STUDY ON PRESENT PRACTICES AND BARRIERS OF ROOFTOP GARDENING IN GAZIPUR CITY

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CERTIFICATE

This is to certify that the thesis entitled ***"STUDY ON PRESENT PRACTICES AND BARRIERS OF ROOFTOP GARDENING IN GAZIPUR CITY"*** *submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka, in partial fulfillment of the requirements for the degree of* ***Master of Science (MS)*** *in* ***Agroforestry and Environmental Science*** *, embodies the result of a piece of bonafide research work carried out by* ***Md. Motlebur Rahman Bappi****, Registration No.* ***1809259,*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated: December, 2020
Dhaka, Bangladesh

Md. Shariful Islam
Assistant Professor
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Dedicated To

My

Beloved Parents

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STUDY ON PRESENT PRACTICES AND BARRIERS OF ROOFTOP GARDENING IN GAZIPUR CITY

ABSTRACT

Rooftop gardens are expected to be one of the most effective ways to improve urban inhabitants' nutritional health while also contributing positively to the environment. From the 5th of January to the 25th of February in 2020, a survey of 100 families was conducted in three metro areas in Gazipur city, Bangladesh. According to the study, maximum (98%) respondents used roof gardening as a hobby; 62% were low experienced in roof gardening; half (52%) of them started roof gardening recently (2005-2014) and 67% of the building were used as roof gardening at 3rd -5th stories of the building. More than half (55%) of the total roof area was used as roof top garden where fruit (100%), flower (100%), vegetables (100%) and others (88%; eg. medicinal, spices etc.) were found to be grown. All (100%) respondents used soil as media in small sized plastic half drum and practiced irrigation and weeding operation in a regular basis. In terms of economic value, 43% of the gardener earned medium income (1001-1500 Tk.) per season from their rooftop garden. Majority (72%) of the gardener faced medium problems in their RTG's whereas "insect, pest and disease infestation" had been ranked as 1st problem.

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ACRONYMS & ABBREVIATIONS

AEO	: Agriculture Extension Officer
BARI	: Bangladesh Agricultural Research Institute
DAE	: Department of Agricultural Extension
PCI	: Problem Confrontation Index
RTG	: Roof Top Garden
SAAO	: Sub Assistant Agriculture Officer
SAU	: Sher-e-Bangla Agricultural University
SD	: Standard Deviation

CHAPTER 1

INTRODUCTION

Today in this world, more than fifty percent of the population are living in urban areas and this percent is expected to increase to 69% by 2050 and 90% in 2100 (UN, 2014). Now, the urban growth and development is very fast and this urbanization process is placing a massive demand of food supply systems in the urban areas. Furthermore, many cities in the world are also facing problems like rapid reduction of green space and increase in heat island effect. In that case, urban agriculture or rooftop farming is promoted as a potential solution to solve this problem (Smit *et al*., 2001). Rooftop faming can improve the microclimate of the building by reducing the temperature that mitigate the urban heat island effect (Ries, 2014). Rain water is captured and absorbed by the plants and overflowing impact on infrastructure is reduced (Ries, 2014). Farming in rooftops helps to increase biodiversity and provide habitat for a variety of insects and birds. Rooftops filled with vegetation can be a great place to relax. The absorption of rain water by plants limited the overflowing impact of building infrastructure (Dubbeling *et al.,* 2014).

Rooftop gardens guide the social life, as an area to be satisfied outside surroundings with household and friends. It additionally develops an experience of self-identification and independence, the place one can in particular acquire self and emotion legislation viewing special flower detached seasons (Rashid and Ahmed, 2009) and affords restorative ride from stressful daily things to do in city excessive upward shove residential building. Roof gardening has additionally a promising plausible as small-scale enterprise that can speed up extra household income. Nevertheless, it may additionally generate some employment services via its backward and ahead linkages. The manufacturing of clean fruits and greens of the rooftop backyard can be multiplied dietary fame of family contributors of the city residents. It will make a high-quality contribution to the environment. The important reason of roof gardening is passing amusement time, growing aesthetic values, contributing in environmental amelioration and economic reap (Sajjaduzzaman, 2005). On the different hand, the financial and social gain of roof pinnacle gardening along with clean meals furnish for city residents, converts the tough floor into smooth green surface, power saving, etc. (Rashid *et al*., 2010).

Bangladesh is an over populated country with limited land. Though the home yard of our villages has some space for gardening but our urban areas lack enough space for gardening. In this aspect roof gardening may be alternative of it. In Gazipur, one of the fastest growing cities in Bangladesh, open and cultivable land has been converting to built-up area indiscriminately and thus agricultural land has been decreased at an alarming rate (Islam and Ahmed, 2011).

Various kinds of plants are found in roof gardening. It may be vegetables, flowers, cactus, medicinal plants, orchids etc. Among the vegetables; okra, papaya, carrot, indian spinach, chili, brinjal, tomato, snake gourd, bitter gourd, ridged gourd, bottle gourd, sponge gourd, long yard bean, common bean, lettuce etc. are common (Mannan, 2016). Among the fruits; citrus (lemon, malta, orange etc.), olive, cherry, guava, mango, litchi, ber, jam(berry), star fruit etc. are common. Red rose, periwinkle, aparazita (blue and white), jasmine, gardenia, cosmos, orchid flower, bauganvelia, balsumetc are more common among the flowers. Medicinal plants are aloevera, basil, mint leaf etc. There are also some spices such as cardamom, coriander, turmeric, black pepper, chili etc. are available. There are so many ornamental leafy plants available in roof gardening. Implementing rooftop farming can be a possible solution to reduce the food and nutrient supply problems, make urban living more self-sufficient and make fresh fruits more accessible to urban individuals (Karmakar, 2016). A survey shows that most of the roofs of Gazipur city are suitable for gardening and do not require major improvement work, sometimes only need some modifications (Islam, 2004).

Gazipur city is a major industrial city located 25 km north of Dhaka. The urbanization and population in this city is increasing rapidly. So, keeping the nutritional and environmental issue in mind, urban agriculture need to be developed in this area. As part of those requirements the study was carried out to fulfill the following specific objectives.

1.1 Objectives of the Study

I. To find out the socio-economic condition of the urban gardener
II. To identify the present scenario of roof gardening in Gazipur city
III. To find out the possible combination of plant species
IV. To gather the problems confronted by the urban gardener of the study area

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to review the past studies conducted by different researchers related to the present study. As far as possible the researcher tried to review the available literature from different countries related to present status of rooftop garden and constraints in rooftop garden practices. This chapter comprises of three sections. In the first section literatures relating to concept of the characters of the respondents. The second section is in connection with the present practices of rooftop garden and finally the third section of this chapter deals with the barriers in rooftop garden.

2.1 Studies Regarding the Selected Characteristics of the Respondents

Education, rooftop area, diversity of plants, labour charges, organic manure, fertilizer variables had been found to exert strong and determining contribution to total income from the study of "Rooftop Gardening: Estimation of Income from a Score of Socio-Ecological Variables" (Acharya *et al*., 2020).

Sheel *et al*. (2018) found from her survey was that majority of the rooftop gardeners belonged to the group of old age (40%), undergrad and above level of education (61.6%) and small family size (55%) with high annual income (41.7%). Almost 65% of the respondents had small size ($\leq$1000 ft^2) roof area suitable for gardening. The rooftop gardeners earned very poor economic benefit from the garden compared to bearing large expenditure for it. Most of the respondents cultivate vegetables (56.65%) and flowers (62.5%) but less number of respondents (13.54%) cultivated more than four types of fruit in their roof top garden.

Rosenbarg and Hovland (2010) kept in mind while framing the structural arrangement for the dependent and independent variables. Problems of roof top gardening of the respondents as dependent variable which is supposed to be influenced and through interacting forces of many characteristics in his/her surroundings. It is therefore, necessary to limit the characteristics which include age, family size, education, family annual income, use of information sources, and attitude towards roof top gardening, training exposure and knowledge on roof top gardening.

Nira (2006) conducted a survey on "Adoption of Roof Gardening at Mirpur-10 area under Dhaka City" and found that out of nine selected characteristics of the respondents, family size, roof gardening experience, use of information sources, attitude towards roof gardening and knowledge on roof gardening had positive significant relationship with their adoption of roof gardening.

Kamron *et al*. (2006) reported that the selected characteristics of the respondents viz. age of the respondents, their family size, roof area experience in roof gardening, and knowledge of roof gardening had significant relation in their adoption and evaluation of roof top gardening.

Islam (2004) found results on "Rooftop gardening as a strategy of urban agriculture for food security: The case of Dhaka city, Bangladesh" showed that the influential variables viz; roof top area, media contact and knowledge were significant contributors on using roof top for gardening.

2.2 Conceptual Issues on Present Practices of Rooftop Garden

Results of the study by Bhuiyan & Ferdous (2021) showed that more than 60% of the respondents got direct support from their roof top gardening during this COVID-19 situation. Almost 41% of the respondents claimed that this food supply was enough for them to sufficiently meet their need for vegetables for a single day. Most importantly, more than 90% of the respondents shared that, if provided with proper training and necessary supports, roof top gardening can be the best solution to ensure food security in post pandemic world.

Dutta *et al*. (2021) revealed that the habit form of the recorded plant composition indicated that herbs (35%) constitute the major plant category followed by trees (34%), shrubs (17%), climbers (12%), ferns (1%) and orchids (1%). The study also indicated that exotic species (50.3%) became dominant than native species (49.7%) in Chattogram city because of their scenic beauty, easy propagation and ornamental value to the city planners and inhabitants.

Mondal and Acharya (2020) conducted a study on "Rooftop Gardening: Estimation of Income from a Score of Socio-Ecological Variables" showed that majority of the practitioners were growing fruits, vegetables and flowers plants organically and they

were able to meet their household requirements to a great extent except during the summer season.

Chowdhury *et al*. (2020) suggested that rooftop agriculture can improve various ecosystem services, enhance the biodiversity of urban areas and reduce food insecurity. Food production from green roofs will help support and sustain food for urban communities and provide a rare opportunity to grow food efficiently in typically unused spaces.

Hossain *et al*. (2020) showed the experimental analysis of thermal performance resulted that the average roof air temperature is reduced by 5.2°C with roof garden while average room temperature is reduced by 1.7°C with roof garden compared to bare roof in the diurnal period. Moreover, the temperature of the residence with roof garden stayed near the thermal comfort zone on maximum hour of the day. In the survey result,60% of the respondents were found to stay within thermal comfort zone which was positively correlated to the vegetation coverage of that roof.

Sheel *et al*. (2019) point out that 100% of the rooftop gardeners used to exercise the intercultural operations of irrigation and weeding alongside with training/pruning (81.7%), control of insects-pests (75%), decoration (70%) and thinning (51.7%). But, most of the intercultural operations had been conducted as per demand and in that case the respondents did now not observe any normal frequency.

Moazzem (2019) studied that 72% respondents used half of plastic drum, 62.5% plastic pot, 59% earthen pot, 53% half-drum made through GI sheet, 51% plastic bucket, concrete made bed/drum and 41.6% plastic tray in the study area of Dhaka.

Sheel *et al*. (2019) stated that, Ant (65%), mealy worm (36.7%) and green leaf hopper (13.3%) were suggested as the primary bugs by means of the rooftop gardeners. There had been also some minor insects named with the aid of whitefly, lemon butterfly, crimson pumpkin beetle, aphid, termite, fruit borer etc. On the other hand, majority (23.3%) of the rooftop gardeners cited about die back; whereas viral diseases, leaf curling, leaf hot and fungal diseases constituted 21.7%, 18.3%, 15% and 13.3%, respectively.

Morshed *et al*. (2019) conducted a study and the study revealed that 66% rooftop gardeners and 70% homestead gardeners preferred gardening for production of healthy and fresh food. There were fruits (97%), vegetables (86%), flowers (64%), spices (72%), medicinal plants (64%), ornamental plants (23%) and plantation crops (12%). They had spent only less than half-an-hour to an hour for gardening. About 28% homestead gardeners received training on gardening from GOs and NGOs while most of the rooftop gardeners gained knowledge from agro-based television programs. A very few gardeners (18%) considered rooftop gardening for economic benefit while a remarkable number of homestead gardeners (24%) considered gardening for economic return on top of producing fruits and vegetables for family consumption.

Kumar *et al*. (2019) found that rooftop farming can benefit the environment by greatly reducing carbon in the atmosphere and can assist urban areas by reducing storm water management cost.

Safayet *et al*. (2017) conducted a survey on "Present practice and future prospect of rooftop farming in Dhaka city: A step towards urban sustainability." and found the most significant findings from the non-practitioner survey is that maximum people are willing to practice rooftop farming and want to provide at least 50% of roof space for rooftop farming.

Uddin *et al*. (2016) found a satisfactory result about crop production in roof top garden. More than 90 vegetables, 60 fruits and 25 spices are being grown in the country. He also indicated that skilled manpower is essential for ensuring success of rooftop gardening at household level. Skills can be improved by training and it could have a role to play in the food production process.

Uddin *et al*. (2016) found from their study that the highest 72% respondents used half plastic drum, 62.5% plastic pot, 59% earthen pot, 53% half-drum made by GI sheet, 51% plastic bucket, concrete made bed/drum and 41.6% plastic tray. In Chittagong areas, the highest 42% respondents used concrete made drum, 40% half-drum made by GI sheet, 31% plastic/earthen pot, 27% half plastic drum, 16% plastic bucket, 7% concrete made bed and 5% plastic tray.

Das *et al*. (2016) found in the case of fruits, the highest average yield was obtained from guava (6.5 kg/year/RTG), followed by mango (4.8 kg), papaya (3.6 kg), hog-plum (3.3 kg), lemon (3.3 kg), wax apple (2.9 kg), jujube (2.0kg), pomegranate (1.4 kg) and sapota (1.0 kg) in Dhaka city areas. In Chittagong areas, the highest yield was obtained from papaya 7.1 kg followed by lemon (5.4kg), wax apple (4.1kg), guava (3.2kg) and mango (2.7 kg).

Khondaker *et al*. (2016) estimated the highest gross return came from fruits as v Tk. 1486 and vegetables as Tk. 1200 while it was Tk. 1395, Tk. 833.5 and Tk. 562.0 respectively in Chittagong areas. Differences of gross return were found statistically highly significant at 1% level of probability in Dhaka but it was statistically insignificant in Chittagong.

Uddin (2016) stated that approximately 25 vegetables and 20 fruits were found to be grown in the current rooftop gardening both in Dhaka and Chittagong city areas. He found that the highest 75% respondents grew mango followed by lemon (72.8%), Guava (72.8%), Pomegranate (38.5%), Hog-plum (26.5%), Jujubee (24.5%), Papaya (24%), Wax apple (13%), Malta (12.8%) and Sapota (10.5%) in Dhaka city areas. In Chittagong city areas, the highest 69% respondents grew mango followed by Guava (74.5%), Lemon (64%), Hog-plum (42.3%), Pomegranate (33.5%), Jujubee (29%), Orange/Malta (22%), Wax apple (20%), Sapota (13%) and Papaya (11%).

In the study of Uddin *et al.* (2016) published that per family whole rooftops house used to be recorded as 1916 sq. ft in Dhaka metropolis areas. Of them common 1593 sq. ft used to be regarded as viable area for gardening and 323 sq. ft used to be remained as open however at present the open house are being used in extraordinary functions through the proprietor of the building

Uddin *et al.* (2016) found in the study that, in Dhaka areas, about 25 veggies and 20 fruits have been observed to be grown in the contemporary RTG‟s. But the composition of fruits and greens various extensively amongst the household. The best 61.6% rooftop gardeners produced tomato accompanied by means of brinjal (61%), Indian spinach (47.8%), Lady‟s finger (46.8%), Chilli (45.3%) and Gourds‟ (25%) irrespective of all chosen metro areas of Dhaka metropolis. In the case of fruits, the best possible 75% respondents have grown mango observed via lemon (72.8%),

Guava (72.8%), Pomegranate (38.5%), Hog-plum (26.5%), Jujubee (24.5%), Papaya (24%), Wax apple (13%), Malta (12.8%) and Sapota (10.5%) irrespective of all chosen metro areas in Dhaka town.

Uddin *et al.* (2016) discovered that in the chosen areas of Dhaka city, the easiest 72% respondents used half of plastic drum, 62.5% plastic pot, 59% earthen pot, 53% half-drum made through GI sheet, 51% plastic bucket, concrete made bed/drum and 41.6% plastic tray.

Thomaier (2015) stated the sophisticated growing systems like high-tech hydroponics to soil based crops cultivated in recycle containers like pallet cultivation have been used for roof top garden. But most of the case, the soil based containers was commonly used than other techniques. Small and large plastic tub, concrete structure also used for roof top garden with soil based media.

Iffat (2015) stated that seasonal fruits and vegetables were the major food produced from roof gardening. According to the survey, total 8 garden owners (20%) grow high food production which is more than 40kg/year and 21 of them (52.5%) grow 21-40 kg/year (medium) and 11 garden owners (27.5%) grow low production which is less than 20kg/year.

Kamrujjaman (2015) is the author of a book named “Green Banking” described about the thermal benefits of establishing roof top gardens and also assess the overall techniques and the plan of action of vegetables, fruits, flowers and the multifunctional uses of roof top garden.

Tanvir (2015) wrote an article on "Mitigating Climate Change Impacts on Urban Ecosystems-Prospects of rooftop gardens in existing buildings of Dhaka city, considering the make and pattern of such buildings" lie wrote that Dhaka city has 14% of open space whereas 25% of open space are required for fresh air and habitable living. They also found vegetation in the Dhaka metropolitan area is only 1.87%. Most of these areas are in the form of parks and roadsides greeneries. One study shows that roof gardens can reduce the indoor air temperature 6.8°C from outdoor during the hottest summer period when the outdoor temperature is recorded 39.72°C.

Rahman *et al*. (2013) conducted a study and revealed that rooftop gardening is generally for mental satisfaction (95.3%) followed by leisure time activity (87.8%) in the study area and almost all the family members of gardeners were involved; while collection of planting materials, sites preparation and marketing of products were reported to be carried out by males only (male 71.33%). Middle income classes were most interested in rooftop gardening (43.78%). The survey recorded 53 plant species (35 families) of which Cucurbitaceae family represented highest eight species. Shrubs (28%) were highest followed by herbs (26%) among agri-crops (36%) and flower species (30%). About 89% of the rooftop gardeners procured planting materials from nursery, market, fair, neighbor, relative and friends and they mostly prefer to use seedlings (48%) for roof gardening followed by direct seed sowing (21%). Gardeners sell products sporadically in different local markets, directly or through intermediaries, with no uniform pricing for system. Rooftop gardening improves the food security and meet nutritional deficiency to the gardeners. Survey revealed that generally very few people consider rooftop gardening commercially to get profit and from the cost-return analysis this gardening system can be economically viable if proper and scientifically managed. The study conclude that active government and NGOs could play vital role to increasing this activity by providing training and motivate people with technical aspects of rooftop gardening.

Rahman *et al*. (2013) found that rooftop gardening is generally for mental satisfaction (95.3%) followed by leisure time activity (87.8%) in the study area they also found middle income classes were most interested in rooftop gardening (43.78%) from their study on "Present status of rooftop gardening in Sylhet City Corporation of Bangladesh".

Rahman *et al.* (2013) discovered that for rooftop gardening 77% used earthen containers, 8% cemented bed, 7% drums, 5% brass made pots and 3% others are in use.

Mostafa *et al*. (2013) found in his study about the present scenario of rooftop gardening in Sylhet City stated that most of the gardening was curious and fantasize about rising of rooftop garden because of income and economic importance. He also stated that most of the respondents involved rooftop gardening for their mental

satisfaction, aesthetic value, food safety, leisure and environmental amelioration. Only 29.8% of the respondents generate roof farming for their income purpose.

Rumana and Hamdan (2012) accomplished a thesis work on "Green roof and its Impact on Urban Environmental sustainability: The Case in Bangladesh". They Find that green application can reduce the indoor air temperature 6.8°C from outdoor during the hottest summer period when outdoor is recorded 39.72°C. comfort zone analysis for Bangladesh according to Sharma, Ali and Mallick (1995) during the summer season, the comfort temperature range is between 24 °C to 32 °C while relative humidity range is fixed in 50% (lower limit) to 90% (upper limit). According to the graph profile the indoor temperature of the residence shows that maximum hour of the day is stay within comfort temperature range. It is a desirable condition for the resident.

Rashid (2010) experimented the temperature potential of the rooftop garden in a six storied building and found the temperature of this building is 3 degrees less than other building and this can reduce the inside air temperature almost 7 degrees from the outside during the summer season of Bangladesh.

Rumana *et al*. (2010) described the economic and social benefit of roof top gardening including fresh food supply for urban residents, converts the hard surface into soft green surface, energy saving, etc.

Niu and Cabrera (2010) stated the effect of irrigation water quality has not been reported on in the literature supporting roof top agriculture, although general horticulture research has many examples of recommendations for pH, total dissolved solids (TDS), and/or specific nutrient or toxicity limits. Irrigation water was supplied by flexible pipe available at the local garden center and delivered via four directional nozzles at the corners of each module array, as well as one Omni-directional nozzle in the center module of each array. All nozzles were placed approximately 35 cm above the module surfaces, and irrigation was applied daily for about 10-15 minutes.

Castleton *et al*. (2010) described the recreational space at the roof level will reduce social problems that are normally encountered at public green spaces such as vandalism, assault and other problems. Contact with nature will results in improvement for the community to know more about environmental education. He

also indicated high-rise buildings can apply sky garden as green space provision in order to create a healthy living and precious environment.

Nira (2006) accomplished a thesis work on "Adoption of Roof Gardening at Mirpur-l0 Area under Dhaka City. She found that majority (62%) of the respondents possessed no adoption compared to 15% and 23% have low and medium adoption of roof gardening respectively. The main problem was lack of time for roof gardening. Most of the respondents were interested to flower plant for their roof garden.

Sajjaduzzaman (2005) reported that the major purpose of roof gardening is passing leisure time (100%), creating aesthetic values (100%), contributing in environmental amelioration (45%) and financial gain being a very minor concern (4% only) in Dhaka Metropolitan city of Bangladesh.

Islam (2004) noticed more than half of house owners (58.80%) did not use their roof top for gardening while 41.20% used for gardening from the study of "Rooftop gardening as a strategy of urban agriculture for food security: The case of Dhaka city".

Islam (2004) suggested that the rooftops of the residential constructions was once used for drying (88%) and washing (45%) clothes, as playground for youngsters (97%), for enjoyable friends (20%), for cool air in the course of the summer time (64%), to sunbathe in the wintry weather (33%). On most of the roofs, some shape of pleasure backyard exists (78%), every so often there are fruit gardens (12%), and, much less often, vegetable backyard as nicely (8%).

Islam (2004) determined that in the rooftop backyard the following fruits and greens are many times grown; Guava, Lemon, Papaya, Grapes, Green Chili, Pumpkin, Squash, Onion, Garlic, Coriander leaves, Tomato, Mushroom, Leafy veggies (e.g., Callaloo, Jute Leaf and Red Amaranthus), and different (e.g., Cucumber, Flat bean, Bitter ground, Ribbed ground, Ladies finger, Amaranthus, Dhudi, Cowpea and Brinjal).

Islam (2004) suggested that the rooftops of the residential constructions was once used for drying (88%) and washing (45%) clothes, as playground for youngsters (97%), for enjoyable friends (20%), for cool air in the course of the summer time (64%), to sunbathe in the wintry weather (33%). On most of the roofs, some shape of pleasure backyard exists (78%), every so often there are fruit gardens (12%), and, much less often, vegetable backyard as nicely (8%).

Brenneisen (2001) noticed that for green roofs, the functionality of a structured surface could be providing as well as the use of local soils effect the highest value of biodiversity. The extent of the area with a high environmental load could be reduced from 19% to 2% of the total. Furthermore, bio-ecological surveys underlined the need for the development of green roofs and the variety of designs available.

Bienz (1980) said that appropriate developing medium should be organized making sure ample water and mineral elements. A number sorts of containers had been used by way of the rooftop gardeners. The desire of containers was once established on availability, preferences and nature of the developing plants.

2.3 Literatures Relating to Barrier of Rooftop Gardening

Pal *et al*. (2020) found poor access to technical advice, non-availability of services and quality inputs at reasonable price, potential leakages, lack of training and follow-up etc. were the major hindrances found in sustaining the rooftop farming from their study named "Rooftop Gardening: Estimation of Income from a Score of Socio-Ecological Variables".

Mahmud *et al*. (2020) stated that in roof top garden all morphological and yield contributing character were suppressing due to the leaching of organic matter. The type of organic matter used will have a large influence on the amount of nutrients available, substrate biological activity and therefore also plant growth and performance.

Moazzem (2019) found from non-practitioner's survey that it had been explored why human beings were now not training rooftop farming. Most of them answered that they did now not have sufficient entertainment or free time to put in force and appear after the garden. 33.3% human beings told that they are busy with their private and

reliable works and do now not have sufficient time to spend on gardening or farming. Lack of technological information is additionally a constraint for not practicing. There are very few opportunities for acquire technological and farming knowledge. There is no government or non-public initiative to train humans and serve desirable farming facilities. So 25% people stated that they are no longer inclined to exercise as they do no longer have suitable farming knowledge. There is additionally a tendency to buy meals objects from near market places as a substitute than developing them. 19% people assume that it is easier to buy vital products from nearby market or kutcha bazar than developing on their rooftop as it requires time, labor and money. So they suppose they can have what they want by using spending some money. Lack of manpower is additionally a limitation.

From the study of Safayet *et al*. (2017) it was found that 33.3% human beings told that they are busy with their private and reliable works and do now not have sufficient time to spend on gardening or farming. 25% people stated that they are no longer inclined to exercise as they do no longer have suitable farming knowledge. 19% people assume that it is easier to buy vital products from nearby market or kutcha bazar than developing on their rooftop as it requires time, labor and money. 15.5% human beings suppose that it is a hassle to them of having no manpower. Only 7.2% humans answered that they do now not have enough area due to the fact their roof is used by way of other purposes. The major finding was that all of the respondents found rooftop farming beneficial but not all could practice it because of many constraints associated with rooftop farming. Most of them have fear of roof damage, so they are not adopting it. However, the respondents who are practicing rooftop farming find it difficult to manage because of lack of proper knowledge. Planting materials include plastic bags, crates, polythene and many other non-recyclable components.

Nira (2006) noticed that the main problem of roof gardening was lack of time from her study on "Adoption of Roof Gardening at Mirpur-10 Area under Dhaka City".

Aloisio *et al*. (2005) explored buildup of bicarbonate ions in the media from the irrigation water is the most likely mechanism responsible for the rise in pH in the media that used in roof farming. The change in chemical condition of the media is almost certainly a result of the irrigation water inputs.

Islam *et al*. (2001) identified the potential for and the possible barriers to urban agriculture with regards to roof top gardening. He also explored the strategies to promote food security in the megacities like Dhaka.

CHAPTER 3

MATERIALS AND METHODS

A sequential description of the methodologies followed in conducting this research work has been presented in this chapter.

3.1 Design of the study

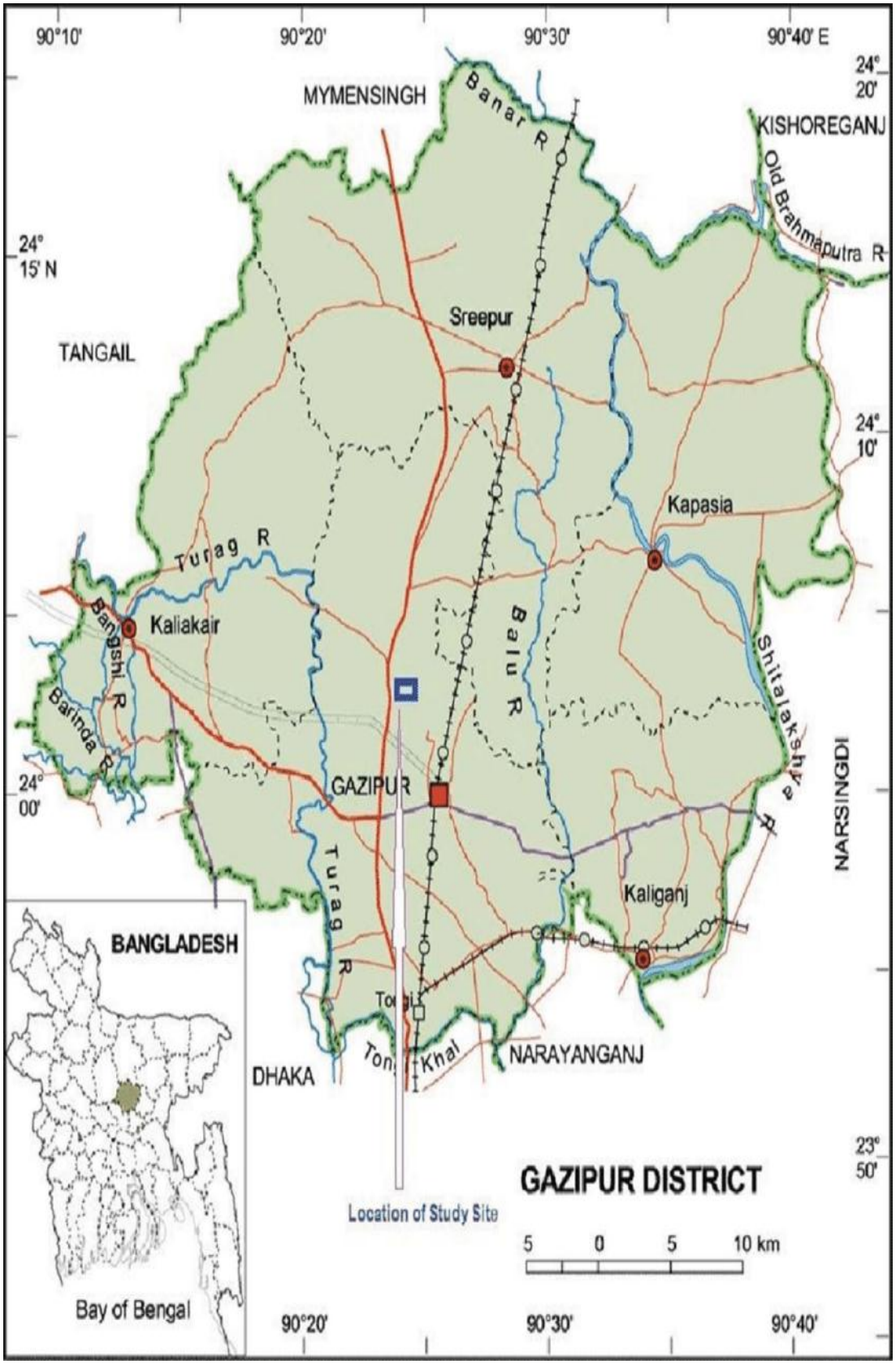
The present study was a social scientific survey. It was designed to study on present practices and barriers of rooftop gardening in gazipur city.

3.2 Locale of the study and sampling

Gazipur is a city in central Bangladesh. It is located in the Gazipur District and a major industrial city located 25 km north of Dhaka. The study was confined to three site of Gazipur city corporation, Gazipur. Those sites were Joydebpur Bazar, Chowrasta and Shibbari. The areas constituted a number of 250 rooftop gardens. Among of those, a total number of 100 rooftop gardens were selected randomly. Data were collected by using random sampling technique where each householder considered as the sampling unit and each householder was treat as active population of the study. The map of Gazipur district and Gazipur sadar are shown in Plate 1 and 2 respectively.

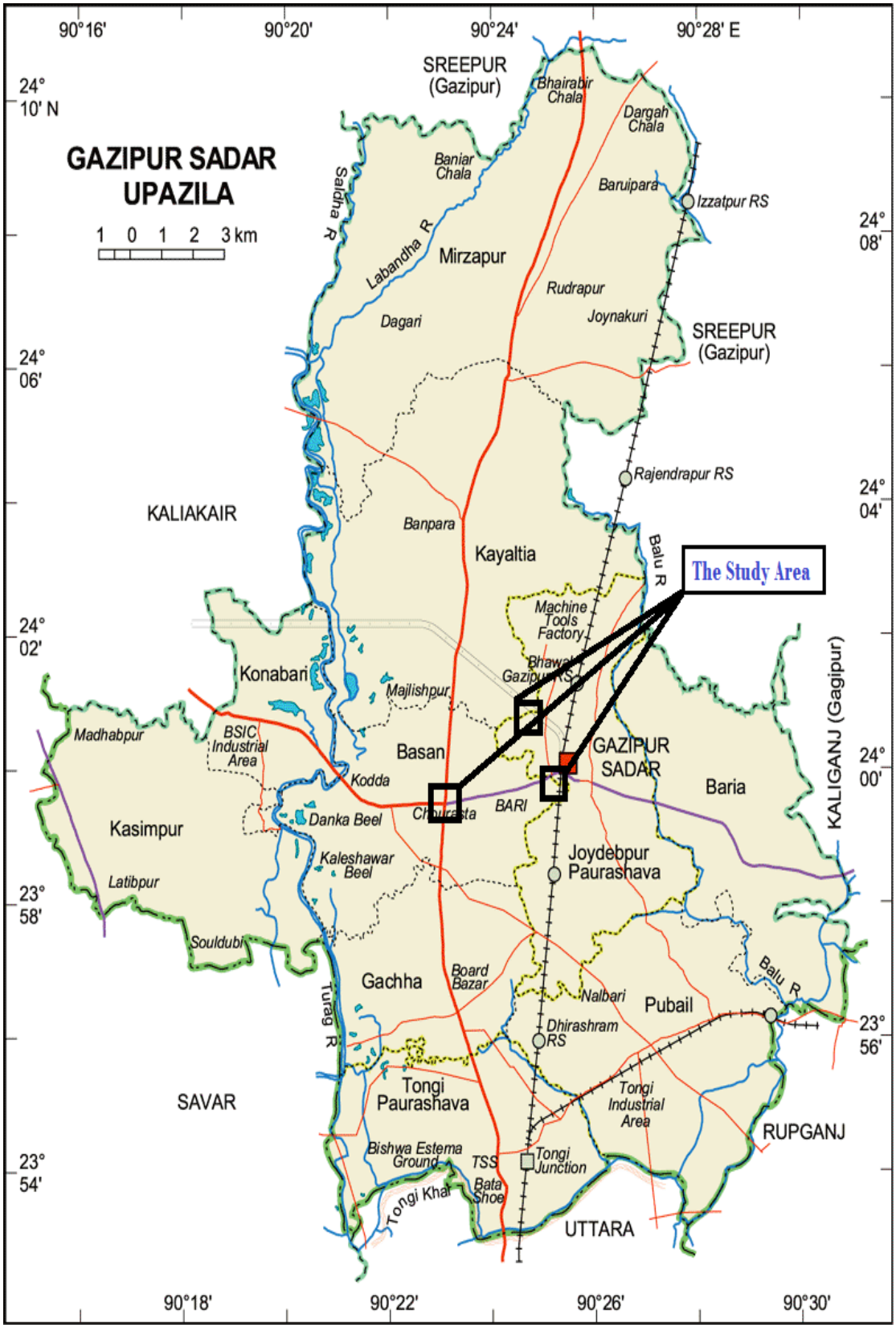
3.3 Preparation of interview schedule

An interview schedule was used as the research instrument in order to collect relevant information from the respondents (Rooftop gardener). The interview schedule was prepared for data collection in Bangla keeping the objectives of the study. The interview schedule contained both simple and direct form of questions to collect data on the selected variables. The interview schedule was pre-tested before final collection of data. After pre-test, necessary correction, addition, alteration and rearrangements were made. The interview schedule was then multiplied in its final form for collection of data. English version of the same interview schedule has been presented in the Appendix A.



(source: https://www.researchgate.net/figure)

Plate 1: A map of Gazipur District



(source: https://www.researchgate.net/figure)

Plate 2: A map of Gazipur Sadar Showing the study area

3.4 Data collection

Data were collected through personal face to face interview using interview schedule during 5th January to 25th February in 2020.

3.5 Data processing

After completion of survey all the interview schedules were compiled for data processing. At first all the qualitative data were converted into quantitative form by means of suitable code and score whenever necessary. In several instances, indices and scales were constructed through the simple accumulation of scores assigned to individual or pattern of attributes. Indices and scales are considered the efficient instrument for data reduction and analysis.

3.6 Selection of variables

3.6.1 Independent Variable

The study was included a total of 5 selected personal characteristics of the respondents as independent variable. Those are age, educational qualification, family size, experience in roof gardening and annual income of the respondents.

3.6.2 Dependent Variable

Data on present status of rooftop gardening as dependent variable was collected based on the parameters of the year of initialization of rooftop gardening, total roof area, actual roof area under gardening, elevation of the building where roof is situated, purpose of roof gardening, types of plants grown in roof garden, total cost of roof gardening, types of media, types of pot, size of pots used for roof gardening. The types of fruit plant grown on the roof top garden, number of fruit plants grown in different pot size, the variety of different fruit plants are also the parameters of the research work.

3.7 Measurement of variables

3.7.1 Measurement of independent variable

3.7.1.1 Age of the respondents

The age of a respondent was measured in terms of actual years from his birth to the time of interview on the basis of their response to the item no A.1 of the interview schedule (Appendix A). Based on age, the respondents were classified into young (≤ 35), middle aged (36-50) and old (>50).

3.7.1.2 Educational qualification of the respondents

The educational qualification of a respondent was measured based on his year of schooling as obtained from his responses to the item no A.2 of the interview schedule (Appendix A). Based on educational class they have passed, the respondents were classified into illiteracy (0), primary (1-5), secondary (6-10), higher secondary (11-12) and graduate and above (>12) respectively.

3.7.1.3 Family size of the respondents

The family size of a respondent was measured by the total number of family members who were eating and staying together as ascertained from the responses to the item no A.3 of the interview schedule (Appendix A). Based on family size, the respondents were classified into small (1-3), medium (4-5) and large family (>5).

3.7.1.4 Experience in roof gardening of the respondents

The experience of a respondent about roof gardening was determined on the basis of the year that how long he is being involved in roof gardening activities as ascertained from the responses to the item no A.4 of the interview schedule (Appendix A). Experience in roof gardening of the respondents were classified into short (≤10), medium (11-20) and long (>20) categories.

3.7.1.5 Annual income of the respondents

Family income of a respondent was measured on the basis of total yearly earning from agriculture and other sources (service, business, daily labor etc.) by the respondent

and other family members as ascertained from the responses to the item no A.5 of the interview schedule (Appendix A). In calculating the family income of a respondent, income of that respondent as well as his family members (earned from different sources) in the year 2019 were added together to obtain total family income of a respondent. On the basis of the annual income the respondents' family was classified into three categories such as low (≤300000 Tk.), medium (300001-600000 Tk.) and high (>600000Tk.).

3.7.2 Measurement of Dependent variable

3.7.2.1 Initiation of roof gardening

Initiation of roof gardening of the respondent was measured in terms of year from when he started gardening on rooftop as ascertained from the responses to the item no B.1 of the interview schedule (Appendix A). On the basis of initiation of roof gardening the respondents were categorized into very recent (2016-2019), recent (2005-2014) and long ago (Before 2005).

3.7.2.2 Elevation of building where roof is situated

This variable was measured in terms of ordinal number of floor on which the roof garden is situated as ascertained from the responses to the item no B.2 of the interview schedule (Appendix A). The buildings were classified into low (≤2 storied building), medium (3-5 storied building) and high (≥6 storied building) according to the elevation where roof is situated.

3.7.2.3 Total roof area of the respondents

Roof area of the respondent was measured in terms of m^2 as ascertained from the responses to the item no B.3 of the interview schedule (Appendix A). On the basis of total roof area, the roofs were classified into small (≤100 m^2), medium (101-150 m^2) and large (>150 m^2) sized roof.

3.7.2.4 Roof area of the respondent under roof gardening

Roof area of the respondent under roof gardening was measured also in terms of m^2 as ascertained from the responses to the item no B.4 of the interview schedule (Appendix

A). On the basis of total roof area, the roofs were classified into small (≤50 m^2), medium (51-100 m^2) and large (>100 m^2).

3.7.2.5 Needs and purposes of roof gardening of the respondents

In this section the respondents were asked 7 types of different purposes as mentioned in the item no B.5 of the interview schedule (Appendix A) and the number of respondents were cumulated who had the same type of needs and purposes.

3.7.2.6 Types of plants grown in roof garden by the respondents

Total number of plants were categorized into Flower, Vegetable, Fruit and Other as ascertained from the responses to the item no B.6 of the interview schedule (Appendix A).

3.7.2.7 Total cost of roof garden by the respondents

Total cost of roof gardening was measured by the sum of all cost of a respondent from initial stage of roof gardening and till the data collection date as ascertained from the responses to the item no B.7 of the interview schedule (Appendix A). On the basis of total cost of roof farming, the respondents were categorized into three classes namely low (≤5000 Tk), medium (5001-10,000 Tk) and high (>10,000 Tk) cost.

3.7.2.8 Media used in roof garden preparation by the respondents

Types of media used in roof garden was measured through the response of the respondent to the item no B.8 of the interview schedule (Appendix A). On the basis of media used in roof garden the respondents were classified into soil, soil + coco dust and others.

3.7.2.9 Types of pot used in roof garden by the respondents

Types of pot used in roof garden was measured through the response of the respondent to the item no B.9 of the interview schedule (Appendix A). On the basis of pot used in roof garden the respondents were classified into plastic pot, earthen pot, tin half drum, concrete structure and others (Geo-tex bag, wood pot etc.).

3.7.2.10 Size of the pot used in roof garden by the respondents

Size of the pot used in roof garden was measured through the response of the respondent to the item no B.10 of the interview schedule (Appendix A). On the basis of size of the pot used in roof garden the respondents were classified into small (≤15 L), medium (16-30 L) and large (>30 L).

3.7.2.11 Intercultural operation

On the basis of intercultural operation practiced in roof garden the respondents were categorized into Irrigation, Weeding, Pruning, Thinning, Pest and disease control and Training as ascertained from the responses to the item no B.11 of the interview schedule (Appendix A).

3.7.2.12 Fruit plants grown in roof garden of the study area

The respondents were asked 30 types of fruit plants which they had in their roof garden as ascertained from the responses to the item no B.12 of the interview schedule (Appendix A).

3.7.2.13 Total number of fruit plants grown in roof garden of the study area

Total number of different fruit plants were accumulated as ascertained from the responses to the item no B.12 of the interview schedule (Appendix A).

3.7.2.14 Number of fruit plants grown in different pot size of the study area

Total number of different fruit plants grown in different pot size were accumulated as ascertained from the responses to the item no B.12 of the interview schedule (Appendix A).

3.7.2.15 Variety of different fruit plants grown in the study area

Different varieties of fruit plants they had planted in roof garden were collected through the response of the respondents to the item no B.12 of the interview schedule (Appendix A).

3.7.2.16 Seasonal income from the roof top garden

Total seasonal income from the roof top garden was measured in terms of Tk. earned per season from the roof garden as ascertained from the responses to the item no B.13 of the interview schedule (Appendix A). The production amount was asked in terms of economic value (Tk.). On the basis of total seasonal income from the roof top garden the respondents were classified into three categories such as small (≤1000), medium (1001-1500) and large (>1500).

3.7.3 Measurement of Barrier of Roof Garden

3.7.3.1 Extent of problem confrontation of the respondents

A total of 12 problems related to roof top gardening were included in the item no. C of the interview schedule (Appendix A). A 4-point scale such as highly severe, moderately severe, less sever and not at all problem was employed against each of the problems and a score of 3, 2, 1 and 0 was assigned against the rating scale respectively. Each of the respondents was asked to rate the extent of problem confrontation against each of the 12 problems. The problem confrontation score of a respondent was calculated by summing up all the scores against 12 selected problems. Thus, the problem confrontation score of a respondent ranged from ‘o’ to ‘36’ where ‘0’ indicates no problem confrontation and ‘36’ indicates high problem confrontation. Based on problem confrontation scores, the respondents were classified into no problem (0), low (1-12), medium (13-24) and high (25-36).

3.7.3.2 Rank order of the problem based on problem confrontation index (PCI)

To compare among the statements related to problems about roof top gardening, a PCI was calculated. Problem Confrontation Index (PCI) was calculated by using the following formula:

$PCI= N_1\times3+N_2\times2+N_3\times1+N_4\times0$

Where, PCI= Problem Confrontation Index

N_1= No. of respondents rated the problems as highly severe

N_2= No. of respondents rated the problems as moderately severe

N_3= No. of respondents rated the problems as less severe

N_4= No. of respondents rated the problems as not at all a problem

This PCI score of a problem could range from '0-300' where '0' indicates as not at all a problem and '300' indicates as highly severe problem as ascertained from the responses to the item no C of the interview schedule (Appendix A).

3.8 Statistical Analysis

After collection, data were tabulated and analyzed for interpretation. Statistical treatments such as number, mean, standard deviation, range, rank order etc. were used to interpret data. To explore relationship between any two variables Pearson's product correlation coefficient 'r', analysis was employed. For analysis of data Statistical Package for Social Science (SPSS) version 20 was used.

3.9 Conceptual Framework of the Study

In scientific research, selection and measurement of variables constitute an important task. The conceptual framework of Townsend (1953) was kept in mind while framing the structural arrangement for the dependent and independent variables. The present study tried to focus on present status of rooftop gardening.

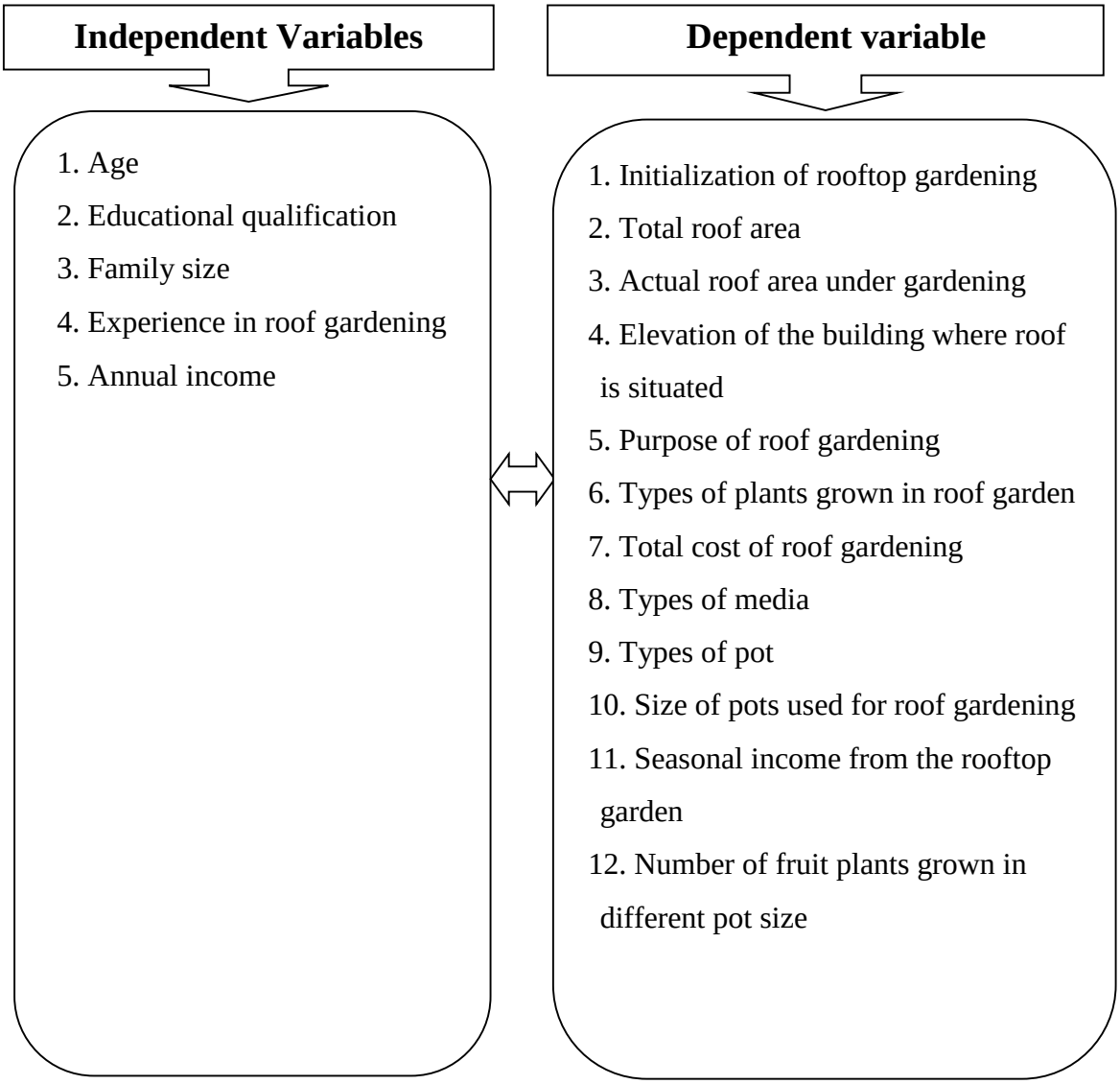


Figure 1: A Conceptual Framework of the Study

CHAPTER 4

RESULTS AND DISCUSSION

The findings of the study and interpretation of results with necessary discussion has been presented in this chapter. The results of this study have been presented in this section. Firstly, the selected characteristics of the respondents have been presented in section and the possible combination of plant species and diversity are presented in the following sections and respectively.

4.1 Selected characteristics of the respondents

4.1.1 Age of the respondent

The age of the respondent was markedly varied. They were categorized into young (≤ 35), middle aged (36-50) and old (>50) as shown in Table 1. Half (51%) of the respondents were middle aged, 29% old aged and only 20% of the respondents were young aged. It is evident that middle aged people (51%) are more engaged in roof gardening.

Table 1: Distribution of the respondents according to age

Categories	Score (Year)	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
Young	≤ 35	20	20			
Middle aged	36-50	51	51	31-69	45.29	9.75
Old	>50	29	29			
Total		**100**	**100**			

4.1.2 Educational qualification of the respondents

The education score of the respondents ranged from 1 to 16 with mean and standard deviation of 12.62 and 3.55, respectively. On the basis of education, the respondents were categorized into five categories as shown in Table 2.

It was revealed from Table 2 that majority (56%) of the respondents had graduation and above level of education followed by higher secondary level (23%) and secondary level (12%). The lowest number of respondents (9%) had primary level of education and there were no illiterate respondents in the study area. It is clear from the study that all the respondents who are involved in roof gardening were educated.

Table 2: Distribution of the respondents according to educational qualification

Categories	Score (Year of schooling)	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
Illiteracy	0	0	0			
Primary	1-5	9	9			
Secondary	6-10	12	12	1-16	12.62	3.55
Higher secondary	11-12	23	23			
Graduate & Above	>12	56	56			
Total		**100**	**100**			

4.1.3 Family size of the respondents

The family size score of the respondents ranged from 2 to 6 with mean and standard deviation of 4.04 and 1.02 respectively. Family size of the respondents were classified into small (1-3), medium (4-5) and large family (>5).

Data presented in Table 3 indicate that majority (67%) of the respondents' family belonged to medium sized family followed by small sized family (19%) while only about 14% belonged to large sized family.

Table 3: Distribution of the respondents according to their family size

Categories	Score (Number)	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
Small	1-3	19	19			
Medium	4-5	67	67	2-6	4.04	1.02
Large	>5	14	14			
Total		**100**	**100**			

4.1.4 Experience in roof gardening of the respondents

The experience score of the respondents ranged from 2 to 36 with a mean and standard deviation of 11.43 and 8.19 respectively. Experience in roof gardening of the respondents were classified into short (≤10), medium (11-20) and long (>20) categories as shown in Table 4.

Table 4: Distribution of the respondents according to Experience in roof gardening

Categories	Score (Year)	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
Short	≤10	62	62			
Medium	11-20	31	31	2-36	11.43	8.19
Long	>20	7	7			
Total		**100**	**100**			

Table 4 indicates that majority of the respondents (62%) were short experienced in roof gardening followed by medium experienced (31%) and only 7% respondents had long experience. As roof gardening is a modern concept that's why most of people had short experience in roof gardening. From the research it was found that very few people (7%) had long experience.

4.1.5 Annual income of the respondents

The annual income score of the respondents ranged from 240000 Tk to 750000 Tk with a mean and standard deviation of 493910 and 154.137 respectively. On the basis of the annual income the respondents' family was classified into three categories as shown in Table 5.

Table 5: Distribution of the respondents according to annual income

Categories	Score ('000Tk)	Respondent (N=100)		Range ('000Tk)	Mean ('000Tk)	SD
		Number	Percent (%)			
Low	≤300	19	19	240-750	493.91	154.137
Medium	301-600	56	56			
High	>600	25	25			
Total		**100**	**100**			

It was found that majority (56%) of the respondents were in the category of medium income followed by high income (25%) and low income (19%). Findings indicate that medium income group peoples were more engaged in roof gardening.

4.2 Present Practices of Rooftop Gardening

4.2.1 Initiation of roof gardening

Initiation of roof gardening of the respondents was classified into three categories as presented in Table 6. Highest proportion of the respondents (52%) started roof gardening recently (2005-2014). Only 31% respondents started roof gardening very recently (2016-2019) and only 17% respondents started roof gardening before 2005.

Table 6: Distribution of the respondents according to initiation of roof gardening

Categories	Score (Year)	Respondent (N=100)		Range
		Number	Percent (%)	
Very recent	2015 to 2019	31	31	1980-2019
Recent	2005 to 2014	52	52	
Long ago	Before 2005	17	17	
Total		**100**	**100**	

Table 6 also indicates that more than half (52%) of the respondents started their roof gardening recently and (31%) started very recently as it is become more popular after the year 2004.

4.2.2 Elevation of building where roof is situated

Data presented on the table 7 showed that 67% of the building were used as roof gardening at 3rd -5th elevation of the building. But the amount of high building (≥6 storied building) where roof top gardening was situated is around 5%. Around 28% of the building where roof garden is situated is in Low (≤2 storied building) category. The mean and standard deviation of elevation where roof is situated is 3.11 and 1.08 respectively.

Table 7: Distribution of the buildings according to the Elevation where roof is situated

Categories	Score (floor)	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
Low	≤2	28	28	1-7	3.11	1.08
Medium	3-5	67	67			
High	≥6	5	5			
Total		**100**	**100**			

4.2.3 Total roof area of the respondents

The total area of the roof was ranged from 56 m^2 to 185 m^2 with a mean of 119.5 and standard deviation of 33.24. Based on the total roof area, the roofs were classified into three categories as shown in Table 8. Majority of the roof was medium sized roof area (50%) followed by small sized roof area (38%) and large sized roof area (12%).

Table 8: Distribution of the respondents according to the total roof area of the respondents

Categories	Score (m^2)	Respondents (N=100)		Range	Mean	SD
		Number	Percent (%)			
Small	≤100	38	38	56-185	119.35	33.28
Medium	101-150	50	50			
Large	>150	12	12			
Total		**100**	**100**			

4.2.4 Roof area of the respondent under roof gardening

The area under roof gardening in the study area was ranged from 28 m^2 to 175 m^2 with a mean of 89.52 and standard deviation of 30.12. Based on area under roof gardening, the roofs were classified into three categories as shown in Table 9. Half of the roof area (55%) was medium sized followed by large roof area (36%) and small sized roof area (9%) for roof gardening.

Table 9: Distribution of the roof according to the area under roof gardening

Categories	Score (m^2)	Respondents (N=100)		Range	Mean	SD
		Number	Percent (%)			
Small	≤50	9	9	28-175	89.52	30.12
Medium	51 – 100	55	55			
Large	>100	36	36			
Total		**100**	**100**			

4.2.5 Needs and purposes of roof gardening of the respondents

The respondents practiced roof gardening for combined needs and purposes (Table 10). All the respondents practiced rooftop gardening for several purposes. Among all purposes the highest portion (98%) of the respondents prioritized hobby for roof gardening along with other purposes. 96% of the respondents prioritized roof gardening for aesthetic purpose along with other needs. Similarly, the respondents practiced roof gardening for combined needs and purposes of fruit production (79%), vegetable production (73%), ecological balance (32%), income generation (5%) and others (27%) respectively. Most of the respondent's roof gardening was for aesthetic, hobby, fruit production and vegetable production purpose.

Table 10: Distribution of the respondents according to their purpose of roof gardening

Categories	Citation	Percent (%)
Hobby	98	98
Aesthetic	96	96
Fruit production	79	79
Vegetable production	73	73
Ecological balance	32	32
Income generation	5	5
Others (keeping busy himself, recreation etc.)	27	27

4.2.6 Types of plants grown in roof garden by the respondents

Types of plants grown in roof gardening of the respondents have been assembled in Table 11. All of the respondents had grown flower (100%), vegetable (100%) and fruit plants (100%) in their roof garden. Almost all of the respondents (88%) also grown other types of plants like spices plant, medicinal plant etc.

Table 11: Distribution of the respondents based on the types of plants grown in roof garden of the study area

Categories	Respondent (N=100)	
	Number	Percent (%)
Flower	100	100
Vegetable	100	100
Fruit	100	100
Others (medicinal, Spices etc.)	88	88

4.2.7 Total cost of roof garden by the respondents

Table 12 represents that most of the respondents (64%) had low cost (≤5000 Tk) of roof gardening. Only 28% respondents had medium cost (Tk.5001-10,000) and only 6% had high cost (>10,000) to build the roof top garden.

Table 12: Distribution of the respondents according to the total cost of roof garden

Categories	Score (Tk)	Respondent (N=100)	
		Number	Percent (%)
Low	≤5000	64	64
Medium	5001-10,000	28	28
High	>10,000	6	6
Total		**100**	**100**

4.2.8 Media used in roof garden preparation by the respondents

Data presented in Table 13 showed that most of the respondents (100%) used soil as a media of roof top garden for fruit, flower and vegetables production. Only 5% of the respondents used soil and coco dust mixture as a media of the preparation of the roof top garden. Besides soil, no respondent used other media for roof garden preparation.

Table 13: Distribution of the respondents according to the media used in roof garden preparation

Categories	Respondent (N=100)	
	Number	Percent (%)
Soil	100	100
Soil + Coco dust	5	5
Others	0	0

4.2.9 Types of pot used in roof garden by the respondents

Types of pot used by the owner of the building is assembled in Table 14. All of the respondents used plastic pot besides other types of pot for cultivating plants and vegetable in their roof. The number of plastic pot is approximately 2117 in the data collection area. On the other hand, along with plastic pot, 32 respondents used earthen pot, 45 respondents used tin half drum, 86 respondents used concreate structure and around 65 respondents used other pot like geo-tex bag, wood pot etc. The total number of pots is approximately 4308.

Table 14: Distribution of the respondents according to the types of pot used in roof garden

Categories	Citation	Total Amount
Plastic pot	100	2117
Earthen pot	32	338
Tin half drum	45	545
Concrete structure	86	386
Others (Geo-tex bag, wood pot etc.)	65	922
Total number of pot		**4308**

4.2.10 Size of the pot used in roof garden by the respondents

The data presented in the Table 15 showed that the size of the pot used by the respondents are classified into three categories like small (≤15 L), medium (16-30 L) and large (>30 L) (Table 15).

Table 15: Distribution of the respondents according to the size of the pot used in roof garden

Categories	Score (L)	Citation	Total Amount
Small	≤15	100	2122
Medium	16-30	87	797
Large	>30	85	1162

4.2.11 Intercultural operation

The respondents of the study area practiced different types of intercultural operation as shown in the Table 16. All of the respondents (100%) practiced irrigation and weeding operation in a regular basis followed by pest and disease control (89%), thinning (78%), pruning (73%), training (47%), drainage (43%) and shading (2%), respectively. (Table 16).

Table 16: Distribution of the respondents according to their intercultural operations of roof gardening

Items	Citation	Percent (%)
Irrigation	100	100
Weeding	100	100
Pruning	73	73
Thinning	78	78
Pest and diseases control	89	89
Training	47	47
Drainage	43	43
Shading	2	2

4.2.12 Fruit plants grown in roof garden of the study area

Fruit plants grown in the roof garden of the study area have been assembled in the Table 17. Mango (89%) is more preferable fruit followed by lemon (83%), guava (75%), papaya (64%), dragon fruit (57%), golden apple (45%), Malta (30%), respectively. The least preferable fruit is rose apple (3%), litchi (4%), almond (8%) and wood apple (8%) respectively.

Table 17: Distribution of the respondents based on the types of fruit plants grown in roof garden of the study area

Fruits name	Citation	Percent (%)
Mango	89	89
Lemon	83	83
Guava	75	75
Papaya	64	64
Dragon Fruit	57	57
Golden Apple	45	45
Grape	32	32
Malta	30	30
Wax apple	28	28
Jujube	27	27
Hog plum	24	24
Banana	15	15
Sapota	15	15
Card fruit	14	14
Pomegranate	14	14
Carambula	13	13
Pummelo	13	13
Olive	12	12
Caronda	12	12
Strawberry	11	11
Jamun	11	11
Orange	10	10
Apple	9	9
Almond	8	8
Wood apple	8	8
Tamarind	7	7
Litchi	4	4
Rose apple	3	3

Table 17 revealed that, people are mostly interested to grow mango (89%) in their rooftop garden which is similar to the findings of Uddin (2016), that the highest 75% and 69% respondents in Dhaka and Chittagong respectively grew mango in their rooftop garden. The reason behind the result is that they usually prefer mango based on the availability of good variety and taste of fruit.

4.2.13 Total number of fruit plants grown in roof garden of the study area

Total number of fruits plants grown in roof garden of the study area has been assembled in the Table 18. Mango (375), lemon (285), dragon fruit (245), guava (152), papaya (133) was dominated over other fruits. On the other hand, custard apple, rose apple, apple, wood apple and almond were least dominant fruit.

Table 18: Distribution of total number of fruit plants grown in roof garden of the study area

Plant name	Plant number	Range	Mean
Mango	375	0-7	3.75
Lemon	285	0-8	2.85
Dragon fruit	244	0-6	2.24
Guava	152	0-4	1.52
Papaya	133	0-5	1.33
Malta	115	0-3	1.15
Golden Apple	48	0-2	0.48
Wax apple	39	0-2	0.33
Grape	33	0-3	0.39
Carambula	33	0-3	0.33
Jujube	31	0-2	0.31
Pumelo	28	0-3	0.28
Strawberry	27	0-6	0.38
Sapota	22	0-2	0.22
Hog plum	19	0-3	0.26
Pomegranate	18	0-3	0.18
Aonla	18	0-3	0.18
Jamun	18	0-3	0.18

Table 18 (cont'd)

Table 18 having (cont'd)

Banana	18	0-2	0.18
Card fruit	17	0-2	0.17
Olive	17	0-1	0.17
Orange	16	0-2	0.16
Caronda	14	0-2	0.14
Litchi	14	0-2	0.14
Arboroi	11	0-1	0.11
Apple	9	0-2	0.09
Tamarind	9	0-1	0.09
Alamond	8	0-1	0.08
Wood apple	8	0-1	0.08
Rose apple	7	0-2	0.07
Custard apple	6	0-1	0.06

Table 18 indicate that the total plant number of mango (375) and lemon (285) is dominant. Besides the domestic fruit, dragon fruit (244) is considered dominant in the study area which may be the better source of economic return.

4.2.14 Number of fruit plants grown in different pot size of the study area

The total number of fruit plants grown in different pot size of the study area is assembled in the Table 19. It was found that most of the fruit plant grown in the study area in large pot (1129) followed by medium pot (431) and small pot (69).

Table 19: Distribution of total number of fruit plants grown in different pot size of the study area

Plant name	Plant number	Small (≤15 L)	Medium (16-30 L)	Large (>30 L)
Mango	375	17	71	287
Lemon	285	17	79	189
Dragon fruit	244	5	43	74
Guava	152	0	49	103
Papaya	133	3	65	68
Malta	115	0	21	94
Golden Apple	48	0	34	14
Wax apple	39	1	11	27
Grape	33	7	19	6
Carambula	33	0	12	21
Jujube	31	0	7	24
Pumelo	28	0	3	25
Strawberry	27	19	8	0
Sapota	22	0	0	22
Pomegranate	19	0	0	19
Aonla	18	0	2	16
Jamun	18	0	3	15
Banana	18	0	5	13
Card fruit	17	0	0	17
Olive	17	0	2	15
Orange	16	0	0	14
Karonda	14	0	0	14
Litchi	14	0	0	11
Arboroi	11	0	2	7
Tamarind	9	0	3	5
Apple	9	0	0	8
Alamond	8	0	0	8
Wood apple	8	0	0	8
Rose apple	7	0	0	7
Custard apple	6	0	0	6
Total	**1749**	**69**	**431**	**1129**
Percent (%)		**11**	**25**	**64**

Data from Table 19 showed that large pot is mostly (64%) used by the city dweller for fruit cultivation in the study area. But, the large pot requires more potting media, thus increase the weight and cost of the pot.

4.2.15 Variety of different fruit plants grown in the study area

Data presented in the Table 20 represents the variety of different fruit plant that planted on the study area. Most of the respondents planted local variety of fruit in their roof top garden. Even they didn't know the name of the variety which they have planted. They went to the local market or nursery, then bought their favorite fruit plants for their roof top garden.

Table 20: Distribution of variety of different fruit plants grown in the roof top garden

Plant name	Name of the variety of fruit plant
Mango	BARI Mango-3, Ashshin, Hariya vangga, Khirshapati, BARI Mango-8, BAU Mango-3
Lemon	BARI Lemon 2,3, Kaguji lebu, Seedless
Dragon fruit	BARI Dragon-1, BAU Dragon-1
Guava	BARI guava-2, Thai guava, Local variety
Papaya	Local variety
Malta	BARI Malta-1
Golden Apple	Bari amra-1, Local variety (12 month)
Wax apple	Local variety
Grape	Local variety
Carambula	Local variety
Jujube	Thai cool, Local variety, BAU cool
Pumelo	Local variety
Strawberry	Local variety
Sapota	BARI Sapota
Pomegranate	Local variety
Aonla	Local variety
Jamun	Local variety
Banana	Sagor Kola, Local variety
Card fruit	Local variety
Olive	Local variety
Orange	BARI Komola-1
Karonda	Thai Karonda
Litchi	China-3
Arboroi	Local variety
Tamarind	Local variety
Apple	Local variety
Alamond	Local variety
Wood apple	Local variety
Rose apple	Local variety

From Table 20 it was found that, the gardeners used only the well-known developed variety for specific fruit, but in case of other fruit variety they did not have specific choice.

4.2.16 Seasonal income from the roof top garden

The average seasonal income from roof garden of the respondents was 1555.41 taka ranging from 800 to 2470 taka with a standard deviation of 155.96. Based on seasonal income, the respondents were classified into three categories as shown in Table 21.

Less than half of the respondents (43%) earned medium amount of money from roof garden followed by low income (41%) and only 16% respondents of them earned high amount of money from roof garden (Table 21).

Table 21: Distribution of the respondents based on the seasonal income from the roof top garden

Categories	Score (Tk)	Respondent (N=100)		Range (Tk)	Mean (Tk)	SD
		Number	Percent			
Low	≤1000	41	41	800-2470	1555.41	155.96
Medium	1001-1500	43	43			
High	>1500	16	16			
Total		100	100			

4.3 Barrier of rooftop gardening

4.3.1 Extent of problem of the respondents

On the basis of problem conformation score, the respondents were classified into three categories that have been presented in the Table 22. It was found that maximum of the respondents faced medium problem (72%).

Table 22: Distribution of respondents according to their problem

Categories	Score	Respondent (N=100)		Range	Mean	SD
		Number	Percent (%)			
No Problem	0	2	2	0-35	19.94	0.41
Low	1-12	10	10			
Medium	13-24	72	72			
High	25-36	16	16			
Total		100	100			

4.3.2 Rank order of the problem based on problem confrontation index (PCI)

The respondents of the study area confronted more or less 12 problems related to roof gardening with different extent of severity.

It is usually assumed that the most common problem is most severe problem. Table 23 showed that the most severe problem in roof gardening in the study area was insect, pest and disease infestation (88.33%), lack of suitable planting materials (81.33%), lack of proper nourishment (73.33%), while the less severe problem was lack of proper sunlight and shade (13.67%).

Table 23: Rank order of problems based on problem confrontation index

Types of problem	Severity of problems (N=100)				Total	PCI	Percent (%)	Rank
	HS (3)	MS (2)	LS (1)	NAA (0)				
Lack of sufficient area	10	32	36	22	100	130	43.33	6th
Lack of proper management	7	26	37	30	100	110	36.67	7th
Insect, pest and disease infestation	79	12	4	5	100	265	88.33	**1st**
Lack of proper sunlight and shade	0	13	15	72	100	41	13.67	**12th**
Disturbance by child, pet animals and thieves	14	23	19	44	100	107	35.67	8th
Transportation problem	3	21	7	69	100	58	19.33	10th
Lack of proper marketing facilities	0	14	21	65	100	49	16.33	11th
Influence of middle man	2	12	29	57	100	59	19.67	9th
Lack of proper training, skill and experience	37	27	34	2	100	199	66.33	4th
Lack of proper nourishment	43	34	23	0	100	220	73.33	3rd
Lack of suitable planting materials	65	21	7	7	100	244	81.33	2nd
Problem of excessive heat	32	31	33	4	100	191	63.67	5th

HS= Highly Sever, MS= Moderately Sever, LS= Less Sever, NAA= Not at all
PCI= Problem Confrontation Index

From the study it was found that 98% respondents initiated rooftop gardening as hobby (Table 10), so they had limited consciousness about proper nourishment, selection of proper planting materials. As a result, they mostly faced insect, pest and disease infestation as severe problem in their rooftop garden. If they would take the rooftop gardening commercially, the extent of problem would be minimized.

4.4 Relationship between dependent and independent variable

To explore the relationships between dependent and independent variable, Pearson's Product Moment co-efficient of correlation (r) was used. The computed value of 'r' was compared with tabulated value of 'r' with 58 degree of freedom (df) at 0.05 and 0.01 level (2 tailed). The tabulated value of 'r' is 0.332 and 0.254 at 0.01 and 0.05 level with 58 df. The relationship appears in Table 24.

Table 24. Computed coefficient of correlation (r) between the dependent and independent variable

		Independent Variable				
		Age	**Educational qualification**	**Family size**	**Experience in roof gardening**	**Annual income**
Dependent Variable	**Initialization of rooftop gardening**	-0.028^{NS}	**0.297***	0.085^{NS}	**0.302***	**0.337****
	Total roof area	-0.033^{NS}	0.188^{NS}	0.078^{NS}	0.213^{NS}	**0.322***
	Actual roof area under gardening	0.212^{NS}	**0.265***	0.192^{NS}	**0.512****	**0.285***
	Elevation of the building where roof is situated	0.056^{NS}	0.132^{NS}	0.018^{NS}	0.097^{NS}	0.222^{NS}
	Purpose of roof gardening	-0.146^{NS}	**0.432****	0.174^{NS}	**0.459****	**0.268***
	Types of plants grown in roof garden	0.128^{NS}	0.188^{NS}	0.056^{NS}	0.132^{NS}	0.112^{NS}
	Total cost of roof gardening	-0.096^{NS}	0.195^{NS}	0.124^{NS}	0.144^{NS}	**0.288***
	Types of media	0.029^{NS}	0.078^{NS}	0.054^{NS}	0.123^{NS}	0.078^{NS}
	Types of pot	0.033^{NS}	0.058^{NS}	0.072^{NS}	0.091^{NS}	0.045^{NS}
	Size of pots used for roof gardening	0.052^{NS}	0.047^{NS}	0.089^{NS}	0.058^{NS}	0.024^{NS}
	Seasonal income from the rooftop garden	0.228^{NS}	0.132^{NS}	0.132^{NS}	**0.299***	0.211^{NS}
	Number of fruit plants grown in different pot size	0.082^{NS}	0.055^{NS}	0.062^{NS}	0.033^{NS}	0.047^{NS}

NS= Non-significant, ** = Correlation is significant at the 0.01 level (2-tailed), * = Correlation is significant at the 0.05 level (2-tailed)

Table 24 furnished the relationship among five selected characteristics of the respondents and twelves dependent variables related present arrangement of rooftop gardening. Among the five selected characteristics of the respondent, educational qualification showed significant positive relationship with purpose of roof gardening at 1% level and with initialization of rooftop gardening, actual roof area under gardening at 5% level. That can be explained in such a way, the higher the educational qualification of the respondent the higher they initiate rooftop gardening, increase actual roof area under gardening and increase the purpose of roof gardening. Again, experience in roof gardening showed positive significant relationship with actual roof area under gardening as well as purpose of roof gardening at 1% level and with initialization of rooftop gardening as well as seasonal income from the rooftop garden at 5% level. Furthermore, annual income also showed positive significant relationship with initialization of rooftop gardening at 1% level and with total roof area, actual roof area under gardening, purpose of roof gardening, total cost of roof gardening at 5% level. Other characteristics have relationship with the dependent variable but those are not significant.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 Summary

Roof top gardening will increase grant of clean meals and by means of bettering the fantastic of perishable meals attaining city consumers. It contributes significantly to creation of healthy environment and food security. Keeping in mind the objectives to find out the socio-economic condition of the roof top gardener, to identify the present practices of roof top gardening and to find out the possible combination of plant species as well as the problems confronted by the roof top gardener, an attempt has been taken to fulfil the objectives at three places named Joydebpur Bazar, Chowrasta and Shibbari in Gazipur city. The selected areas were visited frequently from 5th January to 25th February in 2020. Pre-tested questionnaire was used for the survey during visit, in which a total of 100 respondents were interviewed. Data were collected following purposive random sampling technique and analysis was done by SPSS 20 software. In the aspect of personal characteristics of the respondents, more than half (51%) of them were middle aged (36-50 years) with 56% were well educated (graduate and above). Most (67%) of them had a medium size family (4-5 members) and 56% respondents contribute medium annual income (3,00,001-6,00,000 Tk.) to the family. Majority (62%) of them had low experience (≤10 years) in roof top gardening. The present status of roof top gardening in the study area showed that majority (83%) of the respondents started their roof gardening recently (2005 to 2014) and very recently (2015 to 2019) as it became more popular after the year 2004. The highest portion (98%) of the respondents practiced roof gardening for hobby along with other purposes. Majority (67%) of the buildings had its roof at 3rd to 5th floor. Half (50%) of the gardener had medium sized (101-150 m^2) roof and about 55% of the respondents used medium space (51 – 100 m^2) of total roof area for gardening. All of the respondents had grown flower (100%), vegetables (100%) and fruits (100%) with other (88%) (medicinal, spices etc.) crops. All the gardener (100%) used soil as media in small sized plastic half drum (100%) besides other media and types of pot. 100% respondents practiced irrigation and weeding operation in a regular basis followed by other intercultural operations. Majority of the respondents planted mango (89%), lemon (83%), guava (75%) etc. along with other fruits. The respondents usually planted local variety of fruit in their roof top garden. In every

season, about 43% of the respondents earned medium amount of money from roof garden followed by low income (41%) and only 16% respondents of them earned high amount of money from roof garden. On the basis of problem conformation, maximum (72%) of the respondents faced medium problem confrontation. Among the 12 problems regarding rooftop gardening, "Insect, pest and disease infestation" ranked 1st position and "Lack of proper sunlight and shade" ranked the 12th position.

5.2 Conclusion

Based on the findings and its logical interpretation the following conclusions have been drawn:

I. More than half (51%) of them were middle aged (36-50 years) with 56% were well educated (graduate and above). Majority (67%) of them had a medium size family (4-5 members) and 56% respondents contribute medium annual income (3,00,001-6,00,000 Tk.). In every season, about 43% of the respondents earned medium amount of money from roof garden followed by low income (41%) and only 16% respondents of them earned high amount of money from roof garden.

II. The highest portion (98%) of the respondents practiced roof gardening for hobby along with other purposes. Majority (67%) of the buildings had its roof at 3rd to 5th floor. Half (50%) of the gardener had medium sized (101-150 m^2) roof and about 55% of the respondents used medium space (51 – 100 m^2) of total roof area for gardening. All the gardener (100%) used soil as media in small sized plastic half drum (100%) besides other media and types of pot. 100% respondents practiced irrigation and weeding operation in a regular basis followed by other intercultural operations.

III. All of the respondents had grown flower (100%), vegetables (100%) and fruits (100%) with other (88%) (medicinal, spices etc.) crops. Majority of the respondents planted mango (89%), lemon (83%), guava (75%) etc. along with other fruits.

IV. Most (72%) of the respondents faced medium problem. Among the 12 problems regarding rooftop gardening, "Insect, pest and disease infestation" ranked 1st position and "Lack of proper sunlight and shade" ranked the 12th position.

Recommendation

Based on the research findings it can be recommended that-

I. The present study was conducted in only three areas of Gazipur city. Such studies are required to conduct in other areas of gazipur city and districts as well.

II. The research had only included the rooftop garden but not the garden in "Balcony" was counted here. But at the time of data collection there were found that a large number of respondents had garden in balconies.

III. The present study was conducted in only present practices and barriers of rooftop gardening. It therefore suggested that future study should include improvement, roof damage awareness, specific variety adoption etc.

IV. Based on this information about rooftop gardening a research work would be done on the topic of urban agriculture of Gazipur city.

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APPENDICES

APPENDIX A

AGROFORESTRY AND ENVIRONMENTAL SCIENCE
SHER-E-BANGLA AGRICULTURE UNIVERSITY
DHAKA-1207
Interview Schedule for the Study of

Study on Present Practices and Barriers of Rooftop Gardening in Gazipur City

Sample No: …….. **Date: ……**

Name of the respondent: …….....

Husband/ Father's Name: …….

Community: …… City Corporation: ……

Word: …….. District: ……

Contact No: ……. Gender: Male / Female

A. Personal Characteristics

A.1 Age of the respondent: ---------- Years.

A.2 Educational qualification:

i. Don't read and Write. ( )
ii. Only can sign. ( )
iii. I have read up to class……

A.3 Family size:

i. How many members do you have in your family? ----------members (including yourself)

Male: …… Female: …….

A.4 Experience in Rooftop Gardening: ……..(years)

A.5 Annual Income:

	Sources	Value (Tk)
1	Agriculture	
2	Salary	
3	House Rent	
4	Business	
5	Others	

B. Present Arrangement of Rooftop Garden

B.1 From which year have you started rooftop garden? ……

B.2 Roof is situated in which floor of your building? ……...

B.3 What is the total area of your roof? …….. (m^2)

B.4 How much area of your roof is used as garden? ……(m^2)

B.5 Why have you been practicing rooftop garden?

Categories	(√)
Aesthetic	
Vegetable production	
Income generation	
Ecological balance	
Fruit production	
Hobby	
Others ((keeping busy himself, recreation etc.)	

B.6 What types of plants have you planted in rooftop garden?

Categories	(√)
Flower	
Fruit	
Vegetable	
Other	

B.7 How much was the total cost of rooftop garden? …… (Tk)

B.8 Which type of media have you used?

Categories	(√)
Soil	
Soil + Coco dust	
Biochar	
Other	

B.9 Which type of pot have you used?

Categories	(√)
Plastic half drum	
Earthen pot	
Tin half drum	
Concrete structure	
Others (Tire, wood tub etc.)	

B.10 What is the size of the pot have you used?

Categories	(√)
Small	
Medium	
Large	

B.11 Which type of intercultural operation do you practice?

Categories	(√)
Irrigation	
Weeding	
Pruning	
Thinning	
Pest and disease control	
Training	
Drainage	
Shading	

B.12 Please give me some information related to fruit plants.

Name of Fruit	Number	Variety	Pot (S,M,L)

(S=Small, M=Medium, L=Large)

B.13 How much was the total income in the previous season from rooftop garden?..... (Tk)

C. Problem confrontation in Rooftop Garden

Types of problem	Severity of problems (N=100)			
	HS (3)	MS (2)	LS (1)	NAA(0)
Lack of sufficient area				
Lack of proper management				
Insect, pest and disease infestation				
Lack of proper sunlight and shade				
Disturbance by child, pet animals and thieves				
Transportation problem				
Lack of proper marketing facilities				
Influence of middle man				
Lack of proper training, skill and experience				
Lack of proper nourishment				
Lack of suitable planting materials				
Problem of excessive heat				

(Thank you for your nice cooperation)

Date: ……

Signature of interviewer