems: Ecological structures, functions and services. BioScience 57:823-833.

Rahman, S. R. A., Ahmad, H., S. Mohammad and M. S. F. Rosley. 2015. Perception of green roof as a tool for urban regeneration in a commercial environment: The secret garden, Malaysia. Procedia Soc.Behav. Sci.170:128-136.

Rahman, S. R and H. Ahmad. 2012. Green roofs as urban antidote: A review on aesthetic environmental, economic and social benefits. Proc. South East Asia Technical University, 6:93-97.

Smith, C and M. Boyer. 2007. Who wants to live with a living roof? Green Places. 24-27. 10.1002/9780470995327.ch5.

Stovin, V.R. 2010. The potential of green roofs to manage urban storm water. Water Environ. J. 24:192-199.

Wong, N.H., A.Y.K. Tan, Y. Chen, K. Sekar, P.Y. Tan, D. Chan, K. Chiang and N.C. Wong. 2010. Thermal evaluation of vertical greenery systems for building walls. Build. Environ. 45:663-672

Younis, A., A. Riaz, M. Qasim and S. Akhtar. 2002. Development and management of green spaces on Sumundri road, Faisalabad: A case study. Pak. J. Agric. Sci. 39:292-296.

Yuen, B and W. N. Hien. 2005. Resident perceptions and expectations of rooftop gardens in Singapore. Landsc. Urban. Plan 73:263-276.

[Received 11 Mar 2019: Accepted 14 Jan- 2020 Published 8 Feb. 2020]