Changing Urban Agriculture in the Dhaka Metropolitan Region: Perspective of Climate Resilience and Sustainability

Ph.D THESIS

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Submitted to:
Professor Dr. Nurul Islam Nazem

Submitted by:
Tarafder Md. Arifur Rahman
Registration: 80/2016-17

Department of Geography and Environment
Faculty of Earth and Environmental Science
University of Dhaka

CERTIFICATE

I hereby certify that the work reported here was carried out by Tarafder Md. Arifur Rahman under my guidance and supervision. It is further certified that the work presented here is original and suitable for submission as a Ph.D Thesis.

Professor Dr. Nurul Islam Nazem
Supervisor
Department of Geography and Environment
University of Dhaka

ABSTRACT

The multifunctionality of urban agriculture (UA) offers multidimensional benefits to urban areas and has received the attention of researchers and policymakers as well as urban residents. This study was intended to determine the status of urban agriculture in the DMDP region as well as to explore the prospects and challenges UA in the study area. A decreasing trend of UA was explored in the study area. The study explores the present agricultural practice, obstacles, and assistance needs of the farmers and also the future direction for establishing UA in the DMDP region based on a questionnaire survey of urban farmers and interviews with key informants. Profitability, financing, production costs, market access, availability of land, and freshwater for irrigation were rated the highest challenges by the farmers. Farmers also reported technical assistance needs to bust up their agricultural practices for more economic return which can be addressed by the Agricultural Extension authority. UA has been found the main means of living and the basis of household income for a large number of farm populations in the DMDP area. The study shows that about 58% of household income comes from agricultural activities. The remaining 42% comes from non-farm activities. This indicates that UA is likely a viable livelihood means for a large portion of the population in the DMDP region.

This study followed a cross-sectional survey approach to assess the respondent farmers' perception of climate change and its impact on agricultural practice in the DMDP region. Quantitative and qualitative data were collected through questionnaires, key informant interviews, and visual observation of the author. Variation in climatic conditions was validated by calculating meteorological data collected from the BMD and the finding reveals

that urban farmers in the DMDP region incorporate indigenous knowledge and techniques in observing the changing climate and coping with the impacts imposed by the climate change. The study strongly opines on the institutionalization of UA as a way toward the sustainability and resilience of urban landscapes through creating green spaces. The study also reveals that UA in the DMDP region has huge potential to enrich the green coverage by incorporating suitable landscape horticulture in the existing greeneries (such as parks, botanical gardens, lakesides, institutional playgrounds, etc.), developing roadside landscapes, endorsing pisciculture in the existing ponds, canals and rivers, encouraging homestead gardens and rooftop agriculture and by introducing afforestation and nursery initiatives in the fallow lands.

This thesis argues for the institutionalization of UA to make it a substantial contributor to urban ecology and economy through government interventions. Some legal and institutional interventions have been suggested in this paper for the promotion of UA. In urban development master plans, incorporation of urban agricultural zones can be the best solution through enabling laws; promotion of urban markets for urban agricultural products; extension of advanced technology services along with financial support; subsidies for practicing appropriate urban farming systems; more initiatives in intensive research on the promotion and development of UA.

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LIST OF ACRONYMS AND ABBREVIATION

BADC	: Bangladesh Agricultural Development Corporation
BARC	: Bangladesh Agriculture Research Council
BBS	: Bangladesh Bureau of Statistics
BCAS	: Bangladesh Center for Advance Studies
BCCSAP	: Bangladesh Climate Change Strategy and Action Plan
BISH	: Bangladesh Integrated Household Survey
BMD	: Bangladesh Meteorological Department
CBD	: Central Business District
CI	: Cropping Intensity
CIRAD	: French Agricultural Research Centre for International Development
CO_2	: Carbon dioxide
COAG	: The Committee on Agriculture
CSA	: Community-supported Agriculture
CUA	: Commercial Urban Agriculture
CUS	: Center for Urban Studies
DAE	: Department of Agricultural Extension
DAE	: Department of Agriculture Extension
DCCs	: Dhaka City Corporations
DCA	: Double Cropped Area
DLS	: Department of Livestock Service
DM	: Dhaka Metropolitan
DMA	: Dhaka Metropolitan Area
DMDP	: Dhaka Metropolitan Development Plan
DNCC	: Dhaka North City Corporation
DoF	: Department of Fisheries
DSCC	: Dhaka South City Corporation
DWASA	: Dhaka Water Supply and Sewerage Authority
FAO	: Food and Agricultural Organization
FGD	: Focus Group Discussion
GDP	: Gross Domestic Product
GHG	: Greenhouse Gases
GIS	: Geographical Information System
GS	: Green Space
HH	: Household
HIES	: Household Income and Expenditure Survey
HYV	: High Yield Variety
ICDDR,B	: International Centre for Diarrhoeal Disease Research, Bangladesh
IPCC	: Intergovernmental Panel on Climate Change

KII	: Key Informant Interview
LULCC	: Land Use and Land Cover Change
MDGs	: Millennium Development Goals
MINAG	: Cuban Ministry of Agriculture
NAEP	: National Agriculture Extension Policy
NAP	: National Agricultural Policy
NbS	: Nature-based Solution
NCA	: Net Cropped Area
NGO	: Non-governmental Organization
NSDS	: National Sustainable Development Strategy
O_2	: Oxygen
PRA	: Participatory Rapid Appraisal
RA	: Rural Agriculture
RAJUK	: Rajdhani Unnayan Kartripakkha (Capital Development Authority)
RGA	: Roof Garden Association
RTA	: Roof Top Agriculture
RTG	: Roof Top Gardening
RUAF	: Resource Centre for Urban Agriculture & Forestry
SCA	: Single Cropped Area
SDGs	: Sustainable Development Goals
SRDI	: Soil Resource Development Institute
TCA	: Triple Cropped Area
UA	: Urban Agriculture
UBPC	: Basic Units of Cooperative Production
UF	: Urban Forestry
UHI	: Urban Heat Island
UNDP	: United Nation Development Programme
WHO	: World Health Organization
WWF	: World Wide Fund for Nature

Chapter 1

INTRODUCTION

1.1 The Background

In recent decades, a remarkable change in the demographic composition of Bangladesh has been taking place resulting in a large-scale expansion of the urban landscape. Alterations in agricultural land use, particularly in the close proximity of cities, are caused by the process of rapid and uncontrolled urbanization. The social, economic, and political conditions and processes that are created through urbanization also influence the changes in physical patterns of urban. Agricultural lands have always been subjected to urban pressures both in the central and peripheral areas of urban.

A number of reasons are responsible for rapid urbanization. However, high population growth and in migration are important (Bhatacharya, 2002). Rapid urban development causes uncoordinated and undeliberated growth of cities and towns. The ever-growing population pressure becomes a burden on the limited civic services and resources; the land is the prime among those. Therefore, the present utilization of land against future needs should be balanced. For maintaining open spaces in order to enhance environmental qualities, prevention of agricultural land is a vital issue in expanding cities (Farooq & Ahmad, 2008). Inadequate services, infrastructure, and lack of accessibility, caused by poor land management in urban areas, may be very expensive to resolve (Gupta & Sen, 2008). It is, therefore, essential to monitor the growth of the city in the context of urban sustainability to prevent the land from improper development in any city (Kumar et al., 2007). Land use planning with proper resource allocation and management for development is the key concern that helps in efficient land use planning in urban areas as it is one of the biggest

threats to sustainable urban development, hence, it is important to study and understand the trends of urban land use change (Saravanan & Ilangovan, 2010).

In the process of city development, a major challenge is the allocation of land for green space (GS) for the sustainability of the urban landscape (Caige Sun et al., 2017). A lot of environmental challenges are faced by cities including air and water pollution, lack of green space, lack of ecological biodiversity, excess heat capture, drainage of rainwater, and so on. Urban agriculture (UA) can be a promising approach to the management of urban green space. It includes the fundamental components of urban green structures, such as Hurst and tree coverage in and around city centers (Konijnendijk et al., 2002). The overall objective of UA is not only food or timber production or beautification, but also to provide persistent environmental, social and economic benefits, act in the interface between urban and rural (Nilsson & Konijnendijk, 2002). Therefore, UA can be strategically considered as an integrative, interdisciplinary, and participatory approach (Konijnendijk et al., 2002).

Dhaka is the capital and fastest growing city of Bangladesh. Many researchers have reported that the environment of Dhaka city has been deteriorating. Several factors are responsible for such deterioration. Due to high in-migration and rapid uncoordinated urbanization in Dhaka, environmental and socio-economic degradation have been occurring very rapidly which is alarming for the sustainability of urban life and landscape (Ahmed, 1996). Conversion of land from agriculture to non-agricultural use increases the vulnerability to natural disasters and impacts the urban life and environment through ecological degradation, worsening soil and water quality, groundwater depletion, creating heat zones, municipal water congestion, food, and nutritional insecurity, public health problems, reduction of recreation options, deterioration of mental health, waste management problem and so on.

For current and future urban populations, ensuring a quality life and environment through multifunctional urban agriculture can be a significant task for sustainable urban development (Konijnendijk et al., 2002). The preservation of trees and other green vegetated areas and the creation and expansion of green spaces in and around the cities can increase the quality of life of urban dwellers by providing opportunities for leisure and recreation, and by protecting the quality natural resources. At the same time, green areas also allow citizens to get direct economic benefits in the form of urban agriculture (IADB, 1997).

Urban agriculture works as an important landscape in many developed and developing countries. It can provide substantial health, social, ecological, and economic benefits to communities. Besides production, different ecological benefits are offered by urban agriculture, e.g. biodiversity, ground water recharging, nutrient cycling, micro-climate control, and visual quality that provide benefits to the neighboring community and society as a whole. It can contribute to adding aesthetic values to the urban landscape by creating green space in the city.

Initially, UA is not considered a feasible substitute for urban settings because of the high price of land and other resources of cities. Certain production systems that require large areas of land, high chemical inputs, or create negative impacts on the environment (e.g., traditional crop production or livestock farming) can be completely unsuitable for the urban. Agricultural production systems that take the opportunity of the closeness of consumers, markets and resources would be most appropriate for an urban area. The produced food can be consumed by nearby residents and eventually can offer a large range of benefits to growers, consumers, and the community. Yet, the validation of UA on the basis of agricultural production is a challenge (Lovell & Johnston, 2009). UA should be assessed on

the basis of multifunctionality, which provides different services or benefits to the urban community. UA provides large ecological functions (e.g., biodiversity, ecosystem cycle, micro-climate regulation, etc.) and cultural functions (e.g., recreation and cultural heritage) besides production functions that benefit the overall society (Lovell & Johnston, 2009).

The ecological and environmental benefits of UA often outweighed the production functions for greater public welfare. The energy requirement of the food is reduced due to lower transportation distance and less processing and storage management, as the food is produced locally which increased the efficiency of the production inputs (Bohn & Viljoen, 2005). The reduced requirements of energy can contribute to reducing the emissions of greenhouse gases and the global warming process, which is considered the major fact of climate change (Deelstra & Girardet, 2000). The local urban waste management practice also conserves energy, such as the biodegradable wastes converted into compost, and wastewater used for irrigation (Goddard, 2006; Holmer & Drescher, 2005). The recycling of wastes provides an advantage in decreasing transportation and land use requirements for disposal (Midmore & Jansen, 2003), which helps in reducing fuel consumption for waste management (Drescher, 2005). The conservation of biodiversity also can be achieved if native plant species are integrated into urban gardens and parks (Bernholt et al., 2009). Furthermore, UA can provide bio-energy resources by reducing food miles (Moreno, 2011).

UA can exhibit high levels of biodiversity being a highly managed plant community and which often exceeds the benefits that other green spaces can provide (Brenda et al., 2015). A balance between human beings, the economy and the natural environment should be ensured by using resources carefully in planning and managing cities for achieving sustainable urban

development, this ensures transferring resources to the next generations. Urban agriculture can be one mechanism through which we can contribute to this aspiration.

Urbanization and climate change are closely associated. In urban areas, the rate of emission of CO_2 and other greenhouse gasses (GHG) are the highest. Climate change directly and indirectly affects cities and their inhabitants. Rising temperatures, erratic rainfall, flooding urban food insecurity and health area considered as key issues. Urban agriculture is receiving recognitions as an potential tool for climate change adaptation and disaster risk reduction (RUAF Foundation, 2016). Financial allocation in UA can be recognized to be more cost-effective compared to other approaches to climate change adaptation. The governments sound incorporate food production into urban planning agendas and include UA into the strategies of climate change adaptation to build more sustainable and resilient cities.

Resilience denotes the capacity of a socio-ecological system to resist stresses from different shocks (climate or economic burden) and to renew and rebuild itself afterward (Hollings, 1973). After recovery, preparedness and mitigation, resilience is considered the most advanced step in disaster management (Bostenaru, 2005). The theory of resilience considers that humans and nature are strongly interlinked and influence each other for mutual benefits, and therefore, regarded as a "socio-ecological" system. The ability to be self-organized in sudden shifts between states is the key feature of complex adaptive systems. It is considered as the vulnerability of the landscape against the intervention of disaster management. Urban landscapes are socio-ecological systems (Anderson & Elmqvist, 2012) where social and ecological systems are closely linked to shape the urban ecosystems in an integrated way (Benson, 2009). Cities can be viewed as a network of global ecosystems as humanity is considered an inseparable part of nature (Bolund & Hunhammar, 1999). This system is

uniquely energetic and has stability, dynamics, more non-native species, and different species composition.

Seven different urban natural ecosystems have been identified by Bolund and Hunhammar (1999) which include parks, urban forests, roadside trees, croplands, wetlands, lakes, and rivers. To support and regulate cultural activities, each and every ecosystem generates different ecological services simultaneously (Andersson, 2006). Those systems preserve biodiversity in urban areas, reduce air and sound pollution, use CO_2 and produce O_2, control micro-climates, reduce the heat island effect, have recreational value and are useful for community health, welfare and social safety (Bolund & Hunhammar, 1999). The roles of wooden species and green infrastructure in providing microclimate control, reduction of pollution, and enhancing urban health were investigated and found positive in many countries (Stratu et al., 2016; Panagopoulos et al., 2016).

The annual population growth rate in Dhaka is over six percent, one of the highest in the world. Natural resources, essential municipal services, and drainage facilities in and around Dhaka are stressed by high population growth and rapid urban development. These are further aggravated by climate change, industrial development, slum establishment, and other development processes (Rahman et al., 2015). Urban micro-climate may be influenced by the changing nature of the land cover. So the trend of urban agricultural land use change is important to explore the environmental consequences.

1.2 Overview of Dhaka City

Dhaka is a diverse city and the capital of Bangladesh, located amid Bangladesh along the river Buriganga. The geographical position of the city is between 23°42' and 23°54' north

latitudes and 90°20' and 90°28' east longitudes. The megacity consists of eight principal thanas- Kotwali, Sutrapur, Motijheel, Paltan, Dhanmondi, Ramna, Mohammadpur, Tejgaon and 14 auxiliary thanas- Gulshan, Badda, Khilgaon, Lalbagh, Demra, Hazaribagh Mirpur, Pallabi, Sabujbagh, Dhaka Cantonment, Shyampur, Kafrul, Uttara and Kamrangir char. It comprises two City Corporations; Dhaka South City Corporation (DSCC), Dhaka North City Corporation (DNCC), and five municipal areas i.e. Savar, Tongi , Gazipur, Narayanganj and Kadamrasul (BBS, 2011). It is one of the largest cities in the world, with a population of 18.89 million (BBS, 2011). The area of Dhaka megacity is 1,353 km^2 of which 302.92 km^2 is occupied by the Dhaka Metropolitan (BBS, 2011).

The rate of population growth in Dhaka is estimated at 4.2% per year (World Population Review, 2022) which is one of the highest among megacities of Asia. The trend of population growth of the Dhaka megacity can be observed in Table 1.1. The effect of in-migration in Dhaka is reflected through the continuous growth of the population which accounted for 60% growth of the city. With the expansion of city boundaries, the population of the city is also increasing (Ansari, 2008). According to the Population and Housing Census (2011), the total population of the Dhaka Metropolitan Area (DMA) is 8.9 million with a density of 29,392 persons/km^2.

Table 1.1: Trend of Population Growth and Density of Dhaka Mega City (1961- 2011)

Year	Area (km^2)	Population (million)	% Increase of population over the preceding year	Density (km^2)
1961	124.45	0.7	-	5775.54
1974	335.79	2.0	185.71	6159.66
1981	509.62	3.4	66.32	6750.41
1991	1352.82	6.8	98.95	5059.16
2001	1352.82	10.7	56.51	7918.43
2011	1352.82	18.89	76.54	13963.42

Source: DCC, 2004; Siddiqui et al., 2004; BBS, 2011

Dhaka is historically an important city from 1600 to the present date. After 1947, the regional and political prominence enhanced the city's development in a planned way that resulted to shape it into current features (Chowdhury, 1998). The old Dhaka presents a combination of residential, commercial, and industrial (small scale) setups because residential and commercial settings are situated alongside, generally concentrated beside narrow roads in the past. The commercial hub of the city moved to Motijheel and a large residential area developed at Dhanmondi after the formulation and implementation of the Dhaka Master Plan in 1958. To meet the accommodation demands, housing complexes, educational institutes, universities, lakes, commercial and industrial zones, and other infrastructures were developed gradually over the past decades (Tawhid, 2004).

A serious ecological imbalance has taken place in the city due to unplanned and uncontrolled urbanization processes. FAO (2008) estimated that 11.57% of open space is available in Dhaka of which city parks seized 0.89%, gardens 0.90%, urban forest 0.02%, and 12.12% is occupied by agriculture. The number of buildings is increasing depleting the green without considering environmental consequences. According to a Chief Town Planner of Dhaka City Corporation, an ideal city needs to have a tree coverage of 20% area Dhaka city has only 8% vegetation coverage. Ramna Udyan, Sohrawardy Udyan, Dhaka University campus, National Parliament Bhaban complex, Usmani Udyan, Botanical Garden and National Zoo, etc. are the limited sources to provide ecological services to the huge urban citizens of Dhaka.

1.3 Statement of the Problem

The megacity of Dhaka is densely populated. The environment of the city is seriously deteriorating day by day as a result of rapid and unplanned urban development. Dhaka City

was once popular for its greeneries and natural beauty. Over the decade, the urban development process has engulfed the tree covers to accommodate the excessive population. In addition, industrial development and city expansion that took place in the periphery caused the depletion of existing trees over time. There was no policy guideline to protect green spaces. In some cases, the urban development program of the government also acted as a destroying agent of green coverage. Besides, there is a lack of consciousness among general people regarding the consequence of destroying tree coverage in and around the city.

The city is in a transition stage and the major challenge remains in the allocation of lands for green spaces to ensure the sustainability of urban areas considering the issue of city resilience in the context of climate change. All the facts raise the issue of future planning and management approaches for Dhaka Metropolitan emphasizing the integration of urban greens. The development of UA can be a feasible approach for creating green space in the city. Therefore, the potential of UA to enhance city resilience through incorporating multifunctional benefits to the urban environment of Dhaka Metropolitan needs to be explored.

1.4 Justification of the Research

At the theoretical level, urban green areas in cities make them more sustainable and climate resilient. However, practically most cities fail to maintain such a green landscape in cities and Dhaka is also not an exception. This study will explore the potential of UA to ensure the sustainability of the urban landscape, especially in the context of climate change. The outcomes of this study will provide an understanding of urban agricultural practice, particularly in the Dhaka Metropolitan area through exploring the agricultural land use change; help urban planners and policymakers to make justified and informed decisions to

formulate planning and policy guidelines ensuring ecological balance and climate change resilience for the urban areas by protecting the natural environment. This research will contribute to formulating master plans for the city by providing data and information to the concerned personnel analyzed scientifically. This kind of analytic research is important for making the Dhaka Metropolitan a much more livable and planned urban area in near future.

1.5 Research Question

This research aims to explore changes in urban agricultural land use and their consequences and also assess the scopes and challenges of the UA in Dhaka Metropolitan, particularly in the DMDP region. The present study tried to find answers to the following research question:

- Does urban agriculture have the potential to contribute to urban sustainability?

1.6 Objectives of the Study

The specific objective of the study is to identify the trend of agricultural land use change in the urban area of Dhaka Metropollitan and explore the consequences of such changes under the prevailing climate change condition.

The specific objectives of the study are:

- To explore the trend of decreasing the agricultural land use in the study area
- To assess the environmental impact of UA in relation to public health and environmental sustainability
- To explore the socio-economic impact of agricultural land use change (from agriculture to non-agriculture) in the study area
- To assess the environmental contribution of urban agriculture for sustainable and climate resilient urban development

- To accumulate and synthesize knowledge on agricultural practices in the DMDP region

1.7 Scope of the Study

Uncontrolled urbanization and rapid population growth in Dhaka impose burdens on adjacent agricultural land, forest area, water bodies, and wetlands, which ultimately hamper the urban ecology as well as the urban life. Risks associated with the unplanned urban growth of Dhaka may be further complicated by the impact of natural disasters and climate change as well.

The urban agricultural sector of Dhaka Metropolitan (DM) faces enormous pressure to abandon farming resulting from the continuous expansion of the city. The high cost of land and labor, tenure conflicts, high cost of agricultural inputs, financial crisis, and industrial and infrastructure development in the city can be considered major challenges for sustaining the UA in Dhaka Metropolitan.

On the other hand, the environmental sustainability of Dhaka is under threat due to significant obstacles and challenges resulting from haphazard urban extension and associated land-use changes (agriculture to non-agriculture) and other forms of environmental deterioration that impact negatively public health which is all critically important for the sustainable development of Dhaka.

UA faces various functional challenges that require proper addressing of critical technical knowledge. A good number of researches have already been done globally on the issue of UA. But most of them have been conducted in developed countries. Limited studies have been done in some developing countries as well. Few studies have been conducted in Bangladesh but unfortunately, most of those have missed assessing the potential of UA from

the ecological resilience and environmental sustainability point of view. This study has used a composite approach to assess the environmental benefits of urban agriculture to ensure urban sustainability and resilience in the context of climate change. This study also attempts to address the knowledge gaps and provides a synthesis of knowledge, experience, and scientific information about urban agricultural practices that prevailed in and around the Dhaka Metropolitan Region.

1.8 Limitation of the Study

Although the research has attempted to reach its aims through developing a particular research design, still there were some unavoidable limitations. Some of those are:

- Only farm households in the periphery of the Dhaka Metropolitan area have been surveyed for primary data collection. Households involved with agriculture practice located in the city centers have not been surveyed because of the sporadic position of those in the study area.
- No FGDs could have been conducted due to the pandemic situation caused by COVID-19 during the data collection period.
- In-depth analysis of cattle and poultry farming practices in the study area has not been conducted due to resource limitation
- Only some selected policy documents have been reviewed to analyze policy gaps that are solely relevant to the development of UA, particularly in the study area.
- Cost management was another limitation of this study. The cost is barred from a personal source.

1.9 Structure of the Thesis

This report has been prepared based on the above methodology and is composed of ten chapters with some sections and sub-sections and appendixes.

Chapter one outlines the context, problem formulation, research questions and objectives, scope and an overview of Dhaka city as well as the structure of the report.

Chapter two divides into two sections. The first section provides an overview of Urban Agriculture in a conceptual and theoretical perspective. The second section describes the benefits of UA from different points of view.

Chapter three includes a review of the literature.

Chapter four discusses the methodology used to conduct the research to fulfill its objectives.

Chapter five describes climate change, climatic trends of the study area and projection.

Chapter six discusses the study area profile.

Chapter seven describes the status of urban agriculture in the DMDP region.

Chapter eight draws the result and findings of the field survey.

Chapter nine discusses the finding from KIIs and case studies.

Chapter ten illustrates the policy analysis those are relevant to the development of UA in the study area.

Chapter eleven draws the conclusion based on the research findings.

In addition to the above-mentioned chapters, additional information is provided in the appendixes of this thesis.

Chapter 2

CONCEPTUAL OVERVIEW AND DEFINITION OF URBAN AGRICULTURE

2.1 Conceptual Overview of Urban Agriculture

Concepts are intellectual apparatus we create and modify or accept in accordance with our needs to understand a phenomenon through investigation and incorporation of outcomes with our real-life experience. The concept of urban agriculture evolved through an interaction with the development of relevant concepts which possess a unique architecture of contents and form. The concept needs to be developed according to the need of refining our perceptual experience to ensure its usefulness in accordance with our needs. Its establishment and sustainability depend on internal coherence and external functionality.

Internal coherence is interlinked with our perception of UA: how we want to call it or to see it in the real world. Stevenson et al., (1996) rightly stated the differences amongst agriculture "in the peri-urban zone" and "peri-urban" agriculture. The primary definition of UA provides a full conceptual edifice anchored into the real-world experience. Within the primary concept, situational variations occur according to local and regional relevance. It requires more experiences, resources and intellectual knowledge to build a useful and viable edifice of UA (Mougeot, 2000).

External functionality deals with the survival of UA in a particular place establishing itself competing with other phenomena (e.g. conventional agriculture, commercial food supply chain, sustainable urban development, etc.). The principal concept of UA should clearly describe its potential, synergy and distinguishing feature with related concepts. The principle assumption denotes the unique and value-adding features of UA to contribute to the neighborhood where it is being practiced (Mougeot, 2000).

Interaction between the internal and external concepts can determine the development and usefulness of UA. In this way, the concept of UA can provide a benchmark to identify the empirical manifestations and measurement of reflection of the concept at a particular time and space (e.g. the operational interpretation of the UA concept facilitates us to evaluate specific agricultural activities of a particular urban area). The conceptual benchmark is the primary requirement to identify the meaningful application of policy and technology needed to measure and interfere with appropriate means of promoting and/or managing UA.

In recent days, a new paradigm of UA has developed that suggests a method to understand its potential in terms of economic, social, and environmental benefits. The term "civic agriculture" was first introduced by Thomas Lyson, a sociologist at Cornell University. It describes the alignment of food and farming enterprises in a particular food system resulting from the requirements and demands of local growers and consumers, which in turn integrate communities with the food production system (DeLind, 2002; Lyson, 2000). Urban agriculture, according to the concept, has been described as the most successful and impactful venture where production (food and non-food) and distribution systems interact with the urban economy, environment, and community. The goal of producers is to get more than economic benefits and the consumers' goal is gaining more than just producing and consuming food (DeLind, 2002).

2.2 Definition of Urban Agriculture

The term "urban agriculture" is related to several different definitions and meanings. Many definitional challenges are linked with the topic of UA, which refers to a broad range of activities including crops, livestock, poultry, and aquaculture production, scaling from rooftop gardening to larger-scale cultivation (Thebo et al., 2014). There are several

definitions of urban agriculture suggested by different scholars from different points of view. Among those, the definition suggested by Mougeot (2000) is widely accepted. Mougeot (2000) defined UA as "…the growing, processing, and distribution of food and nonfood plant and tree crops and the raising of livestock, directly for the urban market, both within and on the fringe of an urban area".

The definition provided UNDP (1996) as: "Urban Agriculture (UA) is an industry that produces, processes, and markets food and other products, on land and water in urban and peri-urban areas, applying intensive production methods, and (re)using natural resources and urban wastes, to yield a diversity of crops and livestock".

FAO-COAG (1999) stated that, "Urban and Peri-Urban Agriculture are agricultural practices within and around cities which compete for resources (land, water, labour and energy) that could also serve other purposes to fulfill the requirements of the urban population. Key sectors of urban and peri-urban agriculture include horticulture, livestock, fodder and milk production, aquaculture, and forestry."

Generally, UA is integrated into the local urban economy and ecology (Mougeot, 2010). A big challenge remains in understanding what 'urban' specifically means in the literature on urban green infrastructure (Montgomery, 2008). In a broad sense, urban areas predominantly include human-made surfaces, where the concentration of population and economic activities are very high (Martezello et al., 2014). Broadly UA also includes peri-urban agriculture present around cities and urban areas that deliver products and services to the local citizens (Mougeot, 2010).

The principal concept of UA advocates a distinction from other methods of production functions. The prefix 'urban' differentiates it from "rural" agriculture, which encompasses the production functions taking place in rural areas, or at a place that is separated from the urban areas. An intensive discussion could help clarify how urban is considered against rural. Therefore, UA can be considered a form of a production system that has a potential correlation with the city it is connected with.

Different regions of the world represent diverse terms of urban agricultural categories based on different production systems. For example, in Africa and Latin America, shifting open-space systems seem more important for peri-urban vegetable production, where homestead and peri-urban farms are more established. This can be found also in some parts of Asia. On the other hand, in Asian and most African cities intensive space-oriented cultivation of high-value products is more developed (Richter et al., 1995).

Urban agriculture advocates for a major shift toward ecologically more sustainable production system compared to large-scale, highly mechanized rural agriculture and, therefore, can be considered as an alternative agriculture movement. Principal beliefs and values of UA encompass two approaches; conventional versus specialized agriculture system, those are: (1) centralized versus decentralized; (2) dependent versus independent; (3) individual versus community; (4) prominent versus harmony with nature; (5) specialized versus diversified; and (6) competing versus sustained (Sumner et al., 2010). The importance and influence of cultural values in agricultural practice and their relation to the sustainability of UA have been widely considered by urban agriculture.

2.2.1 Building Blocks of Current Definitions

Reviews on definitions helps to identify and highlight some common building blocks of the concept of UA. The common theoretical building blocks of UA identified are: categories of and sub-categories products (food/non-food), types of production systems, types of areas where it is practiced, characteristics of location, types of economic activities, production scale and product destination (Figure 2.1).

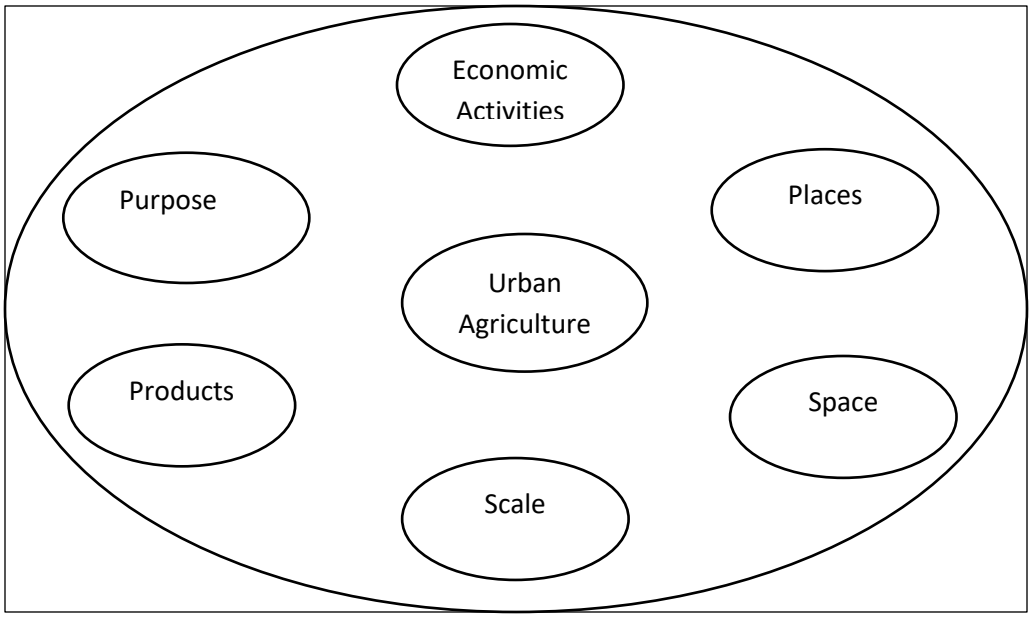


Figure 2.1: Dimensions of Urban Agriculture
Source: Adopted from Mougeot (2000)

i. <u>Food/non-food categories and sub-categories:</u> The definitions of UA include a range of diversified production of agricultural produce fit for consumption either by people or by livestock. The products includes the cultivation of cereals, fruits, vegetables, medicinal herbs and livestock products. Similarly, a certain number deal with plants, such as ornamentals and industrial plants (e.g. tobacco, silkworms, jute, timber plants, etc.). Within food crops, more fresh and high-valued products including vegetable and animal products and byproducts are highlighted by the definitions. Extensive food production is considered in several reports

whereas, other records suggest incorporating both food and non-food productions. Some of the UA systems are mutually complementary and often reinforce food security as well as enhance economic and environmental benefits at different levels (from individual to community). The understanding of the concept of the UA system on a broad spectrum will be hampered if the non-foods are eliminated from the general UA practice.

ii. Types of economic activities: The production phase is highlighted in most of the definitions of UA, whereas recent definitions include trade and processing of products. Besides, the analysis of commodities provides an integrated approach of urban agriculture where, different from of production, processing and marketing system tend to be more inter-related in time and place. In UA, the benefits of unit-based large scale economies may be enhanced through cooperative efforts (Mougeot, 2000).

iii. Intra-urban/peri-urban character of location: Location (in and around) of cities is the most common element of definitions that relates features urban areas with UA (Ganapathi, 1983; Sawio, 1993; Smit et al., 1996; COAG/FAO, 1999). This is the most important element of UA and the biggest source of argument. Records revealed that most of the UA studies have been conducted in large urban centers, national capitals and commercially important cities. However, location is a complex issue and the tasks of differentiation of intra and peri-urban locations was done successfully by few researchers.

Moustier (1998) defines UA as the agricultural practice that is operated within or in close proximity to a city where local resources are used mainly for non-agricultural uses. Researchers around the world have been trying to define the outer border of the peri-urban. Stevenson et al. (1996) reported that this outer boarder varies according to the distance of

those urban areas impacting the production system significantly. The urban and peri-urban zones within the metropolitan boundaries of Quito and Mexico City have been identified as used for urban forestry and animal husbandry (Murray, 1997; Losada et al., 1998). Maximum distances from the city center for supplying perishables foods to the city dwellers on a daily basis have also been reported by the researchers.

iv. Types of areas where UA is practiced: Opinions on criteria for selecting areas for UA vary from author to author: land right, the status of the site, tenure modality of the site (lease, sharing, authorization through personal agreement, commercial transaction, etc.), land use category of the site where UA is practiced (residential, industrial, institutional, etc.) have been recorded in the literature. Improper focus on the location of the original survey often resulted in misleading comparisons of areas drawn in many studies. Some surveys revealed creative interactions between different locational categories, under different tenure modalities (Maxwell, 1995; Sawio, 1993; Drescher, 1999).

v. Product destinations: Urban agriculture is considered in most definitions as a production system that grows produce for both self-consumption and trade (sale, exchange, gifts, etc.). Both purposes are found in varying degrees depending on the willingness or capacity of commercial and individual farmers. Recently, economic research has been conducted aimed at exploring the facts of specific market-oriented productions of UA which helped to understand the economic potential of UA, and its specialty against traditional agriculture, both at the producer and consumer level. In the case of self-consumption and commercial uses, relatively more attention must be given to the development of livestock assets as the feasibility of supplemental food for household consumption and trade is afforded by UA (GTZ, 1999).

vi. <u>Production systems (scale of):</u> Specific types of production systems have been clearly included or excluded by a few definitions. Research efforts generally emphasize personal, household, small and medium enterprises against large, national, or transnational activities. However, contemporary studies reveal that a larger interaction is important for the sustainability of market-oriented units, and often expended to a larger commercial unit. This phenomenon can be found mainly in peri-urban areas where farms have been primarily initiated for self-consumption. In some Asian cities, corporate financing for UA has been practiced for a limited time period, and trade liberalization is found in a increasing number of production systems in African and Latin American cities which made UA more attractive (Maxwell, 1995).

2.2.2 Urban Agriculture from different Approaches

Urban agriculture can be defined from different points of view. Answers to the following questions help to better understand the conceptual aspect of urban agriculture those represent different components of the concept:

Q.1 Where urban agriculture can be practiced? – The *spatial* component.

Q.2 What does it produce? – The functional component

Q.3 Where are the products of urban agriculture distributed? – The *market-orientation* component

Q.3 What is the origin of urban agriculture? – The *origin* component

Q.4 Who carry out urban agriculture? – The *actor* component

Q.5 Why does someone accomplish urban agriculture – The *motivation* component

Q.6 Who share the benefits of urban agriculture? – The *stakeholder* component

Each of the components explores diverse features and characteristics of urban agriculture. Some of these features are more "defining". In a definition of UA, some aspects may be found more crucial, compulsory and appropriate, whereas others may be found obligatory. Comparatively, the significance of various features may vary with the situation. However, all the components are context specific.

The 'spatial' approach deals with the spatial location of UA, particularly the proximity to an urban area. Farming activities can be found in all urban settings, from the urbanized city centers to the open places of the periphery. The boundary between urban and rural has to be defined clearly to outline the spatial extent of urban farming. An urban farm should adapt to the circumstances that the city dictates and respond subsequently to the city's needs taking advantage of the location. Urban farming may be flourished through close contact with huge rich urban markets. In the built-up areas of urban centers rooftop gardening, vegetable production in vacant lots, and orchards may be found whereas opportunities for real urban agriculture is high in open spaces of the urban fringe.

The 'functional' approach describes the activities practiced in the farmed areas more explicitly. Functional profiles are usually used to categorize agricultural farms which explore the strength and magnitude of different farm activities. The concepts of extreme events or externalities take into the account during estimation of the functional profile. Externalities include both positive and negative outputs of UA. Characterizing the multifunctionality of urban, different goods and services are considered those are more urban-oriented compared to others.

Urban agriculture includes different farming operations practiced in a particular urban area. Focus on production can be considered a key feature that divides urban agriculture from rural farming. The production function is the prime feature of most of the farms, whereas, UA provides different functions/services rather than production. Urban farms should have a broader approach to production procedures where residents, health, and recreation may be regarded as the paramount of production activity that allows flexibility in establishing new activities.

The 'market' approach deals with the channel of distribution of farm goods and its procedure. Literature on urban agriculture revealed that the products of UA are distributed in many channels compared to the products of traditional agricultural farms, which is coherent to the market opportunities (Mougeot, 2009). To be considered as urban, the agricultural practice should be market oriented and available to the local residents.

The 'origin' approach relates the proximity of the city boundary with the position of UA. A large number of the urban farms are situated in fallow areas. These areas are mainly kept in the city for other reasons. There are also some farmlands that are surrounded by built-up areas. The existence of these urban farms, in some cases, depends on local environmental conditions. Farmers' decisions to sell or reserve for future urban expansion influence the existence of these farms (Mougeot, 2009).

The 'actor' approach refers to the most prominent features of UA as it is the actors or farmers who are directly involved in farming activities. No agriculture exists without humans, hence actor is the supreme component. A very broad range of populations of the society may act as actors in operating UA. Firstly, the traditional farmers (full-time, part-time and amateur

farmers) are the actors as defined by conventional studies on agriculture. Secondly, the private sector executes farming activities in the community and private gardens.

The 'stakeholder' approach deals with the beneficiaries of urban agriculture which include but are not limited to farm households, individuals, urban communities and relevant institutions. The benefits of UA, include income, employment, groundwater recharge, municipal waste and water management, regulation of microclimatic, biodiversity, etc. are shared with the entire urban community to its close proximity, other stakeholders, and authorities. This on the other hand; takes direct benefit of other services such as educational, recreational, aesthetics, health, and social integration. The most direct service provided by urban agriculture is the food and employment opportunity that provides a direct impact on the individual's livelihood.

And finally, the 'motivational' approach refers to the diverse motivation that enacts actors in establishing and maintaining urban farms. Historically, urban gardening protected the livelihoods of urban laborers through cultivating essential crops, such as wheat, potatoes, rice and vegetables to some extent. The purpose of cultivation is probably also linked to supplying more nutritional foods which may be one of the prominent arguments for performing UA from the socio-economic point of view.

2.3 Working definition of Urban Agriculture

The discussions above illustrate an endeavor to structure and describe the conceptual framework of UA which may lead towards a working definition. The concluding remark can be considered as an effort to define UA:

'Urban agriculture may be defined as the agricultural system that focuses on producing crops and non-crop produces, animal products, biomass and other useful goods by involving all stakeholders and actors of a community emphasizing on the integration of activities, environment and economies of a particular place that according to the local definition and standards is categorized as “urban”.

UA encompasses a set of different activities. The scope of food production in urban and peri-urban areas varies because of many factors, e.g., the economic status of the area particularly the community (determine scale), cultural heritage (regulate categories of crops), communication infrastructure and availability of energy (determine market accessibility), availability to inputs (determine economic feasibility), availability of seeds, climate, soils, and irrigation facility.

Therefore, the major components of urban agriculture may include:

1. Urban and peri-urban crop and horticultural production
2. Urban and peri-urban livestock
3. Urban and peri-urban aquaculture

Chapter 3

REVIEW OF LITERATURE

3.1 Introduction

In the section selected literature regarding urban land use change and its impacts has been reviewed and discussed with a particular emphasis on urban agriculture. The impact of climate change and its consequences related to urban agricultural practice has also been considered in the discussion. This review provides discussions on various features of UA and the potential contributions of these features on food security, livelihood, socio-economic development, urban environmental sustainability and urban resilience.

Ricardo (1817) and Von Thunen (1826) are the pioneers of the land use concept approach during the 1830s, though there was a difference between their individual approaches. Ricardo reported that the intensity of demand for land can be measured most efficiently by the economic value of land (Meir & Baldwin, 1966). He also mentioned that the competition for land varies according to the market value, quality and market accessibility and type of area in which it is located. This ultimately influences the land use arrangement of a particular area. In contrast, Von Thunen (1826) highlighted transportation cost as the principal determinant. According to him, the land use category is determined by the functional distance of the central market. As a result, a series of concentric belts of differing land use are formed around the market.

3.2 Land Use Change in Bangladesh

In the literature, a good number of studies on land use change in Bangladesh are available highlighting intensive use of urban land, land fragmentation, land use changes, etc. Studies

on the transformation of urban agricultural land are also available, but the number is insufficient.

In 1962, the Department of Geography of the University of Dhaka carried out a study jointly with the Ford Foundation in the Fayadabad which is considered as the pioneer study on urban issues. Faridabad area was located eight miles north from the Dhaka city on the Dhaka-Tongi highway. The study explored that urbanization in this area took place converting the agricultural land into residence. The study also identified that Dhaka is expanding towards the north at a remarkable rate and industrialization took place in this area because the elevation of this area is high and flood free which is suitable for construction of industries (Ahmed & Khan, 1963).

The changes of approaches in the land market of Savar had been identified and explained by Ahmeduzzaman (1979). Savar went through a transformation from rural to urban by converting agricultural lands into built-up industrial zone. This was reflected in the increasing trend in land value during the period.

The agricultural land use in the rural-urban fringe area of Dhaka has experienced a rapid change in 80s (Ali, 1983). It was observed that between 1950 and 1980, the built-up area under the settlement had increased by 45.5% and at the same time agricultural land had decreased by 6.92%. Areas under vegetation and the current fellow had increased by 51.3% and 41.7% respectively.

A study entitled, “Land use transformation in Savar: A case study of sub-urban changes” tried to find out land use transformation during 1975-1989 in sub-urban areas of Dhaka and intended to explore the trend, impact and factors. Markov model was used for the evaluation

of land use changes and to find out the stability and instability of different types of land use (Rahman, 1990).

Nazrul Islam (1992 identified the role of various factors in the conversion of a fringe into an urbanized one. The author mainly considered the role of the public sector, industrial sector, formal private sector and government in accelerating the development of the fringe area.

In a study attempt was made to identify the historical roots of urban development of Panchagarh town and to explain the pattern of land use during the period of 1962-1991 (Shaikh & Khan (1995). Main objectives of the study were to examine the trends and patterns of land use changes in Panchagarh town during the mentioned period and to explore the factors responsible for the development of Panchagarh town since 1962. Land use dynamics of Khulna City corporation fringe area from 1980 to 1999" was investigated and observed a change in the land use pattern in a fringe area. The probability of change of different types of land use is not same (Shahriar, 1991).

Livelihood development and household requirement are the ultimate driver of land use change that combining with increase in income and wealth, amplify new housing development (Muhammad Rashidul Hasan, 2004).

Mondal (2007) identified the land use changes in Bangladesh during 1970-2006 with a particular focus on the effect of livelihood change. Some social and economic factors have been reported for land use change.

An in-depth study the land use planning in Bangladesh was surveyed and the existing pattern of land use change was also identified. It was explored that the land use has been changed significantly in the rural areas during the last few decades as a result of inadequakte emphasis

on appropriate land use planning at both the micro and macro levels that resulted in poor and inefficient use of lands (Choudhuri, 1985).

The major Land Use and Land Cover Change (LULCC) in Bangladesh at the sub-district level occurred in agricultural land, water bodies,forest and shrub land (Xu, et al., 2020). Although the average gain and loss of agricultural land are large at the local scale, but the net change of agricultural land at the country scale is almost negligible. In the southeast region, climate change dynamics, extreme events of nature and changes in urban and rural households are driving the changes from forest to shrub land.

The concepts and historical evidences of studies discussed above in brief more or less is the normative description of overall growth and structural change of urban land use. These theories and empirical studies may provide some useful information on the way in which land use transformation is happening all over Bangladesh which may be helpful in our study to understand the trend of land use change.

3.3 Urban Agriculture in Dhaka

The land use pattern of Dhaka Metropolitan illustrates that the highest portion of the land of the city is still under agricultural land use compared to other land uses. Urban agriculture has enhanced the food security status of this area by increasing the perishable food supply to urban consumers (Islam, 2004). About 61% of the land area in Greater Dhaka is nonurban which is used for rural or semi-rural agriculture while the rest is used for urban. Because the city is spreading towards the agricultural lands at an increasing rate. Therefore, a strong political commitment and proper policy guidelines are essential to building a supportive environment for UA.

On the average, most of the areas in the DAP are suitable for urban agriculture. The designated agricultural zones in the DAP are suitable for vegetable production (Ananya et al., 2012). The Government and the concerned authorities should ensure the preservation utilization of the agricultural land through legislation. Increasing the practice of rooftop gardening and community gardening as the built-up area is increasing due to urbanization which can play a vital role for fresh foods supply. Unutilized and fallow lands within the city can be used for promoting urban agriculture (Ananya et al., 2012).

Commercial vegetable production in Dhaka was mainly confined to flood-free land, 4-5 km away from the city center (Pramanik, 2013). The output supplied about half of the market demand in the city. However, now most of the agricultural land has been converted into industrial and housing plots, and the remaining area is steadily declining. As a result, less than 5 percent of the vegetables marketed in Dhaka come from that area. It is difficult to use the remaining agricultural land for any other purpose due to its specific topographical conditions and inundated and occasionally flooded to a depth of 3-5 m, thus making development difficult and very expensive. Similarly, due to access problems, some highland areas are still used for agricultural production. Low-lying lands are utilized for the cultivation of Boro rice. He also reported that horticulture crops are mainly cultivated during the winter season when the water recedes and the land dries out (Pramanik, 2013).

The UA of Dhaka particularly located in the periphery faces huge pressures that compel the farmers to give up agricultural practice as the city is continuously expanding towards its border. Among the challenges, land and labor cost, tenure problem, in-migration pressure, development activities, pollution, and impact of natural disaster particularly the flooding are

major that hampering the sustainability of UA in Dhaka. Integration of urban agriculture into the policy domain can solve the problem (Rahman et al., 2012).

In Dhaka Metropolitan, urban agriculture is an important livelihood means for a significant number of poor populations who reside in the slams. A research on UA was done in 1996 with the support of UNDP. This research was conducted among 400 respondents who were engaged directly or indirectly in urban agriculture. The researchers estimated that the 400 respondents generated an annual production valued about 30 million taka which is equivalent to $US 2000 per annum. Estimating a gross margin of 30% of the earnings of a person comes $US 500 from the urban food production activities. This is far above the poverty line of $US 1 per person per day.

The food production in the city areas of Bangladesh is significant. In 1983/84, the urban farmers have produced about 25,000 tons of rice, 180 tons of meat (beef and mutton), nearly 1,00,000 chicken and 19,000 tons of milk (Asaduzzaman, 1989).

In Keraniganj, water bodies, low-lying and agricultural lands have been converted to built-up area at a substantial rate over the period 1997-2006. As a result, urban settlements in this area most characterized by insufficient municipal services including water supply, sewerage, traffic congestion and social conflict, etc. that hampering the urban governance adversely (Raihan & Kaiser, 2012).

Between 1975 and 2003, a substantial increase of built-up areas was observed Greater Dhaka evaluated by satellite images and socio-economic data. This caused a significant decrease in agricultural land, vegetation, water bodies and wetlands. Rapid urban development through

landfill and destroying vegetation resulted in environmental degradation and, deterioration of habitat quality (Dewan & Yamaguchi, 2009b).

In recent years, development activities inside the DMDP area are flourishing engulfing agricultural land and wetlands. As a result, these lands have been converted into real estate projects. However, information on the consequences of these changes within the DMDP boundary is very limited in the literature. Closeness with the CBD of the Dhaka metropolitan, development of the major transportation network and availability of a vast flood-free undeveloped zone has been identified as the key factors in increasing the real estate in the periphery of Dhaka (Ayon et al., 2020). High selling prices of lands and less economic return from urban agriculture were identified as the root causes of the land sales boom which are considered "Push and Pull" factors. Besides these push and pull factors, the limitations and in most cases, lacking government policies are responsible for the decrease of agricultural lands (Ayon et al., 2020).

The urban area in Dhaka city increased significantly from 1989 to 2014 (Morshed et al., 2017). Over the period the built-up area increased 81.54% at an average rate of 2.41% per annum. The built-up area consumed a significant amount of agricultural land and vegetated areas across the city. Besides this, wetlands have dropped consistently over the last twenty-five years (Morshed et al., 2017).

FAO (2008) reported about 21.57% open are available in Dhaka city of which city parks cover 0.89%, urban forestry 0.02%, gardens 0.90% and 12.12% are covered by agricultural activities. A gradual decrease can be observed in the green spaces against increase in the buildings.

3.4 Roof Top Gardening (RTG) in Dhaka

Rooftop gardens support social life, as a space to be a comfortable outdoor environment with family and friends. It also develops a sense of self-identity and independence, where one can primarily achieve self and emotional regulation by viewing different flower indifferent seasons (Rashid & Ahmed, 2010) and affords restorative experience from demanding everyday activities in urban high-rise residential buildings.

The economic and social benefits of rooftop gardening include fresh food supply for urban residents, converting the hard surface into a soft green surface, rainwater harvesting, energy saving, reducing heat field, etc. (Rashid et al., 2010).

A baseline study on rooftop gardening in Dhaka Metropolitan explored that the rooftop garden (RTG) plays an important role in the sound mental health of the gardeners as well as in the amelioration of the physical environment (Uddin et al., 2016). The production of fresh fruits and vegetables in the rooftop garden can increase the nutritional status of household members of urban citizens and can make a positive contribution to environmental sustainability. A technically feasible, socially acceptable, economically viable, and environment-friendly RTG model can be developed and up-scaled gradually in Dhaka through Government guidance, policy and encouragement. The study report suggested that in order to realize the potential benefits that RTG can offer, major shifts in the thinking of the policymakers is required (Uddin et al., 2016).

The physical and cultural aspect of roof gardening in Dhaka has been assessed by Sajjaduzzaman et al. (2005). The result of the study shows that roof gardening has also a promising potential as a small-scale business that can accelerate additional family income.

Nevertheless, it may generate some employment facilities through its backward and forward linkages. The study suggested establishing training and research facilities and formulating necessary policy measures on roof gardening by relevant government and non-government organizations that may help to mass scale practice.

In Dhaka city, about 80,220 hectares of land are covered by concrete as a continuous roof as a result of construction buildings which constitutes about 65% of the area (Afsar, 1999). This space may have a great opportunity to extend green coverage through food production for feeding the urban dwellers as well as offering livelihoods for city people. An insignificant number of city dwellers already started rooftop gardening. But it focuses only on aesthetic value and beautification rather than food production.

Safayat et al., (2017) conducted a study in the Mirpur and Mohammadpur areas of Dhaka and reported that rooftop farming can support the environment by improving air quality, reducing carbon discharge in the atmosphere, decreasing heat island and can advantage the urban society by reducing stormwater management costs. One of the significant findings from the study is that maximum people are willing to practice rooftop farming and want to provide at least 50% of roof space for rooftop farming. Some recommendations have been suggested to improve rooftop farming practice and encourage more people to practice rooftop farming in the future which includes proper training and awareness programs initiated by the Government to spread the knowledge of rooftop farming through support from NGOs or community organizations.

An estimation showed that around 10,000 ha of land of Dhaka city can be brought under rooftop farming and the residents of the city can eat fresh vegetables as well as over 10% of

the demand of the urban market can be fulfilled through rooftop farming (Wardard, 2014). Another survey shows that most of the roofs of Dhaka city are suitable for gardening and do not require major improvement work, sometimes only needing some modifications (Islam, 2004).

In a recent study, Chowdhury et al. (2020) reported that the trend of growing vegetables on green roofs has gained momentum as a way of promoting agricultural sustainability in Dhaka City in recent years. Rooftop gardens become an important part of the new dimension of the current practice of urban agriculture and offer alternative spaces for urban entrepreneurs to grow vegetables and fruits. As the global populations become more urbanized and urban consumers become more interested in local, fresh and nutritious food for their families. The use of alternative agricultural production systems, such as green roof technologies is increasing and become an important tool for RTG. Though cultivating food on buildings is a key component of making cities more sustainable and habitable, green roofs alone are not the total solution for providing city dwellers with food security. It should be viewed more as a supplement to other sources of food production in urban areas.

A study was conducted in selected residential areas of Dhaka City Corporation namely Dhanmondi, Lalmatia, Mohakhali DOHS and Uttara through a plot-to-plot interview using a questionnaire. It was revealed that 39.1%, 59.2%, 36.6 % and 22.2% of buildings have rooftop gardening in those selected locations respectively (Islam et al., 2019). Nearly one-third of the buildings contain rooftop gardening which is basically established based on the aesthetic sense and moral values of individuals. It was suggested that government should appreciate initiatives and formulate proper planning policy to motivate citizens of the urban areas for planting fruit plants and vegetables on their roofs. RTG system may also be

considered a tool for achieving the Sustainable Development Goals (SDGs). Long-term policy measures for rooftop gardening that can become the basis for a sustainable approach to urban agriculture in essential (Islam et al., 2019).

A study was conducted aiming at evaluating the practices of vertical gardening contributing to eco-sustainability and disaster risk reduction in the context of Dhaka city. The study reveals that vertical or rooftop gardening can hold about 70-90% of the precipitation in summer. Rooftop gardening can reduce the effect of urban heat islands through vegetation coverage. Vegetation can be used as a shade for building and cooling down the surrounding environment by using their evapotranspiration process. A study, conducted in Dhaka, reported that vertical gardening can reduce the cooling cost by up to 50% and 25% of the surrounding area (Rahman et al., 2019).

The overall scenario of the rooftop gardening practice of Gulshan and Mohakhali area of Dhaka metropolitan was explored along with identifying the challenges and solutions to how this practice can be promoted widely from planning perspectives. The large-scale RTG contributes significantly to cooling down the temperature of the top floor of the building rather than small-scale RTG (Huq et al., 2019). It is the responsibility of professionals and policymakers to start a positive ripple of roof gardening on an urban scale. RTG at an urban scale will not only benefit to reduce the UHI effect but also bless the city with aesthetical and psychological benefits.

Growing evidence reveals though there is a huge opportunity for RTA in Bangladesh especially in Dhaka. A gap in knowledge base and misconceptions are major hindrances to the implementation of green roofs through gardening (Hossain et al., 2019). It is also true that

lack of government incentives, higher maintenance requirements, lack of owner/client interest, and lack of awareness about the sustainable environment are the major hindrances in implementing extensive green roofs.

Green roofs can mitigate the problem of water logging in Dhaka city by serving as a kind of water regeneration system (Momtaz & Khan, 2017). Green roofs have the potential to reduce rainwater runoff. The soil of green roofs can hold as much as 15 to 20 percent of the rain falling on planted areas for up to two months, releasing it more slowly into a city's storm system (Theodor, 1999).

At the national level, there is no specific policy provision or legislation that promotes urban agriculture or rooftop garden in particular in the urban areas in Bangladesh. UA needs to be addressed in the policy formulation. Situations are currently changing in Bangladesh. Initiatives like "Urban Afforestation Programs" have played and are still playing a vital role in this context. In 2013, the Department of Agriculture Extension (DAE), Bangladesh launched the "Integrated Quality Horticulture Development Project" which offers training and necessary logistics to individuals for roof gardening and horticultural development in Dhaka. The 'Roof Garden Association' (RGA) in Bangladesh is conducting the "Green Roof Movement" in Dhaka focusing on technical and financial aspects of roof gardening. Recently, the Mayor of Dhaka City Corporation declared- "….any building having a roof garden will get 10% discount in the holding tax." (The Daily Star, 2019). So, it can be said that some positive initiatives have shown the light of hope to uplift the status of roof gardening practice in Bangladesh.

3.5 Urban Green Space in Dhaka

Green space is an integral component of the environment for the proper functioning of the ecosystem, particularly in an urban area. Urban green spaces provide features and services that contribute fundamentally to the quality of urban life (Shafer et al., 2000; Van Herzele & Wiedemann, 2003; Chiesura, 2004). Increasing population growth is largely an urban phenomenon in developing countries around the globe. Bangladesh is not lagging behind on the urbanization front. According to the 14th annual edition of "Demographia World Urban Areas", released in April 2018, Dhaka ranked as the top city among 1,758 urban areas of all sizes comprised of a total population of 2.38 billion. Currently, Dhaka hosts about 17.4 million populations with a density of 47,400 people per square kilometer of area. Dhaka, the capital of Bangladesh, was once popular for its green resources. But in recent times, the city is losing its greeneries very rapidly due to uncontrolled urban development.

According to World Health Organization (WHO), there should be at least 9 sq. meters of green space in a city for every city dweller for ensuring a better and healthy life. Generally, developed countries have plenty of trees in the urban areas (more than 20 sq. meter green spaces per city dweller) to meet the environmental balance for human well-being compared to cities in developing countries. In developing or underdeveloped countries, this proportion often falls below the minimum standard of open green spaces set by the WHO. For example, most of the cities in China have 6.52 sq. meters of green coverage per head. (Rahman & Ahmed, 2012).

In a recent study Jaman et al. (2020) reported that the major green spaces and vegetated areas of Dhaka Metropolitan are covered by urban parks, edge plantations of playgrounds,

botanical gardens, and roadside plantations. The south part of Dhaka City Corporation has 27 urban parks, 10 playgrounds and 3 botanical gardens that contribute to the majority of the urban vegetation of the city. Moreover, the city has 61.45 km of primary and 108.2 km of secondary roads contributing to major roadside vegetation throughout the city.

The green resources in Dhaka are shrinking due to unplanned urban development, the rapid increase of urban population, the transformation of green and other open spaces into other types of land use, and the lack of proper planning and implementation and management restrictions as well. The possible prospects are to the protection of existing green areas such as parks, gardens, playgrounds, etc., increase roadside, avenue plantation, and rooftop gardening, introduce afforestation and nursery activities in newly developing areas in between built-up and peri-urban, and promote homestead gardening and social or community forestry in peri-urban areas (Anasari, 2008).

Dhaka city contains only 21.573 % open space of its total are of which s agriculture accounts for about 12.12%. of the open spaces. Besides agriculture, green resources in Dhaka comprise roads and streets, pavements, parks, public and private gardens, graveyards, nurseries, zoo, sports fields, woodlots and social or community forest areas in peri-urban (SDNPBD, 2005).

In the Dhaka North city corporation area, a study was conducted intended to explore the status of urban greening as well as to investigate the prospects and challenges for enhancing urban forestry and urban greening (Roy et al., 2016). Factors that are responsible for the loss of green resources in Dhaka city include the transformation of existing green areas or open spaces for other land use purposes, unplanned urbanization & improper urban planning, the

rapid increase of urban population, and lack of nature conservation activities for protecting the existing greeneries. Nevertheless, there are huge opportunities remain to enhance the greeneries in Dhaka city by conserving the existing green areas (e.g. parks, gardens, playgrounds, etc.), increasing roadside plantation, promoting homestead and rooftop gardening and initiating afforestation and nursery activities (Roy et al., 2016).

An attempt was made by Byomkesh et al., (2012) to map and monitor green spaces in Greater Dhaka. It was reported that the drastic reduction of green spaces in Greater Dhaka has been attributed to a lack of policy, low political motivation and poor management. Due to rapid rural-urban migration, unplanned urbanization, infrastructure development, commercial boost and industrialization the city is losing its greeneries at an alarming rate. Urban green spaces or greeneries are predominantly crucial for the proper functioning of the ecosystem in any urban environment. In order to ensure the sustainability of green spaces and the proper functioning of the city's ecosystem, there is an urgent need for strategic green space planning.

Almost 80% of the land in Greater Dhaka was non-urban in the 1960s (i.e., it contained vegetation, open spaces, wetlands and cultivated lands), but this figure had been reduced to about 40% by 2005 (Dewan & Yamaguchi, 2008). In contrast, historical records reveal that the city was well planned and beautifully furnished with many parks and gardens during the Mughal period (DCC, 2008).

The green resources in Dhaka are inundated by a number of limiting factors that are integral to the process of urban development. The rapid increase of urban population, the transformation of green and open spaces into other types of land use, lack of proper planning

and implementation and management restrictions are responsible for the extinction of greeneries in the Dhaka Metropolitan (Ansari, 2008).

An attempt was made to examine city dwellers' perceptions of green spaces and explored the relationship between green space and urban sustainability in Dhaka. It was found that the current state of green space was not in satisfactory condition at all (Razia, 2018). It further revealed city dwellers 'low level of satisfaction with the existing utilization of green space in Dhaka. City dwellers' insight into green spaces has some negative social implications. The study suggested city authorities and the national government create more green spaces and formulate policies for better utilization of these green spaces towards enhancing urban livability in Dhaka city (Razia, 2018).

Green spaces provide scope for walking and cycling, and at the same time helps to regenerate natural resource and revitalize urban ecology working as a buffer zone. Besides, it provides socialization opportunities that help to mitigate social inequalities. City residents get the social benefits of urban green space in terms of recreational opportunities, mental health, aesthetic enjoyment, and social bonding. Thus, urban green space can play a vital role in social issues in megacities and Dhaka is not an exception.

3.6 Global Practice of Urban Agriculture

Over the decades, international studies on UA have focused primarily on the development of the concept of UA, pollution management, ecosystem services, nutrient management, urban planning, impact assessment, categories and the role of UA in response to crises (Challinor et al., 2014; Lal, 2020; Pulighe & Lupia, 2020; Marsh et al., 2022; Cederlof, 2016; Martellozzo, 2014). Diverse topics of research on UA have been formed because of improvements in

theories and systems. The development of UA from a macro perspective can provide a theoretical reference for academic research through evaluating the research findings, exploring its historical evolution, and conducting a relatively complete analysis of UA.

Evidence of the increasing role of urban agriculture in urban food production is available in several cities around the globe. Urban agriculture occupies more than 21,000 ha of land in Cagayan de Oro City (Philippines) (Potutan et al., 2000); in Havana-Cuba, about 12 % of urban land is dedicated to agriculture (Cruz & Medina, 2003); and more than 11,000 ha of land are used for agricultural production in Jakarta (Indonesia) (Purnomohadi, 2000).

About 100,000 tons of fresh foods are produced in Dar es Salaam (Tanzania) yearly (Ratta & Nasr, 1996); 100%of milk and 90%of eggs consumed in Shanghai (China) are produced within the city boundaries (Yi-Zhang & Zhangen, 2000).

The rate of the urban population involved in agriculture is estimated at about 50 % in Accra, Ghana (Obosu-Mensah, 2002), while according to both van Veenhuizen (2006) and Shackleton et al., (2009), 80 % in Brazzaville (Congo), 68 % in the five biggest cities of Tanzania, 45 % in Lusaka (Zambia), 37 % in Maputo (Mozambique), 36 % in Ouagadougou (Burkina Faso), and 35% in Yaoundé (Cameroon). In Kenyan cities, about 29% of the families are employed in urban farming (Ghosh, 2004).

During the last few decades, the number of actions addressing the development and promotion of urban agriculture has increased steadily around the world (Drescher, 2001; Cissé et al., 2005). For example, there are many countries where governments promote the development of urban agricultural production through essential support. Among the Latin

American countries Argentina, Brazil, and Cuba have developed robust national policies and programs that promote urban horticulture (van Veenhuizen, 2006).

In Shanghai (China), a program that promotes the city self-sufficiency in cereals production allows a yearly production of 2 million tons of wheat (Yi-Zhang & Zhangen, 2000). In Cagayan de Oro City (Philippines), the local government in collaboration with Xavier University adopted several measures aimed at facilitating the cultivation of community gardens among the poorest households (Holmer et al., 2003; Holmer & Drescher 2005). In Accra, the capital of Ghana, the Ministry of Food and Agriculture extended its support for the development of urban agriculture in a Vision Statement (Obuobie et al., 2006) and started on establishing different sites in the city to explore the ground for safer irrigation water. By following a directive from the central government, the municipality of Bamako (Mali) started to explore the possibilities of leasing to urban farmers up to 600 ha of land near Bamako's international airport (Velez-Guerra 2004). In Niamey (Niger), the inclusive urban development plan of the city considers the modernization and intensification of irrigated and rainfed agriculture, particularly along the Niger River (Cissé et al., 2005).

3.7 Conclusion

UA recently has receiving attention of the policymakers both in the developed and developing countries as an important strategy for livelihood, food security, employment opportunities, socio-economic development and urban sustainability. Rate of participation in UA vary considerably but in some contexts it appear to be an important contributor to income both at the household and community level. UA has the potential to improve food and nutritional security through a variety of means including direct access and availability of

food that also aid in increase of income from the sale of food products. This review identified a widespread range of studies those investigated the association between UA and food security, dietary diversity and child nutritional status, although the quality of the evidence base was highly variable. The review suggests that there are some evidences which revealed that UA is associated with increased dietary diversity and more broadly with food consumption. Studies addressing child nutritional status were perhaps the most significant and viable in terms of quality, hampering strong conclusions. In general, the topic of UA would benefit from increased attention to the quality research designed to carry out in this field level and the evaluation of programmes undertaken to the development of UA.

There is an increasing interest in UA from a wide range of academic, policy makers, urban planners and concomitant researcher groups to increase UA-friendly policies. There has also been concern that UA is popular because of its multifunctionality and cohesion with current policy discourse on community participation, gender equity, and sustainability.

Although green space has always been an important component for ensuring urban sustainability, it did not get proper research focus in Bangladesh. Some researchers have tried to examine the economic and environmental aspects of green spaces where the social implications were ignored. Evidence revealed that there is a huge gap of research on exploring the association between UA and green space management. The review suggests that this gap of knowledge is not only making the city vulnerable to natural hazards through inappropriate urban land management but also reducing the quality of life by diminishing the city's social and aesthetic fabric. Though it is generally argued that urban greeneries are fast disappearing in the DMDP area, little is known about the relation of urban green space dynamics, landscape structure and urban agriculture.

Chapter 4

MATERIALS AND METHOD

4.1 Introduction

The research has been conducted based on both primary and secondary data and information. A questionnaire survey has been carried out in the study area to collect primary data on existing agricultural practices using a structured questionnaire. Besides this KIIs and FGDs have also been conducted to collect qualitative information on the challenges and opportunities of UA. Intensive deskwork has been done to review different reports, articles, newspapers, policy briefs and other available literature to collect secondary information and data to fulfill the gaps of information to achieve the objective of the research work.

A conceptual overview of UA has been discussed in the earlier part of the thesis in order to achieve an appropriate understanding of different aspects including the conceptual framework of urban agriculture. Relevant literature has been used to collect secondary data and information. Related data have also collected through the internet and library of the University of Dhaka. An analysis has been done using both maps and descriptions on the existing agricultural land use situation including green resources of the study area. Some maps have been used directly collected from secondary sources and some were reconstructed. Available maps and images have been collected from different authorities and used. Statistically analyzed data and photographs have also been used and interpreted to depict the situation.

4.2 Concepts and Hypothesis

To achieve the aim of study two principle concepts of UA have been used: the 'Sustainability' and the 'Multi-functionality' of urban agriculture.

Urban agriculture can underpin the three basic components of sustainable development namely economy, ecology, and society (Figure 4.1). Urban planners realized that UA has some explicit functions and benefits for urban life and environment, which cannot be supplemented easily. The functions of agriculture, in fact, are always multiple: production of food (Smith et al., 1996, Snrech, 1997), environmental functions, socio-economic functions, etc. (Temple & Moustier, 2004). Therefore, this research attempted to analyze the different functions accomplished by UA.

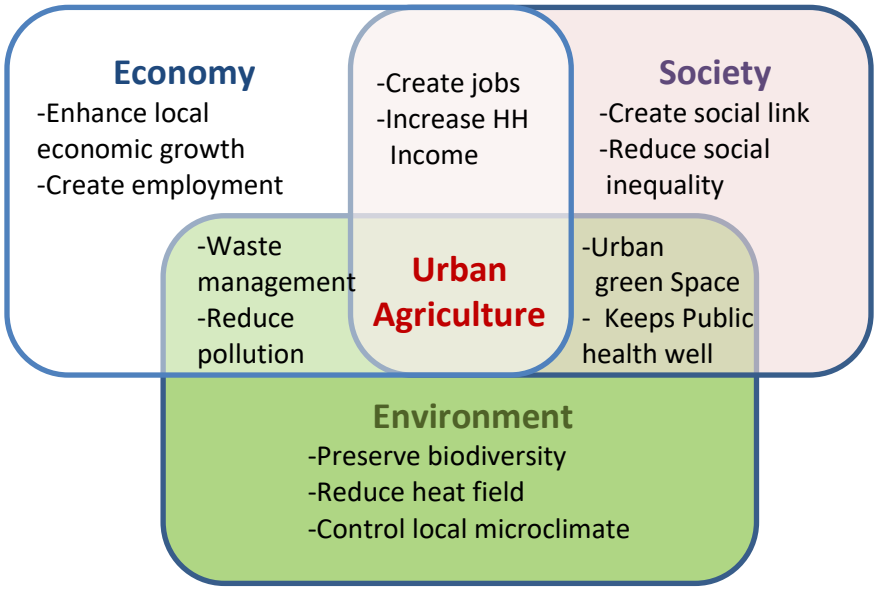


Figure 4.1: Multifunctionality and Sustainability of UA
Source: Adopted from Temple & Moustier (2004)

UA contributes to developing sustainable urban landscapes that mean landscapes where "ecology, economy, and well-being are balanced and strengthen each other". To achieve this, UA needs to be "sustainable" itself. In the literature, "sustainable agriculture" has been defined as the agricultural practice that takes place in a development process that is socially accepted and economically viable, where environmental resources are preserved for present and future needs (Bruntl & Report, 1987). Urban agriculture can be assumed to have two

sustainability levels which are called “dual sustainability”, derive from the specific characteristics of a certain urban area. Those are:

(a) Farm or ‘Internal’ sustainability is the intrinsic sustainability which is dependent on the production features of farms, that means the products are economically viable, socially acceptable, and the resources used are renewable.

(b) Territorial or ‘External’ sustainability is the contribution of agriculture in the sustainable development of an area (Godard and Hubert, 2002). This territorial sustainability can be connected with the vision of city planners to keep agricultural land in a certain city in comparison with the needs for alternative land uses in the context of urbanization. External sustainability is, therefore, related to the “Actors” of the city (its policymakers, planners, residents, etc.).

Internal sustainability suggests studying the diversity of UA farms in detail whereas, external sustainability implies assessing the intention and vision of urban authorities. The concepts of sustainability and multifunctionality seem closely related to the successful establishment of urban agriculture in a particular area (Fleury, 2005).

Better knowledge of the production, management, and marketing of UA is a prerequisite for policy implication. An in-depth discussion of sustainability and functions is, therefore, necessary to understand how UA contributes to the sustainability of urban landscapes which ultimately helps to design future landscapes. Therefore, it is assumed that the incorporation of “urban green” through agriculture in the city can contribute to designing sustainable urban landscapes as an interdisciplinary approach.

The function of food production, risk management, environmental protection, recreational and aesthetic aspects, can lead urban planners to preserve agriculture inside cities which can act as key issue for better retaining agricultural land use in the urban area.

The second concept that has been incorporated in this study is the multi-functionality, a unique feature of urban agriculture globally (Donadieu & Fleury, 2003; Fleury, 2005; Zasada, 2011). Food production, especially fresh nutritional foodstuff (Egziabher et al., 1994; Smith et al., 1996; Snrech, 1997; Temple & Moustier, 2004), management of environmental risks, contribution to reducing pollution by recycling waste (Drechsel et al., 1999; Mougeot, 2005; N'Diénor, 2006), landscape and health functions (Ba and Moustier, 2010), and contribution to urban employment and the reduction of inequalities of residents (Dubbeling et al., 2010) are some of the major functions of urban agriculture that researchers throughout the world have recognized. In the issue of urban sustainability, the multifunctionality of UA can be considered from the point of view of urban communities and planners. Clarifying the functions of urban agriculture to assess the role of agriculture in urban environments is critical (van Veenhuizen, 2006).

The relations between these two concepts are intricate. Historical data shows that urban farms are largely multifunctional worldwide; then the question arises whether multifunctionality is one of the prerequisites of the sustainability of urban land use. It was assumed that territorial sustainability is strongly determined by multifunctionality, agriculture can make a positive contribution to the environment that cannot easily be replaced by other land uses (Ba & Aubry, 2010).

Urban agriculture has the potential to develop multifunctional urban green structures which can be an important contributor to sustainable urban development in terms of improving the quality of life and environment of a certain urban area (Konijnendijk et al., 2004). The conservation and expansion of green areas around the cities can improve the quality of life by providing urban dwellers options for leisure and recreation, and other precious resources.

To study the role of agriculture in sustainable urban development, it is necessary to accomplish research on: (i) assessment of (understand, qualify and quantify) the multiple functions of urban agriculture, from the points of view of urban farmers as well as the planners; and (ii) diagnose the internal linkage of urban agriculture with the sustainable and climate resilient urban development.

4.3 Conceptual Framework of the Study

The study examines urban agricultural practice in Dhaka in the context of rapid urban growth, income generation, climate change, and natural hazards. The assessment focuses on exploring the trend of agricultural land use change and its consequences and related socio-economic impact in relation to public health and environmental degradation. The conceptual framework of the study illustrates the key drivers of urban development, policy intervention and initiatives taken to promote and develop UA. The conceptual framework of the study is presented in Figure 4.2.

The concept of greening and creating open space through urban agriculture is particularly a promising approach for the planning and management of urban green space. It emphasizes the core components of urban green and open spaces, such as cropland, forests, and other tree-dominated vegetation and water bodies (Konijnendijk et al., 2004). UA deals with

multiple functions of urban green resources in the interface between urban and rural (Knuth, L., 2006).

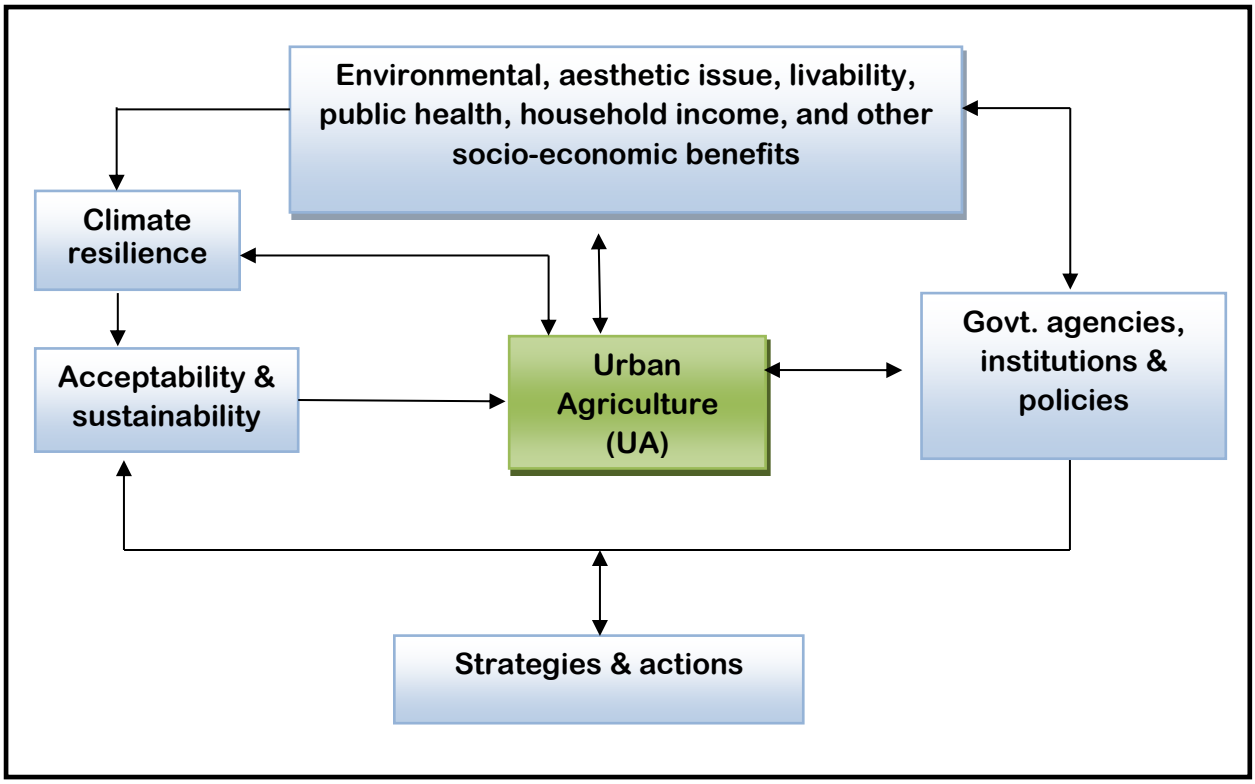


Figure 4.2: Conceptual Framework of the Study

The overall objective of UA is not merely food and timber production or beautification, but a sustainable assembles of economic, social and ecological benefits (Nilsson et al., 2001). Urban agriculture thus can be considered as a strategic, interactive, and participatory and interdisciplinary approach to creating green space in the urban area that can ensure climate resilient sustainable urban development.

4.4 Methodology

This section narrates a brief description of the methodological procedure that has been followed in this research which includes research methods, data collection instruments,

sampling procedure and field data collection technique and statistical analysis. Both quantitative and qualitative methods were used for data collection, which included randomly selected house-to-house interviews using a structured questionnaire, key informant surveys using a structured interview format, case studies and a review of the literature (secondary sources).

An interview checklist was developed to conduct KII. For the questionnaire survey, participants who were involved directly with agricultural activities and were interested in interviews were selected for the survey. More than 10 years of involvement with agricultural activities was the inclusion criteria of the respondents, because of having experience and knowledge of agricultural practices and major challenges in urban agriculture as well as the perception of the impact of climate change. Data collection was started after getting consent from respondents and the interview was conducted by using a pretested checklist.

The study largely focused on the synthesis of secondary information published in peer-reviewed journals, processed data available publically, reports, books and grey literature collected from authentic sources. A large volume of secondary data and information on population, income, land use change, crop agriculture, poultry and livestock, fisheries, forestry, greeneries, and waste management were collected and analyzed. Besides these, primary data were collected through questionnaire survey, KII and case studies and analyzed to fulfill the aim of the research.

4.4.1 Selection and Description of Study Area

Dhaka is the principal focus of urban development in Bangladesh. It is densely populated and became a member of the “mega-city” family of the world. Uncontrolled and rapid

urbanization, industrial development and population pressure worsen the overall city environment severely day by day. Though once Dhaka City was known for its greeneries and natural beauty, at present tree covers are almost extinct and replaced by urban habitats to accommodate the urban population. Considering the facts, the Dhaka Metropolitan Development Plan (DMDP) area has been selected as the study area. The DMDP has been extended up to Keraniganj, Narayanganj Sadar, Bandar and Sonargaon in the south, Rupganj and Kaliganj in the east, Gazipur Sadar in the north and Savarthana in the west.

The DMDP area covers a total area of 1528 km^2 and located in the estuary of three major river systems i.e., Jamuna, Padma, and Meghna. The urbanized part of Dhaka Metropolitan and the adjacent peri-urban areas mainly occupy the flood plains of a number of smaller rivers which are branches of the two (the Padma and the Meghna) larger rivers of Bangladesh and form a complex system of rivers and natural drainage channels (the watershed formed by the river Tongi and Turag on the north, Sitalakhya and Balu in the eastern and Buriganga on the western and southern part). As a result, most of the land within the pear-shaped delta lies about 2-6 m above MSL (Mean Sea Level) that formed the DMDP except for the Mirpur highlands. The elevation of Mirpur is about 13m located along the central axis(World Bank, 2007).

The administrative boundary of the DMDP includes 3 districts (Dhaka, part of Narayanganj and Ghazipur), 5 Pourashavas (Savar, Tongi, Ghazipur, Narayanganj & Kadam Rasul) and the two City Corporations (DNCC and DSCC). A map of the DMDP area defining the administrative boundaries is presented in Figure 4.3 below.

Figure 4.3: Dhaka Metropolitan Development Plan (DMDP) Area
Source: Dhaka Structure Plan (2016-2035)

4.4.2 Types and Sources of Data

It has been described earlier that different types of data have been collected for the study from different sources and therefore, different data collection methods and techniques were used. Major types of data and their sources are provided below:

4.4.2a Primary Data

a) Questionnaire survey in the study area,

b) Key Informant Interview (KII) with policymakers, urban planners, subject matter specialists, personnel of concerned government agencies, researchers and academics.

c) Case studies and visual observation

4.4.2b Secondary Data

i. Published literature, reports, articles

ii. Survey of Dhaka – agricultural land use, green resources

iii. Dhaka City Corporations – Land use, institutional arrangement, policies

iv. Department of Geography and Environment, University of Dhaka, Bangladesh Bureau of Statistics (BBS), Bangladesh Agriculture Research Council (BARC), Food and Agriculture Organization (FAO), Bangladesh Agricultural Development Corporation (BADC), Rajdhani Unnayan Kartripakkha (RAJUK) – land use maps, images, institutional setup, institutional management, water and waste management data.

v. Reports of different print and electronic media - current facts and initiatives

vi. Internet – definition, practices/experiences, examples

4.4.3 Data Collection

To get a general overview of the study area the Metropolitan area of Dhaka has been observed within the whole study period. It has provided an insight on the geographical dominance of the study area. A review of present situation of development activities of the study area has also done (CBD, industrial area, residential area, mixed area, fringe area).

Attempts have been made to explore the existing agricultural practice within the study area through analyzing scientific reports and articles. To collect the primary data continuous observation has prosecuted at the selected sites.

4.4.3a Pre-testing of Questionnaire

To develop an appropriate questionnaire for the Household (HH) survey a pre-test was conducted in Keraniganj with the draft questionnaire with the help of the supervisors of the data collection team. All the personnel selected for the pre-testing and actual data collection were well experienced in the relevant arena and each one of them held at least a bachelor degree. After the pretest, the questionnaire was fine-tuned and finalized.

4.4.3b Household Survey Questionnaire

Household survey questionnaire was structured and pre-coded. This instrument was developed to collect information on agricultural practices, household income and income generation activities, livelihood options, employment, nature/impact of disaster on crops, properties and livestock; preparedness before, during and after the disaster; adaptation and mitigation measures. Some questions were also included to assess the trend of climate change as observed by the local population and adaptation mechanism.

4.4.3c Key Informant Interview

A questionnaire/checklist was developed specifically for key informants, such as policymakers, research personnel, subject matter specialists, university teachers, etc. This questionnaire was intended to pick up insight of urban agriculture of the policymakers and their opinion on incorporating UA in the urban land use plan. Data were also collected on the

challenges of UA to retain in the study area and possible solutions from land use, policy intervention and technical perspectives. A total of eleven key informants have been interviewed.

4.4.3d Case Study

Two case studies have been conducted to get real-life information on the urban agricultural practice in the DMDP region. One case study has been conducted to depict the situation of outcomes of the government initiative to create green space in the city through the renovation of a public park. The other one was conducted to explore the situation of another government initiative to promote UA through involving the community people on a pilot basis.

4.4.4 Research Design

i. At the very beginning of the research work an extensive literature review has been conducted to know the conditions, types, nature, limitations, recommendations etc. of previous research, project reports conducted at home and abroad on urban agriculture, with a particular focus on Dhaka metropolitan region and to acquire knowledge for the basic understanding on that topic.

ii. Then objectives have been formulated to identify the variables that can be measured to assess the contribution of urban agriculture in building urban resilience as well as to determine the socio-economic and environmental impact of agricultural land use change in the study area.

iii. Study area has been selected after that based on the presence of agricultural practices, open space, water bodies and green space.

iv. Relevant secondary data which were required to understand the present situation of urban agriculture in Dhaka city have been collected from different agencies like DCCs, BBS, BMD, BADC, DAE, DoF, DLS, previous research survey reports and the internet. Relevant data have also been collected from print and electric media.

v. At the same time field observation and field data have been collected. Both primary and secondary data were analyzed with a view to achieving the objectives which are set out in the introductory chapter.

vi. Primary data has been used to identify the trend of urban agricultural change and its consequences in relation to environmental and socio-economic perspectives. Whereas secondary data has been used to justify the primary findings.

vii. Satellite images and maps for different time periods have been collected to determine the dynamics of agricultural land use changes in the study area (agriculture, water bodies, housing and settlements, infrastructures, etc.). Images and maps have been collected mainly from the Department of Geography and Environment of the University of Dhaka. Climatic trends data were obtained from the Bangladesh Meteorological Department (BMD), and climate change scenarios of global climate models were obtained from the IPCC Assessment Reports and other published reports.

viii. Meteorological data obtained from the Bangladesh Meteorological Department (BMD) were used to analyze temperature and rainfall trends for Dhaka for the 30-year period from 1987 to 2019, based on the four distinct climatic seasons of Bangladesh. These four seasons are; pre-monsoon (March to May) with high temperature and evaporation rates that increases the humidity, monsoon (June to September) with high-intensity rainfall, post-monsoon (October to November) characterized by hot and humid

conditions, and winter (December to February), which is the driest and coolest time of the year.

ix. The trend of open space (i.e. playgrounds, water bodies, fallow land, etc. and green space (such as parks, forests, orchards, homestead gardens etc.) depletion was determined through analyzing satellite images and maps collected from different institutions and agencies. The status of the level of pollution in the study area was evaluated by analyzing secondary data and records collected from concerned organizations.

x. Environmental impact of urban agriculture was assessed through analyzing secondary data, records, published reports and satellite images. To supplement the data discussion with Professionals, government officials of different relevant organizations and other concerned personnel were arranged. Perception of respondents have also been acquired through the questionnaire survey.

xi. Agriculture and household income and inequality data were obtained from the Bangladesh Bureau of Statistics (BBS), Bangladesh Agriculture Research Council (BARC), Food and Agriculture Organization (FAO), and International Rice Research Institute (IRRI), Dhaka Office. Water data was obtained from the Water Resources Planning Organization (WARPO), Dhaka WASA (DWASA), and the Bangladesh Agricultural Development Corporation (BADC). A questionnaire survey has been conducted in the study area to collect primary data to get a local level assessment of livelihood, socio-economic, employment status and agricultural practices of the study area.

xii. Key Informant Interview (KII) with policymakers and other concerned personnel has also been conducted to get an in-depth scenario of the issue. Along with this, case studies have also been conducted from food security and environmental standpoints to qualify the findings of primary data.

xiii. Different policy documents have been reviewed to analyze the policy gaps regarding the promotion of urban agriculture in the DMDP region. After then important legislative problems which are mainly responsible for the slow progress of the overall UA activities in the study area have been identified and discussed. Finally, the contribution, key opportunities and challenges of UA in the development context in and around Dhaka city within the theoretical framework and current level situation in the study area have been discussed.

The overall methodological procedure followed in the present research is given below in Figure 4.4.

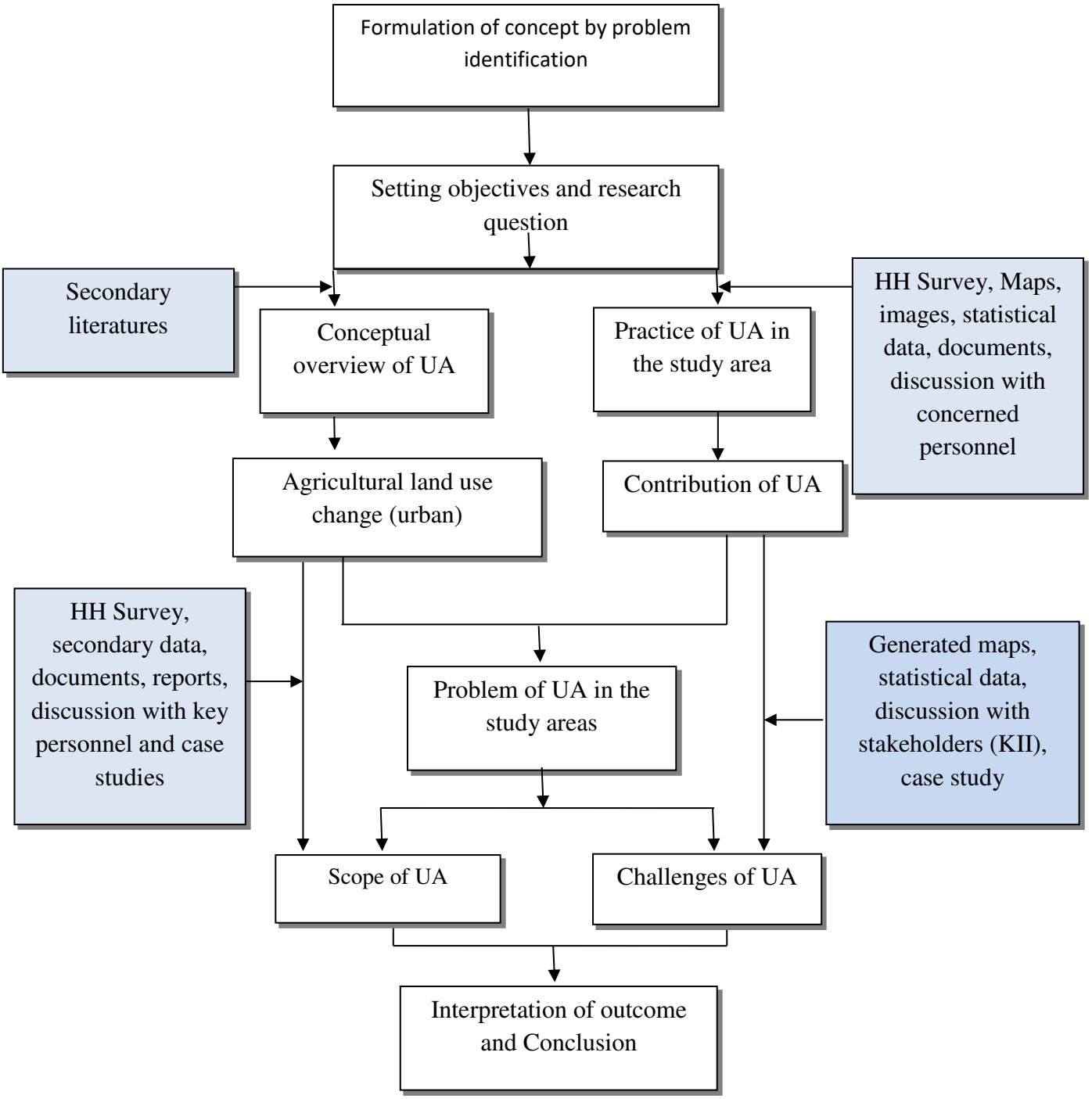


Figure 4.4: Flow diagram of Methodological Procedure

4.4.5 Sample Size Determination

For determining the sample size of this study Cochran's sample size formula has been used. Cochran's formula is considered to be appropriate, especially in situations where the population size is larger. A sample of any given size provides in-depth information about a smaller population than a larger one. The number given by Cochran's formula can be reduced through a 'correction' if the whole population is relatively small.

The Cochran formula to calculate a representative sample for proportions is:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where, n_0 is the sample size,

z is the selected critical value of desired confidence level,

p is the estimated proportion of an attribute that is present in the population,

$q = 1 - p$ and

e is the desired level of precision.

For this study, the households those are directly involved with farming activities in the study area have been decided to select for survey to collect primary data. The percentage of the population was unknown who are directly involve with urban agriculture in the study area. Therefore, it was assumed that about fifty percent of the population in the study area is directly involved with agricultural activates who lives particularly in the periphery of the DMDP region.

Assuming the maximum variability, which is equal to 50% (p =0.5) and taking 95% confidence level with ±5% precision, the calculation for required sample size was as follows:

p = 0.5 and hence q =1-0.5 = 0.5; e = 0.05; z =1.96

So, $n_0 = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2}$ =384.16=384

So, the primary sample size of the study is 384. Considering a 7.5% design effect, the adjusted sample size was {384+(384 x 0.05)}=412.8=413. Therefore, the final sample size of the study has been estimated at 415 households. A total of 415 households have been selected and surveyed for primary data collection of the study.

4.4.6 The Survey

This study intended to utilize the information of farm households to assess their livelihood, socio-economic status and agricultural adaptation practices to minimize the impact of climate change. The attempt has also been taken to explore opportunities and challenges of the farmers regarding continuing agricultural practices in the study area.

Under these circumstances, this study followed a purposive sampling design, in which households have been selected closed to agricultural lands assuming that these households are directly involved with agriculture for their livelihood. Within villages, households have been randomly selected. Randomly one household has been selected from every three households. The farm household survey covered 12 villages (Bara Monoharia, Bhawal Paschimpara, Guita, Rayta, Baraikandi, Krishnanagar, Bhawal Rishipara, Dhampara, Bagnibari, Atasur, Karer Dighirpar and Kaliakoir) in Dhaka, 5 villages (Jalkuri, Paschim Jalkuri, Baniadi, Ganganagar and Darikandi) in Narayanganj and 6 villages (Basan, Islampur,

Aturi, Paragaon, Nasaran and Rosadia) in Gazipurr. Between 15 and 20 farmers per village were surveyed, depending on the village size. The survey covered farmer characteristics, inputs of crop products, information of socio-economic status, perception of climate change, knowledge on modern agricultural technologies and access to finance and training.

4.4.7 Data analysis

Statistical analyses have been completed to analyze data obtained from surveys and secondary sources. Tables, graphs and figures have been drawn to present the findings of the research. Statistical tables and graphs were generated using Microsoft Excel and SPSS software. Results were interpreted using simple and understandable language for easy understanding and wider acceptance by the policymakers, professionals, researchers and general readers.

Chapter 5

CLIMATE CHANGE, CLIMATE TRENDS AND PROJECTION

5.1 Introduction

The vulnerability of climate change to the Dhaka Metropolitan was assessed by considering the certainty and the timing of climatic variables such as temperature and humidity. Externality in climatic events became a significant characteristic in Bangladesh and Dhaka is not an exception. Different studies revealed that Dhaka is already facing the impact of climate change which is reflected through the increase in temperature and related consequences. Therefore, it can be assumed that the upcoming impacts of climate change will be undoubtedly very diverse in Dhaka that will affect public health and urban life.

5.2 Climate Change

Climate change is considered a major threat to urban. Global climate change is perceived as the outcome industrial revolution. As an environmental threat, it has drawn attention globally. Most of the literature focused on human activities e.g. releases of greenhouse gases as the prime cause of climate change (IPCC, 2007). Scientists accepted that these greenhouse gases affect the radiation budget of Earth though there are some conflicts still existing. Paleoclimate records from natural bases indicate a clear warming trend evidenced from the 20th century to the first decade of the 21st century. This warming pattern has been identified by climatologists as concrete evidence of human-induced climate change resulting from the production of greenhouse gases.

Bangladesh is on the frontline of the adverse effects of climate change due to its geographic location. The floodplain formed by the low-lying river delta with a long coastline made it more vulnerable. According to the Global Climate Risk Index, Bangladesh ranked as the

seventh most affected country in the world over the period 1999–2018 (Balasubramanian, 2018).

Cities are arguably the most important battlefields for climate change. About more than half of the world's population is living in cities which is assumed to increase by more than two-thirds by 2050. Developing countries will accommodate above 90% of these new urban citizens (Roy, 2009). Dhaka is the capital of Bangladesh and eventually the administrative, economic, industrial, political, cultural, educational, and research hub of the country. It is considered the most vulnerable among the megacities in the face of climate change (WWF, 2009). Different types of climate-induced hazards are so much intensified in Dhaka, such as variations in temperature, erratic rainfall, flooding, cyclones, and heat and cold waves. These hazards may worsen over time being coupled with non-climatic factors such as population density, poverty, rural-urban migration, unplanned urbanization and lack of public utilities and services.

5.3 Trend Analysis of Climate Variables in the DMDP Area

Meteorological data, collected from the Bangladesh Meteorological Department, have been used to analyze the climate trends for Dhaka Metropolitan based on rainfall and an annual average temperature during the period 1989 to 2019. Temperature and rainfall variability is vital for influencing climate variability and extreme weather conditions. According to the IPCC (2007), the world population will become more sufferers due to the continuous warming of the atmosphere as a result of climate changes. Among the south-Asian countries, Bangladesh ranked the highest in the list of most climate-vulnerable countries on earth (Harmeling, 2008; Rajib et al., 2012). High temperatures, erratic rainfall and seasonal

variation measure the distinguishing characteristics of Bangladesh that separate it from other tropical countries in the region (Hossain et al., 2014).

Trend analysis is the prediction of the future result by using empirical trends. For this, daily temperature and rainfall data were collected from Bangladesh Meteorological Department (BMD), Dhaka station, for the period 1989-2019. Increasing or decreasing trends of the two weather parameters (e.g. temperature and rainfalls) were statistically examined in two phases. The first phase was done by using the non-parametric Mann-Kendall test and the second one was done by the nonparametric Sen's slope estimator. The calculated trend result was verified based on the standardized test statistics (Z) value. When Z is positive, the trend is said to be increasing and when Z is negative, it is said to be decreasing. The trend's slope shows the annual rate and direction of change (Kendall, 1995).

The Mann-Kendall trend test is a non-parametric method for identifying trends using data collected over a specific time series. Mann-Kendall Statistic (S) is given by,

$$S = \Sigma\Sigma \; sign\,(X_i - X_j) \qquad \text{..... (1)}$$

here, i =2,3,……n ; j = 1,2,…, i-1 and

$$sign\,(X_i - X_j) = \begin{cases} 1, & \text{if } X_i - X_j > 0 \\ 0, & \text{if } X_i - X_j = 0 \\ -1, & \text{if } X_i - X_j < 0 \end{cases} \qquad \text{..... (2)}$$

For a sample size > 10, a normal approximation to the Mann-Kendall test may be used. For this, variance of S is obtained as,

$$\mathrm{Var}[S] = \frac{\left\{ n(n-1)(2n+5) - \sum_{j=1}^{p} t_j (t_j - 1)(2t_j + 5) \right\}}{18} \qquad \text{..... (3)}$$

here, $p = 1,2,\ldots q$

where t_p is the number of ties for the p^{th} value and q is the number of tied values.

Then standardized statistical test is computed by:

$$Z=\begin{cases}\dfrac{S-1}{[\mathrm{Var}(S)]^{\frac{1}{2}}} & \text{if } S>0\\ 0 & \text{if } S=0\\ \dfrac{S+1}{[\mathrm{Var}(S)]^{\frac{1}{2}}} & \text{if } S<0\end{cases} \qquad \ldots. (4)$$

The magnitude of the trend is estimated by Sen's slope method (Sen, 1968) which is proceeds by calculating the slope as a change in measurement per change in time,

$$Q' = x_{t'} - x_t / t' - t \qquad \ldots. (5)$$

where, Q' is the slope between data points $x_{t'}$ and x_t, $x_{t'}$ is the data measurement at time t' and x_t is the data measurement at time t.

Sen's slope estimator is simply given by the median slope,

$$Q = Q_{[(N+1)/2]} \text{ if } N \text{ is odd}$$

or

$$Q = \frac{1}{2}\left(Q_{[N/2]} + Q_{[(N+2)/2]}\right) \text{ if } N \text{ is even.} \qquad \ldots. (6)$$

where, N is the number of calculated slopes. A positive value of Q' indicates an increasing trend and a negative value indicates a decreasing trend in the time series.

5.3.1 Trend Analysis of Temperature

Outcomes of daily maximum temperature records for 30 years (1989-2019) have been analyzed in this section based on the BMD data. The results are shown in Table 5.1. An increase in maximum temperature has been observed which is statistically significant. It is seen from Table 5.1 that across the DMDP region the average maximum temperature remains

below 27˚C during November, December, January and February. From April to October, the temperature crosses 30˚C and 41˚C respectively. The highest average temperature has been noticed during monsoon (June to August) which is gradually decreases in winter (December - February). Table 5.1 shows that maximum increases in temperature occur in August (41.85˚C). In winter, the seasonal average maximum temperature was 18.9˚C to 22.1˚C. in the DMDP region, the average maximum temperature has been calculated at 25.35˚C SD 0.85˚C.

Table 5.1: Monthly Average Maximum Temperature during the Period (1989-2019)

Variable	Maximum	Mean	Std. deviation	CV	MK test	p-value	Sen's slope
Jan	20.750	18.943	0.895	4.73	0.240	0.033	0.028
Feb	25.650	22.148	1.256	5.67	0.281	0.016	0.057
Mar	27.850	26.053	1.159	4.45	0.062	0.321	0.021
Apr	31.000	28.000	1.261	4.50	0.078	0.278	0.022
May	32.400	28.623	0.846	2.96	0.155	0.119	0.025
Jun	35.450	29.298	0.555	1.89	0.267	0.021	0.025
Jul	41.200	39.435	0.650	2.21	0.396	0.001	0.038
Aug	41.850	39.623	0.633	2.14	0.033	0.408	0.022
Spt	34.000	32.557	0.761	2.57	0.301	0.011	0.032
Oct	30.400	29.700	0.820	2.96	0.240	0.033	0.033
Nov	26.050	24.243	0.756	3.12	0.319	0.007	0.036
Dec	22.950	20.503	0.792	3.86	0.299	0.012	0.037
Annual	25.350	23.567	0.854	3.63	0.222	0.045	0.031

Source: Data collected from Bangladesh Meteorological Department in 2020

Absolute variability has also observed to increase over the same period which has been measured by standard deviation. But the relative variability, measured by CV, is higher for average maximum temperature. The CV and SD for average maximum temperature and the average mean temperature have been observed to intensify initially and then dropped with frequent fluctuations indicating a variation in climate. This phenomenon may subsequently influence the yield of agricultural products.

Figure 5.1 represents the annual average mean temperature which was the highest in 2013 at 25˚C and the lowest at 22.9˚C in 1993. The linear trend depicted the scenario of increasing the annual average maximum temperature at a rate of 0.25˚C per century according to the BMD data. The major reasons for this unusual temperature rise might be attributed to rapid urbanization, depletion of tree coverage, high population density, and therefore the increase in the built-up area, vehicles, industries, etc.

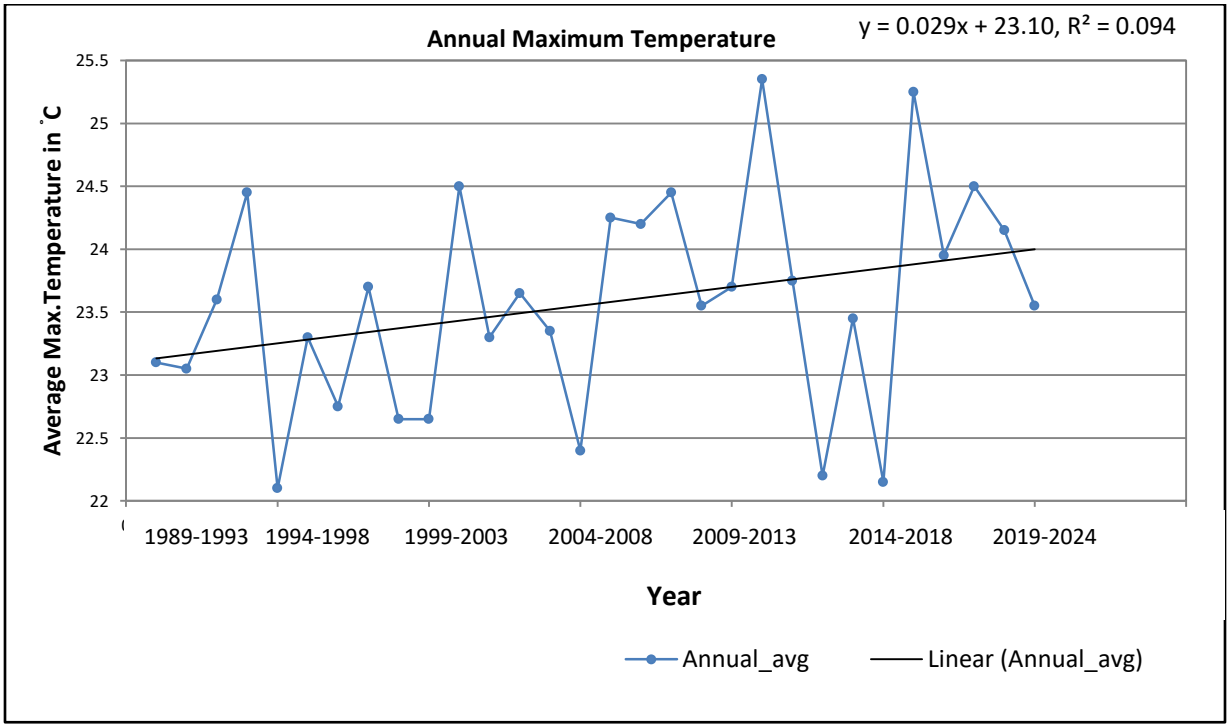


Figure 5.1: Time Series and Trend in Annual Average Maximum Temperature (1989-2019)

Source: Calculated by author based on the data collected from BMD in 2020

Variability in mean maximum temperature for the period 1989 to 2019 was calculated with a projection of a five-year forecasted value. An increase has been observed in the average annual maximum temperature during the time period (1993-1995). However, for the projected year, it has been observed to increase and the overall trend has been found increasing (Figure 5.1).

The DMDP region experienced an average increase in temperature of 0.25°C between 1976 and 2019. The increase in maximum temperatures during this period was observed to be consistent on a month-to-month basis. The temperature starts to increase from March and continues till the end of August, which is considered the warmer season. The rise in maximum temperature across the region was not uniform. For instance, between 1989 to 2019, there is a rise of 0.5°C in the central part of Dhaka and adjacent districts. It can be claimed that summers are becoming lengthier, winters are getting shorter and warmer, and monsoons becoming unpredictable (Mahmud et al., 2021).

5.3.2 Trend Analysis of Rainfall

Rainfall is the key elemental process that transfers water back to the earth's surface from the atmosphere and connects hydrological cycles with weather and climate. The climate of Bangladesh is rainfall dominated and receives the heaviest rainfall in the world (Mirza et al., 2008). The regular data on precipitation have been collected from Bangladesh Meteorological Department (BMD) for the period 1989-2019 for trend analysis which is described in this section.

Table 5.2 reveals that normal rainfall is the lowest in the months of November, December, January and February across the DMDP region. From the month of June to September the major rainfalls were recorded ranging from 293.1 mm to 317.73 mm according to the BMD data. It is seen that the normal rainfall in the winter (December - February) season was 10.97 mm to 5.87 mm. Average annual maximum rainfall was observed 1988.17 mm with of SD 490.43 mm. It is seen from Table 5.2 that 0.3% to 1% of rainfalls have occurred in winter

during the 30 years time period (1989-2019). The highest 51.5% of total rainfalls have occurred in monsoon (Jute - August).

Table 5.2: Monthly Average Rainfall during the Period (1989-2019)

Month	Maximum	Mean	%	Std. deviation	CV	MK test	p-value	Sen's slope
Jan.	49.000	5.867	0.3	11.200	190.9014	-0.120	0.201	0
Feb.	56.000	19.233	1.0	19.102	99.31557	-0.210	0.056	-0.5
Mar.	172.000	50.367	2.5	50.166	99.60075	-0.109	0.205	-1.143
Apr.	309.000	124.167	6.2	75.607	60.89155	0.081	0.728	1
May.	608.000	268.233	13.5	132.177	49.27704	-0.166	0.102	-2.214
Jun.	628.000	317.733	16.0	117.764	37.06367	0.163	0.899	3
Jul.	753.000	395.033	19.9	164.823	41.72385	0.074	0.710	1.75
Aug.	552.000	307.467	15.5	124.025	40.33769	0.085	0.740	2
Spt.	839.000	293.100	14.7	182.971	62.42605	-0.226	0.042	-4.556
Oct.	417.000	171.667	8.6	124.917	72.76712	-0.205	0.059	-3.118
Nov.	116.000	24.333	1.2	39.309	161.5437	-0.143	0.148	-0.037
Dec.	106.000	10.967	0.6	25.037	228.3027	0.026	0.564	0
Annual	2892.000	1988.167	100.0	490.427	24.667	-0.099	0.229	-9.704

Source: Data collected from Bangladesh Meteorological Department in 2020

Table 5.2 represents the Seasonal Mann-Kendall trend and Sen's slope. It can be observed that the winter rainfall has decreased by 1.28 mm per year during the mentioned time period, which is alarming. Rainfall has been observed mostly decrease in the month of January according to the BMD data.

Figure 5.2 represents the result that has been obtained by plotting data in the graph. The variability in average annual rainfall for the period 1989 to 2019 with an extended five-year forecasted value has been presented in Figure 5.2. Over the period, the annual average rainfall has decreased. However, the overall trend of rainfall h is declining in nature.

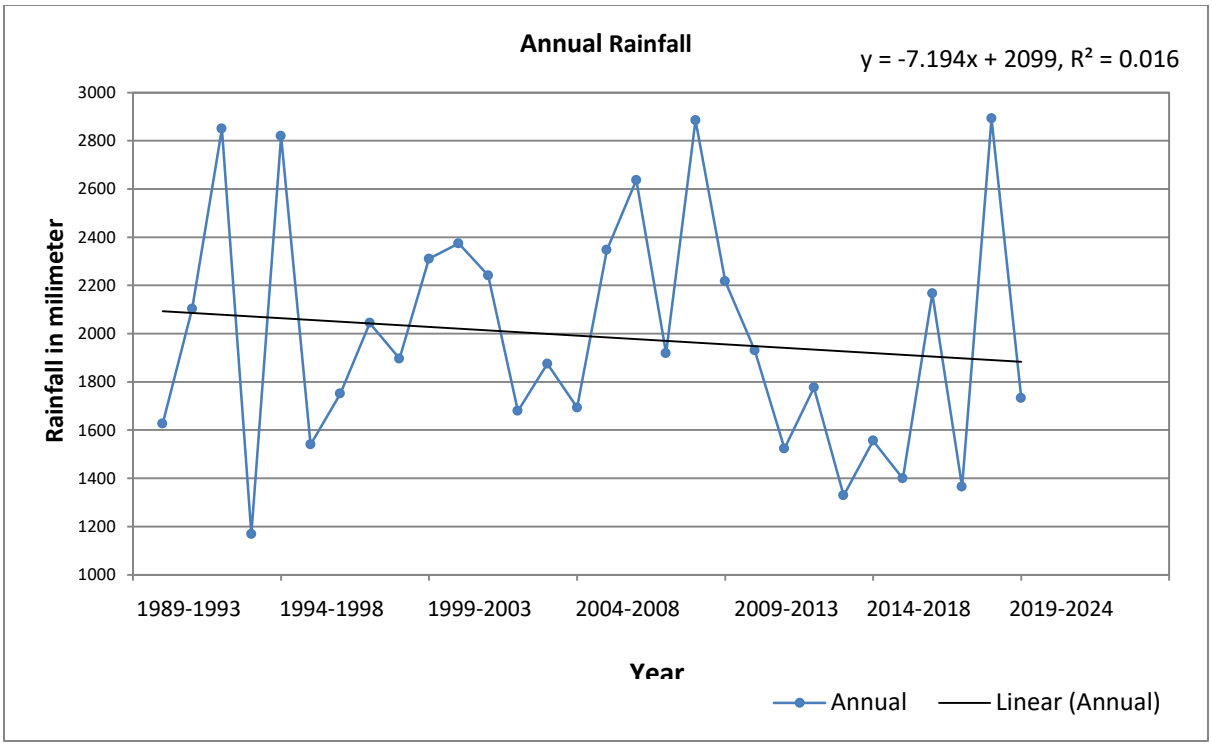


Figure 5.2: Time Series and Trend in Annual Maximum Rainfall (1989-2019)
Source: Calculated by author based on the data collected from BMD in 2020

Figure 5.2 shows the forecasted values for rainfall for the following five years. The average annual rainfall, as forecasted, would be decreased from 2019. The average annual rainfall is observed to decrease at a rate of 9.7%. It indicated that there will be a serious impact of the decreasing trend of rainfall on overall agricultural production in the DMDP region.

An increase in annual precipitation in Bangladesh was estimated by a World Bank study in the year 2000. An average decrease in yearly rainfall was estimated at about 4 mm per annum from 1978 to 2008 in the city. The present study unraveled that over the thirty years of the time period, the pattern of rainfall has changed significantly and the trend in seasonal rainfall has also changed. The Observation suggests that seasonal rainfall during the monsoons (June–August) and winter (December–February) is declining during the 30 years

time period periods. Notwithstanding, the erratic pattern of heavy rainfall is becoming more frequent in the Dhaka Metropolitan (Rabbani et al., 2010).

5.4 Conclusion

From the above results, a changing trend in the annual average maximum temperature and annual average rainfall has been found in the DMDP region. The trend of average maximum temperature has been found to increase whereas; the trend of annual average rainfall has been found to decline. This phenomenon may significantly affect the agricultural practices in the study area by hampering production which may be aggravated seriously by the impact of climate change in the coming future.

Despite being a fast-growing megacity, Dhaka city has some growth limitations. The incapability of the current urban population to cope with the intensity and magnitude of prevailing climate hazards are partially responsible for the limitation. Climate-related risks of Dhaka are closely interlinked with issues such as public health, livelihoods, and the urban environment which may be intensified by the risks associated with increasing temperatures and erratic patterns of rainfall. It has been observed that the monsoon rainfall in Dhaka Metropolitan is decreasing, while erratic and excessive rainfall in other seasons is increasing which may cause waterlogging. This will cause severe negative impacts on normal urban life and livelihood.

The public health sector may be heavily impacted by the sharp increases in the average temperature coiled with erratic. For instance, the seasonal peak of E. coli bacteria-induced Diarrhoea occurs in Bangladesh triggered by the temperature increase that causes food contamination as a result of the bacterial growth (Rowland, 1986). The International Centre

for Diarrhoeal Diseases Research, Bangladesh (ICDDR,B) reported that the high incidence of diarrhea in Dhaka increases during the latter part of the rainy season (Wagatsuma et al., 2003). 1°C increase in temperature above 29°C increases the incidences of rotavirus diarrhoea by 40% in Dhaka (Hashizume et al., 2008).

Chapter 6

STUDY AREA PROFILE

6.1 Introduction

The study was carried out in the DMDP area. The Dhaka Metropolitan Development Plan (DMDP) was a package of three plans- Structure Plan, Urban Area Plan and Detailed Area Plans proposed by Rajdhani Unnayan Kartripakkha (RAJUK) in 1995. It covers an area of 1528 sq.km. The study area comprises eight unions/wards of the DMDP area namely Taranagar, Kalindi, Birulia, Dhamsana, Murapara, Baria, Ward-9 and Ward-14. Taranagar, Kalindi, Birulia and Dhamsona are located in Dhaka district while Murapara, Ward-9 is in Narayanganj and Baria and Ward-14 are located in Gazipur district (Figure 6.1). Among the eight unions and/or wards, Baria union of Gazipur is the largest while Ward-9 of Narayanganj City Corporation is the smallest one as far as the area is concerned. According to the population Dhamsona union of Savar is the largest among the study unions (Table 6.1).

People, from diverse professions ranging from farming to slam business as well as other service sectors, constituted the population of the study area. , Most of the households here are of middle income. The monthly average income of the population ranges from Tk. 7,500 to 20,000. The low cost of house rent compared to other areas is one of the major causes that inspire people to live in the study area. But in recent days, the land price of this area has increased at a high rate as an impact of rapid urbanization (Rahman & Karim, 2019).

Table 6.1: Area and Population of the Study Unions/Wards and Sample Households

District	Upazila/City Corporation	Ward/ Union	Area (Hectare)	Population (as of 2011)	Sample HH
Dhaka	Keraniganj	Taranagar	1,738	42,203	38
		Kalindi	679	46,783	45
	Savar	Birulia	3,014	41,188	37
		Dhamsona	3,277	3,08,024	87
Narayanganj	Narayangang City Corporation	Ward-9	610	30,484	50
	Rupganj	Murapara	884	32,593	53
Gazipur	Gazipur City Corporation	Ward-14	3,422	31,363	52
	Gazipur Sadar Upazila	Baria	4,595	33,715	53
		Total	18,219	5,66,353	415

Source: Population & Housing Cencus-2011, Community Series, BBS

The DMDP is largely dominated by the agriculture like other parts of Bangladesh. The residential areas are spread alongside the road and river networks which is also common for the industrial areas and commercial/business areas. The residential or housing development area mainly done in the agricultural replacing the agricultural land use into infrastructures. A significant portion of the inhabitants of the study area is constituted by the migrants who have been found engaged in agricultural activities in the DMDP region.

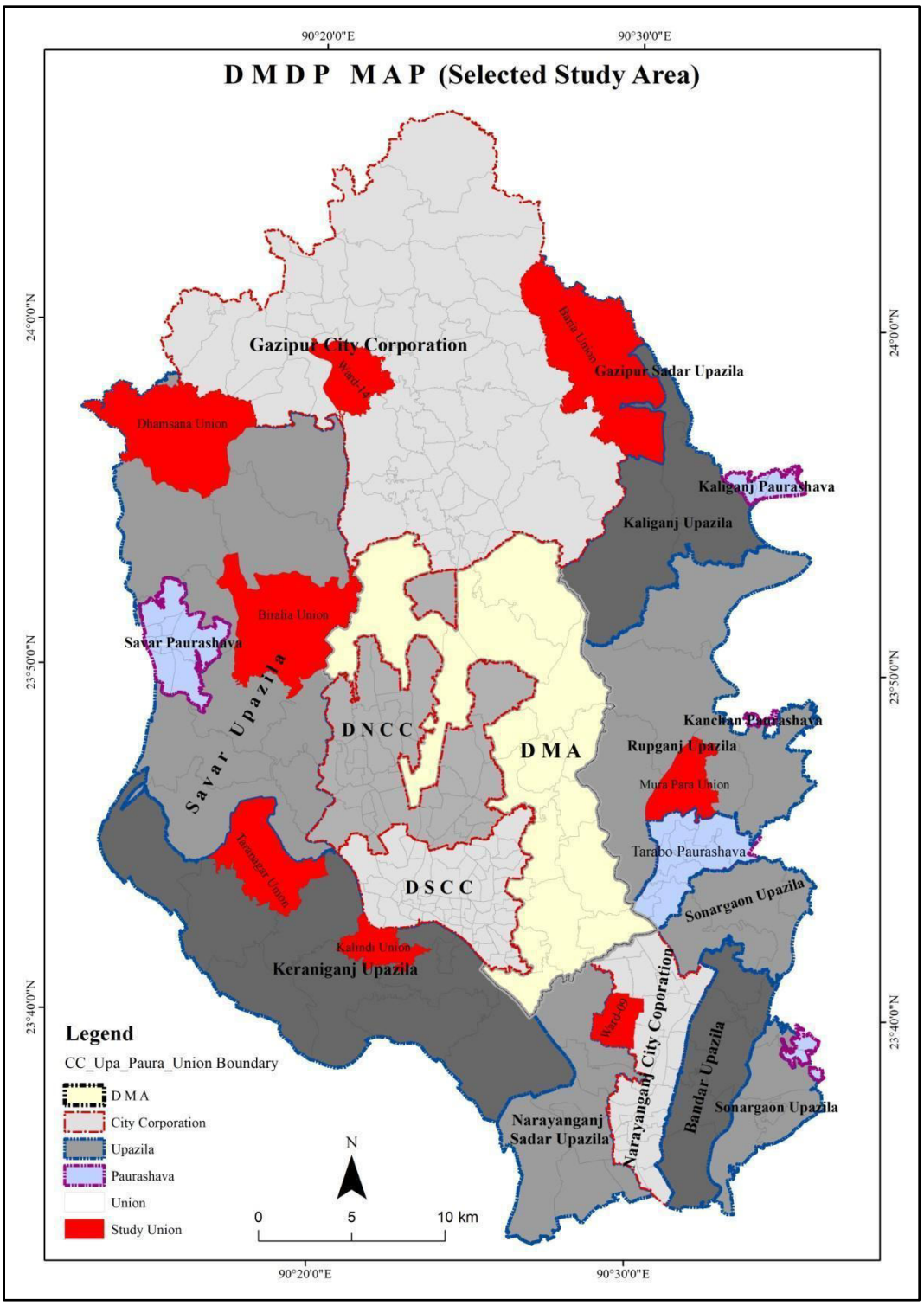


Figure 6.1: Study Area

6.2 Socio-Economic Profile of the Respondents

In order to get a better idea of the socio-economic condition of the respondent farmers, it is necessary to analyze different features of the socio-economic structure of the study area. The socio-economic factors that were likely to impact the income generating capacities of the respondents, as well as the sustainability of urban agriculture, include gender, age, literacy, marital status, family size, land ownership, origin, availability of income generating activity (occupation) and wealth status which have been described under this section.

6.2.1 Gender Distribution

The gender distribution of household members of the respondents was found more or less balanced. The majority of 52.9% of the household members are male and the rest of 47.1% are female (Table 6.2). The variation in the distribution of gender among the districts of DMDP was found less significant.

Table 6.2: Gender Distribution of Family Members of the Respondents

Study Area	Male		Female	
	N	%	N	%
Dhaka	504	54.4	428	45.9
Narayanganj	238	51.4	225	48.6
Gazipur	245	51.8	228	48.2
Total	987	52.9	881	47.1

Source: Field Study, 2019

6.2.2 Distribution of Age

The major portion of the respondents (19.5%) belonged to the age group of 46-50 years which can be considered quite positive because they are more mature and experienced and hence information provided by them is expected to be more dependable. The second majority of 18.8% of the respondents belonged to the age group of 26-35 years followed by 36-40, 41-45 and 51-55 years age groups which constituted 17.1%, 13.3% and 12.5% respectively. An

insignificant portion of 1.4% of the respondents were 25 years or below. The difference was found significant among the study city corporation areas where the trend was more or less similar (Table 6.3).

Table 6.3: Age Group of the Respondents

Age group	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
≤25 years	3	1.4	1	1.0	2	1.9	6	1.4
26 - 35 years	31	15.0	27	26.3	20	19.0	78	18.8
36 - 40 years	34	16.4	19	18.4	18	17.1	71	17.1
41 - 45 years	25	12.1	16	15.5	14	13.3	55	13.3
46 - 50 years	41	19.8	18	17.5	22	21.0	81	19.5
51 - 55 years	28	13.5	11	10.7	13	12.4	52	12.5
56 - 60 years	17	8.2	6	5.8	5	4.8	29	6.9
61 - 65 years	8	3.9	2	1.9	5	4.8	15	3.6
≥66 years	20	9.7	3	2.9	6	5.7	29	6.9
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

6.2.3 Rate of Literacy

The rate of literacy of the respondents was found more or less satisfactory. About 75.5% of the respondents reported having different levels of academic qualifications whereas the rest 24.5% of them reported not having any formal education. Majority of 34.5% of the respondents were found to have primary levels of education only. The next significant category of 17.6% had secondary education up to class 10 which was followed by 16.4% who had passed SSC examination. Around 5.8% of the respondents have been found to pass the HSC examination and only 1.2% of them were found to have graduated. There were, however, differences among the areas. Respondent farmers of Dhaka had the lowest (17.9%) illiteracy while respondent farmers of Gazipur had the highest (42.9%) rate of illiteracy.

Table 6.4: Educational Qualification of the Respondents

Level of Education	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Illiterate	37	17.9	20	19.4	45	42.9	102	24.5
Up to class 5	85	41.1	36	35.0	22	20.9	143	34.5
Class 6 to Class 10	41	19.8	19	18.4	13	12.4	73	17.6
SSC	32	15.5	22	21.4	14	13.3	68	16.4
HSC	9	4.3	6	5.8	9	8.	24	5.8
Graduate	3	1.4	0	0.0	2	1.9	5	1.2
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

It was found that young and moderate to highly educated people are less interested to engage in agriculture in the DMDP region. Most of the respondents (80%) were older than 36 years. A national study found that only 11% of farm households are headed by young farmers who are less than 30 years old (Anderson et al., 2016). The majority of the respondent farmers in our study had low levels of education. However, the rate of illiteracy is observed at around 25% and primary to higher secondary levels of education are common for the larger portion of farmers in the study area. The findings of the study comply with the findings of another study which concluded that agriculture is becoming less attractive to young and educated people who have better opportunities for professional involvement outside agriculture (Kamruzzaman, 2015). However, the urban agricultural sector can be more advanced and sustainable if educated young individuals can be engaged in farming through proper training. Findings also revealed that only 7% of the respondents have medium to higher levels of education (HSC to Graduation). Therefore, it may be suggested that strong motivational programmes need to formulate to raise awareness on the education of the farmers in the study area because education helps to execute any work efficiently

Education helps farmers particularly to face and adjust to unfavorable conditions, take appropriate agricultural practices and different adverse situations of life through reading leaflets, booklets, books and other printed materials. The study, however, indicate that about 25% of the respondent farmers had no education and they faced great difficulty in adjusting to the unfavorable condition regarding cultivation. Such consideration indicates the need for improving literacy levels among the farmers who are engaged in farming in the DMDP region.

6.2.4 Marital Status

On the average the majority of 56.6% of the household members of the study households were found married and this was more or less uniform among the three districts of the study area. The next highest category was found unmarried with about 37.2%.

Table 6.5: Marital Status of the Household Members

Marital status	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Unmarried	329	35.3	180	38.9	185	39.1	694	37.2
Married	541	58.1	258	55.7	259	54.8	1058	56.6
Widow	31	3.3	14	3.0	19	4.0	64	3.4
Widower	20	2.1	7	1.5	9	1.9	36	1.9
Divorced	11	1.2	4	0.9	1	0.2	16	0.9
Total	932	100.0	463	100.0	473	100.0	1868	100.0

Source: Field Study, 2019

6.2.5 Household Size

The average size of the household of the respondents was found to be 4.5 people per house which is slightly larger than the national average. But the distribution was quite large. The majority of 51.6% had a family size of 3-4 persons followed by 39.3%, 5.8% and 3.3% who

had family sizes of 5-6 persons, 1-2 persons and >6 persons respectively. The family size distribution among the study city corporation areas however did not vary significantly.

Table 6.6: Household Size of the Respondents

HH Members	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
1-2	18	8.7	2	1.9	4	3.8	24	5.8
3-4	106	51.2	56	54.4	52	49.5	214	51.6
5-6	76	36.7	41	39.8	46	43.8	163	39.3
>6	7	3.4	4	3.9	3	2.9	14	3.3
Total	207	100.0	103	100.0	105	100.0	415	100.0
Mean of HH Size	4.4		4.5		4.5		4.5	

Source: Field Study, 2019

The average size of the household of the respondents was found 4.5, which is slightly larger than the national average of 4.06 (HIES, 2016).

6.2.6 Land Ownership Status

Different tenurial arrangements were found in the study area. Owner cropping was found to be the most important tenancy system and it involved about 60.2% of the respondent farmers in the study area. It was observed that over one third of the farmers (39.8%) are pure tenants or landless, who do not own any arable land. This can be considered as a unique characteristic of the DMDP region.

Table 6.7: Land Ownership Status of the Respondents

Response	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Own land	125	60.4	54	52.4	71	67.6	250	60.2
Don't own land	82	39.6	49	47.6	34	32.4	165	39.8
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

It was observed that among the landless farmers the majority of 93.1% were sharecropper on the average and the rest of 6.9% collect land for agricultural practice on lease (Figure 6.2).

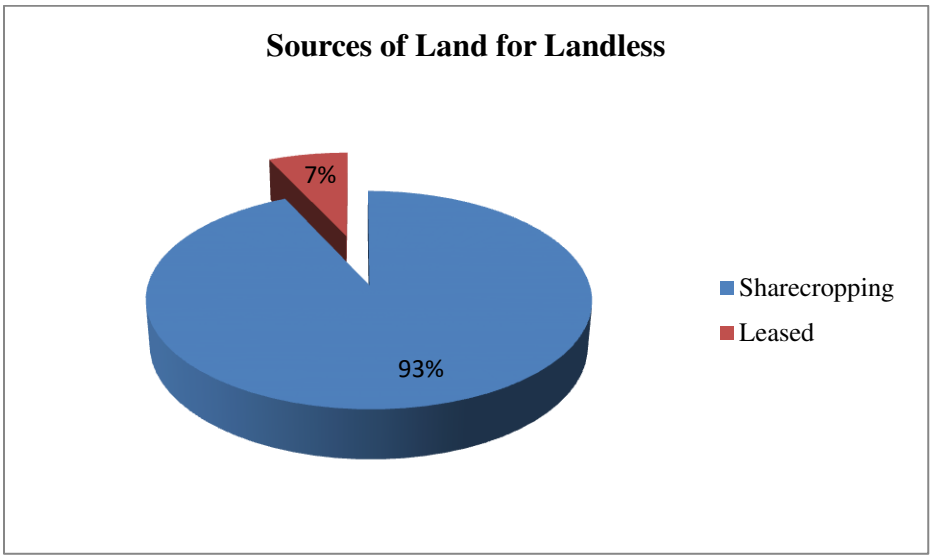


Figure 6.2: Source of Agricultural Land for the Landless Farmers
Source: Field Study, 2019

The overall land distribution pattern of the study area is found similar to the average land distribution pattern of Bangladesh. The country's agricultural sector is dominated by marginal and small farmers (BBS, 2019). The current practice of land tenancy in the study area is found identical to the national average. On average, 39.7% of the respondent farmers rented farmland or cultivable land. According to the Bangladesh Integrated Household Survey (BIHS), in 2015 over a third of the farmers (36%) are pure tenants, who do not own any arable land. Sharecropping has been found to be the most common arrangement adopted by the majority (93%) of them, the rest of 7% was found under the lease agreement. Usually, a certain small portion of agricultural land is cultivated by rich farmers and the rest is cultivated by landless to medium farmers either by sharecropping or leased (Akanda et al., 2008).

The study reveals that most of the farmers in the DMDP region have small holdings and they have to rent some more land for agriculture through various tenurial agreements to utilize their excess family labour and other fixed resources optimally to earn their living.

6.2.7 Amount of Agricultural Land

Land ownership patterns varied widely. A large majority of about 38% of the farmers own less than 50 decimals of land (Table 6.8). Only 7.6% of the respondent farmers owned more than 150 decimal land and can be considered medium to large farm holders. Data indicated that the majority of the land-owning respondents are either small or marginal farm holders. Farmers who own below 0.5 acres of land are considered small farmers and those who own below 1.5 acres of land are categorized as large farmers (BBS, 2011). This appears to be a typical characteristic of land ownership in the DMDP area.

Table 6.8: Amount of Agricultural Land of the Respondents

Amount of land owned	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Up to 49 decimal	28	22.6	23	41.8	44	61.9	95	38.0
50 - 100 decimal	44	35.4	16	29.1	20	28.2	80	32.0
101 - 150 decimal	40	32.3	11	20.0	5	7.0	56	22.4
> 151 decimal	12	9.7	5	9.1	2	2.9	19	7.6
Total	124	100.0	55	100.0	71	100.0	250	100.0

Source: Field Study, 2019

The picture is compatible with the national scenario. According to the Agricultural Census 2008, about 84% of total farm households are constituted by small farmers who operate 5 decimals to 249 decimals of land. The average occupied land is only 74 decimals excluding the homestead area. Besides, 51.75% of the marginal farm households have an average operational land of 47 decimals.

6.2.8 Status of Livestock Assets

Livestock is an important enterprise in agriculture industry operated by medium to small farm households in Bangladesh. Among livestock, poultry is the most widely raised livestock species by small farm households. Table 6.9 reveals that the majority of 57% of the respondents reported about cattle followed by 24.8%, 10% and 8.2% reported to have chicken, goat and duck respectively as livestock assets. The average number of cattle was found 4 owned by a single study household whereas the average number of goat, chicken and duck was 5, 60 and 24 respectively.

Table 6.9: Distribution of Households according to Ownership of Livestock and Poultry

Breed	Study Area									Total		
	Dhaka			Narayanganj			Gazipur					
	N	%	Avg. farm size	N	%	Avg. farm size	N	%	Avg. farm size	N	%	Avg. farm size
Cattle	94	48.2	5	47	24.1	4	54	27.7	3	195	57.0	4
Goat	8	23.5	5	12	35.3	6	14	41.2	5	34	10.0	5
Chicken	12	14.1	50	16	18.8	65	13	15.3	70	41	24.8	60
Duck	11	39.3	25	8	28.6	16	19	67.9	30	38	8.2	24

Source: Field Study, 2019

As informed by the respondents, poultry is one of the major components of livestock assets of the study area. It serves as the major 'livestock asset'. Generally, a family starts with a few chickens and gradually acquires goats and cows by accumulating income and savings. The respondents reported that they have been benefited economically from the potential livestock breeds. The issue of nutrition and food security can be ensured through livestock which contributes to the healthy life of the household members in the study area.

6.2.9 Resident Status of the Respondents

The study indicates that most of the respondent farmers of the DMDP area are local inhabitants of the area. Majority of about 88.9% of the respondents were found permanent residents whereas around 11.1% of them were found migrants.

It can be noticed from the Table 6.10 that 93.2% of farmers who are involved with the urban agricultural practice in Dhaka district are mostly local residents whereas in Gazipur and Narayanganj, the portion of the local inhabitant who are involved with UA is 85.4% and 83.8%. Only 6.8% of the farmers in Dhaka have been found to have migrated from parts of the country.

Table 6.10: Resident Status of the Respondents

Study Area	Local/Native		Migrated	
	N	%	N	%
Dhaka	193	93.2	14	6.8
Narayanganj	88	85.4	15	14.6
Gazipur	88	83.8	17	16.2
Total	369	88.9	46	11.1

Source: Field Study, 2019

The poor financial conditions in rural areas resulting from inadequate economic activities, limited livelihood options, population growth, a diminishing trend of land holdings, and the poor agricultural development, and impacts of natural disasters are pushing rural people towards the urban. The capital city, Dhaka, is a common destination for displaced people. The impacts of different disasters and climate change impose serious threat on their livelihood which compel them migrate to cities. The study found that around 11% of the respondent farmers are non-residents who migrated from different districts of the country.

Employment opportunities, higher economic development, alternative livelihood options and higher wages in urban labour markets act as pull factor for rural people to move to the urban.

6.2.10 District of Origin of the Respondents

People from different area of the country have been found to be engaged with the agricultural activity in the DMDP area. A significant number of districts have been identified as the origin of migrant farmers involved with the urban agricultural practices in the DMDP area. Majority of 43.5% of the respondents migrated from Sherpur district to the study area followed by 30.4% migrated from Mymensingh district.

Table 6.11: Districts of Origin of the Migrants

Districts	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Kishoregonj	2	15.4	0	0.0	0	0.0	2	4.3
Sylhet	1	7.7	0	0.0	0	0.0	1	2.2
Jamalpur	1	7.7	0	0.0	0	0.0	1	2.2
Jessore	1	7.7	0	0.0	0	0.0	1	2.2
Sherpur	3	23.0	9	52.9	8	50.0	20	43.5
Patuakhali	1	7.7	1	5.9	0	0.0	2	4.3
Mymensingh	1	7.7	6	35.3	7	43.8	14	30.4
B.Baria	1	7.7	0	0.0	1	6.3	2	4.3
Rangpur	1	7.7	1	5.9	0	0.0	2	4.3
Thakurgaon	1	7.7	0	0.0	0	0.0	1	2.2
Total	13	100.0	17	100.0	16	100.0	46	100.0

Source: Field Study, 2019

It was observed that people from all of the identified districts were founded in the Dhaka Metropolitan Area. Most of the existing literature identifies economic forces as the push-pull factor that leads the population movements strongly to the core urban center of Dhaka (UNDP, 2013).

The determining factors of in-migration vary across countries. These factors are considered major determinants of urbanization. In Bangladesh, in-migration is largely forced by the push

factors, such as poverty, lack of employment, and the impact of natural hazards and climate change (sea level rise, salinity intrusion, river erosion, flooding, drought, etc.). Furthermore, capital city-oriented biased national policies also help accelerate this forced migration (Hossain, 2003).

6.2.11 Occupational Profile of the Respondents

a. Primary Occupation

A total of 12 types of occupations were identified in the study area chosen by the respondents as the primary means of livelihood (Table 6.12). The major occupation was agricultural crop production which constituted about 85.8% of the total. The second major occupation was found cattle rearing reported by 59.0% of the respondents followed by poultry rearing, small business, horticultural production and agricultural labourer which constituted 47.7%, 30.3%, 26.2%, and 21.2% respectively. This can be considered an interesting finding of the study.

Table 6.12: Primary Occupation of the Respondents (Multiple answers)

Primary Occupation	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Agriculture (Crop)	176	85.0	89	86.4	91	86.7	356	85.8
Farming (Non-crop)	17	8.2	2	1.9	2	1.9	21	5.1
Cattle rearing	87	42.0	73	70.9	85	80.9	245	59.0
Poultry rearing	92	44.4	45	43.6	61	58.1	198	47.7
Horticultural production	51	24.6	28	27.2	29	27.6	108	26.2
Small Business	67	32.4	31	30.1	28	26.7	126	30.3
Agricultural labour	45	21.7	22	21.4	21	20.0	88	21.2
Day laborer	19	9.2	6	5.8	8	7.6	33	7.9
Transport driver	7	3.4	5	4.9	3	2.9	15	3.6
Electrician	34	16.4	17	16.5	7	6.7	58	13.9
Pensioner	17	8.2	5	4.9	8	7.6	30	7.2
Housewife	23	11.1	10	9.7	9	8.6	42	10.1
Unemployed	8	3.9	4	3.8	5	4.8	21	5.1
Total	207		103		105		415	

Source: Field Study, 2019

Among the study city corporation areas, there was insignificant variation in the category of occupation. It was observed that among the overall households about 10.1% were housewives. It is a matter of fact that participation of the population in income generating activities for a sustainable livelihood is increasing day by day which is encouraging. The contribution of women to family income is not recognized in our society. Though they are involved in post-harvest activities, farming, fuel gathering, rice husking, making and selling handicrafts, rearing domestic animals and other income generating activities (Rahman, 2013).

The status of unemployment of the family members of respondents in the study area is not severe. The rate of unemployment was found at 4.1% which is slightly less than the national average. The rate of unemployment in Bangladesh was estimated at 4.2% in 2019 (World Bank, 2020). This may be considered a remarkable finding of the study. The survey revealed that the study households had 1–2 earning members on average. The creation of employment opportunities within urban agriculture for the unemployed and even employed groups is easier as there is no academic qualification required, which makes access easier for people with low or no education to enter and get engaged in urban agriculture. This unique feature of urban agriculture might have been attributed to reducing the rate of unemployment in the DMDP area.

b. Secondary Occupation

Majority of 35.7% respondents reported about small business as their secondary occupation (Table 6.13). Livestock rearing has been observed as the second major occupation reported by 27.9% of the respondents followed by 15.9% and 10.6% who reported about agricultural crop production and poultry rearing as their secondary occupation. About 5.1% of the

respondents were industrial labourers and 4.8% of the respondents mentioned vegetable cultivation.

Table 6.13: Secondary Occupation of the Respondents

Second Occupation	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Service	35	16.9	14	13.6	17	16.2	66	15.9
Livestock rearing	86	41.5	24	23.3	6	5.7	116	27.9
Poultry rearing	15	7.2	12	11.6	17	16.2	44	10.6
Vegetable cultivation	14	6.8	3	2.9	3	2.9	20	4.8
Small business	49	23.7	45	43.7	54	51.4	148	35.7
Industrial labourer	8	3.9	5	4.9	8	7.6	21	5.1
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

The economy of Bangladesh is agro-based. Being engaged in non-farm activities requires huge time and financial support. This is the reason why most of the respondents are engaged in agriculture by accepting it as their second occupation. The study reveals that a certain portion of the respondent households is doing agriculture as their secondary occupation, basically who are owners of agricultural land. They are doing it not because of doing business but to meet their daily needs.

Households generate income from different sources. Income generated from the selling of agricultural products, livestock, business activities, services, and wages from agriculture and/or non-agricultural sector is common among the major sources. The marginal small farm households have very low incomes. A few respondents reported earnings from services and other sources (transport driving, electrician, etc.). Small and medium farmers usually depended on their businesses for household income. The study findings reveal that farmers in the DMDP region diversify their sources of income to boost up livelihood, as they cannot rely solely on agricultural income.

6.3 Income and Expenditure

This subsection provides description of income and expenditure of the study households. Collecting expenditure or income data for welfare monitoring is time consuming. Households were visited and interviewed to report on their food and non-food expenditures over the past weeks using a recall method. The complexity of the data collection procedure can cause enumerators to make mistakes reporting about incomes and consumption information and data when recording the responses of the respondents. To avoid this, the whole data collection team was engaged to collect data on income and expenditure of the study households.

6.3.1 Income

The calculation of the household income of the respondents was done on monthly basis. It was revealed that the average monthly income of the study household was Tk 24,264.1/- which was found to be higher than the national average. Household income per month data was reported at Tk 15,988.0/- in 2016 (HIES, 2016). There was a significant variation observed among the areas. The average monthly income was found higher in Dhaka compared to Narayanganj and Gazipur. The average monthly income in Dhaka was found Tk 25,979/-. The average monthly income was found at Tk 23,209/- and Tk 23,625/- in Narayanganj and Gazipur respectively (Table 6.14).

There was a significant variation exists in the monthly income of respondents ranging from 5,000/- BDT to over Tk 35,000/- (Table 6.14). The largest group of over 23% had an income ranging from Tk. 10,001/- to Tk. 15,000/- BDT which was followed by Tk 5,001/- to Tk 10,000/- range with just over 18%.

Table 6.14: Monthly Income of the Study Households

Income range (BDT)	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Up to 5,000	9	4.3	2	1.9	7	6.7	18	4.3
5,001 - 10,000	42	20.3	21	20.4	14	13.3	77	18.6
10,001 - 15,000	47	22.7	22	21.4	27	25.7	96	23.1
15,001 - 20,000	21	10.2	14	13.6	21	20.1	56	13.5
20,001 - 25,000	9	4.3	15	14.6	18	17.1	42	10.1
25,001 - 30,000	11	5.3	6	5.8	8	7.6	25	6.0
30,001 - 35,000	15	7.3	7	6.8	4	3.8	26	6.3
> 35,000	53	25.6	16	15.5	6	5.7	75	18.1
Total Study HH	207	100.0	103	100.0	105	100.0	415	100.0
Average (Taka)		**25,969.9**		**23,209.4**		**23,625.1**		**24,264.1**

Source: Field Study, 2019

Around 18.1% had a monthly income of more than Tk 35,000/-, 13.5% had an income ranging from Tk 15,001/- to Tk 20,000/- whereas 4.3% had a monthly income of less than Tk 5,000/-. There was a significant difference in income among the study city corporation areas of the DMDP area. In Dhaka, the largest group of over 25% of the respondent household had an income of more than Tk. 35,000/- which was followed by Tk. 10,001/- to Tk. 15,000/- range with just over 22%. In Dhaka, the majority of 25.6% of the study households had a monthly income over Tk 35,000/-. On the contrary, the majority of 25.7% of the study households in Gazipur were found to have a monthly income ranging from Tk 10,001/- to Tk 15,000/-. Similar results were found in Narayanganj. The majority of 21.4% of the respondents reported having a monthly income ranging from Tk 10,001/- to Tk 15,000/- (Table 6.14).

The average monthly income of the respondents generated from agricultural activities was Tk. 13,963.2/- which was found to be greater than the income generated from non-agricultural activities of the households (Table 6.15). The respondents who were mostly

urban farmers and directly involved with agricultural activities have been considered for data collection in this study which may attribute to this finding.

Table 6.15: Average Monthly Agricultural Income of Respondent Household

(Multiple answers) n=415 *(Income in BDT)*

Income Source	Study Area						Total		
	Dhaka		Narayanganj		Gazipur				
	N	Avg. Income	N	Avg. Income	N	Avg. Income	N	Avg. Income	SD
Agriculture	189	4,260.9	54	2,309.4	72	4,,525.6	315	3,986.9	864.91
Lease out	6	1,021.8	2	725.2	5	1,069.1	13	994.3	134.0
Lease in	106	2,049.4	90	2,213	50	2,478.1	246	2,196.4	154.5
Horticulture	9	416.7	15	611.1	22	643.9	46	588.8	87.9
Cattle rearing	90	2,237	54	2,283.9	49	1,702.3	193	2,114.4	229.1
Fisheries	6	1,454.3	9	2,351.9	16	1,302.1	31	1,636.3	402.1
Poultry	25	1,136.6	12	673.6	10	825.0	47	952.1	169.9
Agriculture labor	11	1,515.2	3	1,550.1	31	1,481.0	45	1,493.9	26.1
Total	207	14,091.9	103	12,718.2	105	14,027.3	415	13,963.2	568.7

Source: Field Study, 2019

Therefore, UA can be considered a principal option to meet subsistence needs and supplement income.

Table 6.16: Average Monthly Non-agricultural Income of the Respondent Households

(Multiple answers) n=415 *(Income in BDT)*

Income Source	Study Area						Total		
	Dhaka		Narayanganj		Gazipur				
	N	Avg. Income	N	Avg. Income	N	Avg. Income	N	Avg. Income	SD
Service/ Pension	65	1,389.7	16	1,364.6	10	1,516.7	91	1,399.3	58.6
Small business	56	1,563.1	62	1,552.4	56	1,718.8	174	1,609.4	65.9
Industrial labour	3	1,958.8	5	1,450.1	7	1,250	15	1,458.5	261.6
House rent	3	1,583.5	3	1,444.4	4	1,086.4	10	1,342.9	181.7
Remittance	7	1,190.5	4	1,150.2	14	1,023.8	25	1,090.7	62.9
Transport driving	3	833.3	4	854.2	16	651.0	23	710.1	84.5
Mason	5	820.2	3	506.9	7	714.3	15	708.1	113.3
Carpenter	3	783.3	1	750	7	357.1	11	509.1	175.6
Power tiller rent	5	833.3	5	796.1	9	608.9	19	717.3	85.9
Day labour	9	922.3	3	622.2	13	670.8	25	755.5	114.1
Total	159	11,878.1	106	10,491.2	143	9,597.9	408	10,300.9	826.8

Source: Field Study, 2019

From Table 5.16 it can be observed that the study households earn Tk. 10,300/- on average from non-agricultural activities which constituted about 42.0% of the total monthly income and the rest of 58.0% was constituted by the income generated from agricultural activities (Figure 6.3).

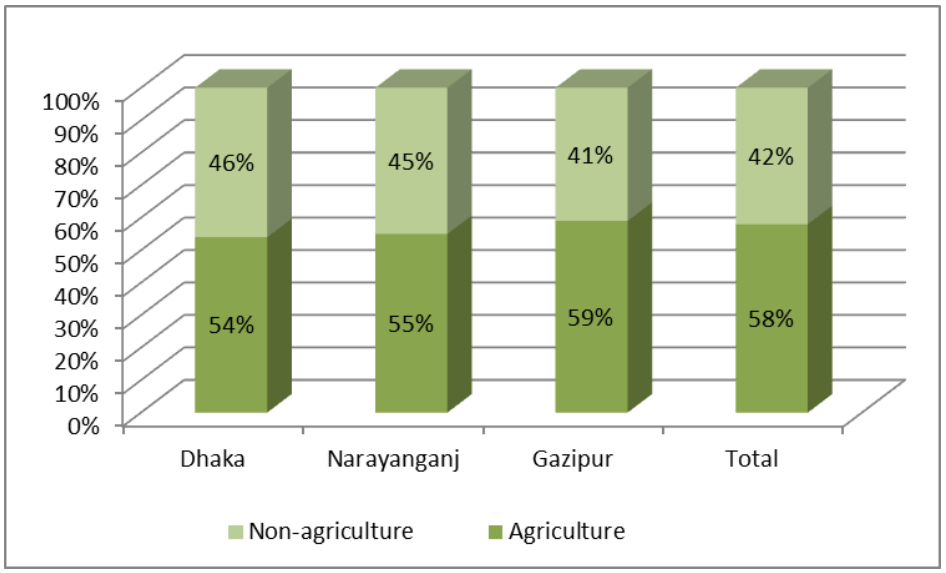


Figure 6.3: Proportion of Agricultural and Non-agricultural Income to Total household Income
Source: Field Study, 2019

Aggregating total income from the different sources suggests that, on average, 41% of the total income comes from businesses, 9.6% from day labor activities, 21.9% from services, and 76% from agricultural activities (Table 6.15 & 6.16).

6.3.2 Expenditure

In the study area, the monthly average expenditure on food consumption of the study households was found about Tk. 4,284/-. Variations among the study city corporation areas were found. In Gazipur, the food consumption cost was estimated at about Tk. 3,992/- which was the lowest compared with other city corporation areas of the DMDP. The average

monthly food expenditure was highest in Dhaka which was estimated at Tk. 4,712.5/- per household (Table 6.17).

Table 6.17: Expenditure on Food Consumption (Monthly)

Study Area	N	Mean	SD
Dhaka	207	4,712.5	216.31
Narayanganj	103	4,040.0	149.79
Gazipur	105	3,991.9	121.75
Total	415	4,248. 1	162.62

Source: Field Study, 2019

Table 6.18 illustrated the monthly average expenditure on non-food items of the study households. It can be observed that the monthly average non-food expenditure of the study households was Tk. 7,761/- which is nearly threefold higher than the food expenditure of a family. The non-food expense was found higher in Dhaka (Tk 9,788/-) followed by Narayanganj (Tk 8,078/-) and Gazipur (Tk 7,799/-).

Table 6.18: Average Monthly Non-Food Expense of a Family (Multiple answers)

Non Food expense sectors	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	Cost (Tk)	N	Cost (Tk)	N	Cost (Tk)	N	Cost (Tk)
Dress and shoes	200	1,271	101	1,046	100	864	401	1,066
House rent and repair	31	2,634	5	1,783	9	1,620	45	2,012
Medical	195	967	101	647	95	647	391	754
Education	137	1,807	76	1,265	86	1,557	299	1,543
Entertainment	181	253	100	329	90	411	371	331
Social festival and gathering	192	434	101	346	97	273	390	351
Travel	201	808	100	560	100	530	401	633
Furniture	16	1,614	22	2,102	38	1,897	76	1,871
Total	1,153	9,788	606	8,078	615	7,799	2,374	7,761

Source: Field Study, 2019

The pattern of investment of the study household has been depicted in Table 6.19. An overwhelming majority of about 94% of the respondent farmers reported investing in

agriculture followed by 8.9% who reported investing in the business and only 0.7% reported investing in land purchase. From this, it can be claimed that agriculture is the main livelihood mean of the respondent farmers in the study area.

6.19: Investment Pattern of the Respondents (Multiple answers)

Sector	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Investment in Business	16	7.7	11	10.7	10	9.5	37	8.9
Investment in Agricultural	195	94.2	98	95.1	97	92.4	390	94.0
Investment in Land purchase	1	0.5	1	0.9	1	0.9	3	0.7
Total	207		103		105		415	

Source: Field Study, 2019

6.4 Conclusion

The study found that urban agriculture supplements the largest share of household income of the urban small and marginal farmers in the study. Still, they are not fully dependent on agriculture for income, a substantial portion of household income also comes from non-agricultural activities. Less involvement of young people in agricultural activities illustrated their unwillingness of them to get involved in UA. A motivational initiative needs to be undertaken to explore different new features and ventures for UA in the study area which will help to promote time-demanding and smart urban agricultural practices. In the DMDP region, particularly the small-scale marginal farmers face many limitations, such as limited access to finance, less profitability, unfair and unstable prices, lack of market linkage, inadequate storage facilities, etc. This may be considered as challenge for UA in the study area. This should be properly addressed in policy formulation to ensure the sustainability of UA that can help enhance the sustainability and climate resilience of the DMDP region.

Chapter 7

STATUS OF URBAN AGRICULTURE IN THE DMDP REGION

7.1 Introduction

The agricultural sector, particularly urban agriculture, faces huge pressure from urbanization that limits farming activities as the city is in a phase of continuous expansion. A large range of obstacles has been identified in different studies which are considered challenges of agriculture in the urban fringe, and some of those are applicable to the UA in the DMDP region. Despite huge urban pressures on the urban land, a significant portion of the land area of Dhaka and its periphery is still occupied by agricultural activities. For example, within the metropolitan area, Tejgaon has 38 percent of cultivable land, while Mohammadpur and Gulshan have only 4 to 5 percent of cultivable land (Rahman et al., 2015).

7.2 Crop Agriculture

In the periphery of Dhaka metropolitan, a substantial share of the land area is still under agricultural practices. Table 7.1 presents the utilization status of agricultural land in the DMDP region. The area under agricultural land use was 92,763 ha in 2008 which was 64% of the total study area. This agricultural land has decreased to 81,160 ha in 2015 constituting 56% of the total land area of the region with a loss of 1,658 ha per annum. This indicates that cropland decreased over the decades in the DMDP region and the rate of loss of agricultural land was estimated at 1.8% per annum during 2008-2015 considering the area (ha) under cropland in 2008 (the 5th round of Agriculture Census) as the base. The rate of decrease in agricultural land in the DMDP region is much higher than that of the national average which has been estimated at 0.73% per annum (BBS, 2014) due to the construction of roads, houses, industries and other infrastructures.

The urban growth of Dhaka gained an impulse after 1947 with the huge inflow of Muslim migrants from India (Siddiqui et al., 2000) which contributed to a rapid population increase in the city with a high growth rate of 65% (BBS, 1974). Historical evidence reveals that the present urban development in Dhaka started get pace after the liberation of Bangladesh in 1971. The population leaped to 3 million within a decade of the independence and the city coverage of Dhaka increased to 510 sq. km. in 1981 from 125 sq. km in 1961 (BBS, 1991).

The share of agricultural land of the total administrative area of corresponding upazilas of the DMDP region was estimated and Table 7.1 reveals that the share of agricultural land was high in Bandar upazila (64%) of Narayanganj district followed by Rupganj upazila (58.4%). In the rest of the upazilas, agricultural land cover ranges from 35.9% to 55.9% of the total administrative area of the corresponding upazilas. The Spatial pattern of land cover indicated that agricultural land use is still dominant in most of the peri-urban upazilas of the DMDP region which constituted about 56% of the total land area. Nevertheless, a substantial reduction of the agricultural land cover has been observed due to the significant pressure of urbanization.

The growth of urban in Savar continued substantially with a higher rate during the time period 2008 to 2015. The total agricultural land was calculated at 28,011 ha or 62.8% of the total area in 2008 which declined to 14,160 ha or 50.6% in 2015 with an annual decrease rate of 2.8%. Land use change in Savar resulted from the establishment of a number of large-scale industrial zones including the Dhaka Export Processing Zones. This, in turn, caused a huge population increase due to a large inflow of migrants for the sake of employment and livelihood in the flourishing industrial sectors in Savar (Islam, 1996).

Table 7.1: Area under Agricultural Practice in different Upazilas of the DMDP Region

Districts	Upazila	Total Area (ha)	Agricultural Land Area in 2008 (ha)	Agricultural Land Area in 2015 (ha)	Annual Rate of Change (%)
Dhaka	Keraniganj	16,687	9,510 (57%)	9,330 (55.9%)	-0.3
	Savar	28,011	17,580 (62.8%)	14,160 (50.6%)	-2.8
Narayanganj	Narayanganj Sadar	10,074	3,752 (37.2%)	3,620 (35.9%)	-0.5
	Sonargaon	17,166	11,317(65.9%)	8,910 (52%)	-3.0
	Rupganj	17,648	13,448 (76.2)	10,300 (58.4)	-3.3
	Bandar	5,439	3,707 (68%)	3,480 (64%)	-0.9
Gazipur	Gazipur Sadar	45,767	18,941 (41.4%)	18,900 (41.3%)	-0.03
	Kaliganj	21,463	14,508 (67.6%)	12,460 (58%)	-2.0
Total		1,44,607	92,763 (64%)	81,160 (56%)	-1.8

Data Source: Census of Agriculture 2008, Yearbook of Agricultural Statistics of Bangladesh 2011 & 2016, BBS

Note: Figures in the parenthesis indicates % of agricultural area of total land area

Keraniganj has been experiencing rapid urbanization in recent times due to the expansion of a number of small and medium-scale manufacturing industries along with large-scale real estate development projects. As shown in Table 7.1, the total cropland area in Keraniganj decreased to 9,330 ha or 55.9% in 2015 from 16,687 ha or 57% in 2008 with a rate of about 0.3% per annum which was the lowest among other upazillas of the DMDP region.

The share of agricultural land in Narayanganj Sadar has been observed to decrease with an annual rate of 0.5% between 2008 to 2015 time period. The city development of Naryanganj occurred due to the establishment of huge RMG factories in the early 1990sn along with other large-scale industrial development. To accommodate the growing number of workers a

large number of infrastructure development resulted in rapid urbanization and urban expansion towards the city periphery. For this, a huge portion of agricultural land has been converted into built-up areas. Among the other three upazilas of Narayanganj (Kaliganj, Soanrgaon, and Rupganj) the annual rate of conversion of land (from agricultural to non-agricultural land use) was calculated higher in Rupganj and Soanargaon during the period. The rate of change was calculated to be 3.3% in Rupganj and 3.0% in Sonargaon. The share of agricultural land decreased to 52% in 2015 from 65.9% in 2008. A historically significant urban development is evidenced in Sonargaon. The rate of development increased significantly with an increase in the tourism sector, govt. institutions, and various private residential development projects. Similarly, in Rupganj, the process of urbanization increased noticeably declining the share of agricultural land area from 76.2% to 58.4% during 2008-2015.

In Gazipur, the northern outskirts of the DMDP, the urban growth increased significantly which can be seen in Table 7.1. As observed, the total land area under agricultural coverage in Gazipur Sadar decreased to 18,900 ha or 41.3% by 2015 from 18,941 ha or 41.4% in 2008, a 1% decrease per annum which was the lowest and other upazilas of the DMDP region. Kaliganj, the northeast upazila of Dhaka Metropolitan, is predominantly a mixture of agricultural, peri-urban and settlement. The Agricultural Census of 2008 estimated that about 67.6% of the total land of Kaliganj was under agricultural land use which declined to 58% according to the land survey in 2015.

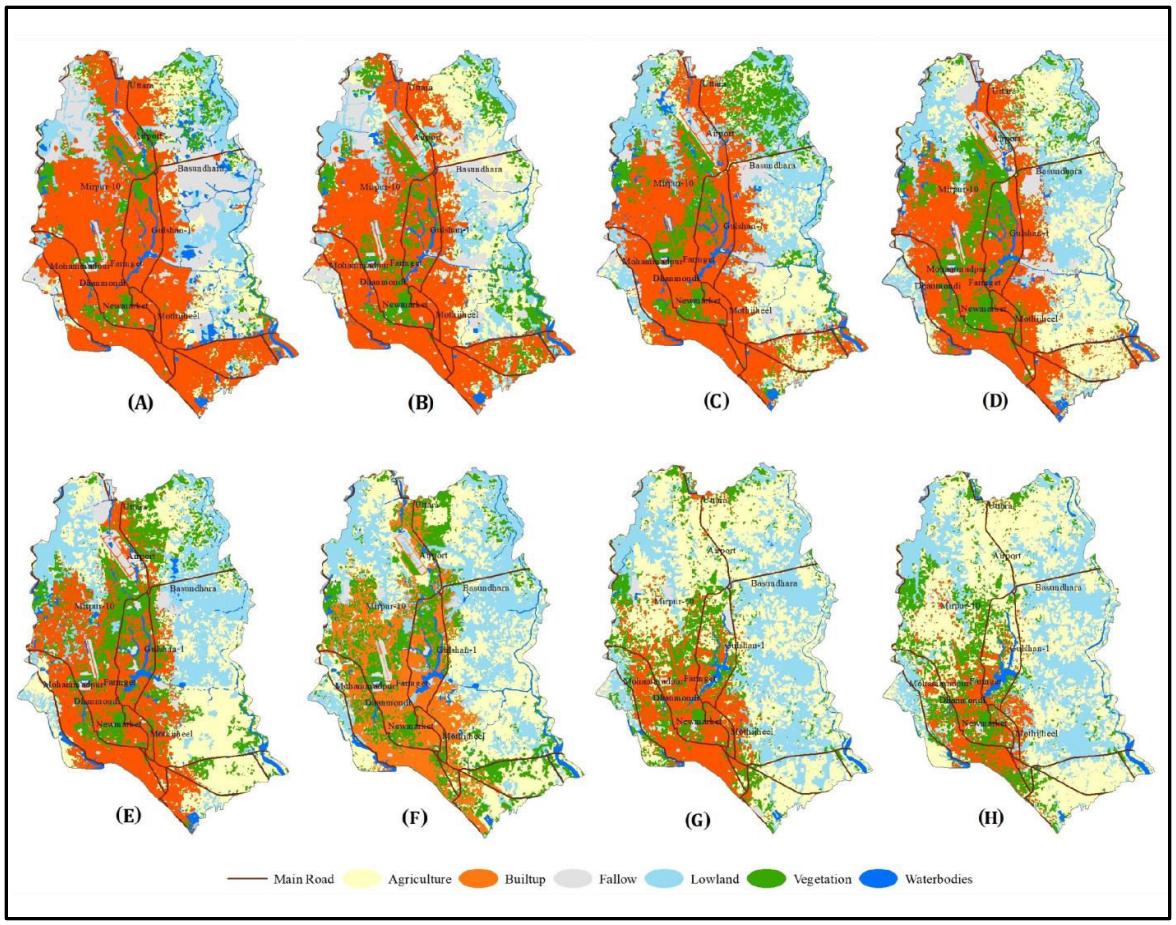


Figure 7.1: Land Cover Map of DMA between 1972 and 2015. (A) 2015; (B) 2010; (C) 2005; (D) 2000; (E) 1995; (F) 1990; (G) 1980; (H) 1972.
Source: Nazrul Islam Urban Studio, Department of Geography and Environment, University of Dhaka (2018); Hassan & Southwoth, 2017

In a recent study, the thematic map of Dhaka City Corporation of 1972 represented that the built-up area in Dhaka from 1972 to 2015 was about 2750 ha or 9% of the total area of DCC (Hassan & Southwoth, 2017). Findings from the study reveal that the adjacent cities of Dhaka Metropolitan such as Gazipur, Naryanganj, and Savar were small townships and the built-up areas were estimated at approximately 243 ha, 238 ha, and 30 ha, respectively. In 1972, the dominant land cover type included agricultural land (60%), vegetation (13%) and wetlands (21%) which accounted for 96% of the area. On the other hand, those land cover

types constituted around 47% for agricultural, 14% for vegetation and 28% for wetlands in Dhaka City Corporations (Figure 7.1).

Evidence reveals that since 1980, the urbanization in Dhaka metropolitan expanded to the north (Tongi-Gazipur) due to the industrial expansion together with residential development or by recovering a vast depressed land in the east and west of the core city. As a result, urban expansion has taken place towards the existing urban edge targeting the cultivable lands and wetlands since the 1990s. This ultimately triggered landfilling surrounding the capital engulfing croplands, canals, water bodies and the vast lowlands in the eastern and western parts of the city. Natural forest cover is quite negligible in the DMDP except for the Gazipur Sadar, which has a forest coverage of 5,452 hectares of land. Savar and Kaliganj have only 28 hectares and 34 hectares of forest land respectively, while in Dhaka metropolitan city, no natural forest coverage exists (BBS, 2011).

The trend of land cover change indicates that the built-up has increased significantly in the DCC. The increase in urban built-up areas was estimated at around 3210 ha. The vegetation and cultivated land decreased by 3,180 ha, wetland/lowland and water bodies by 915 ha (Abdullah & Asif, 2013). Figure 6.1 reveals that the core city area of DCCs was occupied by major built-up areas in the early 1970s which expanded beyond the limits of the old city boundary. Between 1972 to 1980, the total built-up area within the DCCs areas increased by 72%, with a population increase of 3,248,000 resulted a 120% growth rate (BBS, 1983; BBS, 1985). The population of Dhaka became doubled in size (3,248,000 in 1980 to 6,619,000 in 1990) in 1990 with a 104% population growth rate, the same time built-up increased with a growth rate of 46% (BBS, 1993).

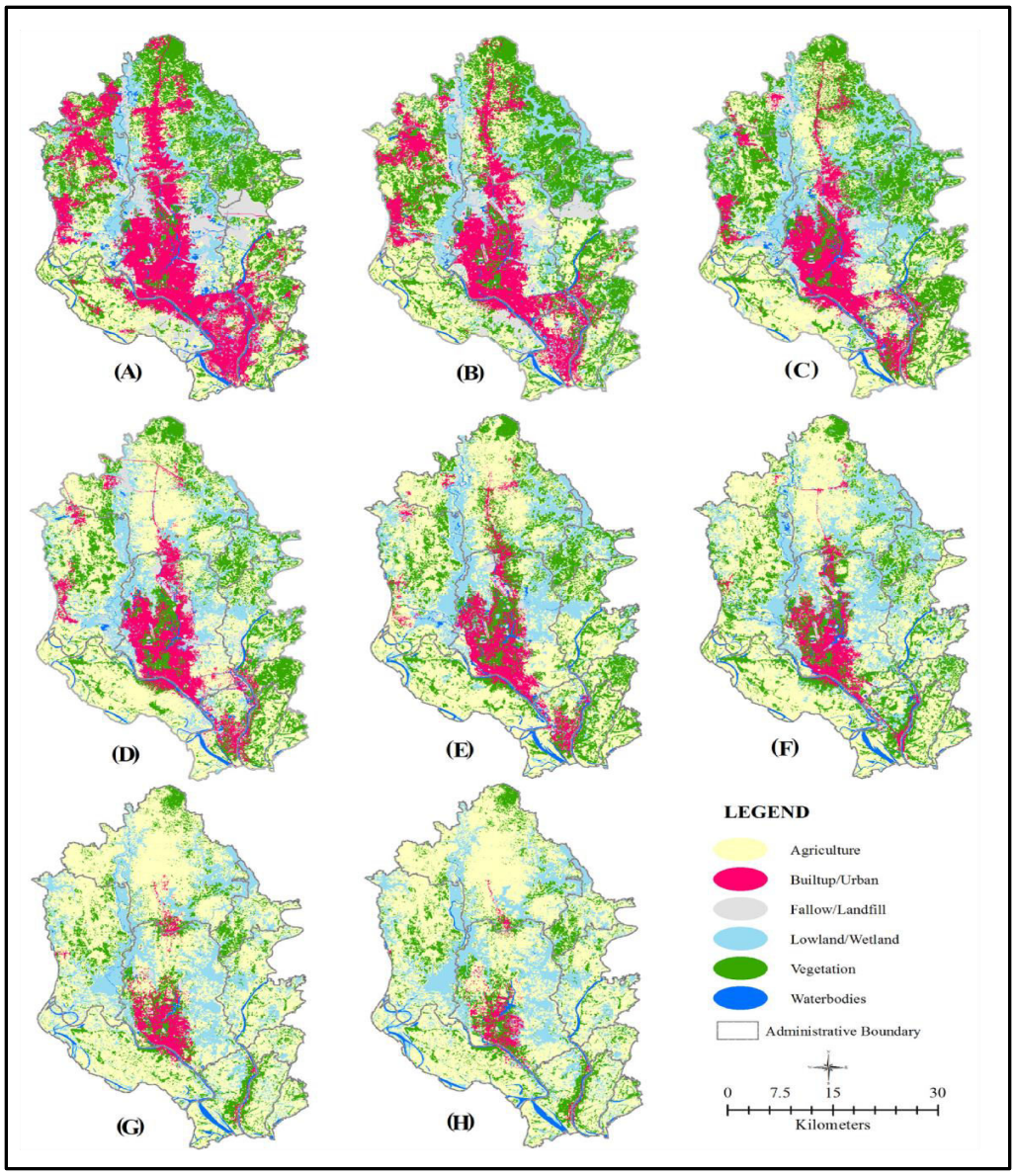


Figure 7.2: Distribution of Land Covers in the DMDP Region from 1972 to 2015 (A) 2015; (B) 2010; (C) 2005; (D) 2000; (E) 1995; (F) 1990; (G) 1980; (H) 1972.
Source: Nazrul Islam Urban Studio, Department of Geography and Environment, University of Dhaka (2018); Hassan & Southwoth, 2017

Urban growth in Dhaka followed a particular direction of converting agricultural lands, landfilling wetlands and water bodies in the north, north-west and west of Dhaka Metropolitan. Historically, the urban expansion in Dhaka has been hampered greatly by the low elevation of lands, surrounding rivers, and flooding risk (Abdullah & Asif, 2013). For

this reason, major urban development occurred in high and medium lands that usually do not flood during the monsoon. Previously, the public sector was the main authority for land developments which were mainly done on agricultural lands by ad- hoc planning (Basak, 2006). Presently, increasing numbers of real state agencies are noticeable in Dhaka engaged in developing new residential areas. As a result, both the agricultural and wetlands are converted into built-up areas without considering the environmental consequences.

The land use and land cover map of greater Dhaka are presented in Figure 7.2 for the time period of 1972-2015. It can be observed that Gazipur has got the focus on both residential and industrial development during the 43 years period due to available flood-free, low-cost land, good road networks and close proximity to the city area. As estimated, total agricultural land dropped to 73% in Gazipur (Hassan & Southworth, 2018). Keraniganj was dominated by agricultural lands and was estimated at around 70% of the total area in 1972. However, in recent times, several numbers of small- and medium-scale manufacturing industries, warehouses, and lower-income residences have been observed established by converting a certain portion of these land areas. The land type of Savar was largely agricultural and marshy because of its location on the northeast bank of the river Dhaleswari. Approximately 85% of the land area was under agricultural practice estimated from the thematic map of 1972 (Figure 7.2).

As observed in the land cover map of 1972, the urban development Naryanganj was confined to the eastern and western banks of the river Sheetolokkha (Figure 7.2). As estimated, about 53.8% of agricultural land area has decreased during the 43 years period. The built-up area covered around 238 hectares of land (Table 7.1). In the early 1990s, huge establishments of RMG factories along with other large-scale industries and associated infrastructures forced

the development of the city to accommodate a growing number of employees. As a result, the built-up area increased to 83% between 1980 and 1990 (Hassan & Southworth, 2017).

7.3 Livestock

In the composite agriculture of Bangladesh, livestock is considered a very important component. It is a vital source of meat protein and acts as also a principal sector for providing farm power and employment as well. About 20% of the total population is employed full-time in this sub-sector and another 50% on a part-time basis (Begum et al., 2011). This sub-sector contributes 1.47 % annually to the national GDP and the total share of livestock in agricultural GDP is 13.46% (BBS, 2020). According to the Export Promotion Bureau of Bangladesh, the export of leather and leather products contributed about 2.43 percent of the total export earnings of the country in the FY-2020-2021. Therefore, the sectoral contribution of livestock is valuable for the national economy of the country.

In Bangladesh, dairy and poultry are kept by smallholder livestock farmers. These two are considered the most vital enterprises of livestock. About 70–80% of the milk is predominantly production produced by small-scale mixed farm households in the country that generally possess 1–2 local cows and/or few goats (Jabbar et al., 2014). On the other hand, poultry is the most common livestock specie held mostly by marginal and landless farm households. Poultry serves as the first 'livestock asset' as a family gains it by keeping a few chickens and gradually acquires a goat, then a cow through accumulated income and savings (Todd, 1998).

7.3.1 Dairy Farms

Figure 7.3 reveals that the number of dairy farms in the DMDP area has increased during the time period 1980 to 2018. The rate of establishing cattle farms in the DMDP area remains

increased during 1980-2018. The rate of establishment of cattle farms was found higher in Narayanganj compared to Dhaka and Gazipur. The trend analyses revealed a surge from mid of the 1990s in the establishment of cattle farms demonstrated in Figure 7.3. Over the three decades, several industrial processors have emerged in the country for collecting, packaging and marketing milk and milk products with an aim to deliver healthy and quality milk and milk products. This has led to establishing new cattle in the urban and peri-urban areas. According to the Department of Livestock Services, the total number of livestock has increased from 52.8 million in 2011-2012 to 55.5 million in 2018- 2019 (BBS, 2019) in Bangladesh. The evidence is also clearly visible in the DMDP region.

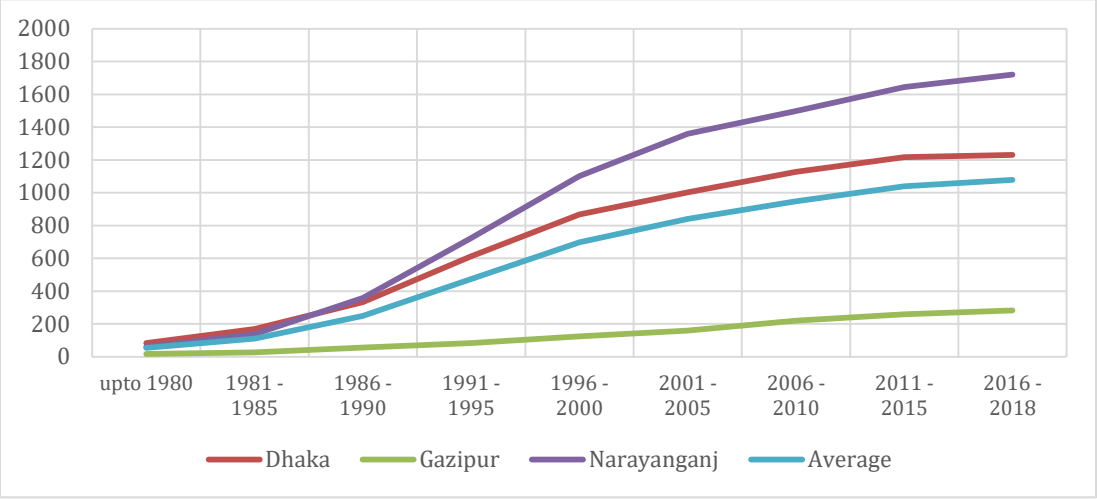


Figure 7.3: Trend of Establishment of Dairy Farms in DMDP Area (Registered Farms) During 1980-2018

Data Source: Department of Livestock Services, DLS

The Department of Livestock Services (DLS) reported an increase in farming activities overall in the country. Around 58,590 farms, each with 10 or more cows, have registered with DLS for producing dairy products till the end of 2019. About 155 new cattle farms have been registered since July of 2019 in Dhaka for producing milk and meat to meet the requirement of the urban dwellers of this particular area (Interview of DLS personnel).

Overall cattle farming is increasing in urban and semi-urban areas of Dhaka for meeting the growing requirement for milk, milk-based products, and meat. Cattle farms have been developed and managed even in the vicinity of the capital city Dhaka. New dairy zones have emerged in Gazipur, Savar and Narayanganj resulting in an increasing concentration of cattle farms in the area (Figure 7.3). The concentration of cattle farms has been observed the highest in Narayanganj City Corporation and Bandar upazila of Narayanganj district particularly in Kutubpur, Fatullah and Kalagachhia union. A moderately high concentration of farms can be observed in Tetuljhora and Bhakurta union of Savar upazila, Kaliganj upazila of Gazipur district and Rupganj upazila of Narayanganj particularly in Nagari and in Rupganj unions, respectively. A large number of cattle farms are located around the Dhaka City Corporations. In close proximity to the city center, a significant number of cattle farms are located at Mohammadpur, Tejgaon, Dhanmondi, Mirpur, Lalbag, Pallabi, Uttara and Demra.

In our country, cattle farming had been limited to smallholders in rural areas. This has changed in recent years. Dairy farms have been established in urban and peri-urban areas and particularly in the DMDP region more than a hundred cattle farms have been established in areas surrounding Dhaka city, particularly in Dhaka's outskirt. Despite the huge pressure of urbanization, a significant number of dairy farms are established in the periphery of the Dhaka Metropolitan, particularly in Keraniganj (Figures 7.3 and 7.4).

The livestock sector contributed consistently to the total GDP within a range of 2.1–3.6% over a long period between 1973–2008 (Rahman et al., 2014). Its impact can be noticed in the DMDP region. The establishment trend of cattle farms in the DMDP region reveals a

surge from 1992 onwards in establishing new cattle farms (Figure 7.3). This has been observed to continue till the end of the time period.

A structural change has taken place in the development planning of Bangladesh during the last few decades. The government of Bangladesh has given the highest priority to the agriculture sector in order to make the country self-sufficient in food. In the Seventh Five Year Plan and National Agriculture Policy, goals have been set to develop the overall agriculture sector.

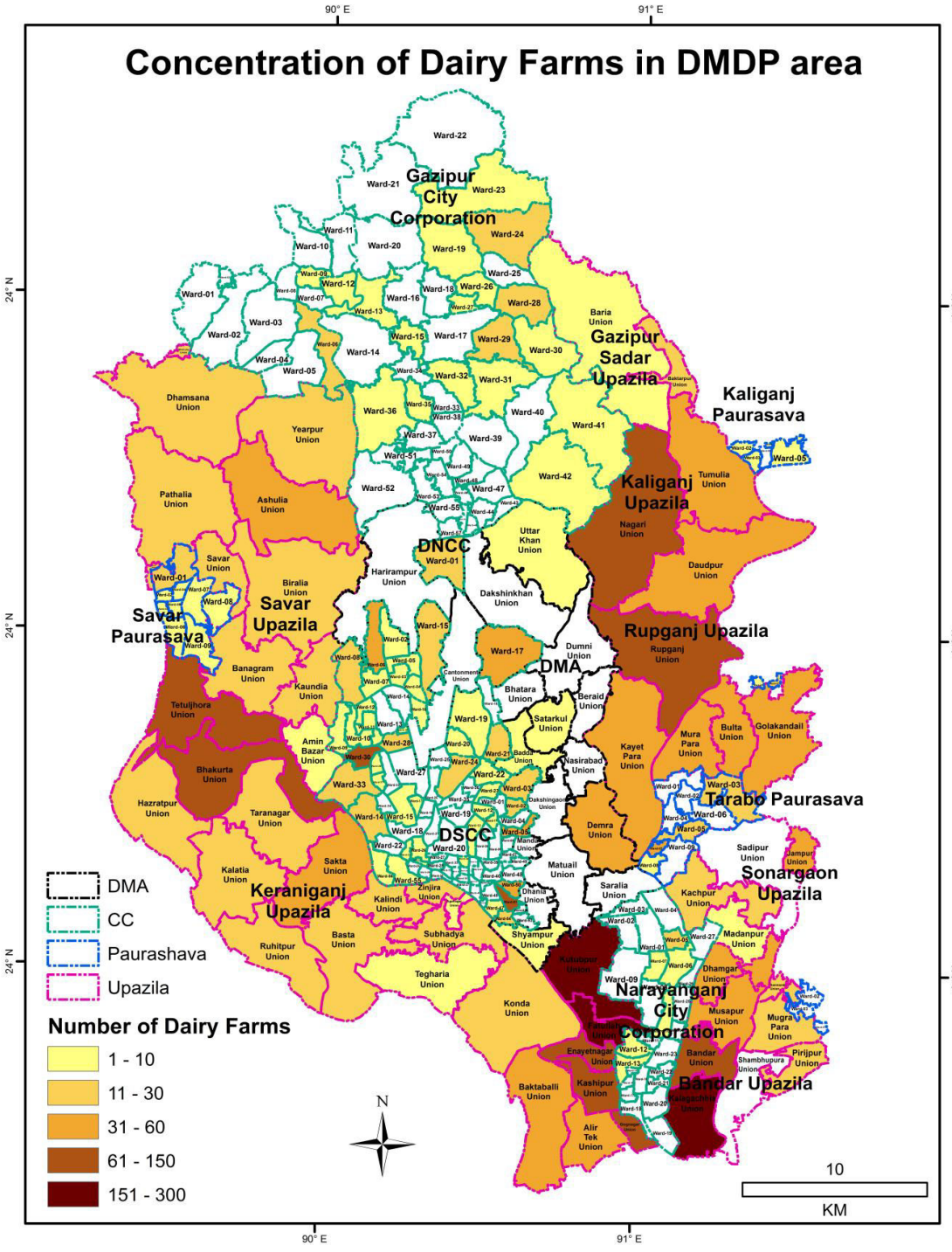


Figure 7.4: Distribution and Concentrations of Cattle Farms in the DMDP Region during 1980-2018

Data Source: Department of Livestock Services, DLS

7.3.2 Poultry Farms

Poultry is another important component of the agricultural farming system in Bangladesh. The poultry sub-sector plays a vital role in the national economy of the country through income generation, creating employment opportunities and improving the nutritional status of the people. According to the Bangladesh Poultry Industry Central Council (BPICC), this sector contributes about 1.5% to 1.6% to the total GDP of the country. The poultry sector has developed as a potential and promising commercial sector in Bangladesh in recent years.

In Bangladesh, a silent revolution has occurred during the last decade in the poultry sector. Though Bangladesh is an agro-based country, the per capita intake of poultry meat is only 11.2 grams per day (HIES, 2011) against the standard requirement of 36 grams (Ahmed and Islam, 1985) which is very unpleasant. It indicates that there is huge potential for this sector to develop in Bangladesh particularly in the urban as the population of the urban is increasing areas continuously at a high rate and chicken and egg are the cheapest sources of protein available to them. This sector can play a crucial role in nutritious food supplements and income generation.

Figure 7.5 reveals a sharp increase in the establishment of commercial poultry farms from the 90s in the study area. During the 2000/01-2011/12 decade establishment of commercial poultry farms registered a vivid growth in the DMDP area. During this time period, a growth of the poultry population of over 5% was recorded nationally (Chowdhury, 2015). Poultry is becoming popular day by day as it has the potential to create employment opportunities and therefore, a certain portion of people recognized it as a profitable business venture. It requires relatively less capital and land compared to crop and dairy products which may be attributed

to the increase in its acceptability. It generates cash income within a short time and creates employment for small farmers, landless, labours, unemployed people and women. These can be considered contributing factors to the explosion of this sector in the study area. Hence, poultry farms are increasing over time in the DMDP region.

Evidence reveals that from the late 1980s to the end of the 1990s, the market value of poultry products increased which leads to an increase in the commercial production of poultry in our country. These changes have been encouraged by increased demand for poultry products resulting from income and population growth. This resulted in an increasing trend of establishing commercial poultry farms throughout the study area, particularly around the city corporations in Dhaka.

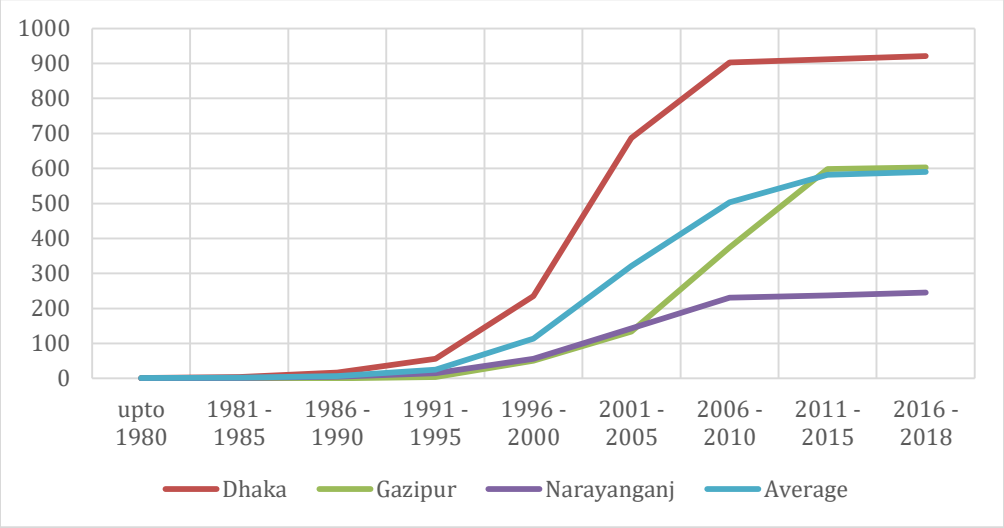


Figure 7.5: Trend of Establishment of Poultry Farms in DMDP Area (Registered Farms)
Data Source: Department of Livestock Services, DLS

Observation from the field study shows that small and marginal households in the study area earn a certain share of their income from livestock particularly from poultry rearing. A rapid growth in commercial poultry production has been observed both in Gazipur and

Narayanganj districts during the 1990s which continues to date. Commercial poultry farms were established by small to medium-scale crop-livestock farmers in the initial stage to increase their household income. But, large mixed farmers and individual entrepreneurs are involved with this business gradually.

Due to high market demand and environment friendly low cost industrial setup, a significant number of small to large-scale poultry farms have developed with heavy concentrations around Dhaka city and neighboring areas, such as Savar, Narayanganj, Gazipur and Keraniganj (Figure 7.6). Dhaka has become the hub of urban development since the independence which impacted to increase leads land, labour and other input costs. This is driving investors to shift from central Dhaka to adjacent districts in the urban area of DMDP. As a result, areas like Gazipur, Savar, Narayanganj, and Keraniganj have gradually become favored locations for the development of commercial poultry farms. Within Dhaka Metropolitan, the district of Gazipur has experienced the largest number and concentration of commercial poultry farms established since the early 1990s (Figures 7.5 and 7.6). The concentration of commercial poultry is rich in Savar and Keranigang upazila of the Dhaka district.

In the DMDP, increasing demand for poultry products enhanced the trend of the establishment of the poultry industry. Poultry production continues to address two basic needs: livelihoods support and nutrient supplement to the growing populations in non-agricultural areas, particularly in urban. Since the 1990s, the poultry sector has become an important component of the 'livestock revolution' and the impact is quite visible in the study area. The pressure of urbanization, population growth, economy and commodity expenses

increased the demand for livestock products such as chicken and eggs (Narrod et al., 2008; Steinfeld & Chilonda, 2006) which can be considered as the cause of the revolution.

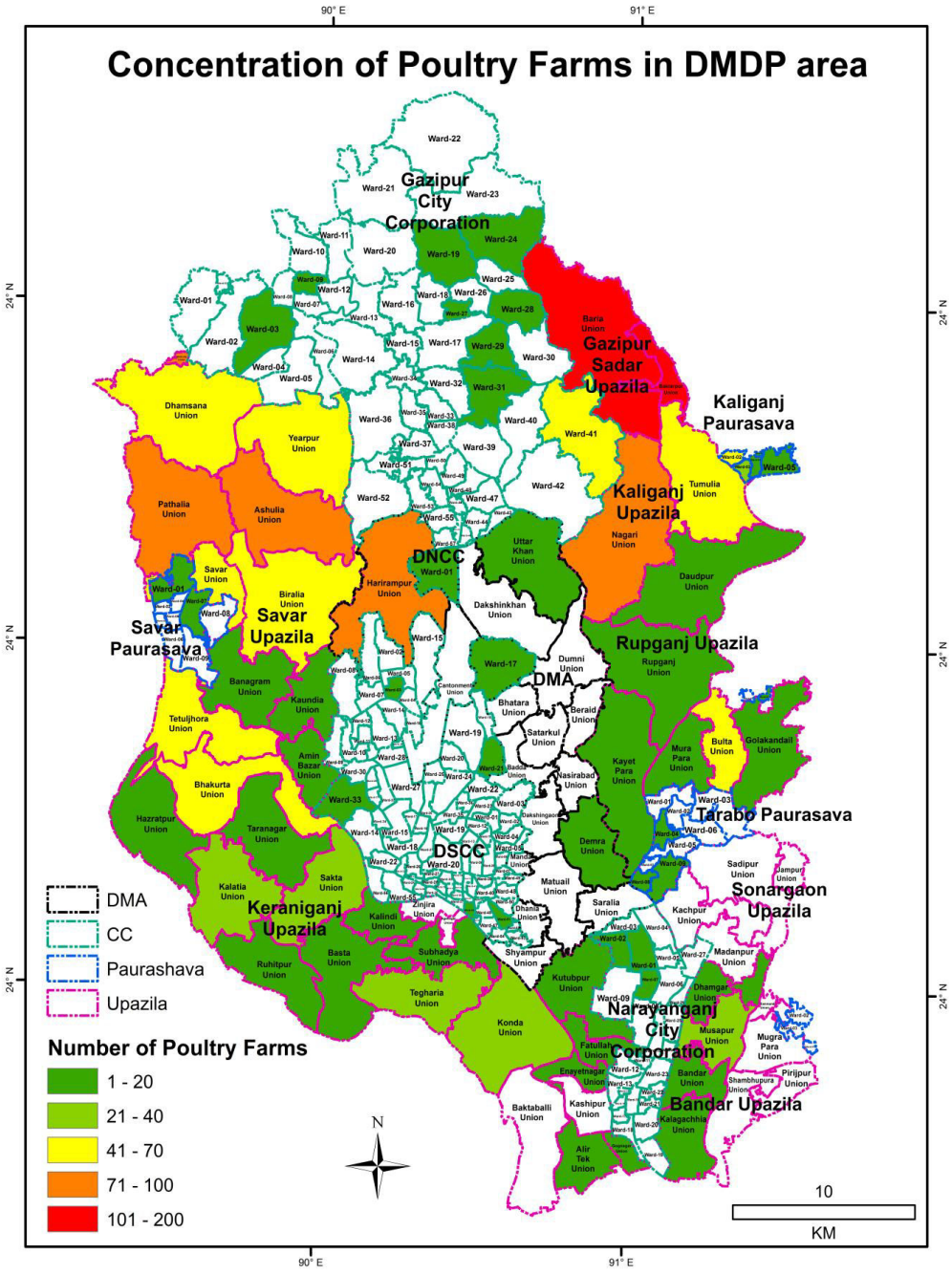


Figure 7.6: Distribution and Concentrations of Poultry Farms in the DMDP Region during 1980-2018

Data Source: Department of Livestock Services, DLS

The development of poultry farms and their geographic concentration in the study areas namely the DMDP region is meaningful for both research and policymaking. The finding will help policymakers to understand the processes by providing scientific evidence that will contribute to adopting appropriate policy frameworks for the industrial development of this sector potentially eliminating regional economic gaps (Cortright, 2006). Further, it will help urban planners to find the solution for the commercial development of markets highlighting geographic weaknesses to plan for new urban settlements.

7.4 Fisheries and Aquaculture

Fisheries and aquaculture are important sectors for food and nutrition security, income generation, foreign exchange earnings and employment in Bangladesh. An estimated 3.4 million fish ponds are located in the country which covers about 0.392 million ha of land. of About 56.24% of the fish production is cultured (BBS, 2019). The fisheries sector contributes 3.61% to the GDP of the country (BBS, 2018). The fisheries sector provides about 63% of the national animal protein consumption (DoF, 2013).

Advanced technology and suitable production environments along with high demand for fish products helps expanding this sector, particularly in the DMDP region. Several captured fisheries are established in the close proximity to Dhaka. There are many small rivers in the peri-urban areas of the DMDP (e.g. Bangshi and Menikhal river in Sonargaon upazila) which are furcated by the Meghna and the Brahmaputra rivers. The floodplains of these rivers are potential sources of fishes when inundated seasonally particularly during monsoons. Increasing demand for fish in the markets in the DMDP region has influenced the expansion of peri-urban pond aquaculture in the last decade. As a result, income generating activities are also increasing linked with aquaculture production in peri-urban areas of the Dhaka

Metropolitan. Fish nurseries occupy a land area of 167 hectares have been established in the nine upazillas (Savar, Keraniganj, Narayanganj Sadar, Sonargaon, Rupganj, Gazipur Sadar, Kaliganj, Kaliakoir and Bandar) of the DMDP area (Upazilla Fisheries Offices during 2012).

Domestic fish production in the DMDP region is more than 10-times greater than commercial fish production (Table 7.2). Among the selected upazillas of the study, Keraniganj of Dhaka and Bandar of Narayanganj district produce the lowest fish compared to the others. The reason for the lagging in commercial aquaculture production may have resulted from the pressure of urban development and the scarcity of sufficient suitable land. Aquaculture farms are also established in the Dhaka Metropolitan area.

Table 7.2: Area under Aquaculture in Different Upazilas of DMDP during Year 2017-2018

District	Upazila	Aquaculture (Ponds)				Total Production (tons)
		Domestic (ha)	Production (tons)	Comm. (ha)	Production (tons)	
Dhaka	Keranigang	98.7	315.0	6.5	22.0	337.0
	Savar	548.8	1,786.5	-	-	1,786.5
Narayanganj	Narayanganj Sadar	546.7	2,373.0	2.5	8.0	2,381.0
	Sonargaon	291.5	872.0	7.9	20.0	892.0
	Bandar	10.0	11.5	207.9	463.5	475.0
	Rupganj	195.4	503.5	37.0	136.0	639.5
Gazipur	Gazipur Sadar	1,208.0	4,055.0	65.37	184.0	4,239.0
	Kaliganj	620.18	2,089.0	72.3	254.0	2,343.0
Total		3,323.88	12,005.5	399.47	1087.5	13,093.0

Source: Divisional Office of Dhaka, Department of Fisheries, 2019

About 950 hectares of land are considered urban water bodies which include several canals, lakes, wetlands and public and private ponds (Dey et al., 2008). Approximately, 7% to 10%

of the fresh fish are sold annually in the markets of Dhaka city which are produced in peri-urban areas of the Dhaka Metropolitan (Islam et al., 2004). This estimate did not include the fish trade that happens in the informal market. High-quality fish including carp, catfish, etc. are produced in peri-urban areas with an aim to sell to economically rich people, whereas, a mix of lower-quality fish is sold to middle and low-income groups (Rahman et al., 2015).

7.5 Rooftop Agriculture

Rooftop agriculture is man-made agricultural arrangements or granaries built up on medium or micro-scale on the roofs and other topmost open spaces of residential, commercial, and industrial buildings. According to Sajjaduzzaman (2005), "Roof gardening is an art and science of growing plants on the fallow spaces within, surrounding or adjacent to the roof of the residence". Other conventional areas of the roof for agriculture gardening include a roof, terrace, balcony, and cornices. Urban dwellers grow mainly horticultural crops and flower plants in the rooftop gardens. Both the typical and advanced techniques are followed for establishing and producing crops, and the products are primarily used for individual or household consumption (Rahman et al., 2015). Roof gardens provide a range of benefits, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, increasing the shades of a building and subsequently helping improve the mental health of the people around the roof by providing a more aesthetically pleasing landscape. It also helps to contribute to mitigating the heat island effect by lowering air temperature that controls the micro-climate at the local level.

According to the Bangladesh Agriculture Information Service, the city corporation of Dhaka have about 4.5 lakh roofs which cover more than 4,500 hectares of area. This is equivalent to or even larger than an upazila (sub-district). Utilizing this large area can bring remarkable

results in urban agriculture. Due to the growing interest, many urban dwellers are passionately engaged in RTG for over two decades, but still, it is far away from fulfilling the opportunities that urban agriculture offers in the capital. Around 30,000 rooftop gardens operating in the capital at present which covers about 7% of the total number of roofs (The Business Standard, 2020). According to a study conducted by the Sher-e-Bangla Agricultural University, about 41% of the roof garden owners in Dhaka are young, middle-aged and elderly people constituting about 30% and 29%, respectively.

From 2018, the DAE is implementing a three-year project on the development of urban agriculture to establish about 600 rooftop gardens in the capital. Under this project, about 1,000 roof gardens will be established in Dhaka. Currently, the project is supervising about 6,975 roof gardens in Dhaka (DAE, 2020). Roughly 10,000 km2 of 'bright' and rooftops can be brought under food production within the city corporations of Dhaka, those are vacant. A community approach (self-funded) of rearing goats and pigeons on the rooftop in Dhaka has been continuing for years that helps build community linkage and strengthen local economies (Kabiret et al., 2011).

7.6 Conclusion

Urban agricultural lands are being converted to built-up areas as a consequence of rapid urbanization. Land use change in the DMDP region clearly demonstrates the significant loss of agricultural land due to urban expansion. The process of urbanization was confined to the north of the study area during the mid of 1970s. Dominant land covers included open spaces, cultivated lands, low-lying areas, water bodies and tree vegetation, those converted into built-up areas gradually over the decades. The direction of urban development further extended to

northwest between 1975 and 1988 influenced by the development of road networks. All the processes caused a significant decrease in cropped lands.

The urban agricultural markets have been found to develop in responding to meet the growing demands of the people of the city. During the last few decades, the demand for dairy and poultry products have been increased which has led to the development of medium to large-scale cattle and dairy farms in the DMDP region, particularly in the adjacent city corporation and towns namely, Narayanganj, Gazipu, Savar and Keraniganj. Poultry farms have also increased in number and scale. The urban agricultural practices in the study area include operating intensive semi or fully commercial farms for raising cattle and chickens, producing milk and eggs and cultivating flowers, rooftop gardening and orchards.

Official records reveal that there are a good number of inland/captured fisheries located in close proximity to Dhaka Metropolitan. The major river system has become polluted due to industrial waste deposition which made the river system unfavorable for fish production. Besides, many other small rivers are embedded across the DMDP region like nets. During the monsoon, estuaries and floodplains of these river systems are inundated and become potential sources of fish production. Furthermore, there are many canals and beels (swamped areas) in and around the -urban areas that are suitable for fish production.

Chapter 8

Results and Discussions

8.1 Introduction

The study was conducted with the aim to explore the trend of land use changes and their consequences, particularly in the DMDP area. Findings on the existing status of urban agricultural practices that prevail in the study area, land use changes and their consequences in light of the impact of climate change have been described in this section. The ability of the respondent farmers to adapt to the impact of climate change and health issues has also been tried to identify in the study in line with the issue of urban resilience has also been described in this section.

The findings of the field survey with their interpretations have been presented in seven subsections in accordance with the study objectives. The first subsection describes the major agricultural practices in the study area, while the second one deals with the management practices of urban agriculture. Land use changes and their consequences are described in the third subsection while the fourth section deals with farmers' knowledge of the impact of climate change and adaptation. The fifth subsection deals with the exposure of farmers to training and the sixth one deal with the challenges and opportunities of urban agriculture in the study area. The seventh sub-section depicted the relationship of each of the selected characteristics of the urban farmers with the different selected features of agricultural practice that are potential for the sustainability of the UA in the study area.

8.2 Major Agricultural Activities

Crop production practice in the urban area of DMDP still maintains some important characteristics of rural agriculture. Different types of agricultural activities have been identified in the study.

8.2.1 Types of Agricultural Activities

Rice has been found to be the dominant agricultural crop cultivated by the majority of 37.1% of the respondents. It reflects the dominance of rice in the cropping systems in the Dhaka Metropolitan region. Besides this, vegetable cultivation has been found to get proportionately the same importance as rice due to market demand and high price which is a significant finding of the survey. A significant portion of 31.1% of the respondents reported cattle farming followed by 20% of farmers who have reported poultry rearing in the study area. This has also been found as an important component of urban agricultural in the DMDP region. A substantial portion of 10.1% of respondent farmers reported the cultivation of flowers. In addition, around 7.7% of the respondents reported homestead gardening in the study area which is an important production system of producing horticultural crops to meet nutritional requirements and demand for fruits and vegetables (Table 8.1).

Diversification into crop cultivation and increasing commercialization led by population demands supports the development of the urban agricultural system in several ways. Production of cereals except rice has been found decreasing whereas cultivation of high-value crops such as vegetables, fruits and flowers has been found to increase in the study area. Besides this, cattle and poultry have also been found vibrant in the DMDP area. It indicates that households are gradually moving from subsistence to semi-commercial and

commercial production systems. This supports the urban farmers in maximizing profits and generating a surplus.

Table 8.1: Type of Agricultural Activities (Multiple answers)

Types of cultivation	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Rice	159	76.8	72	69.9	97	92.4	328	79.0
Pulse	14	6.8	2	1.9	6	5.7	22	5.3
Vegetable	168	81.2	90	87.4	70	66.7	328	79.0
Jute	15	7.3	1	0.9	2	1.9	18	4.3
Flower	29	14.0	0	0.0	13	12.4	42	10.1
Cattle farm	85	41.1	27	26.2	17	16.2	129	31.1
Poultry farm	43	20.8	15	14.6	25	23.8	83	20.0
Homestead garden	15	7.2	6	5.8	11	10.5	32	7.7
Others	1	0.5	0	0.0	1	0.9	2	0.5
Total	207		103		105		415	

Source: Field Study, 2019

Basically, the subsistence farming community grows vegetables and fruits in Bangladesh around their homesteads. In the greater Dhaka region, this growth has contributed to develop the existing farming practices by reducing and to some extent, omitting traditional crops such as jute, pulses and other cereals. Based on the growing season, crops can be categorized as summer, winter, and all-season crops.

The food demand in Bangladesh, particularly in the urban areas is changing over time. Economic growth, improved incomes, and urbanization can be considered as factors responsible for the shifting of the demands that leads transforming the production system from traditional farming into cultivation of high-value food commodities, such as fruits, vegetables, fish and livestock. In addition, uses and demands for flowers have increased significantly. Since the production of many high-value agricultural commodities tends to be

labour intensive it represents an opportunity to generate employment. Moreover, the global demand for high-value agricultural products can also provide additional opportunities to increase access to the global market for producers and exporters in Bangladesh. It is observed in Table 5.1 that increasing capital intensity in production and processing leads to growth in the agribusiness of high-valued crops in the study area of the DMDP region.

8.2.2 Information on Modern Cultivation System

Modern Technology has a major role in farming and agriculture practices. The introduction of the modern cultivation system has made a monumental impact on the agriculture sector in recent decades which has made agriculture more sustainable and profitable. In the process of rapid urban development, the land use within a certain urban boundary changes gradually over time. In the periphery of an urban area, agricultural land use predominates compared to other land uses. UA is embedded in the urban environment and interacts with the natural urban resources and ecosystem. Thus the issue of the sustainability of UA is very much important for the resilience of the urban environment. The modern cultivation system helps ensure the internal sustainability of UA.

An overwhelming portion of about 88% of the respondents reported to have knowledge on modern cultivation technologies which is quite encouraging as it helps for better earning as well as persuade the common farmers to use modern techniques in agriculture. About 10% of the respondents reported not to have knowledge on modern technologies whereas only 2.0% failed to answer the question (Figure 8.1).

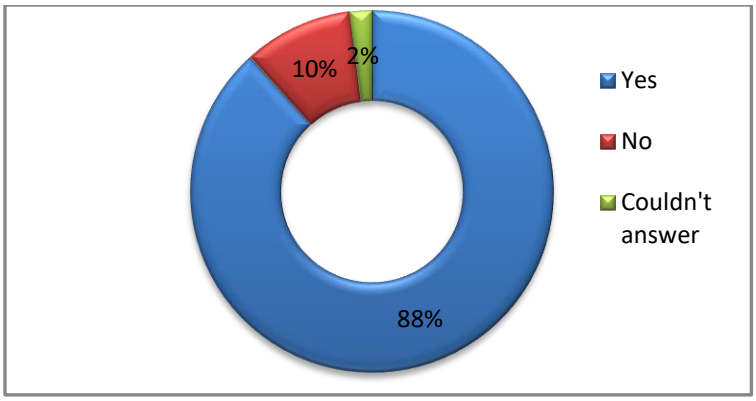


Figure 8.1: Knowledge on Modern Cultivation Technology
Source: Field Study, 2019

The survey indicates that neighbours of the farmers area are the primary source of information on modern cultivation technology in the study. Majority of the respondents (52.3%) reported getting updated information on cultivation practices from neighbours followed by different NGOs (29.4%). About 16.6% of the respondents mentioned newspapers and 16.1% indicated government agencies as their primary source of information on modern cultivation technology (Table 8.2).

Table 8.2: Source of Information on Modern Cultivation System (Multiple answers)

Source	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
News media	14	6.8	21	20.4	34	32.4	69	16.6
Neighbour	135	65.2	39	37.9	43	40.9	217	52.3
NGOs	26	12.6	42	40.8	54	51.4	122	29.4
Concerned Govt. agencies	43	20.8	20	19.4	4	3.8	67	16.1
Total	207		103		105		415	

Source: Field Study, 2019

The above scenario depicts that concerned government authorities, particularly DAE, need to be more active by undertaking different strategies of information circulation through mass media and other vital communication media. This study reveals that most of the respondents were uninformed about different dissemination programmes of the government that deprived

them to attain knowledge on modern agriculture technologies in order to the rampant improvement of the present situation of urban agriculture in the study area.

8.2.3 Cropping Intensity (C.I.)

According to the definition, cropping intensity is the number of crops grown in a given agricultural year on the same plot of land. It is an alternative way of intensifying the production of a particular plot of land which is considered a strategy to enhance household income.

The cropping intensity status of the DMDP area has been represented in Table 8.3. At a glance, the study area possesses 24.3% single cropped area (SCA), 61.2% double cropped area (DCA), and 14.5% triple cropped area (TCA) as reported by the respondents. The DCA accounted for the major share of Net Cropped Area (NCA) followed by corresponding single cropped area and triple cropped area. Among the districts, Dhaka has the highest share of TCA which accounted for about 16.9% of NCA of the district. The net cropped area of the region was estimated at 81,160 hectares (BBS, 2018).

Findings from the household survey comply with the findings of a study conducted in total of 46 upazilas of the Dhaka agricultural region by Parvin et al. (2015) with an aim to find out the existing cropping patterns, cropping intensity and crop diversity in the region. Findings of the study revealed that the agricultural area of the region was occupied 21.25% by single cropped area (SCA), 55.37% by double cropped area (DCA), and 17.23% by triple cropped. The average cropping intensity of this region was calculated to be 191% for the time period of 2015-16.

Table 8.3: Cropping Intensity of the Study Area (Yearly)

Frequency	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Single crop	39	18.8	35	34.0	27	25.7	101	24.3
Double	133	64.3	58	56.3	63	60.0	254	61.2
Triple	35	16.9	10	9.7	15	14.3	60	14.5
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

Farmers of Bangladesh practice an intensive cultivation system to increase financial outcomes from agriculture. The same scenario can be observed in the DMDP area. Cultivable land is decreasing in the study area but the advanced land utilization pattern helped increase the total cropped area (i.e., double, triple, and multiple cropping systems). The extension of the irrigation facility increased the cropping intensity of the study area by enabling multiple cropping. Bangladesh Bureau of Statistics (2016) reported a four times increment of the irrigated area during the last three decades.

8.3 Management of Agriculture

Proper management of agricultural farmland and related activities is important for the overall utilization of the asset. In recent date, the importance of farming exceeded its limit beyond just crop production. It brings together farmers and landowners to address profitability, fertility, conservation, tax issues and so on. The importance knowledgeable and experience on advanced and professional farm management is indispensible for the profitability of the system.

Generally, the management of an agricultural farm involves four key areas of activities: collecting of production inputs, marketing, finance and waste management. These activities in a holistic approach illustrate that agriculture is a composite system undertaken for the

accomplishment of the objectives and goals by keeping the environment healthy and sustainable.

8.3.1 Irrigation

The field survey identified variuos sources of irrigation in the study area. It can be observed from Table 8.4 that groundwater is the chief source of irrigation which accounted for around 66.0% of the total supply of irrigation water for the agriculture in the DMDP region. A substantial proportion of 34% of the respondents is dependent on surface water irrigation. A variation in the dominance of sources of water can be observed among the study city corporation areas. In Dhaka, about 80.6% of the respondents reported that they use groundwater for cultivation whereas 41.8% of respondents from Narayanganj reported that groundwater is their primary irrigation source. About 58.2% of the respondents from Narayanganj reported that they use surface water for cultivation in contrast. In Dhaka, the proportion of respondents was recorded as 19.4% dependent on surface water for irrigation. In Gazipur, the majority (60%) of the respondents have found that they use groundwater for irrigation and the rest of the 40% of the respondent depend on groundwater for irrigation. Deep and shallow tube wells were identified as a thin mode of irrigation for groundwater (Table 8.4).

In the DMDP region, the major sources of irrigation are ground and surface water. Widespread use of shallow and deep tube wells has been observed for irrigation during the dry season (November to March). As rice, particularly the high-yield varieties (HYV) are high-water demanding crops, they need frequent irrigation. Canal, pond and river water are also used as surface water irrigation in the DMDP region.

Table 8.4: Source of Irrigation

Sources		Study Area						Total	
		Dhaka		Narayanganj		Gazipur			
		N	%	N	%	N	%	N	%
Ground water	Deep tube well	122	58.9	26	25.3	25	23.8	173	41.7
	Shallow tube well	45	21.7	17	16.5	38	36.2	98	24.1
Sub-total-1		**167**	**80.6**	**43**	**41.8**	**63**	**60.0**	**273**	**65.8**
Surface water	Pond	16	7.8	0	0.0	10	9.5	26	6.3
	Canal	4	1.9	40	38.8	23	21.9	67	16.1
	River	20	9.7	20	19.4	9	8.6	49	11.8
Sub-total-2		**40**	**19.4**	**60**	**58.2**	**42**	**40.0**	**142**	**34.2**
Total (Sub-total-1+Sub-total-2)		207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

Water, the valuable groundwater resources is becomes a serious issue globally due to its shrinking availability. Like other parts of Bangladesh Dhaka is facing significant challenges for groundwater period. Between 2005-2010 the groundwater levels in Dhaka have dropped by nearly 15 meters, from 54 meters to 69 meters (BADC, 2011). The projected scenario on groundwater depletion revealed that the groundwater table will drop to 120 meters by 2050 holding a depletion rate of 2.81 m/y. The fall in groundwater levels may decrease at a higher rate coiled with increased urbanization, irrational extraction, and encroachment that will also worsen the quality of surface water bodies around the city (Baten & Uddin 2011).

The situations of water supply have negative implications for UA since agriculture is considered an afterthought in urban planning. It will be quite difficult to ensure a regular supply of water to UA from the groundwater sources going to in the coming decades. In such cases, wastewater has a huge opportunity to use in irrigation that could mitigate water shortages. At present, sewage systems are designed to remove sewage from the city making

the potential for reusing wastewater very poor. Moreover, industrial development and encroachment of water bodies have made surface water scarce for use in urban agriculture.

8.3.2 Uses of Products

Literature on UA reveals that urban farmers are engaged in agriculture either for family consumption or selling to the markets for generating income. Findings from the field survey revealed that the issue of food security prevails in the study area, but income generation is also important issue for the urban farm households to operate the production activities in his agricultural lands. A substantial portion of urban farmers reported to sell the agricultural products in the market.

Table 8.5: Uses of Products

Uses	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Selling	175	84.5	85	82.5	82	78.1	342	82.4
Family consumption	25	12.1	15	14.6	18	17.1	58	14.0
Both	7	3.4	3	2.9	5	4.8	15	3.6
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

From Table 8.5 it can be observed that about 14% of the respondent farmers grow agricultural produces for family consumption whereas around 82.4% of respondents sell produces to the market for earning money. About 3.6% of the respondents found to grow agricultural products both for family consumption and selling. A similar finding has been recorded in Latin America and Africa (Maxwell, 2003; Ellis & Sumberg, 1998). This feature emphasizes the socio-economic importance of UA as a feasible alternative to economic subsistence and overcoming emergencies and unemployment.

From Table 8.6 it can be observed that the major portion of 72.5% of the produce grown by the urban farmers goes to the local market of the study area whereas a substantial portion of 60.7% of the produce also goes to the wholesale market for selling. About 25.1% of the product reported selling to the neighbours. In the case of dairy and poultry production, most of the respondent farmers reported selling products in the farm to traders coming to buy.

Table 8.6: Places where Agricultural Products are being Sold (Multiple answers)

Places	Study City Corporation Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Neighbours	62	30.0	29	28.2	13	12.4	104	25.1
Local market	174	85.1	68	66.0	59	56.2	301	72.5
Wholesale market	152	73.4	44	42.7	56	53.3	252	60.7
Total	207		103		105		415	

Source: Field Study, 2019

The study discloses that the urban agricultural markets in the study area are developing in response to the growing demands of city dwellers; the demand for fruits, vegetables and poultry products is increasing, which has led to the development of small farms in the periphery.

In this study, agriculture is clearly reported as the most important income source of the respondent households in the study areas. However, the major portion of the agricultural products is produced for self-consumption, the rest or surpluses are sold in the market. UA thus contributes to family food consumption, income generation, employment and other household requirements.

Urban agriculture can be considered a significant urban livelihood strategy. Literature demonstrates that it is important for household food security, as it provides an additional income, increase food diversity, supplement food during seasonal unavailability in the food

supply (Maxwell et al., 1998; Sustainable Development Solution Network, 2013). Urban agriculture requires intensive production methods that use and reuse natural resources and utilize urban wastes which help to yield a diverse range of land, water, and air-based fauna and flora. This phenomenon contributes to the food and nutritional security, livelihood, health, and environment at local and community level (Smith et al., 2001).

8.3.3 Access to Finance

From Table 5.7 it can be observed that around 79.8% of the respondents carry on agricultural activities with their own finance, 14.4% take loans from relatives and local moneylenders (Mahajon) and only 5.8% reported getting institutional credit. A large number of the respondents indicated reported not to avail of any services from financial institutions. They indicated that the high rate of interest and uncertainty of loan recovery made them fearful of taking loans. The scenario is quite different from the rural areas. The institutional access of for poor households increased to 43% from 21% during the same period of 2011-2012 (Bayes and Patwary, 2012). It reveals that access to institutional agricultural credit is still very poor in the study area. Farmers in the DMDP region have to depend on their own financial ability to continue agricultural activities.

Table 8.7: Sources of Finance for Agricultural Activities

Source	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
From self-income	166	80.2	81	78.6	84	80.0	331	79.8
Loan from relatives and moneylenders	30	14.5	15	14.6	15	14.3	60	14.4
Institutional credit	11	5.3	7	6.8	6	5.7	24	5.8
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

The optimum and timely supply of essential agricultural inputs can be ensured by easy access to credit which helps enhance agricultural productivity and sustainability of UA. The study indicates that people involved with agriculture in the study area are mainly small to subsistence farm holders who depend on UA for their household food requirements and livelihood. The vulnerability of food security of the farmers will increase if the capital shortage limits the access to agricultural inputs of the urban farmers which may cause a drastic reduction in production.

8.3.4 Agricultural Waste Management

Waste management encompasses the arrangements and activities essential to manage waste from its initiation to final disposal. Different human activities, including municipal (residential, industrial and institutional), agricultural, and social (health care, sewage sludge) often produce various kinds of leftover or unwanted materials produced which usually refers to the term waste. The intuitional definition of "agricultural waste" is "waste from premises used for agriculture within the meaning of the Agriculture Act 1947." (Wikipedia, 2013).

Analysis shows that there are available wastes that are recycled and many respondents perceive composting as a good way to minimize waste and as a source of input for agricultural production. There are many potential users in the study area willing to use and buy the compost. Result represented in Table 8.8 reveals that an encouraging number of the respondents (66.0%) reuse organic waste by converting waste into manure. About 37.3% reported dumping the waste in the field and 25.8% reported burning the agricultural waste. Rapid urbanization often causes a major challenge in the issue of waste management that can threaten the protection of the environment. However, the problem can be improved by converting organic waste into organic fertilizers (e.g. compost) for use in urban agriculture.

The present study findings indicate a there is a significant scope exists for the environmental friendly waste management practice in the study as the agricultural practice can be characterized by the special feature of waste management in the DMDP area

. **Table 8.8: Agricultural Waste Management** (Multiple answers)

Method	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Dump in field	44	21.3	39	37.9	72	68.6	155	37.3
Burn	58	28.0	25	24.3	24	22.9	107	25.8
Use as manure	134	64.7	68	66.0	72	68.6	274	66.0
Total	207		103		105		415	

Source: Field Study, 2019

In the context of urban agriculture, the risk to public health can be minimized by applying more appropriate waste management methods. Composting is playing a vital role in urban settlements by recycling a certain quantity of waste - mainly the inorganic portions. Composting is a suitable eco-friendly method of converting organic waste into organic fertilizers that improve soil quality by regulating different biological processes. Through the process, the organic fraction of the urban waste is converted into a rich soil conditioner in the dumping sites and landfills thus can reduce environmental hazards that enhance the sustainability of urban land use and contribute to developing urban resilience. The necessary institutional linkage needs to be established to ensure the sustainability of recycling waste for urban agriculture (UA). Urban agricultural activities in the DMDP can flourish new urban labor markets and develop innovative business ventures by offering new agricultural products.

8.4 Land Use Change and Consequences

Urbanization is considered one of the principal forces driving urban land use change. It always intensifies the conversion of land use from agriculture to non-agriculture. Evidence revealed that a great number of contemporary urban sprawls are created by the process of urbanization those are detrimental to the environment. However, urban land use change usually occurs in relatively diverse forms in terms of design, infrastructure, nature and pace of land use change, etc.

8.4.1 Changes in Land Use

Land use change is a continuous process. Lands in different parts of the study area have been observed changing according to the development initiatives and interventions, reported by the respondents. On average, about 68.3% of the respondents reported observing land use changes in the study area followed by 23.7% who reported not observing any changes during the last five years from the year of the field survey. About 8% of respondent farmers were unable to answer the question (Figure 8.2).

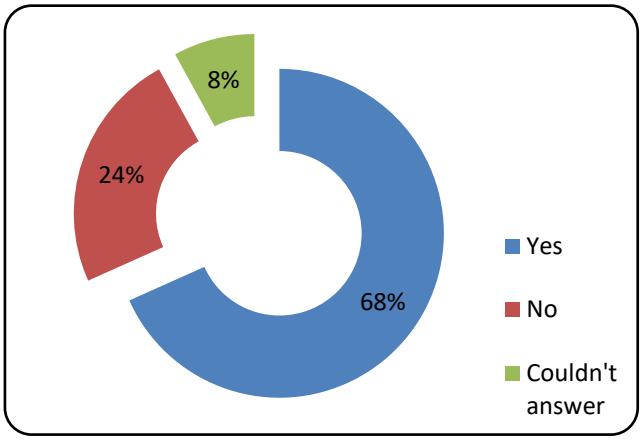


Figure 8.2: Observations on Land Use Change
Source: Field Study, 2019

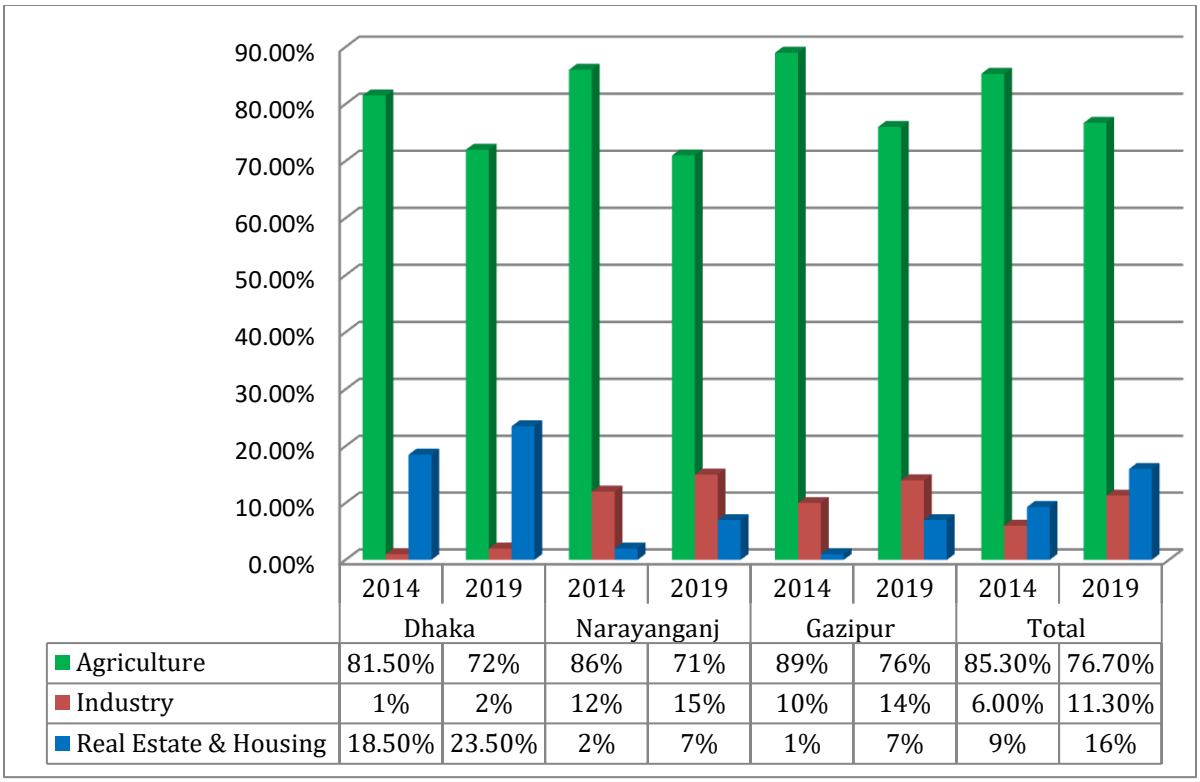
In Bangladesh, changes in land use are a constant phenomenon and the rate of shifting of agricultural land use to non-agriculture is very (Planning commission, 2009, cited in SRDI, 2013).

About 220 ha of arable land is being converted every day in our country for constructing houses, roads, commercial buildings, industries and other non-agricultural activities, which is very alarming for the sustainability of land resources (SRDI, 2013).

8.4.2 Status of Land Use Change

It was observed that intensive development activities are imposing tremendous pressure on the land use of the DMDP region. A constant rapid shifting of agricultural land into non-agricultural uses land use change has been noted in the study area through. Figure 8.3 depicted the situation of land cover changes reported by the respondent farmers in the study area during the last five years (from 2014 to 2019). The dominant land use type was recorded agriculture which has been observed shrinking due to the development of small to large-scale industries and real estate and housing projects.

As reported by the respondents, about 85% of the land area was occupied by agriculture in 2014 which has been reduced to 77% in 2019 with a decreasing rate of 1.6% per annum (Figure 8.3). This is very alarming for the sustainability of urban agriculture and the ecology as well in the study area because the annual rate of transformation is higher than the national average. The observation of the farmers complies with the findings from national data. As calculated from the secondary data of the Bangladesh Bureau of Statistics (BBS), the annual rate of decline in agricultural land uses in the DMDP region was 1.8% (Table 7.1). On the other hand, industries and housing projects have been observed to increase during the time period. As reported by the respondents, real estate and housing coverage increased to 16% in 2019 from 9% in 2014 and similarly, industries increased to 11% in 2019 from 6% in 2014.

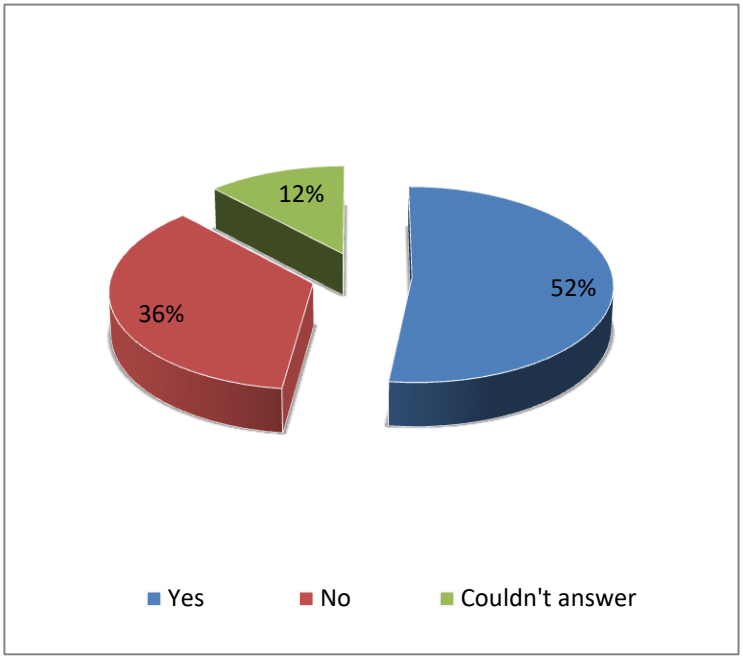


	2014	2019	2014	2019	2014	2019	2014	2019
	Dhaka		Narayanganj		Gazipur		Total	
Agriculture	81.50%	72%	86%	71%	89%	76%	85.30%	76.70%
Industry	1%	2%	12%	15%	10%	14%	6.00%	11.30%
Real Estate & Housing	18.50%	23.50%	2%	7%	1%	7%	9%	16%

Figure 8.3: Changes Observed in Land Use in the Study Area
Source: Field Study, 2019

The findings of the survey illustrate that in Dhaka (particularly in Keraniganj and Savar upazila) residential land activities dominate the land activity pattern after agriculture. There are a significant number of land parcels in which the land is used for both residential and commercial purposes. According to the opinion of the majority of the respondents, small to medium-scale industries are increasing in Keraniganj whereas in Savar land cover is being occupied by medium to large scale industries. In Keraniganj, the influence of real estate and housing activities on land use has been found prominent as an impact on expanding residential projects for the increasing urban population in the study area which become a big challenge for urban agriculture. A similar scenario has been observed in Gazipur. On the other hand, the pressure of industrial development is putting impediments on agricultural activities in Narayanganj.

8.4.3 Impact of Land Use Change on Agriculture



The study reveals that about 52% of the respondents were affirmative in observing the impact of land use change in agriculture whereas 36% of the respondents reported not to observe any impact. About 12% of the respondents could not answer the question (Figure 8.4).

Figure 8.4: Observations on Impacts of Land Use Change in Agriculture
Source: Field Study, 2019

The major impact was observed as a decrease in crop production, identified by 38.4% of the respondents as an impact of land use change followed by 22.7% and 14.8% of the respondent farmers identified a decrease in arable land and an increase in input costs as the major impact of changes in the land use.

A significant portion of 12.9% of the surveyed farmers reported about water pollution, 6.9% reported problem in agricultural management practice and 4.3% reported about water scarcity as serious impact created though land use change in the study area (Figure 8.5).

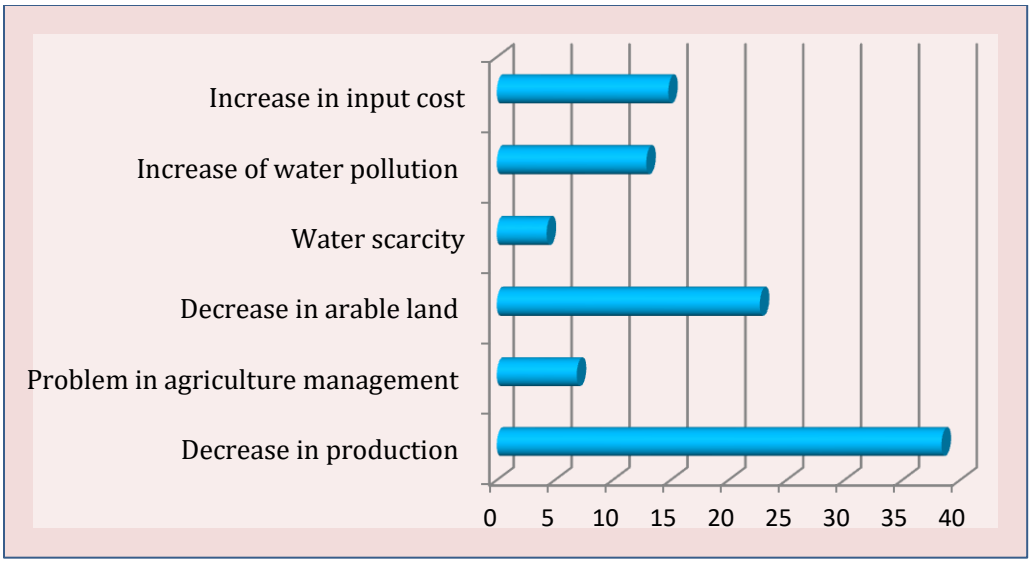


Figure 8.5: Major Impact of Land Use Change on Agriculture during Last Five Years
Source: Field Study, 2019

The study area different micro climatic zones are present which contain various land use patterns, settlements, function, density, characteristics of residential areas, and the communities. This diversity contributed to different magnitude of constrains that hinders the agricultural activities and production in the study area.

8.4.4 Impact of Land Use Change on the Environment

The DMDP region contains a large area where geophysical heterogeneity prevails with different exposure and susceptibility to hazards. Moreover, the population growth of the area and the diversity, under which people live, are high. Therefore, some parts of the city are more vulnerable to disasters compared to other parts. The survey identified an increased intensity of environmental constraints as observed by the respondents which might be resulted from the microclimatic variations due to land use change in the study area.

The majority of 93.3% of the respondent reported that the intensity of flooding has increased during the last five years period. A large portion of 51.8% of the respondents reported drought followed by 38.6% reported water logging as a major environmental concern. A

substantial portion of the respondents (34.7%) reported high temperature whereas 16.4% reported a change in biodiversity during the last five years period (Figure 8.6). Land use change alters biodiversity by reducing the natural habitat of different birds, butterflies and other indigenous species of different flora and fauna. These changes influence the decrease of population sizes and reduce genetic diversity within a species.

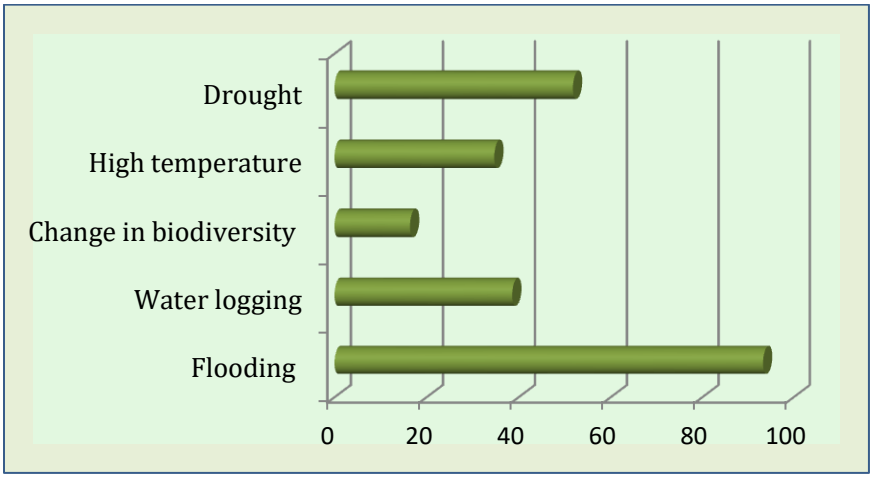


Figure 8.6: Impact of Land use Change on Environment during Last Five Years
Source: Field Study, 2019

Dhaka faces different environmental constrains, many of which may be aggravated by the impact of climate change and the land use patterns. Among the different environmental challenges and disasters impacts, flooding is one of the major concerns. Dhaka is surrounded by two major rivers, the Brahmaputra and Meghna and bounded by numbers of small rivers and canals which cause flooding particularly in the monsoon. Additionally, the internal drainage congestion also contributes to the flooding and water by hindering the natural flow of water. Besides, Dhaka is also affected by heat stress as an impact of depletion of tree coverage. All of these hazards in the DMDP region may be aggravated by the impacts of climate change. .

8.4.5 Impact of Land Use Change on Incidence of Disease

Land use change can impact the environment and human health negatively. Rapidly spreading urbanization causes changes in land use that may cause alteration in biological structure, soil characteristics, biogeochemical composition, surface water dynamics, air temperature, exposure to sunlight, and hydrological cycles. The change in microclimate through land use change can influence the geographic distribution of vectors and factors of different diseases. However, an increasing number of studies combining the ecology and human health demonstrated that land use change impacts the emergence of infectious diseases and change the existing distribution pattern of diseases.

Table 8.9: Intensity of Disease Infestation Observed during Last Two Years

(Multiple answers)

Disease	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Cold and Fever	191	92.3	94	91.3	85	85.0	370	98.5
Gastric and ulcer	52	25.1	22	21.4	5	4.8	79	19.8
Cardiac disease	17	8.2	20	19.4	25	23.8	62	15.5
Jaundice	16	7.7	3	2.9	1	0.9	20	5.0
Pneumonia	9	4.3	4	3.9	2	1.9	15	3.8
Diabetic	30	14.5	18	17.5	18	17.1	66	16.5
Eye and vision problem	1	0.5	7	6.8	1	0.9	9	2.3
Kidney Problem	5	2.4	1	0.9	2	1.9	8	2.0
High blood pressure	17	8.2	13	12.6	10	9.0	40	10.0
Diarrhea	21	10.1	4	3.9	3	2.9	28	7.0
Cholera	10	4.8	5	4.9	6	5.7	21	5.3
Asthma	18	8.7	7	6.8	8	7.6	33	8.3
Typhoid	4	1.9	5	4.9	6	5.7	15	3.8
Anemia	3	1.4	0	0.0	3	2.9	6	1.5
Arthritis	7	3.4	3	2.9	10	9.0	20	5.0
Ski disease	20	9.7	4	3.9	0	0.0	24	6.0
Tuberculosis	2	0.9	0	0.0	0	0.0	2	0.5
Total	207		103		105		415	

Source: Field Study, 2019

Table 8.9 depicted the prevalence of disease and other health risk factors in the DMDP region. The most common non-communicable disease was identified as cold and fever suffered by the majority of the respondents (98.5%) followed by gastric (19.8%), diabetic (16.5%), cardiac disease (15.5%), high blood pressure (10%) and asthma (8.3%). Among water-born diseases, the incidence of diarrhea (7%), cholera (5.3%), jaundice (5%) and typhoid (3.8%) were common in the study area. Besides these, the prevalence of asthma, arthritis, pneumonia, problem with the eye and kidneys, anemia, and skin diseases was found in the study area.

Literature reveals that in developing countries like Bangladesh, the link between urbanization, environmental condition, poor accessibility to health care services and degrading quality of life are prominent. In Dhaka metropolitan large-scale unplanned establishment of slams, the pressure of migration and the continuous depletion of green coverage have resulted in inadequate municipal services, increased impact of natural hazards and a deteriorating living environment that increased the vulnerability of public health in terms of infestation and intensity diseases.

8.5 Impact of Climate Change and Natural Disasters and Their Adaptation

Climate change indicates a delicate change in climatic conditions and associated emerging risks, that a region has not experienced before. Alterations in the timing of and magnitude of precipitation, rise in temperatures and fluctuations in climate variability affect natural resources and the ecosystem in many ways that impact livelihoods and the economy largely. For an effective reduction in the vulnerability to present natural hazards and climate change, coordination among different organizations (both government and non-government) is

essential involving a broad range of stakeholders. Adaptation to climate change does not mean reducing the impact caused by intensive and frequent extreme events. It is not just a part of disaster risk management as well. Climate change adaptation means continuing all life and livelihood activities in a sustainable manner through adjusting to the altered environment and situation.

In developing countries like Bangladesh, a lack of appropriate knowledge of climate change and its impact on agriculture is an obstacle to the sustainability and development of agriculture. The study has attempted to justify the perception of the respondent farmers on the understanding and impact of climate change and their adaptation strategies. Findings have been interpreted in the following sub-section.

8.5.1 Perception on Climate Change

Households were asked about their perceptions of climate change. Table 8.10 shows overall 74.5% of respondents reported noticing some changes in the climatic condition in the last ten years. Almost 24.3% of respondents reported that the climate remains the same whereas only 1.2% failed to give any answer regarding the issue.

Table 8.10: Respondents Knowledge on Climate Change

Perception	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Perceived changes	163	78.7	74	71.9	72	68.6	309	74.5
Perceived no change	42	20.3	27	26.2	32	30.5	101	24.3
Do not know	2	1.0	2	1.9	1	1.9	5	1.2
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

8.5.2 Impact of Climate Change Observed in the Study Area

The respondents indicated that changes have been observed in the climate condition during the recent decades (Figure 8.7). Asking about the annual average temperature, 93.9% of the respondents reported that the former temperature has increased and 81.3% observed that the starting time of the season has changed. Around 72.7% of the respondents reported the irregularities in timing and distribution of rainfall, which have a serious influence on their production system that affect the ability of households to produce crops throughout the year.

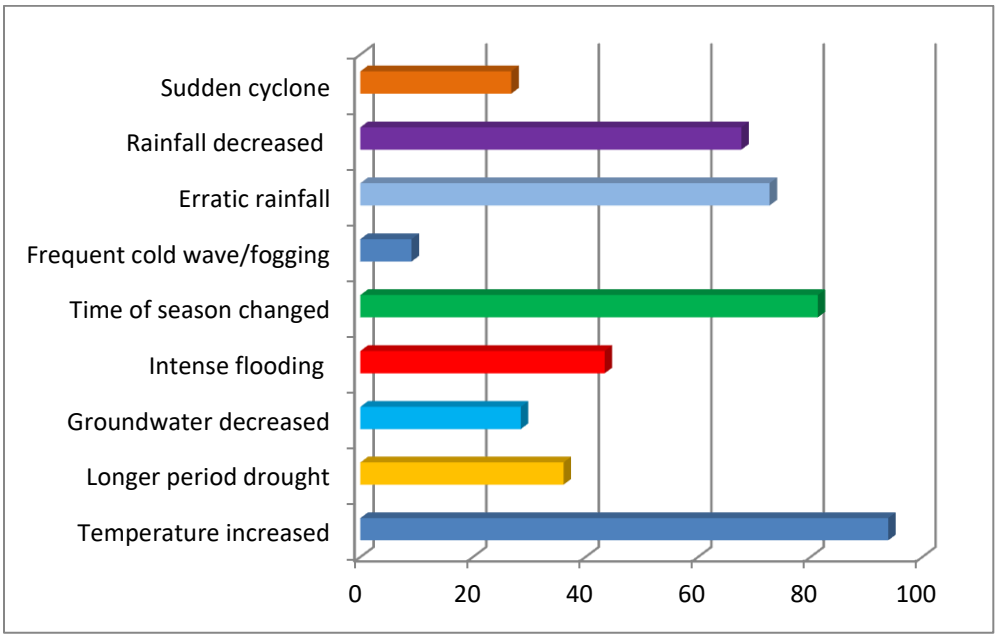


Figure 8.7: Changes Observed in the Area due to the Impact of Climate Change
Source: Field Study, 2019

Additionally around 67.7% of the respondents reported that the rainfall had decreased and 43.4% reported that the intensity of flooding had increased. In the case of droughts, a similar response was observed. More than 36% of the respondents observed the intensity of droughts have increased. About 28.5% of the respondents observed a decrease in the availability of groundwater. Other than rain and drought, sudden cyclone and frequent cold wave and fogging were also noticed by the respondent farmers (Figure 8.7).

The findings above indicate that respondent farmers in the study area perceive the knowledge of climate changes and variability at the local level that helps to guide them to adopt measures of climate change adaptation with a view to minimizing the adverse impacts.

8.5.3 Loses Caused by Climate Change Impact

The impact of climate change was observed to impose significant stress on the environmental resources that hampered the livelihood and economic activities of the respondent farmers in the study area which have been evidenced in the study.

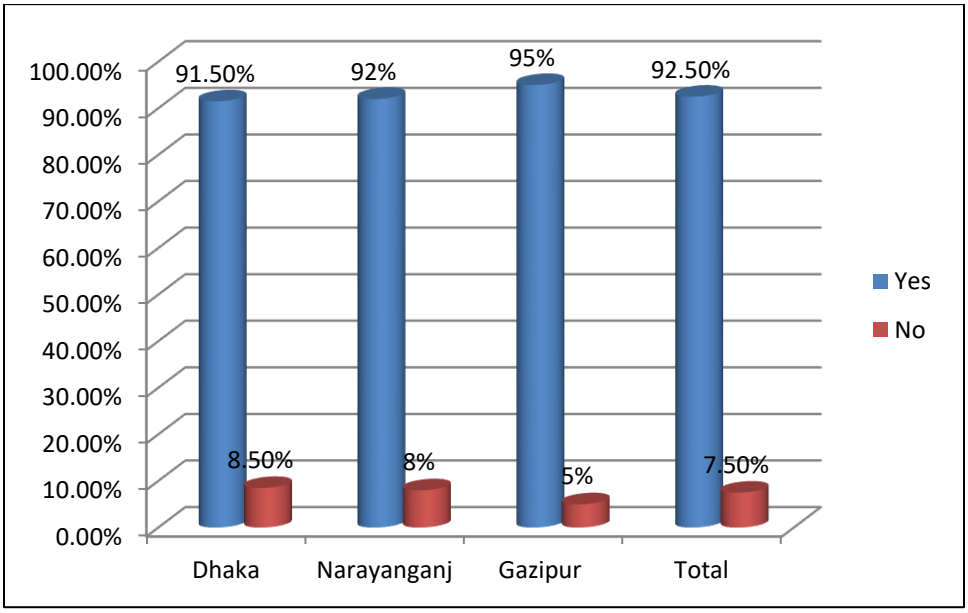


Figure 8.8: Losses Caused by Impact of Climate Change
Source: Field Study, 2019

Variability in rainfall pattern, combined with flooding, drought and extreme temperature are resulting in crop damage and production decrease which ultimately decreasing the household income and livelihood through preventing meaningful earning opportunities. When asked about losses caused by climate change, 92.5% of the respondents indicated that they have been affected by the climate change impact whereas the rest 7.5% denied it (Figure 8.8).

Among the 384 farmers (92.5%) who have reported being affected by the impact of climate change, 78.9% of them indicated direct impact through crop damage and 21.1% reported financial losses by different means (Table 8.11). Some variations have been observed among the study city corporations, about 97% of the respondents from Gazipur reported crop damage and only 3% reported financial losses whereas about 28.9% of the respondents from Dhaka City Corporation reported about the same.

Table 8.11: Types of Losses caused by Impact of Climate Change (n= 415)

Have knowledge	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Crop damages	135	71.1	72	75.8	96	96.9	303	78.9
Financial losses	55	28.9	23	22.2	3	3.1	81	21.1
Total	190	100.0	95	100.0	99	100.0	384	100.0

Source: Field Study, 2019

8.5.4 Source of Finance to Recover the Damages caused by Disasters

About 65.8% of the respondents reported taking necessary action to recover the damages caused by the disasters from their own savings (Table 8.12). In addition, the second majority of about 16.1% of the respondents reported taking loans from local money lenders to recover losses caused by disasters. Around 11.6% of the respondents reported taking loans from friends and relatives and only 6.5% reported institutional loans from different banks, NGOs and other microcredit organizations.

Table 8.12: Source of Finance to Recover the Damages caused by Disasters

Source	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Own savings	146	70.5	51	49.5	76	72.4	273	65.8
Loan from friends and relatives	14	6.8	17	16.5	17	16.2	48	11.6
Loan from banks, NGOs and other microcredit organizations	8	3.9	9	8.7	10	9.5	27	6.5
Loan from local money lenders	39	18.8	26	25.3	2	1.9	67	16.1
Total	207	100.0	103	100.0	105	100.0	415	100.0

Source: Field Study, 2019

8.5.5 Ability to Adapt with Natural Disasters Induced by Climate Change

The respondents were asked to describe their ability to adapt to the impact of natural disasters. The majority of 58.1% of the respondents identified no changes in their ability to adapt while 31.8% identified an increase in their ability to adapt to natural disasters. A significant portion of about 10.1% of the respondents stated that their ability to adapt to the impacts of natural disasters has decreased during the preceding ten years (Table 8.13).

Table 8.13: Changes in the Ability to Adapt with the Impact of Natural Disasters

Opinions	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Increased	95	45.9	31	30.1	6	5.7	132	31.8
Decreased	19	9.2	4	3.9	19	18.1	42	10.1
No change	93	44.9	68	66.0	80	76.2	241	58.1
Total	207	100.0	103	100.0	105	105.0	415	100.0

Source: Field Study, 2019

8.6 Exposure to Training

When asked about the training on climate adaptation only 13% of the respondents stated that they have received some training on climate change adaptation and crop production. The remaining (87%) did not receive any kind of training (Figure 8.9).

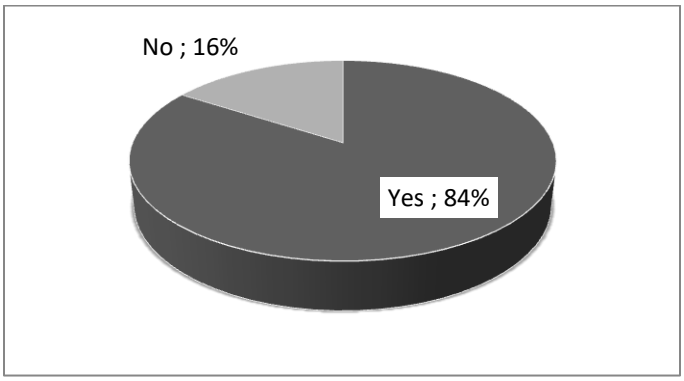


Figure 8.9: Training on Climate Change Adaptation
Source: Field Study, 2019

Among the respondents who received training, 45.5% reported to have received training on livestock rearing followed by 34.8% and 13.6% who received training on modern production technology and pest control respectively. Only 6.1% appeared to have received training on irrigation system water management which is a prime component of agricultural productivity (Table 8.14).

Table 8.14: Type of Training Received by the Respondents (n=415)

Type of training	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Modern production technology	11	35.5	6	35.3	6	33.3	23	34.8
Irrigation management	1	3.2	1	5.9	2	11.	4	6.1
Pest control	4	12.9	2	11.7	3	16.7	9	13.6
Livestock rearing	15	48.4	8	47.1	7	38.9	30	45.5
Total	31	100.0	17	100.0	18	100.0	66	100.0

Source: Field Study, 2019

8.7 Challenges and Opportunities of Urban Agriculture in the DMDP Region

The agro-based economy of Bangladesh contributes a significant percentage of the national GDP. Agriculture also helps to eradicate poverty, improve food security and safety net and facilitate the creation of employment opportunities. The sustainability of urban agriculture in the DMDP region is facing threats from the continuous process of urbanization, industrial development and degradation of land and water resources. The main obstacles to the development of UA in the DMDP region are the shrinking availability of cultivation land, lack of technology extension, profitability and environmental threats. In this section, an effort has been provided to explore and describe the scope and challenges of urban agriculture in the study area from the farmers' point of view.

8.7.1 Constrains Faced in Agricultural Practice

Table 8.15 represents constraints identified by the respondents that hamper agricultural practices in the study area. The respondent farmers reported some constraints faced in with the production and marketing of agricultural products. The lack of adequate and suitable irrigation facilities were identified by 37.8% of the respondents as the most common constraint, followed by financial problems (24.1%), and lack of cultivable land (18.6%). The spread of cities requires a huge amount of agricultural land all over the world in the process of urbanization. For example, China lost nearly one million hectares of agricultural land per year between 1987 and 1992 for urban development and the expansion of roads and infrastructures. In the US, urban sprawl seizes nearly 400,000 hectares of agricultural land each year (The Financial Express, 2021).

About 17.6% of respondents reported intense attacks of insects and poultry diseases and a significant portion of 12.5% of the surveyed farmers identified the high cost of agricultural inputs such as seeds, fertilizer, and pesticides as constraining. Around 11.1% of the respondents identified a lack of proper training in modern agricultural technology as a serious constraint. Moreover, the farmers faced problems with post-harvest management (7.2%), access to credit (7.0%), and improper price of products (4.6%).

The most important constraint with respect to external factors is the adverse impacts of climate and weather identified by 28% of the respondents in total comprised of erratic rainfall (15.4%), increased temperature (13.5%) and drought (10.6%). Mondal (2010) also reported that crop agriculture in Bangladesh has become seriously vulnerable to climate change hazards, particularly floods, drought, and salinity.

Table 8.15: Problems Faced in Agriculture (Multiple answers)

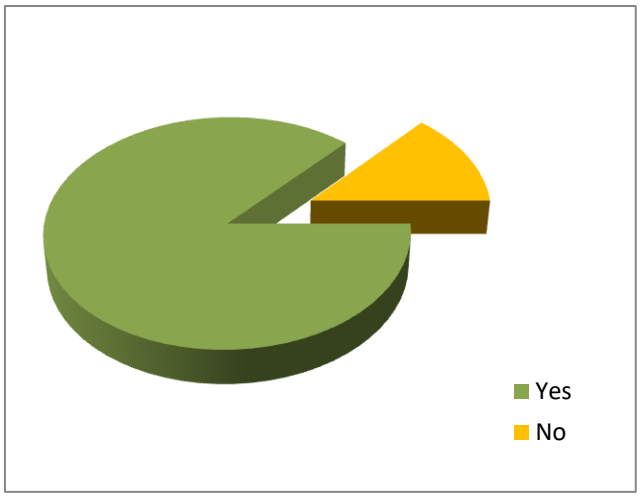
Problems	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Erratic rainfall	37	17.9	15	14.6	12	11.4	64	15.4
Drought	21	10.1	13	12.6	10	9.5	44	10.6
Temperature rise	14	6.8	12	11.7	30	28.6	56	13.5
Lack of cultivable land	43	20.8	22	21.4	12	11.4	77	18.6
High cost of inputs	20	9.7	12	11.7	20	19.0	52	12.5
Less access to market	43	20.8	10	9.7	12	11.4	65	15.7
Financial problem	24	11.6	16	15.5	60	57.1	100	24.1
Attack of pest and poultry disease	18	8.7	18	17.5	37	35.2	73	17.6
Irrigation problem	19	9.2	68	66.0	74	70.5	161	38.7
Problem in post-harvest management	12	5.8	8	7.8	10	9.5	30	7.2
Low price of products	11	5.3	5	4.9	3	2.9	19	4.6
Lack of proper training	20	9.7	12	11.7	14	13.3	46	11.1
Limited access to credit	15	7.2	3	2.9	11	10.4	29	7.0
Total	207		103		105		415	

Source: Field Study, 2019

The study revealed that being an economically viable sector, urban agriculture is obstructed by a variety of constraints. These constraints hinder urban to become more competitive and efficient and discourage the new generation of urban dwellers to participate.

In the study area, urban cultivators reported facing many similar challenges when starting or expanding an urban farm which include lack of land security, financial limitation, limited access to credit and marketing issues. Besides these, the constraint of land acquisition due to the complicated tenure system has also been identified as a major challenge for urban agriculture. This makes it difficult for urban farmers to expand their businesses or start up new initiatives.

8.7.2 Retaining Urban Agriculture



The respondents were asked about their opinion on retaining agricultural activity in the urban area. Majority of 86.7% of the respondents were affirmative on retaining the urban agriculture in the study area whereas 13.3% respondents replied negatively (Figure 8.10).

Figure 8.10: Opinion on Retaining Agriculture in the Urban Area
Source: Field Study, 2019

Various aspects of retaining urban agriculture in the study area have been explored by the respondent farmers which have been represented in Figure 8.11. The majority of the respondents (74.7%) identified an easy transport facility that reduces the cost of transportation as the primary reason for continuing the agricultural activity in the study area. The urban agricultural farms are located in close proximity to the urban centers which reduces the mileage required to transport food to consumers. About 26.1% of the respondent identified the significance of urban agriculture from the standpoint of public health. Providing fresh and healthy food is an important contribution of urban agriculture that potentially influences public health directly and indirectly. Producing food locally is positively correlated with the consumption of fresh fruits and vegetables that help to meet public health nutrition guidelines at a household level.

The reason behind retaining the agricultural activities is the potential of UA to increase the social interaction mentioned by 22.5% of the respondents. The study indicates that UA can

help build social and human capital by establishing intra- and inter-community networks. It can play a facilitating role in creating social linkages through sharing knowledge and information on different modern production technology and advanced crop varieties. This can be considered one of the most significant social benefits of UA which can be considered an important cause of retaining UA in the DMDP region.

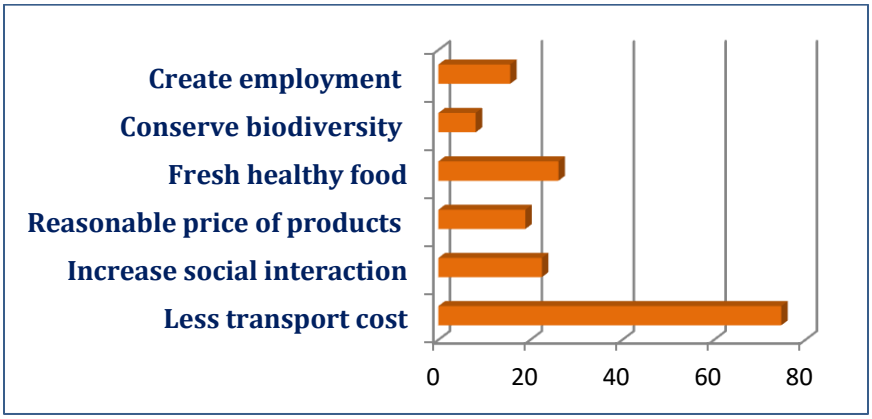


Figure 8.11: Reasons for Retaining Agriculture in the Urban Area
Source: Field Study, 2019

Getting a reasonable price for produces is another important reason for continuing the agricultural activity in the study area was mentioned by 18.9% of the respondents. It was reported that products from the urban farms face fewer barriers to entry directly in the urban markets compared to rural that ensures getting a reasonable price of the produces which contributes notably to the household income of the respondents in the study area.

Unemployment is potentially a serious concern because it impacts economic welfare, production, human capital, social inclusion and stability. A significant portion of 15.6% of the respondents reported the potential of UA to create employment opportunities which have been considered a unique feature for retaining agriculture in the study area (Figure 8.11). It is

evident from different research that high production yields and surplus create an opportunity to generate income and employment.

The potential of UA supporting biodiversity was mentioned by 8.1% of the respondents (Figure 8.11). Natural biodiversity can be preserved both within or nearby UA sites due to a landscape arbitrated 'spillover' of energy, resources, and organisms across habitats. This can be an important means of conserving wildlife populations in human-developed landscapes. Urban agriculture can provide a cluster of other benefits. It helps add greens to the environment which can also give city dwellers a better aspiration of aesthetic senses. .

8.7.3 Challenges of Urban Agriculture

In the survey, about 13.3% of respondents reported that they are unwrested to continue the agricultural practice in the study area. Different issues have been identified by the respondents as major reasons for giving up agricultural practices which have been considered the major challenges to carrying on agricultural practice in the study area. Table 8.16 illustrates the challenges identified by the respondents in the study area. The majority of 38.2% of the respondents reported the availability of land as a major cause of abandoning agricultural practices in the study area. The price of farmland has increased many folds during the last few decades as a result of rapid urbanization. In the study area agricultural land is either converted built-up areas or left fallow in the anticipation of a price hike. Hence, it became very difficult to buy lands in the urban areas of DMDP to undertake farming as a profitable venture.

The second major cause was low economic return identified as low economic return from agriculture identified by 27.3% of the respondents (Table 8.16). The expenditure on the

consumption of the surveyed farmers exceeds their income by a considerable margin. The high price of the land forces them to sell their agricultural land as the return from agricultural production is much less compared to the return from selling lands. This may be attributed to the exit from agriculture in the study area.

Table 8.16: Major Challenges of Urban Agriculture in the Study Area (n=415)

Reasons	Study Area						Total	
	Dhaka		Narayanganj		Gazipur			
	N	%	N	%	N	%	N	%
Availability of land	11	39.3	5	41.7	5	33.3	21	38.2
Water scarcity	1	3.6	0	0.0	1	6.7	2	3.6
Water and soil pollution	2	7.1	1	8.3	3	20.0	6	10.9
Influence of real estate & industries	5	17.9	2	16.7	4	26.7	11	20.0
Low economic returns	9	32.1	4	33.3	2	12.3	15	27.3
Total	28	100.0	12	100.0	15	100.0	55	100.0

Source: Field Study, 2019

Third major cause was identified as the influence of real estate & industries. About 20% of the respondents reported about the issue as a major factor of giving up agriculture in the study area.

The problems associated to real estate and industry development have influence on the availability of land for agriculture which can be considered as a hinder for urban agriculture reported by 20.0% of the respondents. Large use of water for crop production is another major obstacle for urban agriculture and a substantial portion of 10.9% respondents identified the issue whereas 3.6% of the respondents reported about water scarcity as major cause of abandoning agriculture in the study area (Table 8.16).

8.8 Suggestions from the Respondents

On the basis of experience, farmers had pointed out some suggestions which are represented in Figure 8.12. A good number of suggestions have been given by the respondents to develop the present conditions of the UA in the study area, particularly in light of sustainable urban development. An overwhelming majority of the respondents (73.8%) have given their opinion on training programmes on modern cultivation techniques, particularly those which are suitable for improving urban farming practices. Training will empower more people to improve their communities through urban farming by giving them the knowledge and experience needed to grow their crops, conserve natural resources, and engage the community in a positive way. The second majority of 44.6% of the respondents suggested developing market links for selling their products at appropriate prices. Easy access to market information increases farmers' ability to bargain and negotiate for higher prices. About 41.4% of the respondents mentioned the cultivation of high-valued crops. Agriculture in the study area has been observed traditionally rice-based, involving mainly small to marginal farmers with holdings of less than 1 hectare. As such, farmers cannot look to expansion or intensification of traditional crops to increase meager incomes. To improve farmers' incomes and raise their standard of living, high–value crops and varieties need to be introduced in the study area.

About 33% of the respondents suggested increasing the credit accessibility of the farmers which will help to purchase necessary quality inputs for agriculture. The sustainability of any agricultural revolution depends on access of farmers to advanced and quality agricultural supplies including seeds, fertilizers, pesticide to machinery, irrigation and knowledge and

training on production technology. There are considered essential elements of successful production of crop and certainly, farm productivity and profitability.

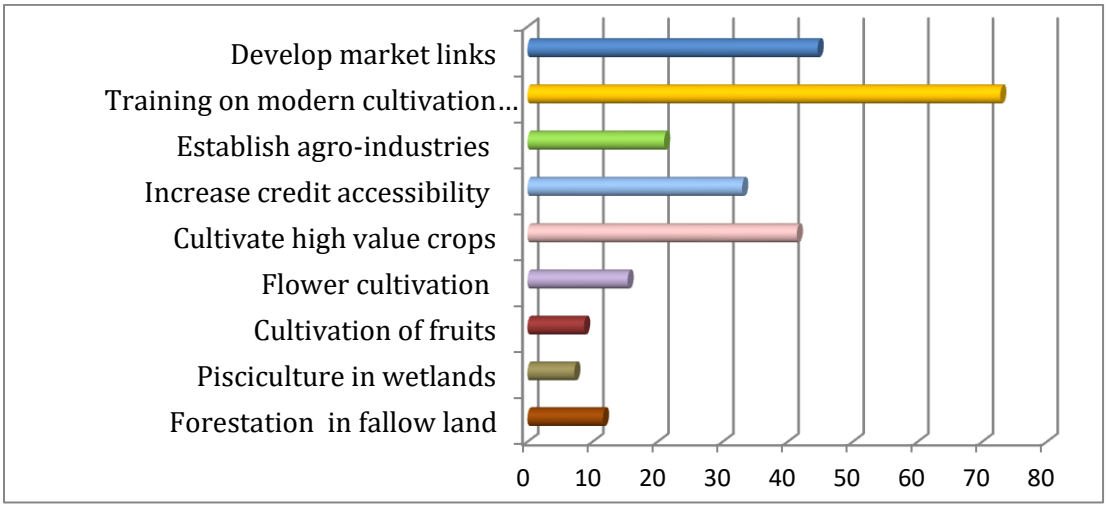


Figure 8.12: Suggestions from the Respondents on Development of UA
Source: Field Study, 2019

Next 21% of the respondents emphasized on establishing agro-industries in the study area (Figure 8.12). Agro-industries facilitate to establish of links between enterprises and market chains that help commercialization of the agricultural sector and accelerate growth, sustainability and inclusiveness of a particular agricultural practice. Other suggestions included floriculture (15.4%), forestation in fallow lands (11.6%), pisciculture in wetlands (7.2%) and fruit cultivation (8.7%).

Urban agriculture is inherently centered on communities located in close proximity to a city which is driven by the needs and demands of the urban dwellers. Growing food is a collective effort. As urban agriculture develop a stronger linkage within communities it likely enhance the sustainability of UA by increasing community interaction in daily life.

8.9 Determinants Influencing the Sustainability of Urban Agriculture

"Pearson's Product-Moment Correlation Co-efficient 'r' was performed to analyze the factors affecting the sustainability of urban agricultural in the DMDP region measured by household income, perception of climate change of the respondents, incidence of diseases and waste management practice. A total of eight characteristics of the farmers were selected as independent variables to perform the correlation analysis to observe the influence of these variables with the issue of sustainability urban agriculture in the study area. The independent variables were age, level of education, household size, farm size, land ownership status, ownership of livestock assets, access to finance and training exposure of the respondent farmers in the study area.

For this study, temperature increasing and rainfall decreasing are considered as the two measures of perception of climate change. To identify the correlation of farmers' perception of climate change, the dependent variable as a binary variable took the value '1' if the respondent farmers can perceive that temperature is increasing or rainfall is decreasing during the last ten years and the value '0' otherwise.

The results of the correlation analysis between each of the selected characteristics of the respondent farmer with their household income, perception on climate change, incidence of disease and agricultural waste management are shown in Table 8.17. As shown in the table, older farmers who are more than 51 years are less productive which has been reflected in the household incomes. It was interesting to explore farmers of which age group are able to observe the climate change which is important to adopt adaptation strategies for ensuring sustainability of UA. Older respondent farmers are more likely to notice the change in annual variation in climatic conditions and adopt coping mechanisms to minimize the impact of

climate change. Households with larger farms and farmers of more years of schooling were observed more productive.

Table 8.17: Results of Regression Analysis of the Socio-demographic and Cultivation Factors influencing Urban Agriculture

Variable (Y)	Variable (X)				Tabulated value significant at	
	Correlation of coefficient (r) with household income	Correlation of coefficient (r) with perception on climate change	Correlation of coefficient (r) with incidence of disease	Correlation of coefficient (r) with agricultural waste management	0.05	0.01
Age	0.098	0.187**	-0.096	0.138*	0.113	0.148
Level of education	0.201**	0.092	0.198**	0.127*		
Household size	-0.221	0.101	0.087	0.97**		
Farm size	0.207**	0.124*	-0.099*	0.121*		
Land ownership	0.129*	0.122*	0.006	0.101		
Livestock assets	0.217**	0.138*	0.284**	0.271**		
Access to finance	0.315**	0.378**	0.128*	0.129*		
Training exposure	0.357**	0.384**	0.397**	0.218*		

**Significant at 0.05 level of probability*
***Significant at 0.01 level of probability*
Source: Field Study, 2019

The coefficient on years of schooling and large farm size indicates that level of education helps to increase household income, perception on climate change that leads adaptation mechanisms and knowledge on waste management practice. The estimated coefficients indicate that the degree of the effects of access to credit and training are greater than the influence of the socio-demographic variables. Accessibility to agricultural credit and training has a positive effect on income, perception on climate change impact and adaptation and waste management practice which is significant. This is probably farmer groups come in contact with different people that helps to develop their knowledge on different livelihood

options and enrich their awareness on modern cultivation system. Similarly, active involvement in different training programmes has positive influence on better knowledge on climate change adaptation and waste management practice.

Findings of the study reveal that level of education, livestock asset of the respondent households, access to finance and training exposure have positive significant relationship with the sustainability concerns of the urban agriculture in the DMDP region. Households having land and livestock assets are more likely to perceive knowledge on different livelihood options, extreme weather events and waste management practices probably because adequate information can be gained though mixing up with more peoples and visiting different organizations which is necessary for successful management of farm activities. Surprisingly, education have strong significant effect in influencing the perception of climate change.

8.10 Conclusion

The descriptive statistical analyses explored some significant features of urban agriculture in the DMDP region. The urban agricultural practices in the study area include operating individual to intensive semi commercial farms for cultivating crops, raising cattle and chickens, producing milk and eggs. Likewise, the trend of flower cultivation, homestead gardening and orchards management have been found increasing in the DMDP area. Hence, it can be said that crop diversification has been taking place in the study area through replacing traditional cereals with high-valued cash crops which is a positive for the sustainability of UA. Crop diversification is considered an effective strategy to utilize agricultural land and water resources, and it makes agriculture more profitable and commercially viable (Joshi et al., 2007; Kumari et al., 2010; Singh, 2001). It offers

comparatively high monetary returns from crops production by maximizing profit and minimizing yield risk imposed by climatic variability. It also offers higher labor productivity, and optimizes the use of natural resources (Ashfaq et al., 2008; Mehta, 2009; Mukherjee, 2012).

Among various sustainability challenges that UA in the DMDP faces are the issue of critical knowledge and information gaps. In some cases, a disorganized and obsolete knowledge base about sustainable agriculture in terms of modern cultivation practices can impact negatively on the sustainability of UA in the DMDP region.

The study indicates that high cropping intensity prevails in the study area. The increase in the multiple crop area indicates extended options for practicing crop diversification in the agricultural land.

Urban water availability is a major consideration for the sustainability of UA. The surface and waste water reuse allows more detailed attention as this is significantly important for urban agricultural practice. Interview with the respondent farmers reveals that the presence of pollutants in surface water in some areas of Narayanganj and Gazipur districts represents a serious problem for urban farmers. There are no standards, institutional arrangements for local water treatment, and monitoring systems to ensure the quality of water applied to the crop fields in the study area.

The study explored that the main objectives of the urban farmers to perform urban agriculture in the study area are to produce food for household consumption and income generation. Apart from food security and livelihood option, urban agriculture works as an important land use tool for health and natural resource management in a sustainable way. It was observed

that agricultural waste is transformed into organic manures (e.g. compost) which are used as manure in urban agriculture. As appropriate eco-friendly waste management practice helps to minimize pollution. Therefore, it can be said that urban agriculture in the DMDP area is more or less sustainable from the management approach point of view.

Access to institutional agricultural credit by small and marginal urban farmers is found still poor in the study area. Results reveal that only 2.8% of the respondents have taken credit from the formal sector and 11.4% of marginal and landless farmers who are basically sharecropper in the study area demanded for agricultural credit. However, cooperatives are not available in the study area. Interestingly, the vast majority of loans are granted by MFIs (Micro Finance Institutes) for family consumption (Kuddus & Kropp, 2020). To reduce the burden of accessing credit, farmers could be subsidized by low-interest loans from MFIs or banks.

Respondent farmers reported that they faced marketing problem of their products due to a lack of necessary initiative to establish proper market chain. Particularly, they require more information about the requirements of commodities, timing of products demands, quantities grades and standards of products, offered market prices, means of delivery and terms of payment. This information would be helpful for growers in the study area to make decisions regarding production activities. Coiled with insufficient market access low level of literacy restricts most of the farmers to understand the dynamics of agricultural marketing.

In order to meet the demand of the urban population, special agricultural production areas have been developed in and around the study area. Here, the production system is intensive and the technology used is much more advanced than that in the rural areas. The study

reveals that rice is the dominant agricultural crop in the study area. Horticulture and more specifically vegetable cultivation, has become a major component of the farming system in the urban area and most of the respondent farmers reported cultivating vegetables in the DMDP region. However, most of the farmers reported that agricultural land has been converted into industrial and housing plots, and the remaining area is steadily declining. It is difficult to use the remaining agricultural land for any other purpose due to its specific topographical conditions and inundated by floods thus making the development process difficult and very expensive. Vegetables are mainly cultivated during the winter season when the water move away and the land dries out. Owners of large farmlands, who are generally well-to-do, usually prefer to invest in the non-farming sectors.

The study explored an empirical scenario of perception farmers on climate change in the DMDP area. Results found that farmers of the study area especially those who are older, with assets and education, access to credit and training exposure; can perceive that the climate is changing. Government should developed policies to improve urban farmers' access to extension services, credit and information, which would ultimately improve the financial ability of the farmers, increase knowledge on advanced production system and perception of climate change and thereby improve their adaptability. Improving opportunities for generating household income could help adopting advanced coping strategy to withstand negative shocks.

The factors analysis regarding the sustainability of agriculture using regression analysis was performed. A positive effect of farming experience on sustainability of UA was found in the study. It was found that creditaccessibility have a positive and statistically significant impact on sustainability of UA. This result is consistent with the empirical investigations of other

studies. Credit access allows farmers to use quality seeds, fertilizer, pesticides and other farm inputs which help to enhance the productivity of the urban agricultural lands. Empirical evidence reveals that a 10% increase in agricultural credit helps to increase productivity by a 1.2 ton per hectare increase (Wicaksono, 2014). It suggests that the government should promote agricultural loans and provide subsidize for applying modern technology in UA.

The urban agricultural markets have been found to develop in response to the growing demands of the city dwellers. The demand for fruits and vegetables is increasing, which has led to the development of small commercial farms and orchards in the periphery of the DMDP region.

Chapter 9

FINDINGS FROM KEY INFORMANT INTERVIEWS (KIIs) AND CASE STUDIES

9.1 Introduction

Findings of the key informant interviews and case studies have been synthesized in this chapter. The Chapter has been organized thematically highlighting the opinions of key informants noted against the questions they were asked. An overall summary has been provided based on the highlighted discussion. The key informant interviews were undertaken to collect qualitative data carefully from selected key informants to develop a holistic approach to analyzing the core issue of the study. Attempts have been made to ensure that the selected interviewees are broadly representative at the national level.

Based on the review of literature and consultation with Ph.D research supervisor, a guideline of Key Informant Interviews (KII) was developed. Interviews were conducted with several national urban planners, policymakers, subject specialists, environmental experts, academics and personnel from concerned government institutes and global experts as well.

Findings from two case studies have also been incorporated into this Chapter. The two case studies have been conducted from two different perspectives of urban agriculture; the first one from environmental sustainability and the second one from the food security perspective of UA.

9.2 Findings from Key Informant Interviews

A total of 11 (eleven) key informant interviews have been conducted. Key informant interviews were recorded and transcribed afterward. Findings that represented the personal

opinion based on experiences of the interviewers were identified and interpreted into the report.

Question-1: What is your opinion on the allocation of land for agricultural activities in urban areas?

Key Informants were asked their opinion on the allocation of lands for agriculture in the urban areas, particularly in the DMDP region. An overwhelming majority of respondents, 72.7% opined positively on allocating lands for agricultural activities in the urban areas whereas 27.3% of them expressed a negative opinion on the issue (Figure 9.1).

Throughout history, the integration of agricultural practice in the urban land use has become a critical task that influences the sustainability of urban landscape. Though the dimension of UA has changed over time is response to the food supply demand of the cities, the interaction of urban agriculture with natural resources and urban ecology remains the same today as it was thousands of years ago (Mougeot, 2000).

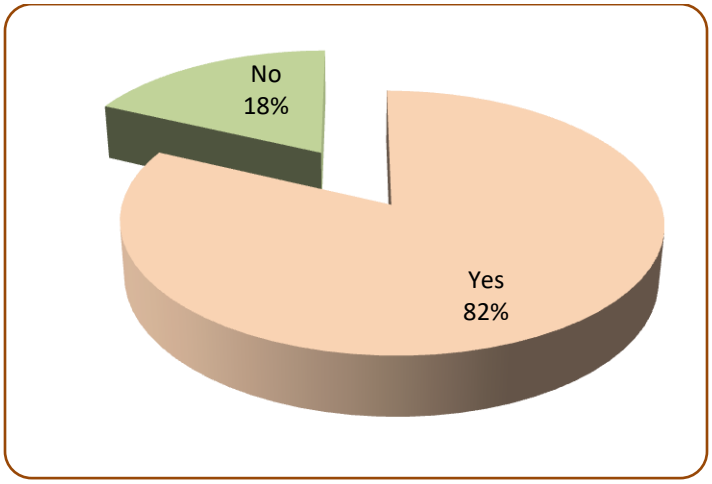


Figure 9.1: Opinion on Allocation of Land for agriculture in Urban Area
Source: KII, 2020

According to the key informant interview, a major portion of the policymakers, urban planners, academics and concerned personnel are affirmative about keeping agriculture in the

urban areas as a land use component to ensure the sustainability of the urban environment. According to their opinion, urban agriculture has the potential to integrate multiple functions in urban areas with high population density by offering alternative land use options. In balance, urban agriculture can be considered an important element for improving urban public health. UA provides healthy and fresh foods, engages local residents in work as well as offers recreational opportunities which contribute to individual and public well- by improving health. Besides food production, UA also offers various environmental and socio-economic benefits.

Question-2: What type of urban agriculture can be practiced in the urban area?

According to the key informants, certain production systems might not be appropriate for urban areas. The agricultural systems that require a large land area, and depend largely on synthetic inputs that may create negative impacts on the surrounding environment are not suitable for UA. The agricultural practice needs to be more diversified (offers fresh and high-value crop and non-crop products) to ensure its feasibility and sustainability in a particular urban setting. The systems that provide food to nearby communities have the potential to offer many other related benefits to growers, consumers, and entrepreneurs. Urban agriculture needs to be evaluated on the basis of a multifunctionality framework that focuses on different environmental benefits besides food production.

Community supported agriculture is a potential ingredient of urban agricultural practices throughout the world. About 63.3% of the key informants opined about establishing CSA in the DMDP region (Table 9.1). Community Supported Agriculture (CSA) is a food production and distribution system that directly links urban farms to the consumers. CSA encompasses a group of individuals of a community to operate farm activities and eventually the farm,

legally or operationally, becomes the farm of that group or community. The producers and customers are the inhabitants of a nearby area who collectively support and share the risks of food production. Briefly, people will become a part of the CSA programme by purchasing a certain share of farm products in advance (they) and will receive a particular portion harvested according to their share. The concept was first introduced in Japan in the 1960s by a group of women. In several European countries, farmers and consumers got concerned about the industrialization of their products and created the model of CSA by the early 1970s that we know today. In the U.S.A, the first CSA was established in Massachusetts in 1984. Currently, over 2,500 CSAs are operating in the United States among which around 100 CSAs are located in North Carolina, the number is increasing as an outcome of the growing interests of both consumers and farmers (Jing Li, 2015).

Table 9.1: Opinion on Suitable Types of UA Practices (Multiple Answers)

Types	Responses	
	N	%
Roof Top Gardening	6	54.5
Vertical Farming	3	27.3
Garden City	4	36.4
Edible Landscape	5	45.5
Urban Community Farming/Community Supported Agriculture	7	63.3
Green Belt Agriculture	8	72.7
Micro Livestock	3	27.3
Commercial Urban Farms	5	45.5
Community Orchards	6	54.5
Urban Forestry	5	45.5
Agro-tourism Farms	6	54.5
Total	11	

Source: KII, 2020

About 54.5% of the key informants opined about establishing urban community orchards in the DMDP region. A community orchard is a pool of fruit trees in a public space (like a park,

schoolyard, etc.), planted with the aim of providing the community with fresh, locally-grown organic fruits. Urban community orchards can help encourage local inhabitants to live more sustainably by growing their own food and fresh fruits for nutritional purposes which also helps supplement additional earnings to the low-income community. Eventually, it can help to animate green spaces to the urban landscape. Increasing the tree coverage can contribute to enhancing environmental sustainability directly through reducing carbon dioxide emissions, lowering stormwater runoff, increasing shade and reducing the urban heat island effect and providing shelter to different natural species important for the ecology.

Recently a noticeable trend of establishing commercial agro-tourism enterprises in urban and peri-urban areas can be observed getting popular worldwide which can be considered as an approach to promote integrated urban development. About 54.5% of the key informants mentioned agro-tourism farms as a solution to keep agriculture on the urban fringe. Agro-tourism is a manifestation of multifunctional agriculture. It combines tourism and agriculture to encourage tourists to enjoy and join agricultural life in urban areas and to educate them about agriculture-related knowledge and experience. The scope of establishing agro-tourism enterprises in the DMDP region is huge opined by the key informants.

Among several functions of modern multifunctional agriculture, agri-tourism is seen as a leading strategy since it can create economic growth while promoting socio-economic development (e.g. local income, services and infrastructure) and social cohesion of the destination (Moscardo et al., 2013). Specifically, agro-tourism is considered to integrate local and regional economies in an inextricable way that generates local income and broader development benefits such as job creation, maintenance of local facilities, and preservation of local cultural and environmental resources on a joint, synergistic and participatory basis

(Telfer, 2002; Saarinen, 2003; Keyim, 2017). For example, the earliest agri-tourism in China was in the periurban of Beijing, with organic fruits and vegetable picking, farm-to-table food, and accommodations as the main activities, and it has a history of more than 40 years (Yang, Hao, Liu & Cai, 2016; Guo et al., 2008).

Rooftop gardening is a private eco-friendly venture that provides a chance to be close to nature and to harvest fruits and vegetables. About 54.5% of the key informants reported that rooftop gardening can play important vital role in urban agricultural development in the present context of shrinking agricultural land in urban areas particularly in the DMDP region (Table 9.1). RTA is reliable small-scale enterprise that can generate extra household income (Yang et al., 2010).

According to the official record of the Agriculture Information Service under the Ministry of Agriculture, there are about 450,000 roofs in the Dhaka Metropolitan area, covering around 4,500 hectares of area, equal to or even larger than an upazila (sub-district).In this case, urban rooftop gardens can be an urban Nature-based Solution (NBS) for the DMDP region to tackle climate change. Rooftop gardening can enhance food security and nutrition in urban and peri-urban areas by meeting part of Dhaka city's growing population's demand for fruits and vegetables. Most importantly, it provides environmental benefits to urban infrastructure by acting as insulators to cool down the temperature of buildings by absorbing heat and minimizing the need for air-conditioning. It also improves air quality by producing oxygen and acts as a carbon sink to adapt to and mitigate climate change impacts.

Edible landscape can be included as a component of sustainable urban landscape design for the DMDP region opined by 45.5% of the key informants (Table 9.1). It can be considered an

alternative to conventional landscapes for producing vegetables, fruits, and other medicinal plants. Edible landscaping is designing a landscape with food plants. It serves both the consumption and aesthetic purposes of a particular urban community except for commercial marketing. The edible landscape includes various types of gardens on different scales. In designing the system the environmental and ecological benefits are prioritized equally as production functions are considered.

Edibles can enhance the functionality of gardens or parks by incorporating unique ornamental features with additional health, aesthetic, and economic benefits (Creasy, 2010). It can promote a sustainable urban agricultural practice through increasing water and energy use efficiency, providing wildlife habitat and reducing chemicals uses in the landscape.

According to another 45.5% of the key informants, commercial urban agriculture (CUA) is an alternative type of UA for the DMDP region that combines economic growth and social development effectively. As agricultural lands become increasingly fragmented and marginalized, there is a practical need to explore commercial urban farming on a larger scale in the DMDP region. According to the literature, CUA can enhance food production and sustainability of a particular urban agricultural by increasing economic returns through involving private sector in production and marketing of agricultural products. CUA has the potential to increase the food security of a particular community (Brown 2010). Urban agriculture in Cuba established a potential and success example of large scale commercial urban agriculture in the 1990s when the shortage of petroleum-based fertilizers and pesticides became a big crisis due to the collapse of the Soviet Union (Ellinger, 2010).

The concept of urban forestry (UF) can be a promising approach for urban agriculture in the DMDP region opined by about 45.5% of the key informants that improves landscape planning and management activities. According to the key informants, urban forestry is a discipline that integrates knowledge and technology of afforestation and applies them to skillfully manage trees and forest resources in an artistic way in and around cities. The practice has the potential to add economic, psychological, social, aesthetic, and environmental benefits to the urban community.

In the literature, forestry in urban areas has been defined as urban forestry. It includes the establishment and management of commercially and environmentally important tree species in parks and streets, agricultural fields and fallow lands of the city. UF is considered a strategic, integrative, interdisciplinary, and participatory approach of UA (Konijnendijk & Randrup, 2004). The UF concept fabricated a history of more than 35 years rooted in North America and moved recently to Europe (Konijnendijk & Randrup, 2004). According to a former Chief Town Planner of DCC, an ideal city needs 20% tree coverage whereas Dhaka city has only eight percent. This indicates that the DMDP region has huge potential to establish UF as an approach to promoting and developing UA.

About 36.4% of the respondents argued that the principles of ‘Garden city' can be utilized in the DMDP region for planning and management of urban agriculture. The garden city is a concept and method of urban land use planning where urban communities are bounded by "greenbelts" and contains scientifically allocated areas for residences, commercial activities, and agriculture to maintain a sound ecological balance. The Garden city promotes an urban agricultural system that allows urban dwellers to grow their own food locally through

cooperative management of common agricultural land, community gardens, roadsides and and in public parks (RAUF, 2018).

The garden city concept and movement was first initiated by a British thinker Ebenezer Howard in the late 19th century. Garden cities were first established in Europe and then moved to cities of the Global South, such as Cairo, Buenos Aires in Argentina and Santiago in Chile and so on (ADB, 2019).

Vertical farming can be a potential method for retaining urban agriculture in the DMDP area opined by about 27.3% of the key informants. This cultivation method offers a whole range of advantages. Scientific records reveal that 4 hectares (10 acres) worth of produce can be grown in a single vertical farm with less than half a hectare of land area. It consumes very less spatial spaces and at the same time reserve space for biodiversity by relieving pressure on natural fallow land that otherwise would be turned into farmland, thereby aiding wildlife conservation (Bayer, 2021). Vertical Farming also helps meet the increasing demand for locally-grown fresh foods. Local production eliminates long-distance transportation from producer to consumer, while also reducing food loss along the journey and food waste.

A. F. M. Jamal Uddin, a professor of the Department of Horticulture of the Sher-e-Bangla Agriculture University, has pointed out the huge scope of adopting the vertical farming method in UA for growing crops in the DMDP region as land availability is a big challenge there. He mentioned that the application of this method in Bangladesh is somewhat difficult at the commercial level as the establishment cost is high. He reported that the Bangladesh government is trying to promote this farming method widely, especially in the areas where

floods are a major constraint. In 2013, the government initiated a project costing $1.6 million to promote this method in eight districts of Bangladesh.

Urban agriculture incorporates a broad range of activities. The nature of these activities varies according to the urban environment in which they are practiced. Each community, therefore, will develop its own understanding of urban agriculture.

Question-3: How urban agriculture can contribute to maintaining the environmental balance of a city?

Substantial green spaces in the city illustrate a good planning and management through offering a healthy environment for its dwellers and wildlife populations. Dhaka city was once popular for its greeneries though rapid and unplanned urbanization and industrialization destroyed greeneries drastically.

When asked about their opinion on how UA can contribute to maintaining the ecological balance of a city, about 90% of the key informants reported that UA can help the creation of green spaces within the urban boundary (Figure 9.2). Urban green spaces can contribute to enhancing the sustainability of an area by reducing the temperature, reducing air and noise pollution, controlling the microclimate, increasing the aesthetic value by beautification, etc. (Davis et al., 2008). Besides these, green spaces also support the building of high-quality residences as these work as the ‘‘lungs’’ of a city (Jim & Chen, 2006).

According to 90.1% of the key informants, urban agriculture can incorporate green spaces into the urban landscape and can provide a vegetative structure for ecosystem functions (Figure 9.2). They stated that green areas in Dhaka city are depleting at an alarming rate. UA can provide significant opportunities to increase vegetation and green space to the urban landscape that will ultimately enhance the city resilience.

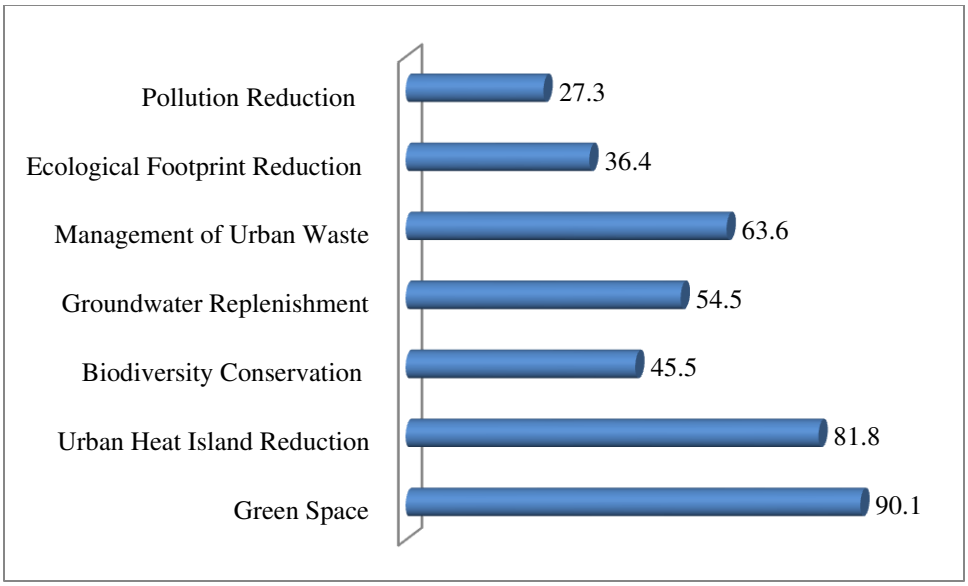


Figure 9.2: Environmental Contributions to Urban Agriculture
Source: KII, 2020

In many cities of the developed world, urban greens have been strategically incorporated into the landscape designing policy of cities through urban agriculture. For example, In Montreal in Canada, and Portland in the USA, community gardens have been designated as 'Parks and Open Areas' as a part of official recognition of UA within the city boundaries (Schukoske, 2000). In Berlin, the concept of 'Urban Landscape Strategy' has been adapted to create urban green spaces through the themes of 'Beautification', 'Landscape productivity' and 'conservation of nature' (Thierfelder & Kabisch, 2016). Integrating urban agriculture within existing green spaces can be a good strategy for designing UA in a particular city (Colding & Barthel, 2013) that offers recreational opportunities to the citizens that traditional public parks cannot provide (Francis, 1987).

Urban agriculture may contribute reducing the temperature through providing shades and increasing evapotranspiration reported by about 81.8% of the key informant (Figure 9.2). This can be considered a unique feature of UA for incorporating it in the urban land use designing process. Many cities are experiencing an Urban Heat Island (UHI) effect and the

DMDP area is not an exception. Urban agriculture can be a strategy to convert abandoned lands into useful urban amenities. Many studies show that UA can efficiently reduce the magnitude of the UHI is by increasing vegetated areas. Stephan Pauleit and Friedrich Duhme were the first who determined that a 10% increase in the vegetation can resulted in a decrease of 1°C of temperature in a radius of $100m^2$ area (Pauleit & Duhme, 2000).

Urban agriculture can be an alternative to biological waste management (both municipal and farm waste) mentioned by 63.6% of the key informants (Figure 9.2). There are a number of positive benefits of acceptance as well as different entry points for integrating urban agriculture into urban planning for mutual benefits. One of such paths is the potential of converting urban organic waste into manure for agricultural production. This could enhance food production as well as reduce health and environmental hazards caused by organic waste.

Groundwater replenishment can be a potential contribution of UA opined by about 54.5% of the key formats (Figure 9.2). In general, the water infiltration rate is high in agriculture, which may attribute to the enhanced capacity of arable land for groundwater replenishment. Soil compaction is one of the most common limitations of urban soils. A substantial increase in infiltration rates, water-holding and evapotranspiration capacities in compact soil can be achieved by tilling the soil and adding compost (Olson & Gulliver, 2011).

UA has the potential to support biodiversity conservation indicated by 45.5% of the key informants (Figure 9.2). UA can be considered an important system for the preservation of wildlife in urban landscapes because it allows the natural ecosystem suitable for the colonization of bio species (Blitzer et al., 2012). The movement of species across different landscapes allows the accomplishment of biological functions at different stratum that

maintain useful services for the ecosystem (Lundberg & Moberg, 2003). Thus, UA can play an important role by providing landscape elements with multiple species across time periods that are supportive of the persistence of biodiversity in cities.

Urban agriculture can help reduce levels of pollution reported by 27.3% of the key informants (Figure 9.2). Urban gardens can reduce hazardous air particles through filtering by dry deposition (Yang et al., 2008). In the process of dry deposition, leaf surfaces of trees act as natural basins for common contaminants in these greened areas (Barreiro, 2012). A number of studies demonstrated that tree overages are very potential in controlling urban air pollution. Scientific evidence revealed that tree coverage can remove approximately 711,000 metric tons of air pollutants from cities per annum (Nowak et al., 2006).

Question 4: What is the potential of urban agriculture to build resilient cities minimizing the impact of climate change?

While asking the question about the potential of UA to build the resilience of cities, about 82% of the key informants agreed strongly that urban agriculture can help increase the resilience of cities by minimizing socio-economic impact of natural hazards through improving food production, and public health, increasing social linkage, and promoting local livelihood options. In contrast, about 18% of the key informants opined negatively about the issue (Figure9.3).

The term resilience is often defined in the literature as “the ability of a system to absorb shocks of all kinds, and its capacity to adapt to the changing conditions without hampering or losing any key functions of it” (Meerow et al., 2016). This has become a buzzword in urban

development that describes the potential of cities to protect and recover different burdens caused by climate change and other disasters (both man-made and natural) (Lee, 2016).

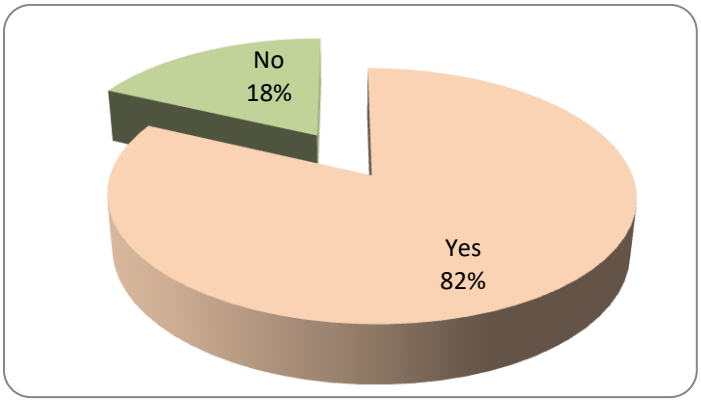


Figure 9.3: Opinions on Potential of UA for Building Resilient Cities
Source: KII, 2020

The key informants claimed that UA possess stronger concerns in urban planning from the view point of resilience and sustainability. They argued that UA can help building urban resilience by enhancing environmental sustainability and delivering multiple co-benefits (ecosystem services) to cities and their inhabitants.

The key informants further argued that a huge loss of UA has been evidenced in the DMDP region as a result of deliberation in urban land-use planning. A number of factors are responsible for the loss. First, insufficient attention on social and ecological vulnerabilities of urban their citizens, including emergency food supply during crisis and different scenarios of change caused by natural disasters and climate change. Second, rejection of the opportunities for job creation and contribution to the social inclusion of migrants as well as other social benefits. Third, the lack of knowledge of multifunctionality of UA that can offers various social, economic and environmental benefits. In the following, these three aspects along with global examples have been discussed.

A. Urban Vulnerabilities and Food Resilience

Food is a key element of the health and well-being of society. Therefore, the supply of sufficient amounts of nutritious food to the urban populations during crises is a fundamental part of resilience (Tendall et al., 2015; Baudoin & Drescher, 2008). The possibility of disruption in food supply can increase local production of food. This can enable the development of the supply chain and reduce dependency on external inputs.

UA not only plays an important role in the food supply but also helps to contribute to an in-depth knowledge of agricultural practice which is useful for people to build social resilience during crisis. Key informants argued that urban agriculture can act as a pocket of socio-ecological platform for conserving agro-biodiversity through agricultural practices and enhancing the knowledge of local ecology that can help increase the resilience of the food chain. For example, UA played an important role in Europe and North America in supplying food to the after-war urban population in the twentieth century (Barthel & Isendahl, 2013). Havana implemented a large UA system in the early 1990s when the Soviet Union broke its promise to provide food substance to the 2 million city inhabitants (Altieri & Nicholls, 2020; Buchmann, 2009).

B. Job Opportunity and Social Inclusion of Migrant Population

Urban agriculture is a part socio-economic development agenda of many countries. For instance, in a country like South Africa where chronic poverty is a big threat, UA appears as a feasible and sustainable business opportunity in addition to its potential social benefits (Nzimande, 2013). There is no academic criterion required, which makes it easier for people with low or no education to engage in urban agriculture.

According to a report of United Nation development program (UNDP), there are around 800 million people, those constitute about 8% of the global population, engaged in urban agriculture around the world (Gittelman, 2009). However, currently urban agriculture is being promoted as a means of sustainable livelihood for the poor and other urban dwellers due to its potential to generate household income as an enterprise (Gete et al., 2007; Mpofu, 2013). In the DMDP region, UA has been observed largely ignored in the planning and development policies of the urban.

People migrate from rural areas into the cities for the sake of a better life with the hope of being employed and gaining income to sustain their life. People moved to cities for diverse reasons, including forced migration. An estimated 258 million international and 763 million internally migrated people of the world are settled in different urban areas (FAO, 2019). Urban agriculture can play a significant role in the inclusion of those huge numbers of migrants in urban livelihood. A wide range of activities is included in urban agriculture, starting from production to postharvest management, processing, and marketing of different kinds of crops, poultry and dairy products as well as ornamentals plants and flowers.

FAO documented many examples that demonstrate the potential of urban agriculture to deal with employment and livelihood resilience of migrant people. In Haiti and Indonesia, vegetable gardening included low-income city dwellers, vulnerable groups and displaced migrants in the production activity and contributed to improve their food and nutrition security and sustainable livelihood (FAO, 2019). In Quito and Ecuador, the products of a participatory urban agriculture program promoted by providing access to the “bio farm markets” through local organic certification. This initiative generally allows those who are

migrated from rural areas and are involved in urban agriculture, to sell products at a good price and operate a sustainable business (FAO, 2019).

Bangladesh is an agro-based country and agriculture is considered an important sector for creating urban employment opportunities. Urban agriculture can generate employment to help fight unemployment. The result of the field survey explored different components of urban agriculture functioning in the study area such as; poultry, dairy, fruit and vegetable, nursery and ornamental crops, and flowers playing multiple roles for the urban farmers through income generation, employment and household food supplement.

C. Multifunctionality and Ecosystem Services

The third and the most diversified potential of UA is the multifunctionality which needs larger acceptance acknowledgment in urban land-use planning (Lovell, 2010; V´asquez et al., 2019). UA encompasses several potential social and environmental resilience benefits explored by different researchers, such as For example, improved access to fresh foods to promote public health, a form of exercise through cultivation activities, micro climate regulation, etc. (Calvet-Mir & March, 2019; Santo et al., 2016). Moreover, food growing practice can help building social capital and reducing inequality by enhancing social inclusion, which are key determinants building social resilience during emergencies (McMillen et al., 2016; Calvet-Mir & March, 2019; Martin et al., 2016; Santo et al., 2016; Barthel et al., 2015). UA also create employment opportunities to fight unemployment and poverty (Dubbeling et al., 2019). And finally, vegetation coverage help to improve air quality, buffer zones balance the urban ecology and decrease the urban heat island effect (UHI). Combined effect of those benefits can potentially mitigating some of the acute and

local climate change effect of a particular urban area (Deelstra & Girardet, 2000; Dubbeling et al., 2019; Scott et al., 2016; De la Sota et al., 2019).

Table 9.2: Functions of Urban Agriculture and their Benefits

Function	Description	Benefits
Food production	Commercial and household production of diversified food crops by local communities	-Help to increase food and nutritional security or urban population and enhance efficiency of using natural resources
Energy management	Local food production conserves energy for packing, processing and transport	-Help mitigating the impact of climate change by decreasing fuel consumption
Urban Waste management	Recycle organic wastes to compost production and increase land productivity for safe food production	-Provide landscapes for sustainable production -Develop nature based solution of waste and reduce pollution
Biodiversity	Landscape planning support a rich collection of local and imported plant species suitable biodiversity of the area	-Help reshaping the distribution of natural flora and fauna -Provide shelter for local biological species
Microclimate control	Landscape usually positively Regulate microclimate through humidity regulation, air cleaning and shade	-Ensure local environmental sustainability with a limited potential contribution to global climate change impact
Economic revitalization	-UA contributes to increasing household income -It offers jobs in the low-income neighborhoods including migrants	-Help to boost-up local economy -Develop social network and create new opportunities of jobs
Community socialization	Gardening activity and sharing cultivation information enhance socialization among residents	-Integrate farming and social together that helps increase social inclusion
Public health	Access to fresh and healthy foods along with green spaces usually enhance physical and mental health of residents	-Provide scope of living a healthy life through enabling community activities
Cultural heritage	UA can provide access to typical, local and high valued food that may be very rare to the area	-Enhance social inclusion and social cohesion
Education	UA extends opportunity to learn about crops, crop production, nutrition, environmental sustainability and other cultural issues	-Enrich fundamental knowledge

Source: Based on key informant interviews and literature review

In summary, it can be concluded that UA can benefit the people and the environment beyond the production function through temperature control, recreation and the creation of cultural bonds between people and the surrounding land.

A number of studies have explored the potential of urban agriculture from different point of view. Table 9.2 summarized various function and supportive strategies of urban agriculture.

Question 5: Describe the potential of urban agriculture to create urban green space in the city particularly in the study area.

UA in a feasibly approach to create green spaces in urban areas opined by 91% of the key informants interviewed in the study. According to their opinion, UA can provide many opportunities for re-vegetation at the local scale within an urban landscape. They argued that urban agricultural practices appear in many forms in relation to location and scale, which can provide cities important environmental as well as social benefits. These benefits include the provision of biodiversity and ecosystem services that contribute to the urban ecological and environmental processes. Furthermore, expansion and development of UA can create green infrastructure that maximize environmental and social benefits in a win-win situation.

There are many definitions of urban agriculture. Among those, the definition provided by the RUAF foundation includes the conception of urban agriculture in an appropriate manner. RUAF Foundation (2004) defined urban agriculture as "Agricultural production (crops and livestock) in urban and peri-urban areas for food and other uses, the related transport, processing and marketing of the agricultural produce and non-agricultural services provided by the urban farmers (water storage, agro-tourism, urban greening and landscape management, a/o)". UA can enhance resilience through creating green spaces.

Table 9.3: Way of Enhancing Urban Greening through urban Agriculture

Sl. No	Practices	Respondents	
		N	%
1	By conserving existing green areas/spaces	5	45.5
2	By increasing roadside plantation	3	27.3
3	By promoting fruits and timber plantation in public spaces	2	18.1
4	By initiating afforestation and nursery activities in fallow lands	1	9.1
Total		11	100.0

Source: KII, 2020

Although evidence has explored that the existing green spaces in Dhaka Metropolitan are decreasing at an alarming rate, however, a huge scope for the concerned authorities, city planners and local communities still remain to enhance urban green by establishing multifunctional urban agriculture for the wellbeing of urban population. It can be observed from Table 9.3 that 45.5% of the key informants indicated to protect existing greeneries areas or green spaces (e.g. parks, gardens, playgrounds, etc.) followed by 27.3% mentioning increase roadside plantation. About 18.1% of the key informants opined about the promotion of fruits and timber plantation in public spaces and 9.1% reported to initiate afforestation and nursery activities in fallow lands.

Question 6: In your opinion, how urban agriculture can be retained in an urban premise, particularly in the DMDP region, minimizing the debate of economic returns from land units?

All of the key informants were acquiesced about the difficulties for allocating space for urban agriculture in the DMDP region by demolishing the issue of strong economic debate. The main barrier for land access in the metropolitans is the high price of land and enormous pressure of urbanization in the DMDP area. Besides this, inadequate policy framework for assigning land for urban agriculture made it more critical. Therefore, the retention of UA in

the urban area remains a big challenge for the policymakers, urban planners and other concerned stakeholders. Economic force will not allow UA to stay in a city boundary. Individual urban dwellers who own a plot of land in the prime city will be influenced to convert the agricultural land to commercial land for getting more economic returns from the plot. In such situation, Government as a sole authority of defining land use have to play the critical role to retain agriculture in the urban setting through proper and legal policy framework. Government has to formulate proper policy framework to promote UA through land zoning and allocation, reluctant tenure arrangement for farmers, subsidies, invention of advances technologies, commercialization and involving public sector.

In addition to food production, urban agriculture is inseparably integrated into the economic, social, ecological and physical process of the urban settlement. The multifunctionality of UA is considered a unique feature of urban agriculture to make cities sustainable. The key informants opined about incorporation of urban agriculture into policies to mitigate challenges. For instance, UA can be integrated at all level of planning agenda, from the master plan to individual plans, to enhance city sustainability. There are vibrant examples available in different countries of the world. In Dae es Salaam in Tanzania, land use planning process has been updated by mainstreaming urban agriculture (Mougeot, 2000), whereas in Germany, the urban planning process has been revitalized through making urban agriculture compulsory (Wen et al., 2018).

From the economic perspective, UA may not be a profitable venture to generate income compared to other commercial land uses available in the DMDP region as the economic return from commercial land use is much higher than UA. But from the social point of view, UA is a very important sector that has the potential to increase and ensure the sustainability

of the urban landscape by providing multifunctional benefits other than food production. A strong motivational approach needs to be designed to promote the establishment and development of UA in the DMDP region.

Question 7: In your opinion can parks, flower gardens and aquaculture considered as urban agriculture?

According to 72.7% of the key informant, parks (plant coverage by timber and fruit trees), flower gardens and aquaculture can be considered urban agriculture (Figure 9.4).

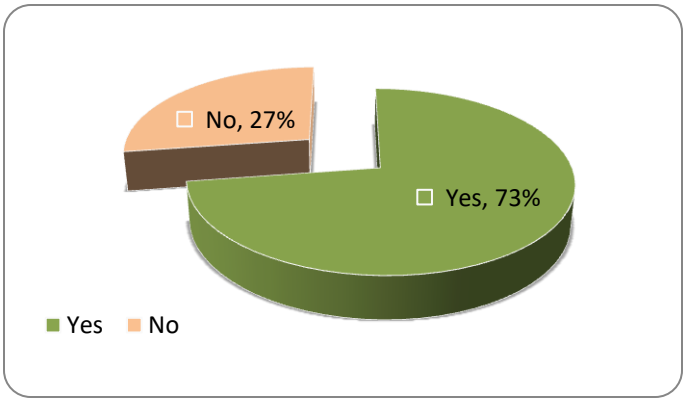


Figure 9.4: Opinion on Considering Parks, Flower gardens and Aquaculture as UA
Source: KII, 2020

The key informants argued that UA has many different approaches and methods including crop production, rooftop agriculture, hydroponics, ornamental horticulture, and other new and advanced methods. Urban agriculture has the potential to produce food for local communities, especially perishable and high-value horticultural crops. An increasing trend of commercial production of non-food crops and beautification of urban areas can be observed around the world, such as flower gardens, commercial fruit gardens, green walls, butterfly parks, landscape horticulture and so on. This can help extend the understanding of the concept of multifunctionality of UA and ultimately upgrade the concept of traditional parks

by incorporating UA into public parks, gardens, natural green vegetation, lakes and other water bodies.

Question 8: What should be the government intervention to protect urban agriculture from its declining or diminishing from urban areas?

Allocating lands for agricultural practices in the urban area is a big challenge as many other competing land uses are present in cities. Land use planners and policymakers are important actors who determine the acceptance of urban agriculture in a particular area opined by the key informants. They determine where it should establish, who will operate, what rules and regulations should be formulated to govern the practices, how much land should be allotted, and legal actions. In Bangladesh, there is a lack of policies to promote and develop UA in the cities, particularly in the Dhaka Metropolitan. It is, therefore, essential to formulate specific policy for UA highlighting the issue of ensuring its sustainability through land zoning, land allocation, increasing financial and technical assistance, technology updating, commercialization and institutionalization process. The key informants indicated that the role of government in land use planning should be passive for the UA which will help to reduce land-use conflicts. During the interview a number of measures have been proposed by the key informants those have been described in the following section:

A. Agricultural Zoning

The zoning of land is one of the most common approaches to implementing land use planning in the urban area often use to preserve agriculture, open space, natural resources, forests, tree coverage and so on argued by the key informants. Zoning land for UA can be applied to improve the efficiency of land use in the DMDP region.

Agricultural zoning will protect arable land from the standpoint of food production and compatible uses, or both. Agricultural zoning is recommended by the key informants on a permanent basis which means that it will prevent converting land to other uses regardless of cost.

B. Public Land Banking

The public land banking approach is also proposed by the key informants to protect urban agricultural land. According to this approach, the government would purchase lands either to keep them as open spaces to incorporate environmental amenities or use the land for food production. The approach of land banking is proposed by the key informants not only to protect the land from other uses but also to restrict land price increases. Land banks can be established by purchasing land in the track of urban extension anticipated that keep the land free from commercial uses which ultimately protects the UA in the DMDP area.

C. Shifting of Land Right

The shifting of the land rights system can be a possible way to protect agriculture within the city boundary argued by the key informants. This land rights system allows individuals and communities to acquire legal rights to use a particular land for particular use for a definite time period determined by the government. This approach can be applied in the DMDP region to protect urban agricultural lands. There is a huge amount of fallow lands available in the DMDP region. A certain big portion of this land can be handed over to the urban farmers through the shifting of the land right agreement who are basically landless or migrated from other parts of the country. This arrangement can help establish and promote urban agriculture in the DMDP region. Besides this, the arrangement can generate other socio-economic and environmental benefits including increasing the land coverage under agriculture that would

help increase food security, enhance household income and create more employment opportunities. Initiating agricultural activities to the land area will help increase green coverage of the DMDP as well.

D. Cooperative Production System

The government can authorize cooperative production systems in the form of state-run cooperative farms in the DMDP region, particularly including the small to medium farms located in and around urban boundaries. Like private cooperative farms, members of the cooperative production system will have the opportunity to form committees, select leaders, get legal rights to land for a particular period, and earn money by selling produces.

For example, the government of Havana authorized the formation of the Basic Units of Cooperative Production (UBPC) in 1993. This contributed to double the agricultural production in Havana by 1996 (Koont, 2004).

E. Conservation and Allocation of land for UA

The key informants opined that official recognition and institutional support for urban agriculture is crucial to ensure and enhance the sustainability of urban agriculture particularly in the DMDP region. Being the supreme authority, Government can legitimate and institutionalize urban agriculture through facilitating the multi-stakeholder process and developing policy to conserve and allocate land for agriculture in the urban area. For instance, key informants suggested that there are 43 canals in Dhaka city that can be reclaimed through excavation and brought under aquaculture programmes. Parks can be developed on both sides of the canals to restore greeneries. Local communities can be

involved in the maintenance and management of the canals. The key informants argued this can be a good example of restoring urban agriculture in the Dhaka Metropolitan.

The key informants argued that urban agriculture is an integral part of the urban environment, now and in the future, and cannot be ignored in planning processes. This paper also emphasizes the importance of multi-stakeholder planning processes for integrating urban agriculture into urban planning.

9.3 Findings from Case Studies

9.3.1 Case Study-1: Regeneration of Public Spaces in Dhaka North

The Dhaka North City Corporation (DNCC) has taken an initiative to renovate and develop about 20 public parks and playgrounds of the Dhaka Metropolitan through a programme titled, “Upgrade, Regeneration and Greening of Urban Open Spaces”.

Justice Shahbuddin Ahmed Park is the pioneer park of this renovation programme located in the neighborhood of Gulshan. The authority of DNCC recently has renovated and developed this park as part of its regenerating strategy of public spaces.

The opinion of the different stakeholders has been prioritized for developing the master plan of the park, particularly the residents of the neighborhood and others, who come to this park for several reasons, such as, walking, exercising, passing leisure time by sitting and moving around, observing the aesthetic sight and so on. A bottom-up approach has been followed including questionnaire surveys, Participatory Rapid Appraisal (PRA) sessions, mine craft simulations and more to set a framework for the renovation and upgrading of the park. A wide range of components; including pavements, cycling paths, ndoor & outdoor gymnasium, play zones for children, a ladies’ corner, a library, stores, gardens, etc. have

been included to meet the demand of the people who use this park. There is a lake in the park connected by waterside walkways. A green amphitheater, a stage, adjourned viewing decks and a drinking water fountain are special attractions of the park that enriched natural beauty of the area and increased the aesthetic value of the park. Landscaping with grass, bushes, ornamental and timber trees, fruit plants, flower beds, and rainwater harvesting system has also been set to ensure beauty and sustainability. There are two entry points, visible fencing, lighting and security systems have been developed to enhance the accessibility and security of the park. A water fountain, public toilet facilities and trash bins are also kept in the park for public conveniences that help to maintain the cleanliness.

The city corporation has developed the framework of operations and maintenance of parks, playgrounds and open spaces by involving the neighborhood community in the planning and operation process through partnerships. Emphasis has been given to incorporating the demand and suggestions of the neighborhood community. The supervision and monitoring of the establishment will be done through a co-management system involving the Dhaka North City Corporation and the community leaders of that area. A similar experience will be utilized in developing another 20 parks and playgrounds in Dhaka North. Besides these, six additional public spaces of the Dhaka Metropolitan will also be developed with the support of UN HABITAT.

Summary

Urban agriculture can be established in a wide range of places within the urban boundary including open space, fallow land, private or public gardens, parks, schools yard, etc. the government particularly the local government authority can offer financial and legal incentives for using public, private and community lands for urban agriculture. Cities have

been incorporating UA in land use planning to meet the demands of the communities offering a scope of improvement of the quality of urban life through contributing to the urban ecology, environment and public health.

9.3.2 Case Study-2: Urban Farming to Ensure Food Security

Korail is one of the largest informal residential arrangements for low-income people in Dhaka. It is located in a part of Ward-19 and Ward-20 of Dhaka North City Corporation (DNCC). There is no concrete plan and implementing authority in Korail for its governance and providing essential municipal services to the community. A formal water supply facility is absent there. The existing political system further complicates the situation as well as hampering the socio-economic development of the marginalized communities of the area. The impact of Covid-19 made the social insecurity and financial condition of the community more vulnerable.

To increase the food security of the community the urban agriculture practice has been extended by some of the community leaders. The essential agricultural input, such as seed, has been provided to the agriculture practitioners by a design and architecture studio named 'Paraa' in collaboration with UN-Habitat (with a net worth of 50,000 BDT) to help them produce their own food. Paraa is working in Bangladesh to enhance spaces within local communities.

The agricultural practices operated in the Korail by its inhabitants in a cooperative and collective manner. Strategically, the agricultural practice follows a diversified cropping system that helps optimize the nutritional status of the people and at the same time productivity of the urban land. The area is located beside the lake and extensively used lake water soil, which is highly cultivable. The neighboring residents are supportive in terms of

resource sharing because they are the customer of the fresh vegetables produced by the farmers. Women are actively involved in agriculture because the closeness of the plots allows them to do household work, particularly nursing their children. One-third of the community members of Korail are women who are directly involved with the management of agriculture. The agricultural practice in Korail is a success story of UA in the core city center of the DMDP region. They could be trained to become potential urban farmers which in turn, would empower them economically and socially. This is necessary to scale up, disseminate and replicate the practice to the other part of the DMDP region as well as the county.

The initiative inspired and motivated several other members among high-income residents of the nearby area who are also growing vegetables and fruits at the household level, not only to meet the household consumption needs but also to get the pleasure of cultivation. The practice which is currently concentrated in one-fourth of the potential cultivable area of Gulshan-Banani lakeside can be extended throughout the entire area.

Summary

Urban agriculture can be established in the informal settlement as an effective solution for food security and economic development of the urban residents. Land tenure complexity is a big threat for the long-term operation of the practice. The participants reported that they can do better in this sector in adequate assistance from the government, NGOs, and other organizations can be ensured in term of modern technology adaptation, technical guidance and financial support.

9.4 Conclusion

Urban agriculture is an alternative agriculture movement that advocates for a major shift toward more ecologically sustainable agriculture compared to traditional agriculture. It

evaluates the potential role and relation of cultural and social values in the sustainability of urban agriculture. Urban agriculture develops access to fresh and nutritious food, supports cultural heritage, and provides social and environmental benefits. Dealing with the term urban agriculture refers to definitional challenges accepting the production activities of crops, livestock, poultry, aquaculture and forestry in the urban setting.

However, growing evidence indicated that the integration of appropriate agricultural practice into the urban setting greatly influenced the sustainability of urban areas in terms of urban natural resources and ecology management. Though UA plays a key role in urban food security, livelihood, empowerment, and other sociological development, it is inadequately supported by policymakers due to a knowledge gap in its feature of multifunctionality. A policy gap restricted the development of UA in urban areas.

In this chapter, the significance of urban agriculture has been discussed, in the face of urban food resilience, urban environmental sustainability, and multifunctionality, and argued that current models of urban land-use planning are insufficiently considering these three aspects. Critically, a new urban planning paradigm is needed for the DMDP region as well as the whole country highlighting the importance of incorporating green areas in the urban planning by developing a supportive legal framework for adopting UA as a land use tool for creating green space and ensuring sustainability of urban landscape. At present, urban land-use planning has started to acknowledge the potential of UA as a nature-based solution for enhancing urban ecosystem resilience for its multifunctionality, particularly in the face of climate change.

Chapter 10

NATIONAL POLICIES INFLUENCING THE PROMOTION OF URBAN AGRICULTURE

10.1 Introduction

Dhaka Metropolitan has been identified as the fastest growing megacity in the world. The actors and institutions involved in urban land management, directly and indirectly, include a wide range of governmental agencies at the national, divisional, and local levels, the private sector, both corporate and informal. A large number of acts, policies, and regulations documents are the fundamental basis for the physical planning and development in urban areas which ultimately influence the promotion of urban agriculture. In this chapter the finding of review of some important policy documents have been illustrated those are closely related to the development of UA in the DMDP area.

10.2 Major Policies Related to the Development of Urban Agriculture

There is no particular policy in Bangladesh that promotes urban agriculture in the cities. Eventually, the Dhaka Metropolitan does not have any specific city policy that promotes urban agriculture. The master plan of Dhaka is the first official document that has included a provision for urban agriculture by the statement that "Three areas of high quality agricultural land within the catchment area of Dhaka will be conserved and promoted as areas of high intensity food production". At the same time, there are no policies that particularly restrict agricultural practice in urban areas.

A brief analysis of policies that influence the development of agriculture practice in the Dhaka Metropolitan area has been described in Table 10.1.

Table 10.1: Brief Analysis on Policy Documents those Influence UA

Year	Name of the Documents with Formulation Authority	Remarks
Category A- Crop		
1995	**Dhaka Metropolitan Development Plan (DMDP) 1995-2015** Rajdhani Unnayan Kartipakkha (RAJUK)	The Dhaka Metropolitan Development Plan (DMDP) is the first policy document of planning for Dhaka Metropolitan which is basically a three-tire mechanism for growth and development management for Dhaka city and adjacent other city corporations including the surrounding areaa. The Structure and Urban Area Plans do not provide any land use zoning principles which could be applied to develop UA in the DMDP area subsequently. The policy does not provide any guidelines for demarking environmentally-sensitive areas where urban development needs to be restricted. This include wetlands, flood flow zones, ponds, canals and natural drainage channels which can further aggravate the problems of urban environmental management. Eventually, no specific direction has been provided on the protection and management of agricultural practices existing in the DMDP area.
1996	**New Agricultural Extension Policy (NAEP)** Ministry of Agriculture	The New Agricultural Extension Policy has been formulated to increase the efficiency and productivity of agriculture in Bangladesh by encouraging different partners and agencies function within the national agricultural extension system. The policy focused on decentralization and demand-led extension of agriculture to meet needs of the farmers, emphasized the coordinated extension service delivery and encouraged development of extension research linkages. No particular policy direction has been provided in the document for the establishment and development of urban agriculture.
1999	**National Agricultural Policy (NAP)** Ministry of Agriculture	The first comprehensive agricultural development policy of the country. The document focused intensively on the Millennium development goal (MDG) to eradicate hunger. Preservation of agricultural land is mentioned as a minor issue. But the preservation of urban agricultural land was not focused on at all.
2001	**National Land Use Policy** Ministry of Land	In this document preservation of agricultural land gained importance for the first time. Land use

Year	Name of the Documents with Formulation Authority	Remarks
		strategies for different regions of the country have been recommended in this policy document to minimize the loss of cropland and synchronize land use with the natural environment. But this policy focuses more on the national level. Agricultural land preservation in the urban areas is missing in the document.
2009	**Bangladesh Climate Change Strategy and Action Plan (BCCSAP)** Ministry of Environment and Forest (former)	Bangladesh has been identified as one of the most vulnerable countries to the impact of climate change due to its geographic location. This integrated plan of action has been prepared to protect the country from the adverse effects of climate change by addressing six basic challenges of the country where food security is placed at the top. This action plan has emphasized the preservation of agricultural land to ensure food security. But the issue of urban food security and resilience of the urban environment is missing.
2012	**National Agriculture Extension Policy (NAEP) Draft** Ministry of Agriculture	The National Agriculture Extension Policy (NAEP) has been drafted after the "New Agricultural extension policy 1996". The Policy emphasizes the integration of extension services in order to upsurge farm production through the collaboration of the public and private sectors. The Agricultural Extension Services was formulated with the aim to play a significant role to motivate, educate and assist farmers to adopt improved farming practices. But the issues of commercialization of agriculture for employment and sustainable technology to adapt to the climate change impacts, particularly in the urban areas are lagging behind. No specific policy direction is provided for the extension of urban agriculture
2013	**National Sustainable Development Strategy (NSDS)** Ministry of Environment and Forest (former)	The National Sustainable Development Policy namely The National Sustainable Development Strategy (NSDS) has been formulated to deal with environmental challenges along with the economic growth of the country. This policy document has highlighted agricultural land along with other development priority sectors to ensure food security with increased pressure of urbanization and climate change. Like other previous policies, the issue of

Year	Name of the Documents with Formulation Authority	Remarks
		management of urban agricultural land has not been highlighted in this document.
2015	**Dhaka structure plan 2016-2035** Rajdhani Unnayan Kartipakkha (RAJUK)	The Dhaka structure plan has been formulated for evaluating the Dhaka Metropolitan Development Plan (DMDP) (1995-2015) and preparing proposals and strategies for future Dhaka. One of the major goals of this document is to make Dhaka increasingly functional and productive. A brief description of the agricultural land use practice in the city has been provided in the document. But the issue of food production and the ecological importance of the urban area have not been recognized in the document. The plan only considered the industrial and service sectors as sources of livelihood.
Category B- Non Crop		
2007	**National Livestock Development Policy** Ministry of Fisheries and Livestock	This policy has been formulated for developing the livestock sub-sector to accelerate the economic growth of the rural areas by poverty reduction. In the document, guidelines have been provided to open up opportunities and harness the full potential of the livestock sector in Bangladesh considering the environmental risks. Key objectives of the policy include the improvement of small-scale poultry and dairy farming, reformation of DLS, enforcement of low and regulations towards animal feeds, upgrading vaccines, privatization of veterinary services, adoption of the breeding policy, and establishment of livestock insurance development fund and livestock credit. The issue of urban poverty and economic development of urban livestock farming is missing in the document
1998	**National Fishery Policy** Ministry of Fisheries and Livestock	This policy has been developed with an aim to enhance fisheries production as a tool for poverty eradication and improve the socio-economic conditions of the fishermen in the country. The issues of creating self-employment opportunities, fulfilling the demand for animal protein, and earning foreign currency by exporting fish and fisheries products were highlighted in the document through maintaining ecological balance, biodiversity conservation, improvement of public health and

Year	Name of the Documents with Formulation Authority	Remarks
		recreational facilities to the urban population. No particular guideline for the development of urban fisheries production has been provided in this document.

Source: Review and analysis of the documents and related secondary materials

The review revealed that the development of rural or the conventional agricultural and the preservation of traditional agricultural land have been emphasized in the policy documents that contributes to the socio-economic growth of rural population in Bangladesh. The issue of urban agriculture is missing in those documents. The Dhaka structure plan (2016-2035) has been found the only local level policy guideline document that recognized the importance of urban environment first time in Bangladesh and mentioned considering the issue of preservation of agricultural land in formulating the guideline for future urban development. But no strategy approach was mentioned in this planning guideline for preserving agricultural lands. It emphasized the profit-driven industrialization approach of urban development.

10.3 Conclusion

The policy analysis illustrates that the issue of agricultural land preservation has been highlighted in different national policies of Bangladesh. But, there is no particular policy that helps to promote agriculture in urban areas. The National Agricultural Policy (1999), National Land Use Policy (2001), Climate Change Strategy and Action Plan (2009), National Sustainable Development Strategy (2013), Dhaka Structure Plan (2016-2035) and other policy documents have not incorporated the issue of preserving agricultural land in the urban development process. Service-oriented urban and industrial development has been the core objective of urbanization in Bangladesh, particularly in the DMDP region. A wide range of national policies is in Bangladesh which can act as the entry points for promoting UA,

particularly the policies that are linked to food security, agriculture development, natural resources management, land resource development, livestock development and housing and urban development (Rahman et al., 2015).

The Ministry of Agriculture recently set up a unit for developing urban agriculture, particularly in Dhaka Metropolitan. A different program on livelihood management of the vulnerable communities of Bangladesh has been operating by BRAC where food security and environmental perspectives are combined. In the rapid urbanization process, efficient use of urban spaces and resources for agricultural production becomes obligatory to achieve the SDG goals. To achieve the SDG goals, particularly the SDG-11, underpins the need to "Make Cities and Human Settlements inclusive, safe, resilient and sustainable", urban agriculture can play a significant role. Policymakers and experts need to essentially focus on broadening the scope for developing and promoting urban agriculture in Bangladesh, particularly in the DMDO region to maintain the ecological balance and sustainability of the urban landscape.

Chapter 11

CONCLUSIONS

11.1 Introduction

This concluding Chapter intended to provide the answers to the research questions that have been raised at the beginning of this research for achieving the objectives. This research aimed at exploring the change in agricultural land use and its consequences in urban areas and to discuss the opportunities and challenges of UA in Bangladesh taking Dhaka City, particularly the DMDP area as an example. A household-level questionnaire survey, in-depth interviews of key personnel, case studies and a review of literature on UA practices both in global and Bangladesh contexts have been carried out to accomplish the research goal by answering the research question (does urban agriculture has the potential to contribute to urban sustainability?).

11.2 Synthesis of Key Issues

The leading development challenge of Bangladesh today is environmental management in the context of high population density and urban development. Being the capital and hub of development of the country, the concentration of urban poor is the highest in Dhaka in the informal settlements, where addressing the environmental problems is so difficult due to the lack of proper services. Integration of environmental protection policy with urban land use policies remains one of the biggest policy challenges. Urban agriculture can be integrated into land use policies to address sustainable management of the environment, one of the core components of sustainable development.

Sustainable urban development is important for the sustainability and resilience of urban landscapes and essential for the protection of the urban environment and conservation of natural resources. Mougeot suggests that urban agriculture "…. must be viewed not as a problem but as one tool contributing to sustainable urban development (Mougeot, 2006). For improving the fresh food supply, health conditions, local economy, social integration, and environmental sustainability of the urban area, UA agriculture offers a unique opportunity in a holistic approach.

Achieving climate resilience in the cities is a big challenge, particularly in densely populated cities like the Dhaka Metropolitan region. It cannot be achieved through an engineering solutions. It is also a social issue undoubtedly. The contribution of urban agriculture to city resilience is explicitly a new concept in academia, though, there is growing evidence for its multifunctional benefits. Understanding the potential role of UA in building city resilience is still under study. UA faces a number of socio-economic, environmental, technical and most importantly economic challenges. Therefore, the success of the UA requires the support of different stakeholders, including government authorities, nongovernmental organizations, researchers, the private sector, and the general people. A holistic, interdisciplinary, and inter-institutional approach is important for the successful integration of UA into the urban land use policy assimilating scientific knowledge and experience of different related sectors.

Urban agriculture has the potential to enhance the sustainability and resilience of an urban area by contributing to the social, economic and environmental aspects of that area. Economic growth and development alone cannot sustain the prosperity of urban communities. Investments in human and social capital are also required for example, exploring new dimension of healthy livings and entertainment. Comprehensive planning for

the urban sustainability should address the availability and replenishment of both the economic and resource (human and natural) and a proper direction can be achieved through a continuous dialogue. If the economic prosperity of a community alone get the entire emphasis in the dialogue, then UA will loses the debate. This is because the non-agricultural land use (such as commercial or industrial) produces a huge amount of economic benefit from a prime city land. On the other hand, an individual can get a minimum economic return from an urban plot if it is used for agricultural production. But the environmental consequence of the land use change (from agriculture to non-agriculture) will be detrimental for the urban community as it will hamper the biodiversity that triggers the ecological imbalance of that particular area. This has been evidenced in different records around the world. Therefore, from the community viewpoint, considering only the economic perspective of a particular land area can be considered a negative approach for the welfare of the urban residents.

However, it may be difficult to quantify the social and environmental functions of a suitable urban agricultural practice. These social and environmental functions highlight the importance of urban agriculture as a tool to create urban green space in the city landscape which can attribute to the livability and sustainability of the urban area. For a sustainable urban community, a safe, healthful, and productive natural environment is a prerequisite. The community gardens, public parks, and open spaces may be renovated by appropriate types of urban agriculture which constitute a small part of an urban environment, but these can provide useful models for urban sustainability.

The study revealed the declining feature of agricultural practice in the DMDP region resulted from the negligence of UA in the urban planning policy. Though, UA has been found a vital

source of livelihood and sustenance in the study area for a large portion of the urban farm population. UA provided them with diversified nutritious diets and multifunctional services. There is a big opportunity for UA in the DMDP region. Different features of urban agriculture have been explored in the study those are taking strong shape in the Dhaka Metropolitan region due to contributing to income generation and creating employment opportunities for the urban dwellers. Eventually, UA has the capacity to meet the demands of fresh agricultural products of the city dwellers which led to the development of small-scale urban enterprises for vegetable, floriculture, and horticulture gardening, poultry, fisheries, and livestock production in the DMDP region.

For the sustainability of urban agriculture, availability of resources namely land, water for irrigation and support services including agricultural inputs, advanced technology, expert technical advice, access to the market, and finance are considered as the prerequisites. The study explored that the urban farmers in the study area are interested in continuing the agricultural practice though a number of obstacles prevail there. As pointed out in the result and discussion chapters, the availability of land, water and finance are the critical factors that influence the success of urban agriculture in the study area. They also need advanced techniques and technologies suitable for developing the farming practice in urban areas. The agricultural credit, training, extension, and education services are mostly available for the farmers engaged in traditional farming; the urban counterparts have not been focused and included yet. These services need to be available for urban farmers for ensuring the sustainability of urban agriculture. Otherwise, UA itself would not be sustainable.

The government can take different measures to establish and promote UA in urban areas. In a particular urban area, the optimum utilization of land cannot be ensured without the direct

intervention of the concerned government authorities. There are a huge amount of ???and allow lands in the country; the DMDP is not an exception. Government can designate those lands for urban agriculture and can develop the land tenure system to allot those lands to the landless farmers. A proper legal framework can be developed by the government to lease or rent those farmlands to the public sector as well for commercial UA where different advanced technology and tool of UA can be initiated. Agricultural lands in and around city boundaries are converted into non-agricultural land illegally in an undismayed manner without the permission of the concerned departments. Formulations of proper zoning policies along with enabling laws are essential for the legal protection of areas designated for urban agriculture. Institutional support is crucial for the farmers to get access to necessary resources for urban agriculture. Motivation to bring together the urban farmers, service-providing institutes, and urban land owners is important to enhance the sustainability of UA from the stakeholder context.

Stakeholders, from the large to the marginalized farmer groups, as well as concerned government departments and agencies, should be involved in all phases of the planning, from the identification of land to strategic planning. In the Dhaka Metropolitan, local government units such as the DCCs could coordinate the stakeholder meetings. The identification of appropriate sites for urban agriculture could involve municipal survey departments and other stakeholders who are involved in land management. The acquisition of land within identified urban agricultural areas or zones may be difficult as compensation needs to be provided. Many farmers may need financial assistance to purchase land. In certain cases, land should be made available to certain landless or migrant farmers groups on a temporary basis so that they can practice agriculture in urban areas. Funding is essential and in order to access

government funds, agriculture must be incorporated into municipal budgets and priorities. This should be done very carefully and special care should be given to qualifying farmers for getting funds from the government.

At the national level, a national policy concerning the requirement of urban agriculture needs to be formulated so that the ministries involved e.g. Land, Agriculture, Livestock, Fisheries, and Environment, Forest and Climate Change and other relevant ministries can get opportunities to better coordinate their activities to promote urban agriculture, and have a mutually recognized common reference point formulating relevant policies. The policy, therefore, can be interpreted into regulations and guidelines to direct ministerial and local action. This will allow public ownership of land dedicated to agriculture and will offer the opportunity to address public as well as environmental health concerned. This will also help in quality control of urban agricultural production more certainly. In this way urban agriculture can be monitored, issues can be addressed and a database also can be built.

The multifunctional benefits of UA have been described broadly by a large number of researchers, academics, urban planners and policymakers evident in the literature, illustrating its capacity to build urban green spaces. It is perceived that policy domains such as food security, poverty alleviation, health, education, sustainable development, economic growth, land reform, environmental protection, and others are closely related in promoting UA, and vice versa, but, do not prevent each other. Therefore, this thesis focuses on the promotion of UA under the scope of the sustainable urban development domain with a particular focus on green space creation. As the Dhaka Metropolitan is facing a green deficit now a day, the potential of UA as a land use to creating green space needs to be explored. Despite a number

of challenges, urban agriculture can be considered as an integral component of the future resilient cities through innovative solutions, policy formulation, and planning process.

To keep urban agriculture viable inside the urban boundary, the government has to play a vigorous role by initiating different potential and protection measures. Land use policy formulation for promoting UA, land zoning, land allocation, financial support, involvement of the public sector in UA, market development and institutionalization can be considered essential government interventions for the establishment and development of UA.

The Government can create an opportunity to make urban land available for agriculture by acquiring lands and distributing these lands to the farmers. Apart from production, these agricultural practices can be environmentally friendly and climatically sustainable.

Intensive researches need to be designed for a comprehensive assessment of the potential of UA in ecosystem management, economic development, social inclusion, public health urban resource management and environmental aspect of urban agriculture. Increasing the acceptance and contribution of UA in enhancing the sustainability and climate resilience of the DMDP region, as well as in the country overcoming challenges, appropriate context-specific technology invention, mechanisms of increasing collaboration among government agencies, policymakers, researchers, public sectors and local communities need to be explored.

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Appendix

1.1 Questionnaire for Household Survey

1. Information of Household Members:

Sl. No	Name of member	Relation with HH head	Gender	Age (Year)	Educational qualification	Marital Status	Primary Occupation	Secondary Occupation
	2	3	4	5	6	7	8	9
1								
2								
3								
4								
5								
6								
7								
8								

2. Types of Agricultural Activistes involved with:

Code	Type	Put tick	Code	Type	Put tick
1.	Rice/wheat cultivation		7.	Horticulture	
2.	Pulse cultivation		8.	Roof top Garden	
3.	Vegetable cultivation		9.	Goat farm	
4.	Jute cultivation		10.	Poultry farm	
5.	Flower cultivation		11.	Duck farm	
6.	Dairy farm		12.	Others	

3.Do you own agricultural lands? Yes ☐ 1 No ☐ 2

If yes, then mention the amount : …….. (in decimal)

4. Who cultivates the agricultural land ?

1. Self ☐ 2. Sharecropped ☐ 3. Leased ☐

5. If do not own agricultural land What is the source of agricultural lands

1. Sharecrop, Amount of Lnad ..... .(In decimal)

2. Lease/Mortgage, Amount of Lnad ... ……..(In decimal)

6. Are you a permanent resident of this area ? Yes ☐ 1 No ☐ 2

i. If no, then mention the name of the place of origin…….

ii. Types of profession involved there .....

7. Ownership of Livestock Assets:

Sl No	Name of Breed	Amount	Current Market Price
1.	Cow/bulffalo Cow/Buffelo		
2.	Goat/Sheep		
3.	Chicken		
4.	Duck		
5.	Others		

8. Monthly Average Income of the Household (Excluding the production cost):

Sl. No	Source of Income (Agriculture)	Total Income (Taka)	Sl. No	Source of Income (Non-agriculture)	Total Income (Taka)
1.	From own cultivation lands		1.	Service/pension	
2.	From leased out lands		2.	From small business	
3.	From leased in lands		3.	From industrial labour	
4.	From horticulture		4.	From house rent	
5.	From dairy farms		5.	Remittence	
6.	From pisciculture		6.	From other family member	
7.	From poultry rearing		7.	Fron CNG/van/ rikshaw/ truck drivig	
8.	Others		8.	Others	
	Total			Total	

9.Yearly household income …….. (Taka)

10. Monthly expenditure on food consumption …… (Taka)

11. Expenditure on Non-food Items (According to the previous year):

Sl. No	Item	Total Expenditure (Taka)
1.	Costume, Shoes/Sandals	
2.	Maintenance, repairing and reconstruction of building	
3.	Treatment	
4.	Education expenditure	
5.	Travel/Recreation	
6.	Social occasion	
7.	Transportation	
8.	Furniture	
9.	Others	
Total		

12. Investment (According to the previous year):

Code	Items	Total cost (Taka)
1.	Investment in business	
2.	Investment in agriculture	
3.	Purchase of house/lands	

13. How the agricultural products (crops, dairy and poultry products) are used?

1. Household consumption ☐ 2. Sell ☐

14. Where are the agricultural products sell ?

Code	Place	Tick
1.	Neighbours	
2.	Local market	
3.	Wholesale market	

15. Which varieties of crops are cultivated ?

1. Local variety ☐ 2. Developed variety ☐ 3. Hybrid ☐

16. How many time a year the land is cultivated?

1. Once ☐ 2. Twice ☐ 3. Thrice ☐

17. Source of irrigation water: _____

18. Source of information of modern cultivation system

1. News media ☐
2. Neighbours ☐
3. Training (Govt. and non-govt.) ☐
4. Concerned authority ☐
5. Others _____

19. Management of agricultural waste:

1. Left in the field ☐
2. Burn ☐
3. Use to produce compost ☐
4. Others _____

20. Source of finance for agriculture:

1. Self-funding ☐ 3. Institutional credit ☐
2. Loan ☐ 4. Grant from Govt. ☐

21. Mention the constrains of agricultural practice?

_____

22. Mention the reasons of continuing agriculture (crop, dairy and poultry farms)?

_____

23. What types of land use prevailed around the agricultural field before last five years?

_____

24. Any changes observed in the land use during the last five years? Yes ☐1 No ☐2

If yes, what type of changes observed?

_____

25. Any Impact of land use change observed? Yes ☐1 No ☐2

i. If yes, what types of impacts have been observed in Agriculture?

_____

ii. What type of impacts have been observed in the environment:

_____

25. Mention the types and intensity of incidence of diseases during the last two years.

_____

26. Instance of natural disasters during the last five years

1. Excess Rainfall ☐
2. Erratic rainfall ☐
3. Flooding ☐
4. Water logging ☐
5. High temperature ☐
6. Drought ☐
7. Others _____

27. Initiatives taken to minimize the impact of natural disasters during the last five years:

_____

28. Have any concept of climate change? Yes ☐1 No ☐ 2

29. Experienced any impact of climate change? Yes ☐1 No ☐ 2 Couldn't answer ☐

If yes, what types of impacts experienced?

_____

30. Types of climate change impact observed:

☐1 Change in season
☐ 2 Water crisis in dry season
☐ 3 Drought/Heat wave
☐ 4 Intensity of flood increased
☐ 5 Erratic rainfalls
☐ 6 Intensity of disasters increased
☐ 7 Change in rainfall time
☐ 8 Excess rainfall
☐ 9 Temperature increased
☐10 Others (Mention)

31. Is urban agriculture important for the city and should be retained?

Yes ☐1 No ☐ 2

If yes, then mention the reasons for retaining

_____

32. Your Recommendation for developing urban agriculture:

☐ 1 Afforestation in fallow land
☐ 2 Picsiculture in wetlands
☐ 3 Vegetable cultivation
☐ 4 Cultivation of high value crop
☐ 5 introducing agro-based industries
☐ 6 Training
☐ Others (Mention)

1.2 List of Key Informants:

Sl. No.	Name	Professional Details
1.	Qazi Kholiquzzaman Ahmad	Found Chairman Dhaka School of Economics & Chief Coordinator, Bangladesh Climate Change Negotiating Team
2.	Dr. Zinnatul Alam	Former Professor Department of Entomology Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur
3.	Dr. Md. Ghulam Murtaza	Former Professor Urban and Rural Planning Discipline Khulna University
4.	Dr. Mohd. Shamsul Alam	Professor Department of Geography and Environment Jahangirnagar University, Dhaka
5.	Dr. Tariq Bin Yousuf	Chief Urban Planner Dhaka North City Corporation
6.	Md. Sirajul Islam	Chief Urban Planner Dhaka South City Corporation
7.	Dr. Abul Kalam	Former President Bangladesh Institute of Planners
8.	Akhter Mahmud	Former President Bangladesh Institute of Planners
9.	Zeenat Sultana	Assistant Director Divisional Livestock Office, Dhaka Ministry of Fisheries and Livestock People's Republic of Bangladesh
10.	Dr. Abu Wali Raghib Hassan	Specialist Extension Management and Capacity Department of Agricultural Extension, Ministry of Agriculture People's Republic of Bangladesh
11.	Dr. A F M Jamal Uddin	Professor Department of Horticulture Sher-e-Bangla Agricultural University, Dhaka