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PROSPECTS OF ROOFTOP GARDENING IN DHAKA CITY: A CASE STUDY ON KADAMTALI THANA

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Abstract

Dhaka, the capital city of Bangladesh and a city of at least 22.5 million people made it one of the most densely populated countries in the world which suffered unrecoverable damage to the green areas of the city (Nation, 2021). Having the most polluted air, the residents of this city are forced to live in a dusty, polluted, toxic, and poisonous environment. The rapid growth of Bangladesh`s capital has destroyed crucial ecosystems, caused rising temperatures, and quickly lost its green. One of the ways to bring back its green area, and good air in any particular area is "rooftop gardening". This research focuses on the impact of rooftop gardening on people and the environment. What are the challenges of the garden and how to deal with it has been identified in this research. The benefits of rooftop gardening and what are the present scenario have been described in this study. For this, aim of this study is to explore the prospects of rooftop gardening in Dhaka city. The purpose of the study is to find out the effectiveness of gardening based on economic and environmental concerns. This study has been conducted by collecting primary and secondary data. Both types of primary data such as qualitative and quantitative data have been used to complete the analysis part. The data collection has been done by questionnaire survey conducted at selected households. By analysing the data, it is found that rooftop gardening is economically profitable. There is some decent amount of income coming from gardening. Besides, rooftop gardening is quite environmentally beneficial. It reduces temperature by almost 2.3ºC of the roof and 1.9ºC of the top floor of the building. Finally, some recommendations have been provided to deal with the challenges as well as to improve the present scenario of rooftop gardening in the study area.

Keyword: *Rooftop Gardening, Temperature, Humidity, Multiple Regression analysis, Path Analysis, Kadamtali Thana*

1 INTRODUCTION

1.1 Background of the study: Almost 64.81 million people live in urban areas by 2020 in Bangladesh (AFFAIRS, 2020). In 2009, percentage of people live in urban area was 29.71% which increased to 36.63% by 2018 (Nation, 2021). The average rate of urbanization is about 5% since the independence of Bangladesh (Lipi & Hasan, 2021). As a result, green area of the urban site has been decreasing for the limitation of the land. Due to increase in urban areas and reducing the green places, world environment become unhealthy day by day. This thing disturbs the ecological equilibrium and the relationship between the nature and human beings (Deelstra & Girardet, 2000). By implementing green roof, it can be achieved to maintain a good ecological environment in urban areas. Most of the urban areas have unused roof which can be utilized by establishing roof gardening (Bay Localize, 2007; Canadian CED Network, 2007; kisner, 2008; kortright, 2001; Lim and Kishnani, 2010). Over the world, the Rooftop Gardens are a common include of the present-day city. The idea of Rooftop Gardening is the only demonstrated a viable degree being practiced and creating day by day all through the Globe. Rooftop Gardening can be set on person homes, organization and office buildings and rooftops of restaurants and serve either domestic utilization, utilize of new deliver in restaurants or regulation kitchens or commercial generation. Overheating cities of due to the thick concentration of asphalt (counting housetop and asphalts) and global warming that retains sun-oriented radiation. Rooftop Gardening is without a doubt is much more basic and practical strategy particularly for the cities packed. To utilize unused space at housetop, to expend new natural food, to utilize recreation and sit out of gear time, to spare roof from harm, to form the environment cooler, to beautify and brighten the atmosphere' to get fresh food without much effort or waste of time, to convert organic waste into organic manures to help the nation enrich. The number of rooftop gardens is increasing, helping the city environment and climate (Amin, 2019). There is no exact data on rooftop gardening. The Green Savers Association conducted a study and found that in Dhaka, roof space is 1,800,000 katha of which 810,000 katha is usable. Ahsan Rony of Green Savers Association said: "Of the total roof space in Dhaka, 3% has a garden at present. We have the possibility to make the city greener by using more of the rooftop space. Rooftop gardening is a term which means the planting trees and plants on the roof of the building. Rooftops are one of the cities' greatest untapped resources (Hussein et al., 2020). It can reduce the adverse effect of UHI (Urban Heat Island) in city (Hui, 2006). According to some expert, Rooftop gardening reduces the heat of the roof and room in the building (ANI, 2022). In order to mitigate these adverse circumstances, rooftop garden observes great performance. Dhaka is the largest city with a large number of people living in this city area, is called a mega city. Numbers of building have covered all over the city. There are a few lands to cultivate vegetables, fruits and flowers or ornamental plants. But there is a great demand for vegetables, fruits flowers or ornamental plants in this city (Mou, 2012), so it can be perfect place to install the rooftop garden in Kadamtali Thana. This area has good resources of rooftop. This study is also monitoring the present scenario of the rooftop gardening in Kadamtali Thana.

1.2 Aim and Objectives: The aim of the study is to explore the prospects of rooftop gardening in urban region. For fulfilling this aim the following objectives are taken;

- To explore the present practice and challenges of rooftop gardening that was encountered by practitioners.
- To find out the cost effectiveness of rooftop gardening in the study area.
- To evaluate environmental impacts of the rooftop gardening and provide some recommendations for enhancing the present practice for Dhaka city.

2 Literature review

In the review of literature, it is found The Rooftop Garden Project of Canada published a guide after 5 years of gardening and experimenting titled "The Guide to Setting up Your Own Edible Rooftop". It explored new ways to interact with each other, with the built environment, the urban ecosystem and the food chain, and discovered that change can happen in a manner that is participative, pleasant and inclusive. A general guideline for container gardening, hydroponics container, choice of plants, fertilization, composting and mulching is also provided. This guideline provided a great help in my research work. There is a website of City Farmer (www.cityfarmer.org), Canada's Office of Urban Agriculture very useful for my research work. The website provided general guideline for rooftop gardening. Many articles and journals also published in this website. On the section of Rooftop Gardens, the reasons to rooftop garden were mentioned. Besides, the environmental benefits and opportunities in Landscape Design, building insulation and food production were mentioned. Robin Kortright's article "Evaluating the Potential of Green Roof Agriculture" published on City Farmer's website establishing an experimental vegetable garden on the green roof was helpful to my research. Shawn Overstreet's article named "Creating a Native Plant Container Garden" seemed quite interesting to me. This article is of great significance on container gardening. "Green roof and its Impact on Urban Environmental sustainability: The Case in Bangladesh" co-written by Rumana Rashid, Mohd. Hamdan Bin Ahmed, Md. Sayem Khan published in World Journal of Management, Volume 2, Number 2 was helpful in my research work. It also provided a sustainable, energy saving, comfortable and healthy environment. Green application on the residential building is more appropriate into the contemporary building as a thermal comfort strategy for the modern design of Bangladesh. "Greening Rooftops in the Garden City" by Heather Hobbs released on the website of Lifecycles of cultivating communities discusses the potentiality for rooftop gardens as an important part of the solution to food security issues on Vancouver Island was also viewed. He defined food security from physical and economic view of access to safe and nutritious food to meet dietary needs. A Degree project within Urban Forestry and Urban Greening titled "The relationship between Urban Forestry and Poverty Alleviation -Dhaka as a case study" by Mohammad Nasir Uddin under Department of Landscape Management and Horticultural Technology in Swedish University of Agricultural Sciences was helpful in my research. His report described how the poor people of Dhaka can be benefited by well-planned Urban Forestry Program. By analysing the present green resources and poverty

situation in Dhaka and using more practical and life experienced example, this project presented overall ideas of major direct and indirect benefits of Urban Forestry program. As the paper was written in context of the existing condition of Dhaka city, it provided a great help in my research. “Green Roof Specifications and Standards - establishing an emerging technology” by Christopher G. Wark and Wendy W. Wark published on the The Construction Specifier -Vol. 56, No.8 was much interesting. It presented the history of green roofs and increased interested among people for it around the world. It showed rooftop construction design in figures. There is the article published on DIMENSI (Journal of Architecture and Built Environment), Vol. 37, No. 1 titled “Thermal Performance of Rooftop Greenery System at the tropical Climate of Malaysia - A case study of a 10 storied building R.C.C flat rooftop at UTM, Johor Bahru, Malaysia” co-written by Rumana Rashid and Mohd. Hamdan Bin Ahmed was in my center of attention. In tropical countries rooftop greenery is more sympathetic to the prevailing climate and provides comfortable indoor environment. One of the Bangla guidebooks titled “Shohojey Chadey Bagan” (Easily Gardening on Roof) by Tipu Sultan Khan, the pioneer of Bangladesh Green Roof Movement supported a lot in my study. Basic guidelines and advices are provided in this book for those who are interested in rooftop gardening in Bangladesh. It provided instruction for gardening in container, drum or in soil. It also provided some information of choice of plants. A publication written by Maibritt Pedersen titled “Roof Top Permaculture - Transformation of the Inner-City Environment” published on Rooftop Gardens Project’s website drawn my attention. Many cities have a lot of ‘lost’, left over space; that is space which exists without consideration. It is the space between buildings, the roof tops, the median strips and the awkward street corners. This book emphasizes to use these unproductive spaces in a productive manner. This publication helped me to link permaculture with rooftop gardening and providing guideline in utilization of left over spaces in a productive manner. In addition, there is a website www.greenroofs.com much useful. An article published on Bangladeshi Daily Newspaper Prothom Alo titled “Bagan Kortey Chailey.” (If you are Interested in Gardening) providing general instruction for gardening was helpful for my work.

3 Study area

The location has been taken at Kadamtali Thana in Dhaka district. The area is situated beside the Buriganga River which is a part of the old Dhaka. The location is between 23°39' and 23°42' north latitudes and in between 90°26' and 90°28' east longitudes. The total area is about 10.16 square kilometer. It is bounded by Jatrabari Thana on the north, Keraniganj upazila on the south, Narayanganj sadar upazila and Demra Thana on the east, Shyampur and Jatrabari Thana on the west. Kadamtali Thana is actually used as residential purposes. There are fewer commercial activities occurs in the area of this Thana.

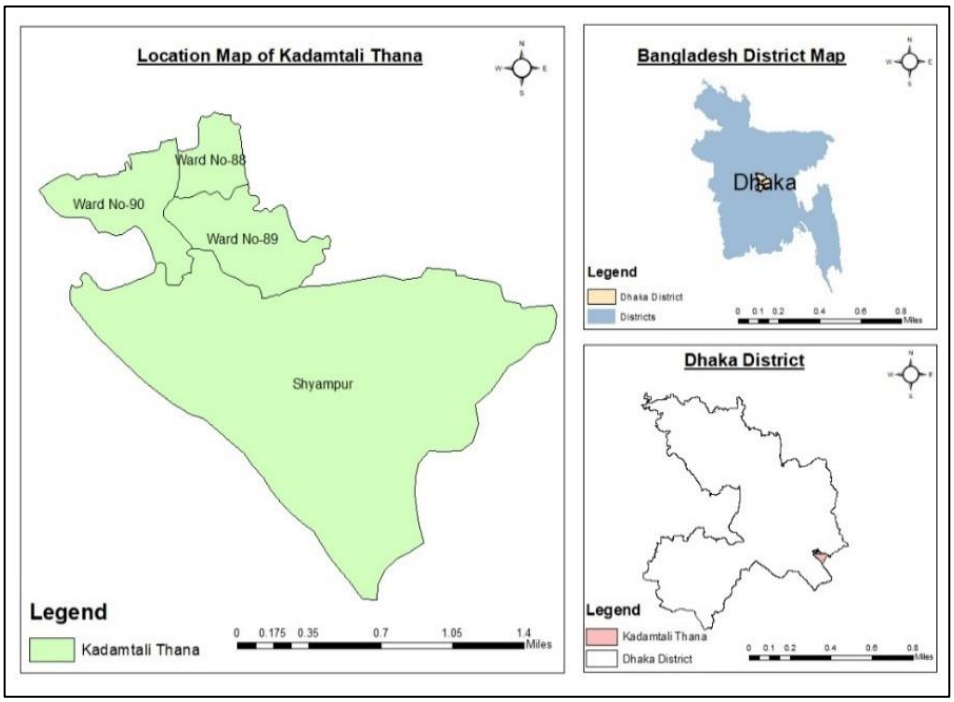


Figure 3.1: Location Map of Kadamtali Thana
Source: *LGED, 2010*

4 Methodology

4.1 Data Collection: There are two types of data has been collected in this study such as (1) Primary data collection and (2) Secondary data collection. Both types of data have been collected in different process to obtain the desired data.

4.1.1 Primary Data collection: Primary data means that type of data which is collected from the field survey. The surveyor collects the primary data directly from the survey in the study area. Both quantitative and qualitative data has been collected from the field survey. The primary data containing quantitative and qualitative was collected by questionnaire survey. The questionnaire has been attached in the appendix of this paper. The questionnaire survey was

conducted to achieve the present scenario of the study area. For this, the random sampling method has been taken and collected the household information of the area. This data helps to evaluate the importance of the rooftop gardening. Again, two roofs have been selected to find out the comparison of the environmental impact of roof top garden. For this, there is a bare roof and a green roof has been selected with the minimum distance between them. The bare roof means the roof which has no garden on it and green roof containing the roof with garden. The comparison between two roofs based on the temperature and humidity has been done to evaluate the environmental concern. Also, the top floor of the bare roof building and green roof building has been selected to make a comparison between them. Measurement of the temperature and humidity has been conducted of the top floor of the building. The temperature and humidity were measured using digital Temperature Humidity Meter HTC-1 to get the data smoothly.

4.1.2 Secondary Data Collection: The secondary data has been collected from different types of papers, articles and books. Secondary data such as benefits of the rooftop gardening and challenges of the rooftop gardening has been collected from the literature review.

4.1.3 Sample size: To determine the sample size many types of formula has been used. Anyhow, Yamane's (1967) formula has been used in here for study group

$$n = \frac{Z^2(p * q)}{e^2}$$

Where,
n = Sample size; e, the level of precision = 7%; z = the value of the standard normal variable given the chosen confidence level (e.g., z = 1.28 with a confidence level of 90 %) and P = The proportion or degree of variability = 50%;
The sample size (n) is = 84.

4.2 Data Analysis: For primary data analysis, the correlation and regression analysis has been used. In this stage, the collected information was analysed and necessary evaluations were made. Both the opportunities and challenges of rooftop gardening came out from analysis. The analysis helped to provide guidelines to install roof gardens.

4.2.1 Multiple Linear Regression Model (MLRM): Regression model is an analysis of finding out the relationship between a dependent variable and various independent or explanatory variables (Everitt, 2001). In the late 19th Century, Sir Francis Galton firstly developed Regression Analysis (Everitt, 2001; Kutner, Nashtsheim, Neter, & Li, 2005). He made a mathematical description of the observed relationship between height of children with height of their parents which is known as Regression Model (RM) nowadays.

Basic concepts: An RM is a formal means to express ingredients of a statistical relationship.
1. A tendency of the response variable Y to vary with the predictor variable X in a systematic fashion
2. A scattering of points around the curve of statistical relationship.

These two characteristics are embodied in a regression model by postulating that:
1. There is a probability distribution of Y for each level of X.
2. The means of these probability distributions vary in some systematic fashion with X.

Regression analysis involves not only the development of statistical techniques but also to use these techniques to examine how the observed variable changes with the change of circumstances. Regression analysis is aimed to derive an equation representing the relationship between the dependent variable and one or more explanatory or independent variables (Everitt, 2001). RM has three purposes namely description, control and prediction of dependent variable in respect of independent variable (Kutner et al., 2005). If the regression is made by one dependent variable and more than one quantitative independent variable, then it is called "Multiple Linear regression model" (Olive, 2010). Everitt (2001) has derived a mathematical expression of regression model which is given below.
$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + ...+ \beta_iX_i$

Where, Y is the dependent or response variable and X1, X2, X3.....Xį, is the independent or explanatory variables where i = 1, 2, 3 ...n. β_0 is the constant value and β_1, β_2, β_3..... Bi is the coefficients of corresponding independent variables. The regression coefficients give the amount of change in the response variable associated with change in the corresponding explanatory variable conditional on the other watery variables in the model remaining unchanged.

Coefficient of multiple determinations, R^2: Coefficient of multiple determinations which is expressed by R^2 is a measure of the proportion of the variation in the dependent variable that is explained by the several explanatory variables included in a multiple regression model. R^2 always laid between 0 and 1 and the higher the value the more variation will be observed to the dependent variable explained by different explanatory variables. And the value of R2 increases with the addition of more explanatory or independent variables in the model (Feinstein & Thomas, 2002).

Partial regression coefficient: It's a measure of the influence of a particular independent variable on the dependent variable while the other independent variables are held constant (Feinstein & Thomas, 2002).

Standardized Beta coefficient: The beta coefficient is a measure of the relative effect of each of the partial regression coefficients in comparable units. For any explanatory variable, X_k

$$\text{betak} = b_k \frac{S_x}{S_y}$$

Where, S_x is the standard deviation of the relevant explanatory variable, X_k and S_y is the standard deviation of the dependent variable, Y (Feinstein & Thomas, 2002).

Adjusted coefficient of multiple determination, $\bar{R}^2$

$\bar{R}^2$ is the corrected value of R^2 for explanatory variables plus the intercept which is represented by following equation,

$$\bar{R}^2 = 1 - \left\{(1 - R^2)\frac{n-1}{n-k}\right\}$$

Where, k = the number of explanatory variables plus the intercept, and the number of degrees of freedom, df =k-1. The equation explains that if the sample size is large then there is a little difference between $\bar{R}^2$ and$\bar{R}^2$. But if the sample size is small and the explanatory variable is large then the difference is significant (Feinstein & Thomas, 2002),

The coefficient of multiple correlations, R: The coefficient of multiple correlations (R) represents the overall variation in the dependent variable provided by the all-independent variables together. Numerically, for any given set of variables, R is simply the square root of the corresponding coefficient of multiple determinations, R^2. By convention R is always presented as positive, but the sign of the overall correlation coefficient has no meaning, since some of the explanatory Variables may be positively correlated and others negatively, R can vary between 0 and 1. A value of 0 indicates no linear relationship, but - as with the two-variable case - it is always possible that there is a strong nonlinear relationship (Feinstein & Thomas). 2002).

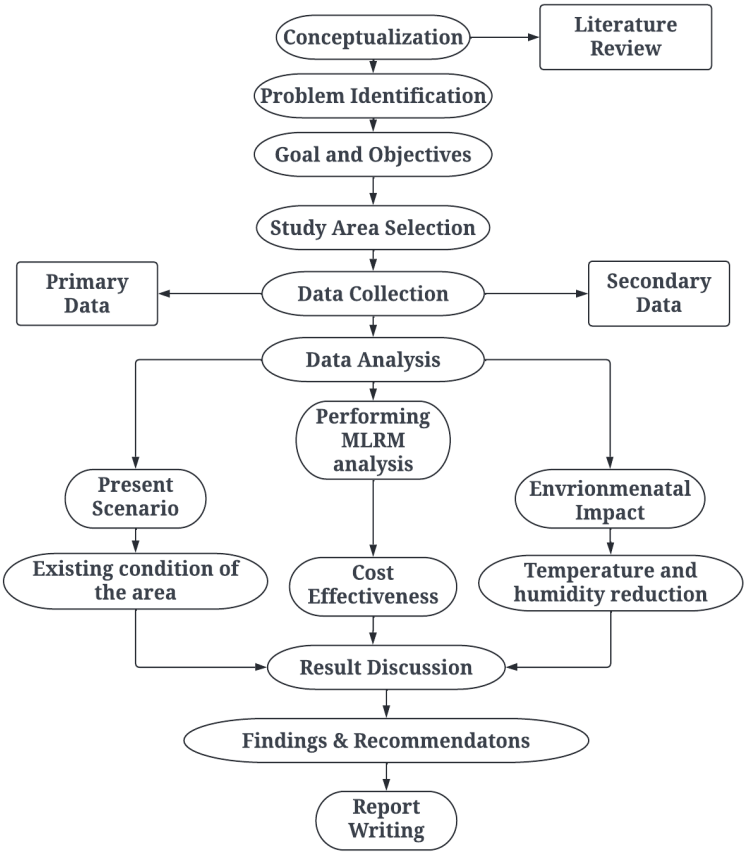


Figure 4.1: Flowchart of the Methodology

5 Present Scenario of Rooftop Gardening in Kadamtali Thana

5.1 Existing condition of rooftop gardening: Different kinds of people live in that area. They are associated with different types of the occupation. The tendency of practicing rooftop gardening is very satisfactory in that area. Most of the houses have rooftop garden in their roof. It should be mentioned that all but a few houses the owner of the house is practicing the garden. This is because the house owner doesn't want to allow any other person to use their roof for practicing the garden. The area is not full of high rise building so it is convenient to practice the rooftop gardening in that roof. Most of the households are not so rich. The monthly income of the people of that area is average.

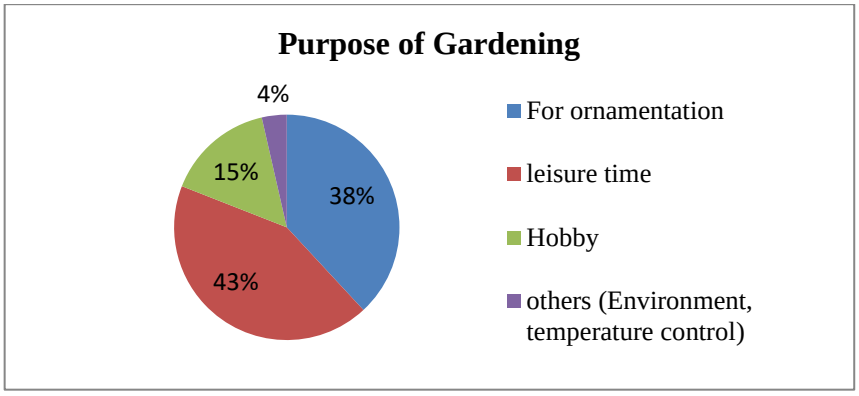


Figure 5.1: Purpose of the gardening
Source: *Field Survey, 2021*

The figure 5.1 represents that the purpose of practicing the rooftop gardening in the surveyed area. After analysing the data, it is found that maximum number of the people are practicing the gardening is for pasting their leisure time. The percentage is of 43 percent from whole data. Also, about 38 percent of people are practicing for ornamentation purposes. About 15 percent and 4 percent of people are practicing for hobby and other like temperature control respectfully. There are different number of plants are cultivated in the rooftop garden of the surveyed area. The plants are divided into ornamentals plants, fruits plants, vegetable plants

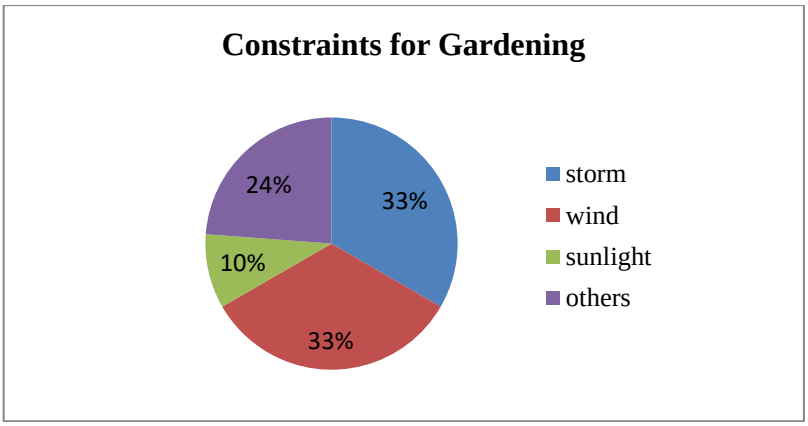


Figure 5.2: Constraints for Gardening
Source: *Field Survey, 2021*

The figure 5.2 shows the constraints of gardening while practicing the gardening in the study area. It is found that about 33 percent of the obligation of practicing gardening is storm and wind. It was said that most of the plants were broken and fell off from the roof because of the strong wind and storm. Also, about 24 percent of the household experiences the sunlight as the obstacles for practicing the garden. Only 10 percent have claimed the constraints are from others source such as heavy rainfall claimed by the households.

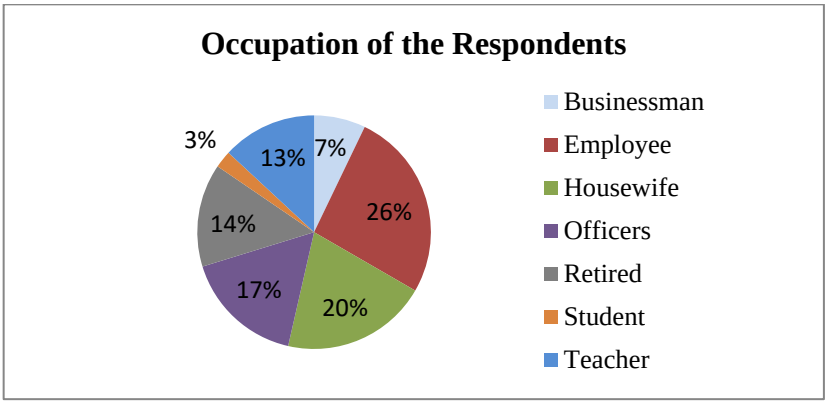
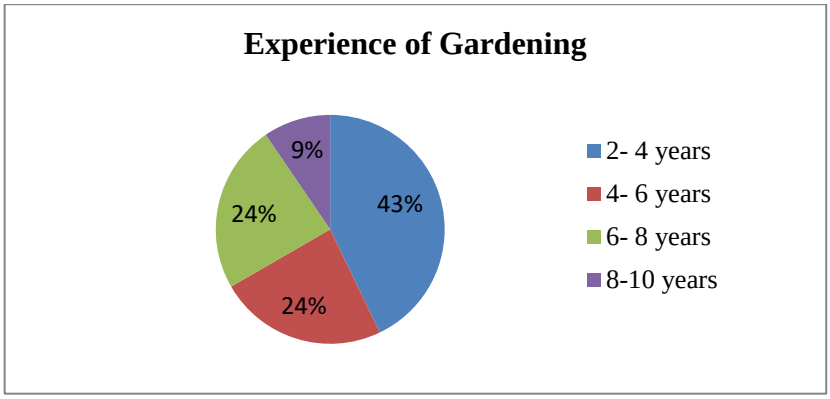


Figure 5.3: Occupation of the Respondents
Source: *Field Survey, 2021*

In the figure 5.3 shows the occupation of the respondents who are practicing the rooftop gardening on their house. In the figure, it is shown that most of the practitioners are employee and housewives. The percentage of the practitioners who are employee and housewife are of 26 percent and 20 percent respectfully.



5.4: Experience of practicing rooftop gardening
Source: *Field Survey, 2021*

The figure 5.4 represents the experience of gardening of the respondents. It is found that about 43 percent of people are practicing the gardening for 2 to 4 years. Also, about 24 percent of the respondents are practicing the rooftop gardening from 4 to 6 years and 6 to 8 years. Rests of the respondents are practicing the gardening for 8 to 10 years.

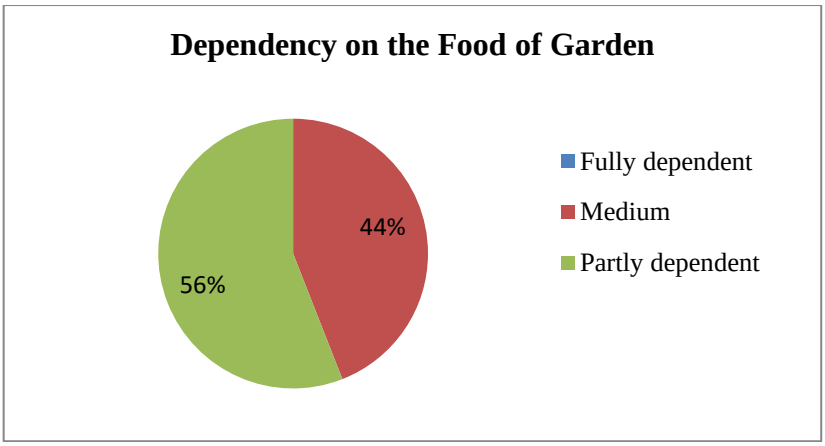


Figure 5.5: Dependency on the garden
Source: *Field Survey, 2021*

The figure 5.5 represents the dependency of the respondents on the food of the garden. The result shows that almost 56 percent people are partly dependent on the food of the rooftop garden for their daily needs. Also, about 44 percent of the respondents are medium dependent on the garden. And it is shown that none of the respondents are fully dependent on the garden for daily food products.

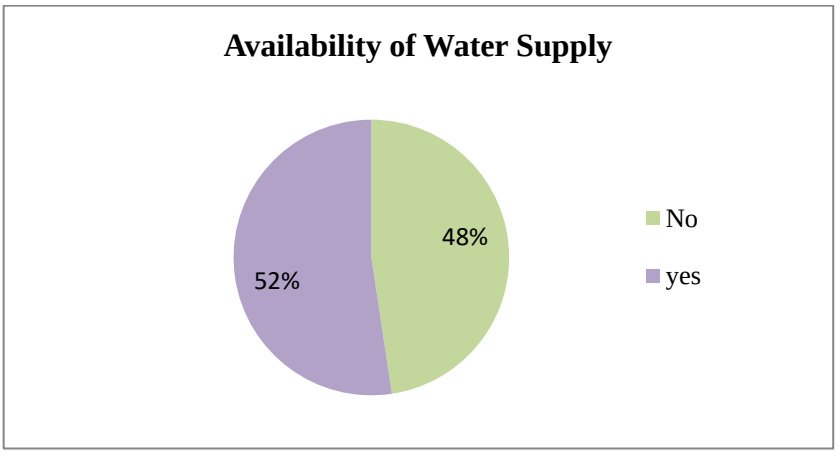
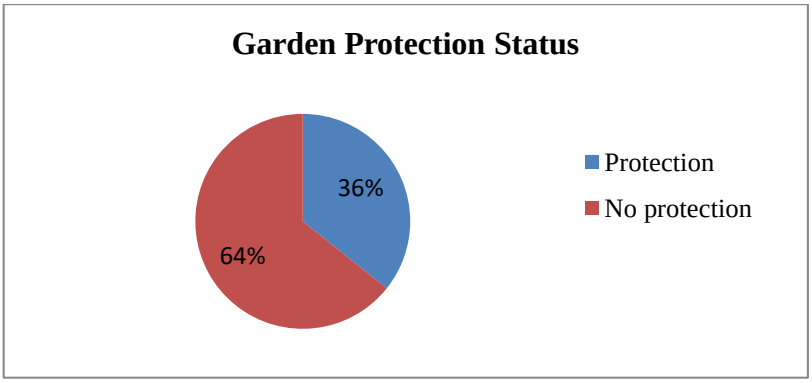


Figure 5.6: Availability of Water Supply
Source: *Field Survey, 2021*

The figure 5.6 represents the percentage of the water supply facility on the garden. It is found that most of the garden has the water supply facility on their roof. But the ratio between the availability and non-availability of water supply is almost close enough. The respondents who don't have water supply on their roof are managing the water from their home tap.



5.7: Protection Status of the Garden
Source: *Field Survey, 2021*

The figure 5.7 represents the status of the protection of the garden from different consequences in the study area. About 64 percent of the garden has no protection and 36 percent of the garden has the protection on its roof. Most of the roofs are protected by the tin shed, iron grill, straw shed, fencing, etc. Protection is from the storm, wind, excessive rainfalls, etc., and also from insects, birds, etc.

5.2 Challenges for practicing the Rooftop gardening: Getting the roof damp is one of the major challenges for the practitioner of the garden. There are many houses has some incidents of the plant being stolen from the roof. The protection of the plants is a great matter of concern. Lack of proper knowledge of the gardener is another concerning matter as the outcome of the garden is highly dependent on it. There are no facilities to provide the training for making a sustainable roof garden in the particular area. In most cases, the house renter cannot get permission from the owner for building a rooftop garden on the house.

6 Economic Relationship with Respect to Rooftop Garden Parameters

Table 6.1: Descriptive Distribution of cultivation cost and total income from rooftop gardening

Variables	Minimum	Maximum	Mean	Std. Deviation
Cost of Maintaining of the garden	2000	7000	4321.429	1547.7206
Income From rooftop garden	2000	10500	6636.905	1890.6096

Source: *Prepared by Authors, 2022*

Table 6.2: Descriptive statistics of independent variables with respect to Range, Mean, Median Standard Deviation and Coefficient of variance values

Variables	Minimum	Maximum	Mean	Std. Deviation	CV%
Age (X_1)	22	68	42.07	12.289	29.21
Education (X_2)	5	18	12.15	3.221	26.51
Family size (X_3)	2	7	4.15	1.207	29.08
Years of gardening (X_4)	2	9	5.04	2.187	43.39
Rooftop area in sq. ft. (X_5)	360	2160	1238.57	494.653	39.93
Rooftop height in ft. (X_6)	10	70	40.59	14.086	34.70
Hours of gardening (X_7)	1	3	2.07	0.672	32.48
Cultivation cost per year (X_8)	2000	7000	4321.42	1547.720	35.81
Organic manure (X_9)	250	1000	538.69	156.072	28.97
Pesticide Apply (X_{10})	120	500	298.92	115.466	38.62
Fertilizer (X_{11})	250	1200	648.80	208.114	32.07

Source: *Prepared by Authors, 2022*

6.1 Coefficient of Correlation

Table 6.3: Coefficient of Correlation between Total Income and independent variables

SL. No.	Variables	R value	Remarks
1	Age (X_1)	0.131	
2	Education (X_2)	0.514	Sig.
3	Family size (X_3)	.160	
4	Years of gardening (X_4)	-0.14	
5	Rooftop area in sq. ft. (X_5)	0.918	Sig.
6	Rooftop height in ft. (X_6)	-0.021	
7	Hours of gardening per day (X_7)	0.579	Sig.
8	Cultivation cost Annually (X_8)	0.523	Sig.
9	Organic manure (X_9)	0.522	Sig.
10	Pesticide Apply (X_{10})	0.003	
11	Fertilizer (X_{11})	0.685	Sig.
**Correlation is significant at the 0.01 level			

Source: *Prepared by Authors, 2022*

6.2 Multiple Regression Analysis

Table 6.4: Multiple Regression analysis between Total income and eleven independent variables (X_1-X_{11})

Sl. No.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Age (X_1)	3.374	7.293	0.022	0.463	0.645
Education (X_2)	19.528	29.121	0.033	0.671	0.505
Family size (X_3)	-84.559	72.774	-0.054	-1.162	0.249
Years of gardening (X_4)	-50.601	37.024	-0.059	-1.367	0.176
Rooftop area in sq. ft. (X_5)	2.817	.295	0.737	9.553	0.000
Rooftop height in ft. (X_6)	-6.462	5.876	-0.048	-1.100	0.275
Hours of gardening per day (X_7)	294.59	146.533	0.105	2.010	0.048
Cultivation cost Annually (X_8)	.009	.064	0.007	0.138	0.891
Organic manure (X_9)	.175	.658	0.014	0.266	0.791
Pesticide Apply (X_{10})	.306	.726	0.019	0.421	0.675
Fertilizer (X_{11})	1.546	.546	0.170	2.830	0.006
a. Dependent Variable: Earn From garden per year thousands (Y)					

Source: *Prepared by Authors, 2022*

6.3 Path analysis between the variables

Table 6.5: Path analysis Total income (Y) and eleven independent variables (X1-X11)

Variables	Total Effect	Direct effect	Indirect Effect	Remarks
Age (X_1)	0.131	0.022	0.109	
Education (X_2)	0.514	0.033	0.481	Sig.
Family size (X_3)	.160	-0.054	0.214	
Years of gardening (X_4)	-0.14	-0.059	-0.081	
Rooftop area in sq. ft. (X_5)	0.918	0.737	0.181	Sig.
Rooftop height in ft. (X_6)	-0.021	-0.048	0.027	
Hours of gardening per day (X_7)	0.579	0.105	0.474	Sig.
Cultivation cost Annually (X_8)	0.523	0.007	0.516	Sig.
Organic manure (X_9)	0.522	0.014	0.508	Sig.
Pesticide Apply (X_{10})	0.003	0.019	-0.016	
Fertilizer (X_{11})	0.685	0.17	0.515	Sig.
**Correlation is significant at the 0.01 level				

Source: *Prepared by Authors, 2022*

7 Evaluation 0f The Environmental Impact Containing Rooftop Gardening:

7.1 Comparative analysis between green roof and bare roof:

Table 7.1: Descriptive analysis of Temperature of bare roof and green roof

Temperature			
Description	**Minimum**	**Maximum**	**Mean**
Bare Roof	35.6	39.1	37.233
Green Roof	32.5	36.7	34.867
Top floor of Bare roof	32.9	37.3	35.0467
Top floor of the green roof	30.1	34.5	33.14

Source: *Prepared by Authors, 2022*

Table 7.2: Descriptive analysis of Relative Humidity of Bare roof and green roof

Humidity			
Description	**Minimum**	**Maximum**	**Mean**
Bare Roof	58	62	59.8667
Green Roof	61	66	63.4
Top floor of Bare roof	60	63	61.6
Top floor of the green roof	63	68	65.4

Source: *Prepared by Authors, 2022*

Assumption: There are so many Factors that Affecting Temperature and humidity. These are not a universal value and depends on a number of constituents, including slope, vegetation cover, compaction, moisture, and naturally, the sunlight available. The survey has been conducted at 12 pm to 2 pm. Since the limitation of device and enough manpower, the time of taking the temperature and humidity could be kept in consideration. Furthermore, there is no water body besides of that area. The study area is situated in old Dhaka, so the buildings are congested with one another. Temperature and humidity have been taken almost same height of building and has been almost tried to take readings at nearby buildings. For this, height of the building has been considered constant while recording the temperature and humidity. Again, every roof of the building has been made by same kinds of materials in that area. The roof conditions are same while practicing the rooftop gardening. It can be said that the moisture of the building's roof will be same for the study. So, it is clear that the temperature and humidity of roof and topmost floor of the building is changed for practicing the rooftop gardening on that building.

7.2 Relation between Vegetation Coverage with Temperature and Humidity

Table 7.3: Distribution of Respondents with respect to vegetation coverage

Category	Range	Observed	N	P (%)	Mean	SD
Low	Up to 25%	25-86%	2	5	60.615	17.49401
Moderate	25%- 50%		16	40		
High	50%-75%		12	30		
Very High	>75%		10	25		
Total			40	100		

Source: *Prepared by Authors, 2022*

Table 7.4: Distribution of Respondents with respect to Temperature

Category	Range	Observed	N	P (%)	Mean	SD
Low	Up to 30ºC	30-35ºC	1	2.5	32.3325	1.1665
Moderate	30-32ºC		22	55		
High	32-34ºC		16	40		
Very High	>34ºC		1	2.5		
Total			40	100		

Source*: Prepared by Authors, 2022*

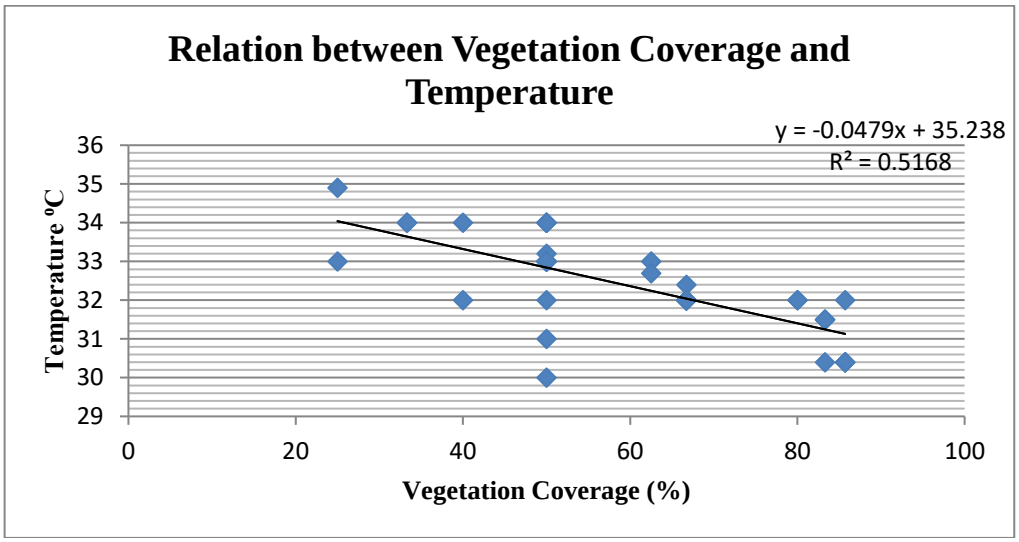


Figure 7.1: Relation between Vegetation Coverage and Temperature
Source: *Field Survey, 2021*

The figure 7.1 shows the relationship between the temperature and vegetation coverage. Temperature has been taken in degree Celsius and the vegetation has been transformed to percentage. In the figure, it is found the negative relationship shown by the regression line. It represents in high vegetation coverage area gives low temperature and in low vegetation area gives high temperature. The linear line shows the negative change. R^2 Value is of 0.5168 which is significant.

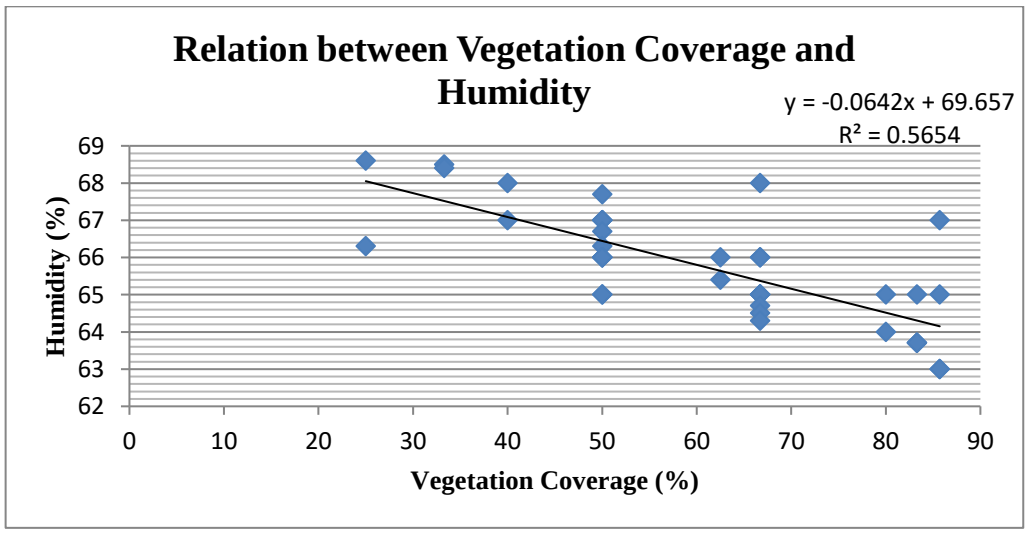


Figure 7.2: Relation between Vegetation Coverage and Humidity
Source: *Field Survey, 2021*

The figure 7.2 shows the relationship between the Humidity and vegetation coverage. Both humidity and vegetation coverage has been taken in percentage. In the figure, it is found the negative relationship shown by the regression line. It represents in high vegetation coverage area gives low humidity and in low vegetation area gives high humidity. The linear line shows the negative change. R^2 Value is of 0.5654 which is significant.

8 Findings and Recommendations

The gardening has economically significant as there are some good amounts of income has been come from the gardening. Almost 2000 BDT has been earned from rooftop garden per year which is less but not a loss project. Frequency of the income is correlated to education, rooftop area, cost of cultivation and organic manure and fertilizers. Also, income has directly affected by rooftop area, organic manure and fertilizers. From the research it is found that the rooftop garden reduces almost 2ºC of temperature as well as decreases almost 4 % of humidity of the roof. It is also found that the rooftop garden can reduce the temperature and humidity of top floor of the building is about 2ºC and 4 % respectfully. There is a negative relationship between rooftop garden area coverage with temperature and humidity. It is found that when rooftop coverage is high temperature become low as well as when garden coverage low temperature become high. Again, when rooftop coverage is high humidity become low as well as when garden coverage low humidity become high. It can be said that the rooftop garden is economically sustainable. So, the practice of the garden should be increased. The project is not the loss project and has some return from it. Government should take some initiative to improve the scenario of the rooftop gardening. Such as government can reduce or remission the holding tax if there is a rooftop garden on the building. Proper instruction and guideline have to be provided for better implementation and installation of the garden on the roof. Government should make this gardening commercially in every area and provide funding for the improvement of this sector. There is proper research has to be conducted on this topic to obtain better way of practicing the garden. There are some training facilities should be provided to the people to become more skilful for better result. The rooftop garden should be made more cost effective so that the house owner of the building will be interested to build the garden on their roof. As it is shown that rooftop gardening reduces the temperature; it can diminish the use of air-conditioner of the building.

9 Conclusions

It is important to know the present scenario of the garden as well as the challenges for practicing the garden in the study area. It provides the important information about the strength and weakness of the rooftop gardening. Besides, it gives an idea about what initiative should be conducted in that area. This study finds out the cost effectiveness of the rooftop gardening and how it becomes cost effective to perform. But the study cannot evaluate the way of increasing the cost effectiveness of rooftop gardening. Also, rooftop gardening has environmental impact by reducing the temperature. The study shows the environmental impact on reducing the temperature but it does not evaluate the other parameters to create environmental impact in the study area. The study shows the rooftop garden is beneficial for the economic and environmental concerned. For this there are some objectives has been set to complete the work. In further, roof top gardening can be a center of the research. The rooftop garden can be practiced commercially in future.

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