

## **Nutritional and Recreational Benefits of Roof Top Gardening: An Empirical Evidence from the Selected Households of Dhaka City**

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### **Abstract**

*Rapid population growth, migration, and poor urban planning of Dhaka city resulted in an unhealthy and fragile environment, alarming to the city dwellers. This study aims to provide information regarding rooftop gardening's nutritional, recreational, and other aspects. The study was conducted in 50 households in Dhaka metropolitan city through a direct interview method with a structured questionnaire. Tabular techniques and some statistical measures like semi-log regression were used. The study's objectives were addressed through Descriptive statistics and the Cobb-Douglas production function model. House type, area of a rooftop garden, the experience of rooftop gardening and variety in rooftop garden significantly affected the net return from rooftop gardening. The primary purpose of rooftop gardening considered by rooftop garden owners was passing leisure time and psychological health improvement. Rooftop gardening is the number one choice as recreational activity of the significant sampled garden owners. Rooftop gardening has improved rooftop garden owners' mental health, psychological well-being, and life satisfaction. Lack of time, inadequate soil nutrients, and proper guidelines were the major drawbacks for the rooftop gardener. However, people of Dhaka city are leaning toward Rooftop gardening, and they are better scope to spend their time after the COVID-19 pandemic.*

**Keywords** Rooftop gardening · Nutrition · Recreation and benefit analysis

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## 1. Introduction

Bangladesh is an agriculture-based country. 'Agriculture' is one of the reasons for which Bangladesh is known worldwide. Rapid population growth, migration and poor urban planning of Dhaka city resulted in an unhealthy and fragile environment which is alarming to the city dwellers (Gupta, 1992; Khan & Titumir, 1992). With rapid and unplanned urbanisation, urban poverty and food insecurity have also increased alarmingly in Dhaka City (Choguill, 1995). One of the ways to mitigate this issue is doing "Rooftop gardening". Roof gardening is an art and science of growing plants on the fallow spaces within, surrounding or adjacent to the residence, most often referred to as a garden. Other conventional areas of roof gardening include atrium, balcony and window boxes. Plants are grown for various utilitarian and non-utilitarian purposes (Sajjaduzzaman et al., 2005).

Farming on the rooftop of the buildings in urban areas is usually done using green roofs, hydroponics, organic, aeroponics or container gardens (Asad & Roy, 2014). The first benefit of this practice is increasing the local supply of fresh food. In Bologna, Italy, if all suitable flat roof space is used for urban agriculture, rooftop gardens in the city would supply around 12,500 tons of vegetables annually, which would meet 77% of residents' needs for vegetables and an estimated 624 tons of CO<sub>2</sub> would be captured each year (Science for Environment Policy, 2015). Lufa Farms, Montreal, produces over 25 varieties of vegetables, and production is adequate to supply the needs of over 1000 people (Carrot City, 2014a). It is estimated that 10,000 ha of space in Dhaka city can be brought under rooftop farming, and the residents of the city can taste fresh vegetables as well, as over 10 per cent of the demand can be fulfilled through rooftop farming (Wardard, 2014).

Presently, the residential buildings' rooftops are used for various purposes such as gardening, drying and washing clothes, playground for children, entertaining guests, and passing pleasure time. In the study, results revealed that the highest percentages of the respondents' rooftops are being used for gardening (87%), drying cloths (25.8%) and others (11.5%) irrespective of all areas in Dhaka city (Table 1). Islam (2004) reported that the rooftops of the residential buildings were used for drying (88%) and washing (45%) clothes, as a playground for children (97%), for entertaining guests (20%), for cool air during the summer (64%), to sunbathe in the winter (33%). On most of the roofs, some form of pleasure garden exists (78%); sometimes, there are fruit gardens (12%), and, less often, vegetable gardens as well (8%) (Uddin et al., 2016).

*Table 1: Estimation of potential space on rooftop and use of open space in the selected household [Dhaka city (n = 97)]*

City/ Metropolitan areas	Size of space on rooftop per household (in sq. feet)			Used of open space as % of each respondent		
	Total space	Open space	Potential space for RTG	For gardening	For drying cloths	Others
Mohammadpur	1500	325	1175	79	36	7
Mirpur	1950	338	1612	76	6	24
Gulshan	1806	256	1550	94	11	11
Uttara	2035	460	1575	90	35	10
Kamrangirchar	2131	356	1775	100	25	-
Tejgaon	2075	200	1875	83	42	17
All	1916	323	1593	87.0	25.8	11.5
F-value	1.863 <sup>ns</sup>	1.111 <sup>ns</sup>	1.210 <sup>ns</sup>			

*Source: Uddin et al., 2016 (FAO report)*

This study aims to provide information about the nutritional, recreational and other benefits of rooftop gardening. It will show the critical perspectives of rooftop gardening. At the same time, it will show how it influences urban people's lives in positive ways. This study will show the contribution of rooftop gardening products to the urban people's food consumption. Moreover, it will present the happiness of the rooftop garden owner with their rooftop gardening. It will determine whether rooftop gardening can be considered a supplementary economic activity in urban society. It will let us know the types of people and their socio-economic status in rooftop gardening. Furthermore, it will also help us understand the recreational value of rooftop gardening.

## 2. Materials and Methods

The pertinent information on the subject was collected from various primary as well as secondary sources. A purposive sampling of representative rooftop garden owners was done in 50 households. The data were collected through face to face interview method with the respondents using a pre-designed and pre-tested interview schedule. A rooftop household was the unit of analysis. Tabular techniques and statistical measures like semi-log regression were used to analyse the data. The data were presented in tabular form for analysing the financial condition, and a cost-benefit analysis was done. Descriptive statistics and the Cobb-Douglas production function model addressed the study's main objectives.

## 3. Result and Discussion

### 3.1 Socio-economic profile of the rooftop garden owners

The age distributions of sample rooftop garden owners were divided into four groups. Out of total rooftop garden owners, about 2 per cent of the rooftop garden

owner fell into the 21-30 years of age group, 26 per cent were between 31-40 years, 48 per cent were between 41-50 years, and 24 per cent of the rooftop garden owner belong to above 50 years of age groups.

The education levels of the respondents were categorised into three groups: higher secondary, graduate, and post-graduate. At the highest, 58 per cent of respondents completed their graduation, and at the lowest, 14 per cent completed their higher secondary certification.

Many diversified respondents were involved in various occupations such as services (Govt. and private), business and homemakers. The highest 34 per cent of respondents were homemakers, followed by servicing persons (30 per cent) and businessmen (22 per cent). Moreover, a minimum number of people were found to be a teacher (6 per cent), doctors (4 per cent), engineers (2 per cent) and bankers (2 per cent).

The annual income of rooftop garden owners varies from Tk. 6 to 65 lac. About 42 per cent of rooftop gardening households get 6 to 15 lac per year, followed by 32 per cent of rooftop gardening households. 16 to 25 lac per year. Furthermore, about 8 per cent of rooftop gardening households get Tk. 36 to 45 lac per year.

Considering the overall scenario, most rooftop garden owners were homemakers, and their educational status graduated. They were mostly between 40 to 50 years old, belonging to a small-sized family with various plants in their gardens.

### 3.2 Cost and return of rooftop gardening

Rooftop garden owners in the study area used purchased and home-supplied inputs valued at the prevailing market rate during the survey period or at the price they paid. The output was also valued at the overall market price. Purchased inputs such as seeds, fertilisers, material, containers, etc., involved direct expenses; therefore, pricing these inputs was straightforward. However, since no cash payment was made for the home-supplied inputs, these inputs' costs were estimated using the opportunity cost principle. The average per household garden calculation is given below:

Table 2: Total Cost and Return of Rooftop gardening

Items	Cost (Tk.)	Percentage
Construction cost per year	475.2	3.63
Container cost per year	577.22	4.41
Soil cost per year	3691	28.22
Material cost per year	86.8	0.66
Seed collection, planting and maintenance cost	497.61	3.80
Irrigation/Watering cost	5306.67	40.58
Fertiliser cost	880	6.73
Insecticide cost	530.20	4.05
Labourer cost per year	1733.333	13.2546
Gross cost per year		13077.22
Gross return per year		14757.1
Net return per year		1679.88

*Source:* Author's calculation based on the HHs' data

It can be concluded that rooftop gardening is not non-profitable; instead, it can be turned into a very profitable business in a place of no land with many considerations.

### 3.3 Functional analysis of rooftop gardening

Semi-log regression analysis was done considering 50 rooftop garden owners. The model was specified as:

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^{u_i}$$

In the semi-log form, it can be written as follows:

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + U_i$$

Where,

Y = Net Return from rooftop garden (Tk. /Owner)

X<sub>1</sub> = Age of the rooftop garden owner (Year)

X<sub>2</sub> = Educational qualification of the rooftop garden owner (Year)

X<sub>3</sub> = House Type (Categorical value where 1 means ‘owned RTG’ and 0 mean ‘tenant owned RTG’)

X<sub>4</sub> = Area of rooftop garden on roof (sq. ft.)

X<sub>5</sub> = Experience of rooftop gardening (Year)

X<sub>6</sub> = Variety of fruits and vegetables (Number)

ln = Natural logarithm;

a = Intercept/constant;

b<sub>i</sub> = Coefficients; and

U = Error term.

Table 3: Estimated values of co-efficient and related statistic of Semi Log Regression Function

Explanatory variables	Coefficients b <sub>i</sub>	Standard Error	t-value
Intercept	-26.53	5.50	-4.83
Age	1.33 (0.0926)	0.77	1.72
Educational Qualification	-0.19 (0.8677)	1.16	-0.1676
House type	4.15*** (2.26E-14)	0.36	11.23
Rooftop garden area	3.58*** (2.58E-06)	0.58	6.20
Experience of rooftop gardening	0.62*** (0.0068)	0.22	2.84
Variety of fruits and vegetables	-1.13** (0.04)	0.546469	-2.07523
F-value	101.05		
R <sup>2</sup>	0.93		
R <sup>2</sup> (adjusted)	0.92		

Source: Author’s calculation based on the HHs’ data

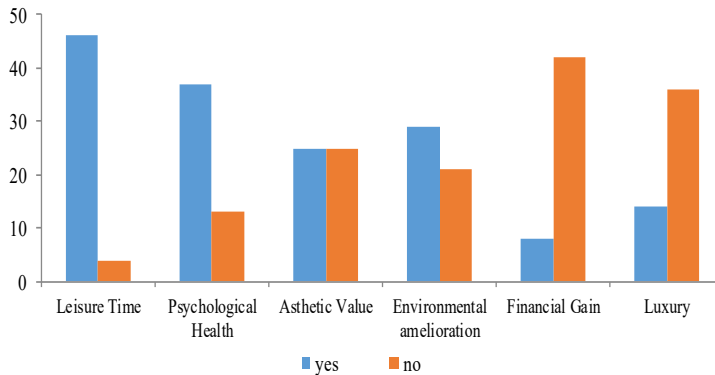
Based on the empirical evidence from the analysis, the findings can be concluded that house type, rooftop garden area, rooftop gardening experience, and variety in rooftop garden significantly impacted the net return from rooftop

gardening. However, variation in plants causes a negative impact on them. i. e. more there is variation in fruits and vegetables, the less is the net return. So, it was anticipated that higher application of the significant variables along with being positive and lowering significant negative variables would increase the net return of rooftop garden owners.

### 3.4 Analysis of achievement of the purpose for rooftop gardening

Firstly we need to know the purposes of practising rooftop gardening. Thus six purposes were considered. They are, passing leisure time, for psychological health, aesthetic value, environmental amelioration, financial gain, and luxury. The bar diagram for rooftop gardening gives a clearer picture of the considered purposes.

Figure 1: Purpose of rooftop gardening



*Source: Field Survey, 2019*

### 3.5 Analysis of nutritional proportion from rooftop gardening

One of the significant causes of rooftop gardening is to get fresh and pure fruits and vegetables from own garden. As these products are grown with supervision, they do not generally contain the harmful chemicals that market products carry. The gardeners apply a proportionate amount of pesticides and fertiliser. The fruits and vegetables they were supposed to buy from the market, they get from the garden. The proportion of nutrition they were supposed to get from the market product is obtained from the rooftop garden. The percentages of nutrition they get from fruits are Guava (64.23193), Lemon (54.39252), Mango (59.07376), Jujube (94.56522), Hog Plum (81.10236), Olive (90.47619), Pomegranate (69.33333), Orange (39.66346), Malta (46.19289), Carambola (84.61538), Water apple (98.91304), Sapota (92.64706), Litchi (25.88235), Pummelo (92.24806), Dragon fruit (77.52809), Grape (50), Strawberry (66.66667), Sugar Apple (100), Muskmelon (50), Banana (38.20106), Pineapple (62.5), Papaya (53.04348).

### 3.6 Rooftop gardening as recreation for rooftop garden owners

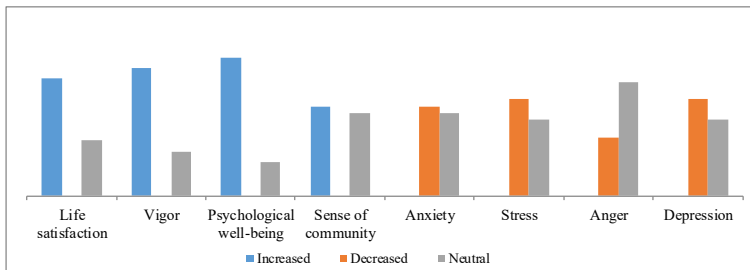
There are different ways to enjoy or relax, or refresh. Sleeping is the best recreation, while others may enjoy reading books and a good story. However, for rooftop garden owners, the view is different. Through analysis, it is seen that 64 per cent of rooftop gardeners considered rooftop gardening as for number one recreational activity.

### 3.7 Mental health

Recreation is a way to balance or improve mental health. A person needs recreation for peace of its mind. Moreover, some aspects are life satisfaction, vigour, psychological well-being, sense of community, anxiety, stress, anger, and depression. Rooftop gardening directly or indirectly stimulates life satisfaction, vitality, psychological well-being, sense of community, anxiety, stress, anger and depression. About 68 per cent of rooftop garden owners felt their life satisfaction has increased through rooftop gardening. For 74 per cent of the rooftop garden, their vigour has increased through rooftop gardening. Moreover, 80 per cent of their psychological well-being is being increased with rooftop gardening. Along with positive impacts, negative impacts like anxiety, depression, etc., have decreased or been neutral but did not increase.

The bar diagram of the recreational benefit of a rooftop garden is presented below:

Figure 2: Recreational benefits of the rooftop garden, including mental health



Source: Field Survey, 2019

### 3.8 Problems and constraints associated with rooftop gardening

The rooftop garden owners face several problems. Some rooftop gardeners do not get sufficient quantities of seeds, fertilisers, pesticides and technical support. Again, some complaint about getting insufficient support from governmental agencies. Rooftop garden owners face significant problems, and constraints of rooftop gardening are considered and ranked according to their opinion.

*Table 4: Overall ranking of problems relating to rooftop gardening*

Problems	Rank
Difficult for a tenant to make a rooftop garden	6
It is laborious	5
Difficult to supply essential plant nutrients	2
Lack of time	1
Lack of rooftop gardening knowledge	3
Seedling damaged	4
Stealing seeding, flowers, fruits etc. by the thief	7
Zero benefits in roof gardening	11
Lack of irrigation facilities	9
Damaging building strength	8
Lack of neatness	10

*Source: Author's calculation based on the HHs' data*

Lack of time is the major problem of all other issues, followed by difficulties in supplying essential nutrients. Moreover, it can be summarised that maximum rooftop gardeners do not consider rooftop gardening a zero-benefit activity. They do it to satisfy family consumption, recreational benefit and health issues.

#### **4. Conclusions and Recommendations**

Though rooftop gardening is considered a luxury hobby, it has many other sectors that need to be noticed. Throughout this study, analysing the financial, recreational and nutritional aspects, it seems that primarily middle-aged, graduated homemakers are practising rooftop gardening. Going into the financial factors, mostly rooftop gardeners belong to high to medium-class society. In a busy city like Dhaka, rooftop garden owners find recreation and stress relief through culturing and nurturing plants on the rooftop. Their mental condition, psychological well-being, life satisfaction, etc., are improving through this activity. Enlargement in rooftop garden size positively impacts the profit of rooftop gardening. Experience influences the economic side of rooftop gardening positively. Too much variation in fruits and vegetable plants requires effort and carefulness in rooftop gardening. Negative factors like anxiety, stress, and depression have been lowered by spending quality time in rooftop gardening. Almost half of their respective fruit and vegetables come from rooftop gardening for rooftop garden owners. Lack of time is one of the significant drawbacks of rooftop gardening. Rooftop gardeners find it hard to identify the causes of different incidence in their rooftop gardens and to collect and supply essential nutrients for plants. Protecting seedlings from being damaged is hard for them. Finally, in an economic sense, i.e., from its cost-benefit analysis, rooftop gardening is profitable and has a vast scope for expansion due to its inbuilt characteristics.



Based on the study results, it can be concluded that rooftop gardening is a rising fact in urban areas. A roof garden plays an essential role in the mental well-being of the gardener. The number of participants in this activity is gradually increasing. The study results show that roof gardening also has a promising potential as a small-scale business that can accelerate additional family income. Moreover, its value to the rooftop garden owners is unparalleled in all sorts of measurements. The happiness it provides cannot be measured in monetary value. Nevertheless, it may generate some employment facilities through backward and forward linkages.

The following recommendations are made for sound rooftop gardening in the study areas:

- i. The potential use of unused spaces for rooftop gardening and proper drainage facility will be the best option for the dwellers of the building.
- ii. Training programs should be spontaneously held on rooftop gardening so that people interested in rooftop gardening have basic knowledge like container preparation for planting, fertiliser application, and irrigation methods.
- iii. Training on insect and pest management for the safe and quality production of fruits and vegetables would be helpful for garden owners.
- iv. Enable a marketing option for the rooftop garden owners to consider it an economical choice.
- v. High yielding variety of BARI should be made available for rooftop garden owners to be happier with the production.
- vi. For the longevity of rooftop gardens, the place is to be kept neat and clean.
- vii. Tenants should be given more chances to do rooftop gardening with mutual agreement with the building owners.
- viii. A technically feasible, socially acceptable, economically viable, and environment-friendly RTG model should be developed and up-scaling gradually in Dhaka city areas.
- ix. Need to change the mindset of the RTG owner for adopting improved technologies through motivation or awareness program;

A suitable rooftop gardening model can be developed and implemented by maintaining linkage among BARI, DAE and NGOs.

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