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An Analysis of Food Security in Bangladesh

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An Analysis of Food Security in Bangladesh



M. Phil. Thesis

A Thesis Submitted to the Department of Economics, Faculty of Social Science, University of Rajshahi, in Fulfillment for the Degree of Master of Philosophy

Submitted

By

Tithy Dev

Session: 2008-09

Roll No. 08805

Supervisor

Professor Dr. Md. Elias Hossain

DEPARTMENT OF ECONOMICS
UNIVERSITY OF RAJSHAHI
BANGLADESH

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UNIVERSITY OF RAJSHAHI
BANGLADESH

December, 2014

Dedicated
to
My Beloved Parents

DECLARATION

I, the undersigned, do hereby declare that this thesis entitled “An Analysis of Food Security in Bangladesh” submitted to the Department of Economics, University of Rajshahi, is entirely my original work except for quotations which have been duly acknowledged. This work has not been submitted previously, in part or full, for any academic degree to any University, except at the Department of Economics, University of Rajshahi, Bangladesh.

.....

Signature

.....

Date

SUPERVISOR'S CERTIFICATE

This is to certify that the dissertation entitled “**An Analysis of Food Security in Bangladesh**” is an original work accomplished by Tithy Dev, M.Phil. Fellow in the session 2008-2009, Department of Economics, University of Rajshahi, Bangladesh. The findings and views expressed in the dissertation are originated from both primary and secondary data and entirely her contribution. She has prepared this dissertation under my supervision and guidance. As far as I know the dissertation has not been submitted anywhere else for any purpose, e.g., any degree, diploma or publication. I have gone through the draft of dissertation thoroughly and found it satisfactory for submission. The dissertation is therefore recommended and forwarded to the University of Rajshahi through the Department of Economics for necessary formalities leading to its acceptance in fulfillment of the requirements for the degree of Master of Philosophy in Economics.

Supervisor

Prof. Dr. Md. Elias Hossain
Department of Economics
University of Rajshahi, Bangladesh

ACKNOWLEDGEMENT

First and foremost, I record my best regards, profound gratitude, indebtedness and deep appreciation to my honorable and beloved supervisor Dr. Md. Elias Hossain, Professor, Department of Economics, University of Rajshahi, for his sincere supervision, inspiring guidance, enthusiastic encouragement and wise advices throughout the entire period of my research work. I am really grateful to him for giving me such a rare opportunity to work in close association with him.

I express my heartiest thanks to Professor Mohammad Ali, Chairman of the Department of Economics, University of Rajshahi for his help, advice and cooperation during the period of my research work. I am also grateful to all my teachers in the Department of Economics, especially, Professor Dr. Abdul Quayum and Professor A. N. K. Noman, who made my course work fruitful and helped me to enrich my knowledge.

My sincere and special thanks should also go to my teachers Professor Sanath Kumar Saha, Professor Dilip Kumar Nath and Dr. Abdur Rashid Sarker and to my colleagues Kazi Julfiker Ali, Zeenatul Islam, Md. Selim Reza, Noor-E-Sabiha and Md. Khairul Islam, in the Department of Economics, University of Rajshahi for their continued assistance during the entire research process. I am grateful to Dr. Mohammad Alauddin, Associate Professor, Department of Economics, The University of Queensland, Brisbane, Australia, for his kind cooperation. I also like to thank the office staffs of the Department of Economics, who have helped me a lot by many ways.

This study is based on the primary data. So, I express my deep appreciation to the households of three districts in Northern part of Bangladesh who were my respondents during the data collection. I greatly appreciate the work of all the enumerators in favour of my study during the primary stage of data collection.

I would like to thank my husband Sudeb Kumar Biswas for his continuous inspiration and maintaining all the responsibilities of my family. My only daughter, Spriha, who missed me a lot during my research period but always keeps her innocent love for her mother, inspired me a lot. I would like to extend my heartiest thanks to my parents and other members of my family for giving me encouragement and support to complete this work. I am really grateful to them. Finally, I thank all my friends and well wishers who directly and indirectly contributed to the completion of this research work.

ABSTRACT

One of the fundamental rights of the citizens of Bangladesh is food security for all which is stipulated in the constitution of the country. The overall conditions of the economy of Bangladesh keep getting better and the economy begins to find some stability. However, food security is still an issue in the last several years for the Bangladeshi people. At the national level, food security means the sufficient stocks of food to meet domestic demand and at the individual level it means that all members of the society have access to the food. So, it is important to identify whether Bangladesh is secured in food at national and household level and factors that influence the food security in Bangladesh. This requires analyses of the present situation of food security in Bangladesh, factors that are instrumental in influencing the level of food security, effects of different factors on food security, relevant policy issues and the ways forward towards ensuring food security condition in the country. Therefore, this research is an attempt to comprehensively study the food security status in three northern districts of Bangladesh. The paper employed a multistage random sampling technique to obtain 180 households through a structured questionnaire. Descriptive statistics, Food Security Index and Binary Logistic Regression model are employed to analyze the data. To estimate the model data has been collected from sample households from six upazilas of three districts - Rajshahi, Natore and Naogaon. The food security measures applied in this research are Head Count Method, Food Insecurity Gap and Squared Food Insecurity Gap to capture successively more detailed aspects of the food insecurity status of the households. Descriptive statistics is used to assess the socio-economic characteristics of the households and the Food Security Index is used to measure the household food security status. It is found that Bangladesh has made steady progress in the expansion of domestic food production. Net national food availability increased from about 27 million tons in 2004 to more than 32.0 million tons in 2013. However, the food expenditure has climbed up from Tk 2477 to Tk 6030 at national level, Tk 2299 to Tk 5542 in rural areas and Tk 3174 to Tk 7361 in urban areas during the period of 2000 to 2010 in Bangladesh. It is also found that average per capita per day intake of rice was 416.01 gm in 2010 in Bangladesh, which was 441.6 gm in rural areas and 344.20 gm in urban areas. The overall average daily per capita calorie intake by households is observed to be 2240.3 kcal in 2000 which increased to 2318.3 kcal in 2010. It is found that majority of households in the study area were food insecure as most of them subsist below the food security line which is 2280 kcal in this study. Using the recommended calorie approach, using the FAO benchmark of 2280 kcal per capita per day; households are profiled into food secured and food insecure, and it is found that 39% were food secured while 61% were food insecure. The shortfall or surplus index (P) indicated that, the food secured households exceeded the benchmark by 8% while the food insecure categories fell short by 9%. Eight main variables are used that can affect food security. These include: total monthly income, quantity of own cereal production, educational status of household, farm size, age of household head, household size, gender of household head and own livestock. Four factors are found to be statistically significant which are total monthly income, quantity of own cereal production, educational status of household and farm size. The analysis found that monthly income has a significant and positive effect on households' food security status. Farm size has a significant impact on food security and has expected sign that is, positive. Educational attainment level of household's head has also significant and positive impact on food security status of household. Quantity of cereal production has a significant and positive effect on household's food security status. However, age of household head, household size, gender of household head and own livestock are not statistically significant. Finally, some suggestions are made to increase the food security status of household level and at the national level in Bangladesh.

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LIST OF ABBREVIATIONS

ADEQ	Adult equivalent unit
BBS	Bangladesh Bureau of Statistics
BDHS	Bangladesh Demographic and Health Survey
BDT	Bangladeshi Taka
BIDS	Bangladesh Institute of Development Studies
BRRRI	Bangladesh Rice Research Institute
CIA	Central Intelligence Agency
DCI	Direct Calorie Intake
EP	Essential Priority
FAO	Food and Agriculture Organization
FFW	Food for Work
FIH	Total Number of Food Insecure Household
FPC	Fair Price Card
FSI	Food Security Index
FY	Fiscal Year
GDP	Gross Domestic Product
GHI	Global Hunger Index
GNP	Gross National Product
gm	Gram
GoB	Government of Bangladesh
GR	Gratuitous Relief
HCR	Head Count Ratio
HDI	Human Development Index
HIES	Household Income and Expenditure Survey
HYV	High Yielding Variety
INFS	Institute of Nutrition and Food Science
Kcal	Kilocalorie
kg	Kilogram
LE	Large Employee
LPM	Linear Probability Model

MLE	Maximum Likelihood Estimation
MoA	Ministry of Agriculture
MoFDM	Ministry of Food and Disaster Management
MT	Metric Ton
NGO	Non- Government Organization
NNS	National Nutrition Survey
OLS	Ordinary Least Squares
OMS	Open Market Sales
OP	Others Priority
PFDS	Public Food Distribution System
RLF	Restricted Log-Likelihood Function
SAARC	South Asian Association for Regional Cooperation
SFIG	Squared Food Insecurity Gap
TFR	Total Fertility Rate
Tk	Taka
TR	Test Relief
ULF	Unrestricted Log-Likelihood Function
US\$	US Dollar
USDA	United States Department of Agriculture
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
WB	World Bank
WFP	World Food Programme of the United Nations
WFS	World Food Summit
WHO	World Health Organization of the United Nations

CHAPTER ONE

INTRODUCTION

1.1 Overview

One of the fundamental rights of the citizens of Bangladesh is food security for all which is stipulated in the constitution of the country. Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to maintain healthy and productive lives (World Food Summit, 1996). The key elements of food security are availability of food from domestic production and imports, access of the people to food all times at their available income, and that the food ensures enough safety and nutrition to maintain good health. Bangladesh is an agriculture dependent country in South Asia with a total population of around 160 millions. The major source of livelihood of the people of Bangladesh is agriculture. Around three fourths of the total population of Bangladesh are living in the rural areas and about 90% of the rural families are directly involved with agriculture and agriculture related activities.

At the national level, agriculture sector employs about 51% of the total labour force of the country and provides over 90% of the rural employment (BBS, 2004). Although the relative share of agriculture in the GDP has been declining in the recent past, it still contributes around 19% to the total gross domestic product of the country (BBS, 2013). However, rapid population growth, increased food demand, natural disasters and urbanization are the main reasons which have created tremendous pressure on agricultural land, making it an increasingly scarce resource. As a result agricultural land per capita has been decreasing over the years in Bangladesh. Food security, therefore, remained as an important concern in Bangladesh and in the real sense, nearly 30% of the population still cannot afford an adequate diet (BBS, 2010).

Food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as

carbohydrates, fats, proteins, vitamins, minerals, etc. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, or stimulate growth. An adequate food intake, in terms of quantity and quality, is essential for healthy and productive life. Although enough food is available in the world, a huge population, majority of whom live in the Asian countries, continue to experience inadequate access to food intake despite progress with respect to food availability (WHO, 1998). Ensuring the availability of food requires enough production or import of food in terms of calories available per day for every person in the population. The Nobel laureate economist Amartya Sen pointed out in his analysis of famines that it occurs not because of unavailability of food, but due to non-accessibility to the food (Sen, 1981).

In the last several years, the overall condition of the Bangladesh economy keeps getting better and the economy begins to find some stability. However, food security still remained as an issue to the people of Bangladeshi. Because, in spite of important economic progresses achieved, the country remains highly food-insecure. Bangladesh is ranked 68th out of 79 countries in the 2012 Global Hunger Index (WFP, 2013). The Household Food Security and Nutrition Assessment (2008-2009) of WFP found that 37 million people, almost a quarter of the population, in Bangladesh are food insecure. Again, low dietary diversity is a persistent problem in Bangladesh, and showed no significant change across all income groups even though the country experienced a significant decline in poverty (World Bank, 2010).

At the national level, food security means availability of sufficient stocks of food to meet domestic demand, and at the individual level, it means that all members of the society have access to the food. An individual may consume food from their own production or they buy it from market or they may receive from the government's transfer payment programmes. In this viewpoint, Bangladesh has achieved food security at national level but at individual level the country has not achieved food security in terms of access to food (Clay *et al.*, 1988). The country experienced famine in 1974 due to the destruction of infrastructure during the liberation war against Pakistan in 1971 and successive natural disasters which caused reduction in rice and other crops production. In view of that experience, long run food security and

achieving self-sufficiency in rice production was an important policy issues of Bangladesh government (Dorosh *et al.*, 2004). According to a report of the ministry of food, by the end of the 1990s food grain production in Bangladesh has exceeded the target requirements based on 454 gram per person per day. However, food security has not been achieved yet now and the progress that has been achieved was found difficult to sustain because of growing pressure of population in the context of extremely scarce natural resources (Hossain, 2005). Moreover, Domestic food grain production of Bangladesh remains vulnerable due to floods, droughts and other climatic change events which may continue to cause production shortfalls and inadequate food availability. Increases in cereals production have not been accompanied by significant increases in availability of other foods (Hossain, 2005).

In Bangladesh, poverty and food security are intertwined as poverty is considered as the major cause of food insecurity in the country. The incidence of poverty, as measured by the headcount ratio, is 31.5% in 2010. Over the 1984-2010 periods, total population increased by about 52.0 million and the number of rural poor stood 38.7 million in 2010. The number of urban poor, however, increased by 2.0 million over the same period (BBS, 2011). The persons who are living in chronic poverty are most vulnerable nutritionally. The incidence of absolute poverty (in terms of percentage of total population with less than 2,122 kcal/person/day) was 40.4% in 2005 (BBS, 2005) while the incidence of hardcore poverty (with less than 1,805 kcal/person/day) increased during the late eighties (1988-89) and is remained as 20% in 2010.

Bangladesh's high poverty and under nutrition rates are worsen by frequent natural disasters and high population density. Poverty alleviation is a core challenge for Bangladesh. Because of poverty, malnutrition is also a fundamental problem in Bangladesh. To reduce poverty and malnutrition of the people of Bangladesh, it is necessary to accelerate the growth and productivity of agriculture sector along with non-farm sectors of the country. The country also needs to improve the quality of social services, and to ensure proper functioning of its community and rural institutions with the expansion of rural infrastructures.

In Bangladesh, food security is tried to be achieved by increasing the production of rice both by employing modern agricultural technology as well as by increasing the area under rice production. Some time efforts and policies to expand production of other cereals were also taken. The rapid expansion in the production of cereals was partly achieved through reductions in area for production of pulses, oilseeds and sugarcane. Pulses and oilseeds are important sources of protein and micronutrients, especially for the poor. The decrease in the production of these crops has had adverse impact on nutritional balance among the people. There has been perceptible decline in the production of pulses and sugarcane, and somewhat of oilseeds. The productions pulses, oilseed and sugarcane have either remained stagnant or has declined. The production of oilseeds has picked up in recent years due to favorable prices, some progress in the development of higher yielding varieties. The dependence of Bangladesh on the world market for the availability of pulses, edible oil and sugar and milk has been growing.

Bangladesh is also dependent on import of many food items to meet the demand of the growing population. In the recent past years Bangladesh is seen to import rice in the years following poor harvests due to floods and droughts. In some years, following bumper harvests, the government declared achieving self-sufficiency in rice production, only to find the country slipped back to import dependence to meet increasing demand of growing population. The import of wheat has increased over time despite the growth in domestic production due to the reduction in food aid in recent years. Recent wheat imports have reached 3300 thousand million tons in 2014 (USDA, 2014). The other food items for which imports have been increasing fast are oils, pulses, sugar, milk and fruits. The rapidly rising imports of these food items are becoming a major drain on limited foreign exchange earnings of the country. Another thing is that although food grain is more available in good harvest years, Bangladesh as a whole still has a very low level of nutrition. This means many households and individuals cannot manage to eat a balanced, nutritious diet, even in good years.

During the last two decades, Bangladesh has made significant progress in several areas such as higher child immunization rates, augmented life expectancy, lower infant mortality, declining total fertility rates (TFR) and larger number of people

having access to safe water. Despite these gains, the public health scenario is dismal in Bangladesh. Access to adequate healthcare still eludes many. Prevalence of malnutrition, particularly child malnutrition is very high. Rural-urban disparity in child malnutrition is quite stark with the percentage of rural malnourished children being significantly higher than that of urban areas. Bangladesh also has one of the highest prevalence of low birth weight children in the world.

Despite the impressive gains in increasing domestic food grain production, problems of food and nutrition security still remain. Bangladesh is yet to achieve comprehensive food security that resolves the problems of inadequate food intake and chronic malnutrition among those who are poor and vulnerable. Addressing these problems satisfactorily would not only require rethinking of strategies and policies to promote food security in the country but also require decisive actions by all stakeholders- the government, the NGOs, the private sector and individual households. In fact, ensuring food security through physical availability and economic access to food would continue to be a major challenge for Bangladesh in the coming years. To meet these challenges, an integrated strategy encompassing major aspects of comprehensive food security namely, (a) adequacy of food supply through increased domestic production and imports (b) access to food through public distribution and expanded safety net programs and (c) improved food utilization and nutrition is required.

As far as the above issues of food security are concerned, Bangladesh faces formidable challenges to feed its population in the future from an increasingly vanishing and degraded natural resource base for agriculture. Crop agriculture in Bangladesh is heavily dominated by the cultivation of rice and over the last four decades Bangladesh has experienced significant growth in food grain production mainly due to increasing reliance on high yielding variety (HYV) rice, especially in the Boro (winter) season. However, crop agriculture has to face many challenges. Natural disasters regularly damage output. In many places there are serious problems with soil degradation and poor seed quality. The technology development and dissemination systems are constrained by both lack of resources and institutional weaknesses. In addition, water-use efficiency is low and climatic variability is already

exacting a heavy toll on agricultural production. The future climate changes are likely to magnify these adverse effects.

Food security has been emphasized on the policy agenda of the government of Bangladesh and the government has been making efforts to augment domestic production of food grain through technological innovations and investments in irrigation, infrastructure development and subsidies. Food security is an intricate issue which includes diverse aspects as well as many linkages. A better understanding of food security dynamics and its linkages with poverty, adverse shocks (such as massive floods and droughts), rural income, is important. Appropriately targeted income transfers, credit programs and other initiatives in times of crisis may generate very high pay-offs in reducing poverty and improving food security. These interventions should be part of a broader social protection strategy that is both cost-effective and comprehensive in coverage.

1.2 Problem Statement

Bangladesh is one of the lowest income and most densely populated countries in the world. Though Bangladesh is among the major rice producing countries in the world, it is very difficult for her to meet the increasing food needs of her growing population. Besides, very often the price hike of the basic foods is causing sufferings for the people of low and middle-income groups in managing their needed food intakes. Slow growth of food production, and low per capita income have contributed to the decrease in food intake causing malnutrition in Bangladesh. In Bangladesh, about 60% of the rural children are malnourished, and the infant mortality rate in Bangladesh is about 35 per 1000 live births (World Bank, 2012).

Thus, the issue of food security turned to be a burning issue for the country. Giving importance to this issue the governments of the country at times have adopted various policies to increase food production and thereby increasing the availability of food to the people of the country. As a result of these measures, Bangladesh has made steady progress in the expansion of domestic food production. Net food grain production increased from about 10.0 million tons in the early 1970s to more than 33.0 million

tons in fiscal year 2012-2013. This growth in production has been achieved through expansion of irrigation facilities, spread of modern varieties and increase of cropping intensity (Talukder, 2005). Moreover, the government has taken measures to import various food items through the private sector when needed. According to various reports and opinions of the experts, at present there is enough availability of food in the country. This fulfills a significant condition of food security in the country.

Although there remains complacency about achieving the target of food availability through food production and food import, controversy exists as to the state of self sufficiency in production of different food items in the country. A disaggregated account of production of individual crops portray a gloomy picture of food security in the country as food self sufficiency in Bangladesh has long been synonymous with achieving self-sufficiency in rice, the dominant staple food. In terms of other crops self sufficiency situation is still vulnerable.

Over the past years Bangladesh has made remarkable progress in rice production and the production of rice has increased from 11 million metric tons in 1971 to 33 million metric tons in 2012 (BBS, 2012). The growth of rice production has increased due to the adoption of higher yielding crop varieties developed by scientists, supported by rapid expansion of irrigation infrastructure through private investment in tube wells. The second staple food of the people of Bangladesh is wheat and recently, the country has progressed in wheat production. The production of wheat has increase from 112 thousand million metric tons in 1971 to 1260 thousand million metric tons in 2013 (BBS, 2013). Besides this progress, Bangladesh is used to receive substantial amount of wheat as food aid from developed countries. Commercial import of wheat has however, increased despite growth in domestic production. The import has recently exceeded 3 million metric tons. It appears that although Bangladesh achieves self-sufficiency in rice production, the import of wheat indicate that the country is not self-sufficient in wheat production.

Maize is one of the oldest and most important crops in the world. It is the highest yielding grain crop having multiple uses (FAO, 2004). Now maize has become an important cereal crop in Bangladesh as well. The production of maize in 1999 was

4075 million metric tons which increased to 521525 million metric tons in 2005. In 1999, per hectare maize production was only 1.29 metric tons and the rate increased to 5.30 metric tons per hectare in 2005 (BBS, 2006). Potato is among the major staple foods in the world. It is rich in calories, carbohydrates and proteins and substantial amount of vitamins. Potato tuber contains about 75% to 80% water, 16% to 20% carbohydrates, 2.5% to 3.2% crude protein, 1.2 to 2.2 protein, 0.8% to 1.2% mineral matter, 0.1% to 0.2% crude fat, 0.6% crude fibre and some vitamins (Schoenemann, 1977). Potato emerged as a major crop in Bangladesh and is being cultivated on an area of around 520 thousand hectares every year. The total production is 7800 thousand metric tons with an average yield of 15 tons/hactare. Bangladesh has become a major potato producer in the SAARC countries.

In Bangladesh, people are basically dependent on major cereal crops- rice, wheat and maize etc. for food and in a situation increasing population in our country, such an over dependence on cereals results in increasing vulnerability regarding food security, in the decades to come. In such a situation, potato can help to widen the food supply base and thereby help to minimize the risk of serious food shortages (Uddin *et al.*, 2010). The major problem faced by potato and vegetable production is the volatility in prices leading to large year to year fluctuations in production. Another problem faced by potato and vegetables production is lack of cold storage and agro based industries in Bangladesh which could ensure the supply of potato and vegetables for all the people at all times of a year (Islam *et al.*, 2008).

Fish occupies a significant position in the daily dietary habits of the people of Bangladesh. The country has rich biological resource base for fish production. The growth in fish production was sluggish in the 1970s, it picked up in the 1980s. Recently, the growth of fish production is about 7% per year and it has become possible due to the expansion of pond aquaculture. The total fish production was 1781057 metric tons in 2000-01 fiscal year which increased to 2899198 metric tons in the fiscal year 2009-10 (GoB, 2010). However, production of fish and fish products are not sufficient in relation to the total nutritional needs of the people of the country.

The growth in the production of meat and milk has also remained unsatisfactory despite the expansion of the poultry industry in Bangladesh. With economic progress, the demand for animal products has been growing fast. The growth in livestock and poultry farming is constrained by lack of feed, risk imposed by various diseases, and poor processing, storage and marketing infrastructure. Meat, milk and egg production has increased significantly over the last ten years. However, the shortage is still present. In FY2001-02 total production of meat was only 0.78 million metric ton which increased to 2.95 million metric ton in FY2010-11. Total milk production was 1.78 million metric ton in FY2001-02 and increased to 1.98 million metric ton in FY2010-11. Again, the total production egg was 4424 million and the production increased to 6078 million in FY2010-11. Another food items is fruit which contain low calories and fat, but are a source of simple sugars, fiber, and vitamins, and essential for optimizing our health. Fruit's health benefiting properties are crucial because of their richness in vitamins, minerals, micro-nutrients, pigment anti-oxidants. The production of fruits has increased from 17.25 thousands metric tons in 2004 to 32.68 thousand metric tons in 2012. However, production of fruits is not sufficient in relation to the total demand of the people of the country.

Thus, it is evident that although Bangladesh has obtained success in increasing production of various food crops and other food staffs, the achievement is not satisfactory when it is observed from a disaggregated viewpoint. While the total production of major food crops gives an indication of achieving food security in terms of availability of some foods grains relative to the total requirement, national self-sufficiency with respect to production within the country gives a dismal scenario as Bangladesh achieved self sufficiency in the production of rice and potato only.

However, food security not only implies availability of food staffs in the country but also implies physical and economic access of the people to the required amount of food from the viewpoint of healthy nutrition. Economic accessibility to food is directly linked with the purchasing power of the people. It means, food availability in the market has no significance for food security for the people unless people can afford to buy those foods. For food security food price must be reasonable so that

people can purchase it. That means, food security is actually related with sufficient income or supports those make food available.

Food access depends upon income available to the households, on the distribution of income within the households and on the price of food. It is ensured when households and all individuals within them have adequate resources to obtain appropriate foods for a nutritious diet. Therefore, the sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households ensuring food. In Bangladesh, per capita income remained low until the end of the 1980s due to slow growth in Gross National Product (GNP) and high growth in population. Income growth accelerated since 1990 and it reached above 6.0% in the recent years. The per capita income of the people of Bangladesh is now US\$ 1044 (BBS, 2013).

During the last fifteen years, monthly household expenditure has risen at national level and this has increased both in rural and urban areas. The household expenditure has scaled up mainly due to the higher food expenditure. The food expenditure has climbed up from Tk 2477 to Tk 6030 per household at national level, Tk 2299 to Tk 5542 in rural areas and Tk 3174 to Tk 7361 in urban areas, during the period of 2000 to 2010 in Bangladesh. It is to mention that this food expenditure has increased at a faster rate than that of income. During the period of 2000 to 2010, the monthly household income has increased with a growth rate of 18.20%. At the same time, the monthly household food expenditure has risen with a growth rate of 19.72%.

Besides the issues of availability and access to food, Bangladesh also faces the challenge of nutrition security, given its high though declining poverty and malnutrition levels. Although the incidence of poverty declined from 40% in 2005 to 31.5% in 2010, still large proportion of population live below the poverty line. While growth alone cannot take care of the vulnerable groups and social safety net programs are needed, it is also true that higher growth resulting in greater employment and income earning opportunities is a more sustainable solution to ending malnutrition and hunger. Malnutrition is a serious challenge in Bangladesh since it causes almost a third of children to be underweight or stunted and poor nutrition is responsible for a large number of child deaths in the country.

Food nutrition implies energy intake obtained from food consumption which is measured by the unit of kilocalorie. It is found from different studies that total calorie intake derived from consumption of food items by the people of Bangladesh on the average is lower than required. Apart from the prevailing deficit in total calorie intake, the normal diet of Bangladeshi people is seriously imbalanced, with inadequate consumption of fat, oil and protein, and with more than 80% of calories derived from cereals. This dietary imbalance reflects insufficient domestic production of non-cereal foods like pulses, oilseeds, fruits, meat, milk and eggs along with low incomes, and lack of nutrition education (Hossain *et al.*, 2005). For example, rice is the main item of foods for consumption in both rural and urban areas of Bangladesh. Average per capita per day intake of rice was 416.01 gm in 2005 in Bangladesh, which was 441.6 gm in rural areas and 344.20 gm in urban areas. The second important food item was observed to be vegetables and the consumption rate was about 166.10 gm. per capita per day at the aggregate level.

The National Nutrition Surveys conducted by the Institute of Nutrition and Food Science (INFS) report a consistent decline in the energy intake till the mid-1990s. More recent data is not available. Per capita energy intake for rural people reportedly has declined from 2251 kcal during 1962-64 to 2094 kcal in 1975-76, 1943 kcal in 1981-82, and further to 1892 kcal in 1995-96. The decline in the protein intake was even sharper. In contrast, the Household Income and Expenditure Survey (HIES) data show that during the early 1980s and 1990s, per capita calorie intake went up steadily for the rural population, but declined for the urban population due to the reduction in per capita cereal consumption. Between 1991-92 and 2000, urban per capita calorie intake fell by about 5%, from 2258 kcal to 2150 kcal. Thus the picture on the trend in nutritional status obtained from different sources is confusing. It remains an issue of great controversy.

The proportion of the population living under the poverty line still remains very high and high levels of income inequality is persisting in Bangladesh, a significant proportion of population lives below the food consumption-based poverty line, lacking sufficient resources to afford diet of 2122 kilocalories (kcal) per person per day, along with other basic necessities (HIES, 2010). Women and children are

especially vulnerable due to their greater nutritional requirements (WEP, 2013) and according to USAID, 43% of children under five years old suffer from some kind of malnourishment, and 30% of the women have low body mass index.

There have been a number of studies focusing on the food security conditions of the developing countries. However, studies on food security of Bangladesh are very few (Paul Dorosh, 2002). Moreover, the studies made are mainly based on surveys. Use of qualitative and quantitative methodologies is very rare in those studies. Hence, it is worthwhile to investigate the determinants of food security of the households of Bangladesh in a more scientific way. Moreover, research on food security in the context of rural and urban households of Bangladesh are very scant. Food security situation at rural and urban areas of Bangladesh are completely different and factors influencing the food security situation in the rural and urban areas are also different.

Focusing on the above components of food security concept and the prevailing situation of poverty and inequality, uncertainty persists as to whether Bangladesh is food secured at national and household levels. As there are many dynamics related to poverty, employment, government policy issues many factors turn to be instrumental in the solution of food insecurity in the country and these factors play diversified influence on food security in Bangladesh. Thus, the relevant research questions concerning food security that need to be answered are:

- (a) What is the present situation of food security in Bangladesh at both national and household levels?
- (b) Which factors are instrumental in influencing the level of food security?
- (c) What are the effects of different factors on food security?

These relevant questions regarding the food security of Bangladesh need to be analyzed through estimating the level of food security in Bangladesh. It is to note that the existing studies are not enough to generalize the above questions in the context of Bangladesh. Therefore, the researcher has taken on the issue of food security in the light of the above questions for empirical investigation in three districts of Bangladesh.

1.3 Objectives of the Study

As food insecurity has multidimensional interrelationship with development issue, ensuring food security for population in Bangladesh is a crucial step of development policy. Therefore, the main objective of the present study is to analyze the food security status of Bangladesh. The specific objectives of the study are as follows:

(i) to analyze the food scenario of Bangladesh at the national level.

(ii) to estimate the food security status at the national level and household level in the rural area.

(iii) to identify the factors influencing food security at household level in the rural areas of Bangladesh and to measure quantitatively the impact of those factors on food security.

(iv) to put forward some policy suggestions towards achieving food security in Bangladesh.

1.4 Justification of the Study

Despite a dramatic increase in global food availability and substantial progress in poverty reduction, hunger, food insecurity and undernourishment remain at unacceptably high levels and progress in addressing this dimension of poverty has been disappointingly poor. Research highlighting the issue in the context of Bangladesh is also very scant and the available ones are insufficient to cover all the aspects of food security. Some researchers believe that improving the performance of agriculture sector food security could be ensured. Others state that the causes of food insecurity and hunger are complex and that improving performance of agricultural sector is less important than tackling the underlying poverty that remains the fundamental cause of food insecurity and hunger. The world produces more than enough food to feed its population. However, the reality is that still a significant proportion of the total population of the world remains under fed. Hence, how food security can be ensured in such a situation is a critical question.

So it is necessary to conduct research focusing on these areas to get proper understanding of the food security problems and its solutions in the case of Bangladesh. The intended study scrutinized the situation of food security and the impact in different dimensions. It will shed sufficient lights on these issues. This study synthesizes evidence concerning the role of agriculture in reducing food insecurity, particularly its roles in making food available at lower prices, and in generating incomes so people can buy food. The findings of this research would be an effective working guide for the policy maker of the Bangladesh Government's related Department. Researchers of food and nutrition faculties under different public and private institutions and organizations will also be benefited from this study. And lastly, the results of this research will be an invaluable resource for those who will work in this research area in the future.

1.5 Organization of the Thesis

This thesis have been organized and divided into seven chapters. The first chapter provides an overview of the impact of socioeconomic factors on food security in Bangladesh including, the research problem, study objectives and justification of the study. Chapter two provides a review of literatures covering the issues of food security, the methods of analyzing the linkages between socioeconomic factors and food security pattern, the empirical results of the earlier studies with some literature gaps. Chapter three deals with and explains the concepts and theoretical linkages of the study. It explains the concept of food security and insecurity, food security with some flowcharts exhibiting the interactions and the interdependencies between socioeconomic variables and level of food security. Chapter four provides the methodology of the study and describes the data in details. It also describes the specification of model equations and estimation techniques, the definition of different variables, the study area and the method of sampling and data collection as well. Chapter five provides an overview of the food related scenario in Bangladesh has been discussed. Chapter six, deals with the estimation results and discussion of findings. The final chapter contains the study summary and policy implications of the study findings. It concludes with some policy suggestions and guidelines to food security in Bangladesh.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The objective of this chapter to provide a comprehensive review of literature that dealt with different aspects of food security in the context of Bangladesh as well as other countries. Literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions related to a particular research topic. Literature review is a useful starting point to putting into context the research issue. Thus, the purpose of literature review is not only to provide an exhaustive review of previous literature but also to illustrate various methodologies used to analyze different aspects of food security and main results obtained in these studies.

In this research, various aspects of food security concepts are analyzed and the measures of food security estimated and the relevant linkages are explored. There are several literature and empirical studies on this issue. The review of those pervious literature play a positive role in moving this research study forward by identifying important unsolved theoretical questions and also focusing the results of recent empirical studies and providing the integrated assessment of our current condition. To do so, this study focuses on the following questions:

- a) What is the relationship between socio-economic factors and food security?
- b) How does the relationship exist in the components of food security?
- c) How does the relationship exist in different region and country context?
- d) What are other aspects related with food security?
- e) What are differences found in the studies with respect to methodologies used and results found?
- f) What are the gaps remaining in the existing literature?

To answer these questions, this chapter is organized into five sections. Section 2.2 describes the different literature on food security that is a brief analysis of different context and aspects of food security such as country, areas, components of food security and others. In the following Section 2.3, we have tried to describe empirical approaches and econometric methods used in different studies. Section 2.4 provides the major findings that were found in previous studies and weakness in the existing literature. Finally, conclusion on this chapter is provided in section 2.5.

Literature on Food Security: Contexts and Types

The socio-economic factors of individual households have been identified as basic factors influencing the food security status of households (Sanusi *et al.*, 2006). This has led to the measurement of the food security status of households in large population using several studies. However, Food security has been defined as a situation when all people, at all times, have physical and economic access to sufficient, safe and nutritious food needed to maintain a healthy and active life (FAO, 1996). The implication of this definition is that achieving food security requires that the aggregate availability of physical supplies of food is sufficient, that households have access to those food supplies through their own production, through the markets or through other sources and that the utilization of those food supplies is appropriate to meet the specific dietary needs of individuals households (Babatunde *et al.*, 2007). However, there are some studies which tried to investigate the conceptual components of food security in the context of different study areas for example, Sharmin *et al.* (2009), Kashem and Faroque (2011), Faridi and Wadood (2010), Uddin (2011), Chowdhury (2009), Ploeg (2009), Meade and Rosen (2002), Wehler (1995), Okwudilio and Wheelock (2006), Elijah (2010), Orewa and Iyange (2010), Rahman and Islam (2012), Hossain *et al.* (2005), McDermott *et al.* (2013), Saaka and Osman (2013), James and Ruel (1999), Osei *et al.* (2010). Extended studies have been done on different aspects and issues relevant to food security in home and abroad. Especially, food security has become one of the most important issue for the government of Bangladesh and to reduce poverty and improve food security both national government and international community have developed several policies and programs (Paloma and Loushichi, 2013). Several studies have been conducted in the area context and the field of food security in the households. For example,

Babatunde *et al.* (2007), Hossain *et al.* (2009), Ramakrishna and Demeke (2002), Arun and Keshav (2006), Yusuf *et al.* (2011) analyzed the food security of rural/farming households. Omonona and Agoi, (2007), Sultana and Kiani (2011), Iorlamen *et al.* (2013) studied the food security of urban households. Talukder (2005), Islam *et al.* (2009), Salam *et al.* (2009), Hossain *et al.* (2013) analyzed the food security pattern of Bangladesh. Some researchers have concentrated on other related aspects of food security for example, Ojo and Peter (2012), Jacobs (2009), Paloma and Loushichi (2013), Nawrotzki *et al.* (2014), Kahane *et al.* (2013), Muzaffar (2009), Hanjra and Qureshi (2010). The available literature which the researcher has reviewed are synthesized in the following sections.

2.2.1 Availability of and Access to Food Security

Availability of food in a country can be ensured through domestic production, net imports (commercial or food aid) and carry-over of stocks. Such food can be supplied through household production, other domestic output commercial imports or food assistance. There are some studies which tried to investigate the components of food security in different contexts.

Food security is an important factor that contributes to a country's socio-economic stabilization and development. At the initial stage food security depends in both availability of and access to food in the country. Kashem and Faroque (2011) focused on the availability of food as an essential element of the concept of food security and role of government to get food sufficiency. They found that despite the growth in food production and its availability, food insecurity is still a major problem mainly because of the lack of purchasing power and thus of access to food, especially for the ultra poor community. They also found that Bangladesh attained self sufficiency in food production in 2010-2011 with a gross production of rice and wheat of 35.3 million metric tons which marginally met the country's requirement for the population of 148.69 million, taking 453.6 gm per capita per day requirement. However, production of vegetables and fruits, fish and livestock (meat, milk and egg) has increased and is critical in ensuring food availability at both national and household levels. The study also found that Government of Bangladesh is trying to integrate and address all the

elements associated with food security to achieve touch the MDG setting for the country.

Different household characteristics seem to be strongly correlated with food security indicator which might be helpful in identifying the food insecure households. Faridi and Wadood (2010) investigates the determinants of household food security situation in Bangladesh using a logistic regression model. The regression result of the study indicated that food security indicator is also highly sensitive to rice price changes. The study also revealed that comparison of different occupational groups was also studied with the findings that wage earners, both daily wage and salary wage earners, are worse off in terms of food security status compared to self, employed, both in agriculture and non-agricultural sector. They suggested that it is very important to understand the dynamics of these factors since alleviation of food insecurity among the vulnerable is crucial in the current scenario of high food grain prices for policy making.

Smith *et al.* (1999) explained that causes of food insecurity in developing countries. The study examined that the relative importance of two of food insecurity's most basic causes: national food availability and the inability of people to access food due to poverty. They found that little correlation between national food availabilities and food insecurity using child malnutrition as a proxy. The study revealed that exhibit the highest severity of food insecurity are those with high poverty and food (dietary energy) surpluses, consistent with the view that poverty is the most widespread cause of food insecurity in the group of countries. The study suggested that the appropriate geographical and policy targeting to improve food security for the greatest numbers of people at the fastest pace.

It is always agreed that access to food is an important component of food security and there are some researchers who concentrated on different aspects of access to food in different contexts. Uddin (2011) analyzed the household food security status of the marginal farmers in a selected storm surge prone coastal area of Bangladesh. The study also assessed the extent of livelihood vulnerability and coping strategies of the storm surge affected marginal farmers. The finding of the study revealed that 56.67%

of marginal farmers were food insecure while 30% were moderately food secured and only 13% were food secured. They also found that though, adequate food was available in local markets those were beyond affordability of the marginal people. The partial food insecurity was due to poor food utilization in marginal farmers' family. The most three valuable options of livelihood for the marginal farmers were crop farming, fish farming and livestock farming. The study observed that respondent farmers adopted six self coping strategies and three assisted coping strategies to cope with the vulnerability and food insecurity. The self coping strategies were decreasing the number and size of daily meals, consumption of naturally obtained, selling labor at very low rate, selling fixed and movable household assets, contracting new loan at a high interest rate and cultivation of short duration crop. On the other hand, assisted coping strategies include relief food, social network and begging.

Chowdhury (2009) investigated physical and economic access to food. The study explored the link between landlessness and access to food in rural Bangladesh. The study found that in Bangladesh, food insecurity remains for millions of farmers and landless laborers. Due to increasing population, unjust market intervention, poor governance, medium and small farmers are losing their productive land and becoming landless gradually. Moreover, climate induced hazards, such as recurring floods, cyclones, river bank erosion are also contributing to the increasing landlessness of this section of people. The study revealed that even though 75% food production comes from the rural areas, due to landlessness and some associated factors, the small and marginal farmers in the rural areas are still deprived from their access to food. Landlessness of the farmers leads to their insufficient purchasing power to buy adequate nutritious food for their families.

Ploeg (2009) assessed the extent of areas with limited access to affordable and nutritious food. The study found show that a small percentage of consumers are constrained in their ability to access affordable nutritious food because they live far from a supermarket or large grocery store and do not have easy access to transportation. Urban core areas with limited food access are characterized by higher levels of racial segregation and greater income inequality. In small-town and rural

areas with limited food access, the lack of transportation infrastructure is the most defining characteristic.

Meade and Rosen (2002) analyzed the state of access to food in nine developing countries in Latin America. In these countries, annual per capita income ranged from \$430 in Nicaragua to \$2390 in Peru in 1999. The annual cost of a low-cost food basket averaged \$130, ranging from a low of \$88 in Guatemala to a high of \$154 in Colombia. They found that the food security threshold to purchase food and basic necessities is double the cost of the food basket, averaging \$260, with a low of \$176 in Guatemala and a high of \$309 in Colombia. Average incomes are still above this threshold in all nine countries, but as because incomes are distributed unevenly, some segments of the populations face inadequate purchasing power and cannot afford sufficient food.

Wehler (1995) investigated the issue of hunger in families with children, specifically intending to detect food insufficiency resulting from limited household resources in developing countries. The study found that the amount of financial resources (i.e. income, food stamps), rent and utilities have important effects on food insufficiency. He explained that food insecure families are characterized by very low-income, spending a significantly large amount of income on shelter compared to food secure families. He found that affected children are more likely to suffer from ill health in terms of fatigue, lack of concentration, weight loss and chronic illnesses (such as colds and ear-infections), and children from these families are more likely to miss school, hence affecting their performance.

Okwudilio and Wheelock (2006) analyzed food insecurity status of low-income households in selected Southern States in USA. They used logit model to analyze the food security status of sample households. They classified the sample households into two categories namely households with children and households without children. They found that income is a significant factor that affects food security and food insecurity status of the households. Elijah (2010) assessed the food security of households based on certain demographical characteristics with 'Rasch model' in the two selected states (Kogi and Kwara) of the North-Central Nigeria (NCN). The study

showed that only 23.7% households are food secure (FS) in the study area. It is also found that 15.5 % and 37.4% adults and children respectively are food secure. While 18% households are FS in the urban areas, only 13.7% are FS in the rural areas of the NCN. In addition, 21.9% female-headed households are FS and 14% male-headed households are FS. He also found an inverse relationship between household size and food security in the study area. Households with small sizes of ≤ 3 members are more FS (25%) compared to those (15.1%) with larger sizes of 8-11 members.

2.2.2 Food and Nutrition Security

There are several studies investigating the nutritional aspects of food security. Rahman and Islam (2012) explored the nutritional status and food security of farm households under different land use patterns in Bangladesh. The study estimated the impacts of changing land use patterns on food security for the farm households. The study revealed that households of alternate shrimp and rice farming consumed the highest amounts of food followed by year round shrimp farming whereas the highest per capita calorie intake was observed in households of alternate rice and wheat production. But households of year round shrimp farming generated the highest amount of income followed by households of alternate shrimp and rice farming, year round banana production and year round floriculture, respectively. But there were no systematic and regular patterns of relationships among income, food, protein and calorie intakes in different land use patterns. Large households consumed the highest amount of food and protein followed by medium, small and marginal households, respectively. They concluded that all land use patterns should be made sustainable to the farmers by properly addressing environmental factors and by easing access of farmers to inputs and outputs markets by the government.

Hossain *et al.* (2005) examined the progress of food and nutrition security in Bangladesh. The study analyzed that the country has made good progress in increasing rice production through technological progress, facilitated by private sector investment in small scale irrigation, although it is difficult to sustain the progress made in view of the growing pressure of population on scarce land resources. They found that the availability of other foods has not increased and the progress in

nutritional outcome has remained slow. The study also found that 40% population live below the poverty line and income inequality has been worsening which affect food production, availability of food and their impact on nutrition outcomes.

McDermott *et al.* (2013) explained the contribution of agriculture to households' nutritional security in the context of developed economy. They found that agriculture improve households' nutritional. They suggested producing diversified crops, highly nutritious crops, bio-fortified foods etc. to improve nutrition of people. They also suggested to ensure safety of food, health service, pure water and sanitation, social protection, social protection etc. Lawal and Jibowo (2006) assessed the impact of household food security and nutrition program on the nutritional status of children (0-5 years) in Oyo state in Nigeria. The results of the study showed that women farmers who participated in programme activities possess some personal and household characteristics which influenced the nutritional status of the children. The result also indicated that the need for constant surveillance and collaborative efforts of the health, agricultural extension and education departments in providing women farmers with the education and training needed to reduce the incidence of malnutrition and food insecurity.

Hanson and Connor (2014) analyzed the associations between food insecurity and dietary quality in US adults and children. The study found that food insecure adults consumed fewer vegetables, fruit, and dairy products than did food secure adults and had lower intake of vitamins A and B-6, calcium, magnesium, and zinc. The study also found that food insecure children consume less fruit compared to food secure children. Saaka and Osman (2013) examined the magnitude of household food insecurity and its consequences on the nutritional status of children 6–36 months in Tamale Metropolis of Northern Ghana. They measured household food insecurity access scale (HFIAS), household dietary diversity score (HDDS), and food consumption score (FCS). They found that of the three food access indicators, 30-day HFIAS was not related to any of the nutrition indices measured. HDDS and FCS were both significantly associated with BMI of mothers and chronic malnutrition (stunted growth) but not acute malnutrition (wasting) with FCS being a stronger predictor of nutritional status. Compared to children in food insecure households, children in food

secure households were 46% protected from chronic malnutrition. The results of this study showed that different measures of household food insecurity produce varied degree of the problem. Efforts at reducing chronic child malnutrition should focus on improving the adequacy of the diet.

James and Ruel (1999) showed that income is an essential determinant of calorie availability and nutritional outcomes in both rural and urban area in Mozambique. He explained that income-generation in both urban and rural areas is undoubtedly important for achieving food and nutrition security in Mozambique, although there are some debate about the effectiveness of increasing income in reducing food insecurity and malnutrition. The study found that the recent poverty assessment of the Ministry of Planning and Finance in Mozambique emphasized the importance of investing in education, agricultural productivity and rural infrastructure, as key elements of a poverty-reduction strategy. He indicated that the determinants of food security and nutritional status are not very different between rural and urban areas. He suggested that policymakers and program administrators must understand specific community-level conditions so that they can identify which of the key variables programs must address.

Selepe (2011) studied the impact of home gardens on the nutritional status of pre-school children in an informal settlement in South Africa. Children aged two to five years (n=40) were selected to participate in the study. The sample children were divided into groups: 24-35 months (four boys and one girl), 36-47 months (four boys and five girls) and 48-60 months (14 boys and 12 girls). The children's anthropometric measurements were taken and recorded. The results highlighted that malnutrition is problematic among children all age groups in this sample. Home gardens had no statistically significant impact on anthropometric measurements of the children. A concerning, negative statistical difference was found between pre- and post-study height-for-age z-scores for boys, showing significant deterioration of nutritional status among boys. S-Y Oh and Hong (2003) examined household food insecurity of urban low-income families and the associations of the food insecurity with children's dietary intake and body size in Korea. Using the 10-item Radimer/Cornell Scale they found that 62.7% of the households have some degree of

food insecurity (8.6% for food insecure for family, 28.4% for food insecure for adults and 25.7% for child hunger households). Food insecurity was linearly and negatively associated with household economic conditions as well as the caretaker's use of nutrition knowledge. There were also significant associations of food insecurity with the children's dietary intakes, indicating the largest amount of nutrients for the children from the household food insecure, followed by those from the food secure, adult food insecure and child hunger groups. The household food insecure children were fatter than the food secure children. The fatter condition of the former children appeared to be related to more frequent intakes of low-quality foods.

Osei *et al.* (2010) assessed the relationship between food insecurity and malnutrition among children aged 6 to 23 months in Kailali district of Nepal. They found that more than 69% of households were found as food insecure considering insufficient access to adequate food. The prevalence rates of stunting, underweight, and wasting among children were 41%, 24%, and 9% respectively. They also found that the prevalence of anemia was 58%. However, there were no significant associations between household food insecurity and stunting, underweight, or anemia. Stunting and underweight were associated with maternal height and household wealth. Underweight was also associated with maternal education and anemia was associated with low maternal hemoglobin concentration.

Naser *et al.* (2014) investigated the relationship between household food insecurity and nutritional status of children in low-income households. They found that about 16.1% of the households were food secure, while 83.9% experienced some kind of food insecurity. Out of food insecure category, 29.6% households were food insecure, 19.3% women were individual food insecure and 35.0% fell into the child hunger category. Education of the mother, household size, number of children, number of children going to school, total monthly income, income per capital, number of household members contributing to the income and food expenditure were significant risk factors for household food insecurity. The prevalence of underweight, stunting and wasting in children were 61.0%, 61.4% and 30.6% respectively. Based on multinomial logistic regression, children in food-insecure households were 2.15 times more likely to be underweight and three times to be stunted than children in the food-

secure households. Hanson and Connor (2014) analyzed the associations between food insecurity and dietary quality in US adults and children. The study found that food insecure adults consumed fewer vegetables, fruit, and dairy products than did food secure adults and had lower intake of vitamins A and B-6, calcium, magnesium, and zinc. The study also found that food insecure children consume less fruit compared to food secure children.

2.2.3 Food Security in Urban and Rural Contexts

A growing concern in the food security literature is stemming from rapid urbanization and consequent rise in urban poverty. But considering the severity of the problem the volume of literature on this issue is still limited. Some researchers have studied the food security of urban household. For example, Omonona and Agoi (2007), Sultana and Kiani (2011), Iorlamen *et al.* (2013), Iorlamen *et al.* (2014) analyzed different aspects of food security of urban households. They have identified factors that affect food security of urban households using different empirical techniques.

Omonona and Agoi (2007) analyzed the food security situation among the urban households in Nigeria. They used primary data collected with a structured questionnaire. They analyzed collected data using mathematical and statistical techniques and found that food insecurity incidence for the study area is 0.49. Using regression techniques they found that food insecurity incidence increases with increase in age of household head. They also found that food insecurity incidence is higher in case of female-headed households than male-headed households and food insecurity incidence decreases with increase in level of education. It is also revealed that food insecurity incidence is relatively low for those engaged in professional occupation. Again, they found that food insecurity incidence increases with increase in household size and it declines as income increases. Another findings of the study is that food insecurity incidence increases with increase in dependency ratio.

Iorlamen *et al.* (2013) assessed the food security status and different socio-economic factors that affect food security status of urban households in Nigeria. The study found that 67.3% urban households are food secure while 32.7% are food insecure in

Benue state of Nigeria. The study also found that mean age, education, income of household, food expenditure, and quantity of food consumed by households are statistically significant factors that affect food security of the urban households. In a different study Iorlamen *et al.* (2014) assessed expenditure on food among urban households in Benue State of Nigeria. They used food security index, multiple linear regression and logit regression model to analyze food security. The study revealed that size of household, income of the household head and price of food commodities are major factors influencing household food demand decisions in the study area. Moreover, size of the household and income of household head are the main determinants of food demand in the study area. Age and income of household head as well as household size influence the probability that a household will be food secure.

Sultana and Kiani (2011) examined the determinants of urban households' food security in Pakistan using a logistic regression model. The study used five main variables in addition to some other demographic indicators that may affect food security which are place of residence, dependency ratio, social capital, employment status and level of educational attainment of household head. They found that three factors are statistically significant with expected signs. The analysis found that place of residence (urban) has a significant and negative effect on the households' food security status. Dependency ratio has a significant and negative impact on food security. Level of educational attainment of household head beyond intermediate level has significant and positive impact on food security status of the household. Social capital and employment are found as statistically insignificant implying that they do not have any significant effects on food security status of the households.

Hillbruner and Egan (2008) investigated that the role of seasonality in determining the food security and nutritional status of low-income urban households and to isolate specific pathways through which seasonality has its impact. They used secondary panel data collected from approximately 600 households in low-income areas of Dinajpur district in Bangladesh. They also used paired t-tests and logistic fixed-effects modeling to explore the role of seasonality. The study found that the prevalence rates of food insecurity, wasting, and inadequate growth were all significantly higher during the monsoon season as compared with the dry season. However, dietary

diversity and lost work due to the weather were identified as specific pathways through which season affected household food security. The study also found that mechanisms hypothesized to contribute to seasonal declines in nutritional status, such as child illness, were not found to be significant. They found that season had a significant effect on both food security and nutritional status in Dinajpur, with households consistently worse off during the monsoon season. They suggested that initiatives to promote food market development, support employment during the hunger season, and prevent seasonal declines in nutritional status should be implemented.

Three out of every four poor people live in rural areas and depend on agriculture either directly or indirectly for their livelihood (World Bank, 2008). In most part of the world and especially in the developing countries, concerns regarding food security and its related issues are vital for poverty reduction. Attainment of food security is core problem confronting farming households, especially women and rural populations due to low productivity in staple crop production, seasonal variability in food supply as well as price fluctuations. Food security of farming households is of serious concern if a country wants to consolidate her macroeconomic gains because; farmers who are vulnerable to food and nutritional insecurity have limited capacity to respond to agricultural programmes.

There are several studies which dealt with food security scenario of households living in the rural areas. Babatunde *et al.* (2007) examined the factors influencing food security status of rural farming households in Kwara State of Nigeria. The study applied a three-stage random sampling technique to obtain a sample of 94 farm households. Using the calorie intake approach, they found that 36% and 64% households in the study area are food secure and food insecure, respectively. In their study, the food insecurity gap index showed that the food insecure households fell short of the recommended calorie requirement by 38%, while the food secure households exceeded the recommended calorie intake by 42%. They also used a logistic regression model which found that total annual income, household size, educational status of household heads and quantity of food obtained from own

production are the significant factors of food security status of farming households in the study area.

Ramakrishna and Demeke (2002) assessed food insecurity situation in the North Wello zone of Ethiopia using household survey data. They constructed an aggregate household food security index. They also recorded the survival mechanisms of the people. The study found that the sample area is highly food insecure and survival mechanisms are traditional. They applied logistic regression technique to determine the effects of different factors of food security status. The results of the regression model found that per capita land, cereal production, livestock, level of education of farmers, fertilizer application are significant factors that have positive effects on food security, whereas family size is a significant factor that has negative effect on food security.

Hossain and Rashid (2009) explained that the food security status of marginal farmers of a village under Basail upazila in Tangail district of Bangladesh. They used Cobb-Douglas production function and logistic regression model to achieve the objectives. They found that marginal farmers obtained much lower per hectare yields of modern variety of Boro (4940 kg./ha.) due to financial capital constraint compared to the yield achieved by well-to-do farmers (6175kg./ha.). This has significant impact on the food security of the marginal farmers of that village. Shaikh (2007) studied the food security and consumption pattern of Sindh households in Pakistan. The author found that 39% rural Sindh population are food insecure in the study area. He also found that the policy makers of both military and democratic governments have not taken any keen interest to address this crucial issue. He suggested that rural women may be assisted to improve their productivity on ecologically sound and sustainable basis. Additionally, strategic policies might be implemented for improving the food security awareness among the rural households.

Arun and Keshav (2006) examined the relationship between households' resource endowment and food security status in rural areas of Nepal. The study indicated that the distribution of resources is highly favorable to higher caste and has direct impact on household food security condition. They have also shown that the depth and the

severity of food insecurity vary according to socio-economic characteristics of households. They revealed that both depth and severity are higher in occupational caste, small landholders, fewer livestock holders, laborers, and households with less consumption expenses. To become more food secure and in response to food deficit condition, households adopted both ex-ante and ex-post coping strategies, such as casual laboring, occupational work, small business, selling of agricultural and livestock products, collection of wild foods, borrowing food or money, use of savings, use of pension, seasonal migration to the places outside the district, within the country or in abroad, and so on. Khan and Gill (2009) examined the determinants of three aspects of food security in rural areas of Pakistan, i.e. food availability, accessibility and absorption. For that purpose a series of models applied on district level data of rural areas of Pakistan. The study found that the production of wheat, rice, maize, pulses, oilseeds, poultry meat and fish at the district level is found to affect food availability positively. They also found that all the district except of Sindh are more probable to be food insecure in availability and electrification and adult literacy emerged as the factors having negative effect in the food accessibility. And child immunization, safe drinking water and number of hospitals have shown positive effect on food absorption.

Adeniyi and Ojo (2013) investigated the food security status of rural farming households in selected Local Government Areas (LGA's) of Osun State in the South-west Geo- political zone of Nigeria. They estimated the extent and magnitude of food insecurity in the study area and determined factors that affect households' food security. The study found that majority of the rural farming households in the area are food insecure as most of them subsist below the food security line which is 2280 Kcal in this study. It also found that 69.9% of the population are food insecure comparing to recommended calorie intake. The study revealed that food secure households have a small family size, earn a high monthly income and make use of modern farm inputs. Yusuf *et al.* (2011) examined the dynamics of food insecurity (FI) transitions among rural households in Southwestern Nigeria. The study used Markov Probability Chain (MPC) and Probit regression model. They found that 71.8% rural households in the study area moved into FI during planting season and 86.1% of households would transit to FI during planting season in the long-run. Household size, educational status

of head, age, asset ownership, remittances, occupational status of head, and access to credit and access to extension services are factors that significantly influence these movements.

Kuwornu *et al.* (2013) examined the food security status of farming households in the forest belt of the Central Region of Ghana. The study applied a multistage random sampling technique to obtain a sample of 134 farm households. The study revealed that 60% farming households in the study area are food insecure. The binary logistic regression results revealed that an increase in household's income, having access to credit as well as increase in the quantity of own farm production may have the probability of improving the food security status of farming households in the study region. However, holding all other factors constant, increases in non-working member of households worsens the food security status of farming households. Ahungwa *et al.* (2013) examined the food security status of farming households in Benue State of Nigeria. The study assessed the socio-economic characteristics of the households using descriptive statistics and it measured the household food security status using the 'food security index' followed by the FAO benchmark of 2500 kcal per capita per day. They found that households were profiled into food secure and food insecure where 36.67% were food secure while 63.33% were food insecure and the shortfall or surplus index indicated that the food secure households exceeded the benchmark by 33.80% while the food insecure categories fell short by 29.60%. The study recommended that government and all stakeholders should take advantage of existing structures such as the Fadama Development Project to improve their food security status.

Babatunde *et al.* (2010) examined the nature of the relationship between income and calorie intake among farming households in rural area of Nigeria. The study used both parametric and nonparametric techniques to examine the relationship. They estimated that the average per capita daily calorie intake in the study area is 2428 kilocalories, which is below the recommended intake level. They found that income has a significant positive relationship with calorie intake. Nonetheless, the calorie-income elasticity is estimated at 0.181, suggesting that calorie intake does not increase substantially with increases in income. The results also reveal a positive and

significant relationship between farm size and calorie intake. They suggested that a combination of policy strategies, including income growth, agricultural development and targeted food programmes may be reduce the problems of inadequate calorie consumption among poor households.

Sharmin *et al.*(2009) examined food security status of urban and rural households and compared rural and urban food security conditions using three major indicators- food availability, food access and food utilization. They observed that aggregate food availability and consumption depend on domestic production, import, public food distribution, price, income, and consumers' preference. The study opined that rice is consumed more in quantity in rural areas than in urban areas but wheat consumption is very common in urban areas while all food items excluded rice are consumed more in quantity in urban areas than in rural areas. They found that in urban areas average caloric (2193 gm.) and protein (64.88 gm.) intake are slightly higher compared to rural areas. The intake of calorie and protein showed ups and down over the period 1990-2005 in urban areas and rice is the single major source and on average it contributed about 71 percent of total calorie intake. They found that, among many other indicators of determining the food security, calorie and protein intake are considered as key determinants. The study recommended that, planning and evaluation efforts may be directed towards assessment of adequacy of food and to improve the average calorie and protein intake of masses as well as different classes of people.

Orewa and Iyangbe (2010) estimated the degree of food insecurity among rural and low-income urban households in Edo State of Nigeria. Using the food security index approach, they found that 79% low-income urban households are food secure as against 71% of the rural households are food secure. However, the level of insecurity measured by the depth and severity is more within households in the rural area as compared to low-income urban households. As much as 25% increase in daily calorie intake is required by rural households as compared to 23% required by low-income urban households to meet the recommended daily allowance by FAO. The study also revealed that salary earners and farm families are more secured than non-salary earners and nonfarm families.

Demi and Kuwornu (2013) examined the level of food insecurity among farming household in the Central Region of Ghana. They used a multistage sampling technique to select the respondents with using a structured questionnaire. The study revealed that the proportion of households who practiced no strategy was high (41.7%) in forest communities than the coastal communities (30%). The proportion of households who practiced low index of coping strategies was higher (25.0%) in the forest belt than the coastal belt (20.8). However, the proportion of households who practiced medium index of coping strategies was higher (48.3%) in the coast compared to forest communities (33.3%). They found that among households who practiced coping strategies, medium index of coping strategies were the highest (40.8%) followed by low index of coping strategies (22.9%) and high index of coping strategies were the lowest (0.4%). They suggested that the government should broaden the pro-poor policies such as Livelihood Empowerment against Poverty (LEAP) and school feeding programmes, and food insecurity coping strategies adopted by households can only temporally minimize the impact food insecurity.

Anik *et al.* (2013) analyzed the impact of farm level corruption on households' food security using survey data collected from 210 Bangladeshi rice farmers. They used regression model with using a multi-stage sampling technique. They found that average calorie intake for the sample households was 2,693 kcal/day/AE, whereas the national average for 2005 is 2,238 kcal/day/person. The results showed that the cost of corruption adversely affects households' calorie consumption and the marginal effect of corruption is higher for the low expenditure households relative to the high expenditure households. And variables such as the better education of women and land holding also positively contribute to food security. They suggested that the government and NGOs should be taken some steps for households' economic status, controlling the leakage of households' income by reducing corruption, and improving the level of education, in order to improve households' food security. Haile *et al.* (2005) analyzed the causes of household food insecurity for Ethiopia by logistic regression model using primary data. The factors analyzed were farmland size, ox ownership, fertilizer application, education of head of household, household size and per-capita production of the household. The study defined the food security as the difference between per-capita calorie available and needed for the household.

2.2.4 Food Security in Bangladesh

Food security in Bangladesh is one of the important issues to be analyzed comprehensively by different researchers. For example, Talukder (2005), Islam *et al.* (2009), Salam *et al.* (2009), Hossain *et al.* (2013), Khanam *et al.* (2009), Ahmed *et al.* (2011) etc. have conducted their studies in the context of Bangladesh to examine the different aspects and dimensions of food security. The major findings of these studies are synthesized in this section.

Talukder (2005) studied food security and food self-sufficiency status of Bangladesh. He found that the aggregate and per capita food availability in the country have increased over the years, resulting from increased domestic production and improved food management. However, about 40% people live below the absolute poverty line defined by food intake of 2122 kilo calorie per person per day. Islam *et al.* (2009) analyzed that farmers have changed their land use patterns and introduced new crops along with rice in different areas of Bangladesh. The study was conducted in 8 districts of the country namely- Mymensingh, Tangail, Dinajpur, Rangpur, Pabna, Jessore, Khulna, and Sathkira. They found that introduction of new crops along with rice increases household income which helps farmer households to choose appropriate food items that increase nutritional status of households. Additional income also helps to support educational expenditure of children and creates employment opportunity. Thus, they concluded that changing land use patterns increase food security status of the households.

Salam *et al.* (2009) explained that self sufficiency in food production in Bangladesh is considered as an important strategy of the government. They found that emphasis is given to technological advancement in enhancing the level of cereal production, since the possibility of achieving higher production through horizontal expansion of area is very difficult. In addition, cultivable land has a shrinking trend over the period in Bangladesh. Therefore, they concluded that it is necessary to adopt high yielding varieties and others modern agricultural technology which will increase the productivity of existing land. Thus, the increase in production will help ensuring food

security of the country. Hossain *et al.* (2013) examined the link between internal migration and food security in the context of Bangladesh. They found that rural-urban migration has significant implications on food security. Their study also found that the average amount of income is higher for migrant households. The regression results of this study indicated that the number of migrants at household level has had significantly positive impact on the per capita calorie intake and the per capita calorie intake was found to be increased by 2.2% for one unit increase in number of migrants. The study also revealed that food security outcome is highly appreciable both at origin and destination of migration. Therefore, they urged the policy-makers to make policies to facilitate in creating a congenial atmosphere for optimizing the net benefit from rural-urban migration by providing support to leverage the opportunities arising from migration and remittances.

Khanam *et al.* (2009) observed that mushroom cultivation is a potential source of food security for small households in Bangladesh. They explained the consequences of mushroom cultivation practices on farmers' income and women's status that may play an important role to remedy food and nutritional insecurity. They used primary data collected with a structured questionnaire and estimated the Cobb-Douglas production function to achieve the objectives. They found that mushroom cultivation is profitable which improved the conditions of farmers and their total annual income which helps farmers to purchase food for their families. It is also revealed that gender status in particular has improved significantly in these households evidenced by the increased participation of mushroom culture practicing women in taking decisions on crucial household socioeconomic matters. Kazal *et al.* (2010) analyzed the determinants of food insecurity and formulated the strategies to overcome the food insecurity problem obtaining in the haor area in Bangladesh. They used descriptive and inferential statistical tools and techniques to measure household's food security condition and socio-economic condition, to determine the predictors of food insecurity using both multiple binary and logistic regression models. The study identified the predictors of food insecurity by developing three binary logistic regression models for the three levels of food insecurity as well as ordinal logistic regression model considering the severity of food insecurity as order. The results found that the decrease in landholdings increase the risk of food insecurity very significantly irrespective of

scale and the level of education of the household head also shown similar trend. The result also found that increase in the level of household income reduced the risk of food insecurity significantly for all the scales. They suggested that more research should be conducted on haor economy focusing on identifying the problems in different dimensions and discovering projects in the corresponding fields for pragmatic and urgent policy implications and comparative study with other people in other haors to share experience and other coping strategies in food insecurity.

Ahmed *et al.* (2011) explained the challenges of food security in Bangladesh. They found that rice monoculture cannot provide a sustainable food supply without harming the environment in the long run. They suggested that integrated rice-fish farming may play an important role in increasing food production as the integrated farming system is better than rice monoculture in terms of resource utilization, diversity, productivity, and both the quantity and quality of the food produced. They used Cobb-Douglas production model which suggested that higher yields may be achieved by increasing inputs in the integrated farming system. They concluded that integrated rice-fish farming can help Bangladesh keep pace with the current demand for food through rice and fish production. They also concluded that rice and fish production should be increased to meet the food demand for the people of Bangladesh. Azimuddin *et al.* (2009) explained the potato is a food items which positively impacts on food security in Bangladesh. The study conducted at Comilla and Munshiganj districts during 2008 to generate information on area, production and utilization of potato using both primary and secondary data. They found that area and production of potato have been increasing rapidly compared to cereal crops like rice and wheat, per unit of land and time potato was more productive than any other food crops. However, average yield of potato was 22.25 t/h. maximum yield was 36.23 t/h in the study area, average production cost and selling price of potato were Tk. 6.95 and 10.95 per kg respectively. The study also found that Benefit Cost Ratios (BCR) was 1.58. Potato contains about 16% carbohydrates of which starch is the major part i.e. about 14% starch on fresh weight basis. Results showed that Potato is an efficient food crop. If percentage of potato consumption is increased pressure on rice would be reduced. They suggested that potato can play an important rule in the food security of Bangladesh.

Ali *et al.* (2010) examined that the efficacy of maize as an alternative food for improving the food security of the people in Chittagong Hill Tracts of Bangladesh. They used primary data collected from 3 hill tract districts (Bandarban, Rangamati and Khagrachari) with using multiple linear regression model. The study found that 47% of total respondents had food supplies throughout the year, 30.67% had food for 7-9 months, 20.78% had 3-6 months, 1.22% had 1-2 months and 0.33% respondents had no food in their house from their own farm. Regression results showed that income is one of the important factors that determine food security, food security decreases with the decrease of annual income. It also observed that there was a significant relationship between education level and food security that is the illiterate group is less food secured while the literate group is more secure with some exceptions where some of the illiterate people have a large amount of land. The study also found that 11.56% of respondents reported non consumption of maize, 49.11% consumed once a week, 29.11% 2 to 3 times/week, 7.89% 4 to 5 times/week and 2.33% consume maize daily. And the percentage of food secure people who consumed maize daily was very low but their food availability month was comparatively higher than the other groups. They found that the duration of food availability from their farm of the maize cultivators were longer and they benefited more than the non maize cultivators. The study concluded that maize cultivators are more food secure than the non-cultivators. They suggested that the department of agricultural extension and the policy makers should be made aware of different types of maize food preparation with cultivation and take appropriate policies to improve its marketing facilities.

2.2.5 Food Security and Other Aspects

Some researchers have concentrated on other related aspects of food security. Ojo and Peter (2012) explained the food security pattern of households in Nigeria. The study found that a comprehensive review of Nigeria's agricultural policy noted that much still needs to be done if the crisis in the sector will not escalate more so, in a supposedly democratic dispensation which expectedly should promote the value of welfares. They suggested that for food security, Nigeria needs to come up with food

policy which for now it lacks and public policy makers pursue is merely an agricultural policy that still suffers enormously from a wide gap between intent and actual practices.

Jacobs (2009) investigated the conceptual and methodological challenges to develop a set of baseline indicators for South African food security targets. He explained that a food security target is a well-defined and measurable goal to reduce the numbers of people who lack enough food of the right quality to live healthy lives. The study analyzed the baseline indicators for household food security using the average cost of a nutritionally adequate food basket per person. He found that food expenditure shares of the poorest households vary between 38% and 71% according to different surveys. The study also found that deep levels of food insecurity exist in rural areas with 85% of rural households unable to afford even the 'below average dietary energy cost. He suggested that food security policy based on refined baseline indicators can be better target food insecure households.

Paloma and Loushichi (2013) applied a generic farm household model in the context of developing countries to gain knowledge on food security and rural poverty alleviation under different policy options. Results of the study found that seed policy would improve farm productivity and boost household income which may reduce the poverty and food insecurity status of the farm households. Nawrotzki *et al.* (2014) explained the impact of the 2008 global food crisis on food security among vulnerable households in rural South Africa. They explored that recent change in food security between the years 2004 and 2010 in rural area of Northeastern South Africa. The study examined differences in food security trajectories among vulnerable sub populations with a unique panel data set provided by the Agincourt Health and Demographic Surveillance System (Agincourt HDSS), used a longitudinal multilevel modeling approach to estimate adjusted growth curves for the differential changes in food security across time. They observed an overall improvement in food security that leveled off after 2008, most likely resulting from the global food crisis.

Kahane *et al.* (2013) explained agro biodiversity for food security and income. They analyzed that agriculture provided the food and nutrition requirements, and

environmentally sustainable production systems to maintain the level of productivity indefinitely. In this context, they argued that diversification must be introduced in agriculture that will ensure food security and will keep environmental degradation. Gregory *et al.* (2005) analyzed the food systems affected by climate change. They found that climate change may affect food systems in several ways ranging from direct effects on food production, to changes in markets, food prices and supply chain infrastructure. The study also found that the relative importance of climate change for food security differs between regions. For example, in southern Africa, climate is among the most frequently cited drivers of food insecurity because it acts both as an underlying, ongoing issue and as a short lived shock. In other regions, through such as parts of the Indo-Gangetic Plain of India, other drivers, such as labour issues and availability and quality of ground water for irrigation, rank higher than the direct effects of climate change as factors influencing food security.

Muzaffar (2009) assessed the possible consequences of climate change on the extreme poor of Chittagong region in Bangladesh in the context of agricultural and food security. He explained that the climate change has already affected the vulnerable population, especially the extreme poor provided by secondary sources. He suggested that strong international support need to adapt and manage the impacts due to climate change through mainstreaming of all development activities with the climate change. He found that the purpose of alleviate poverty of the downtrodden people in both rural and urban areas, several projects and programmes implemented in Bangladesh in recent years, effects of these programmes in 2008 to lift out one million of the very poorest out of poverty by 2015. He recommended that education may an important a role to play provide market-relevant skills training to be less vulnerable to climate-reduced impacts that likely most severe in the agriculture sector. Butt *et al.* (2006) examined the impact of climate change on food security in developing countries and various adaptations that can be pursued by presenting findings from a case study conducted in Mali. They used a suite of biophysical models to project the impact on crop and livestock sectors and following biophysical results, an economic model used to project the availability of food for human consumption and the consequent impact on the incidence of malnourishment in Mali. They found that while malnourishment in the country may double its present level, adaptations to climate change may improve food security conditions considerably.

Hanjra and Qureshi (2010) examined that global water crisis and future food security in an era of climate change. The study showed that food policy should serve humanity by advancing the humane goals of eradicating extreme poverty and hunger, but these goals have recently been challenged by emerging forces including climate change, water scarcity, the energy crisis as well as the credit crisis. This study analyzed that the overall role of these forces and population growth in redefining global food security. Specifically, global water supply and demand as well as the linkages between water supply and food security are examined. They revealed that the water for food security situation is intricate and might get daunting if no action is taken. They suggested that investments are needed today for enhancing future food security; this requires action on several fronts, including tackling climate change, preserving land and conserving water, reducing the energy footprint in food systems, developing and adopting climate resilient varieties, modernizing irrigation infrastructure, shoring up domestic food supplies reforming international food trade, and responding to other global challenges.

Calabrese (2012) analyzed food safety and security through testing food for chemical residues such as pesticides, antibiotics etc. He used dose-response model to assess the health standard of food. The study revealed that the major risk assessment models used by international regulatory agencies, such as the threshold dose-response model, were never validated prior to their acceptance and use by international regulatory agencies. The study also found that the thresholds and linear dose-response model fails to make accurate predictions in the low-dose zone. Pete Smith (2012) assessed that delivering food security without increasing pressure on land. He explained the challenge of feed for large number of population, with reducing adverse impacts of food production on a whole range of ecosystem services. The study suggested that the response is “sustainable intensification” which entails delivering safer, nutritious food from the same area whilst maintaining ecosystem service provision. He examined that sustainable intensification and consider alternatives such as management of food demand and waste reduction. He found that sustainable intensification may a role to play, accompanied by fundamental change in global food systems.

Khanam *et al.* (2009) observed that mushroom cultivation is a potential source of food security for small households in Bangladesh. They explained the consequences of mushroom cultivation practices on farmers' income and women's status that may play an important role to remedy food and nutritional insecurity. They used primary data collected with a structured questionnaire and estimated the Cobb-Douglas production function to achieve the objectives. They found that mushroom cultivation is profitable which improved the conditions of farmers and their total annual income which helps farmers to purchase food for their families. It is also revealed that gender status in particular has improved significantly in these households evidenced by the increased participation of mushroom culture practicing women in taking decisions on crucial household socioeconomic matters.

2.3 Methods Used in Different Studies

Review of literature reveals that researchers have followed mainly two types of methods to conduct their studies on food security. The methods are qualitative and quantitative. Some studies were done only on the basis of survey, and some studies were conducted through estimating the parameters using econometric methods. Most of the researchers have used empirical methods for testing some set hypotheses. Hossain *et al.* (2009), Yusuf *et al.* (2011), Khanam *et al.* (2009), Hossain *et al.* (2013), Babatunde *et al.* (2007), Ahmed *et al.* (2011), Sultana and Kiani (2011), Iorlamen *et al.* (2014), Ramakrishna and Demeke (2002), Kuwornu *et al.* (2013), Elijah (2010), Babatunde *et al.* (2010), have used empirical methods in their research to investigate the different aspect of food security.

Hossain *et al.* (2009) used econometric methods to estimate the food security status of marginal farmers using Cobb-Douglas production function. They used Logit model to achieve the objectives. Yusuf *et al.* (2011) in their article used econometric methods and Probit regression to show that household size, educational status of head, age, asset ownership, remittances, occupational status of head, and access to credit and access to extension services are factors that significantly influence the movements of food insecurity (FI) transitions among rural households.

Hossain *et al.* (2013) used econometric methods to estimate the links between internal migration and food security. The multivariate regression showed that the number of migrants at household level has had significantly positive impact on the per capita calorie intake. Babatunde *et al.* (2007) also used econometric model to measure the factors influencing food security status of rural farming households. They also used logistic regression model which found that total annual income, household size, educational status of household heads and quantity of food obtained from own production are the significant factors of food security status of farming households in the study area. However, some studies were done only on the basis of analysis for example Hanjra and Qureshi (2010), Muzaffar (2009), Kahane *et al.* (2013), James (1999), Chowdhury (2009), Salam *et al.* (2009), Talukder (2005), have used simple analysis methods in their research to investigate the different aspect of food security.

2.4 Major Findings of Reviewed Literature and Gaps in Literature

In the above review of earlier literature it is found that focus has been given mainly on three broad categories namely availability of food, access to food and nutrition of food. In addition, literature related to others aspects of food security covered basically policy issues and climate change aspects of food security. Different studies regarding various aspects of food security are carried out in home and abroad used econometric, mathematical and statistical techniques. The major findings that are observed from earlier studies are stated in this section.

Several studies, for example, Uddin (2011), Chowdhury (2009), Ploeg (2009), Meade and Rosen (2002), Wehler (1995) etc. analyzed the extent of access to food by people of different classes. Some studies found that around 56.67% of marginal farmers are food insecure while 30% are moderately food secured and only 13% are food secured. These studies also found that though there is available food in market, marginal farmer cannot purchase food from the market because of not having adequate income and purchasing power. Some other studies found that food insecurity remains for millions of farmers and landless labourers in Bangladesh. Landlessness of the farmers leads to their insufficient purchasing power to buy adequate nutritious food for their families. Another study found that many people cannot access to nutritious food

because they live far from a supermarket or large grocery store and do not have easy access to transportation.

James and Ruel (1999), S-Y Oh and Hong (2003), Hossain *et al.* (2005), Lawal and Jibowo (2006), Osei *et al.* (2010), Selepe (2011), Rahman and Islam (2012), Dermott *et al.* (2013), Saaka and Osman (2013), Naser *et al.* (2014), etc. analyzed the nutritional aspects of food security. Some of them found that around 30% population in Bangladesh live below the poverty line and income inequality has been worsening which affect food production, access to food and finally nutrition outcomes of farmer families. It is also found that agriculture improves household's nutrition. The production of diversified crops, highly nutritious crops, and bio-fortified foods improve nutrition of people. Some found that household food insecurity affects the nutritional status of children. The food insecure families cannot afford adequate and nutritional food and hence, children of those families suffer from malnutrition. It is also found that child malnutrition is higher in rural areas compared to urban area. Some studies analyzed the factors of food insecurity. They found that food insecurity and malnutrition is also related to some socio-economic factors such as family income and asset, cultivable land, family size, education level of family head, education of mother, family size, number of children, number of children going to school, income per capital, number of household members contributing to the income and food expenditure.

In this chapter, efforts are given to review comprehensively the earlier literature regarding food security issues in order to have a clear idea of food security and to find out the gaps in those research studies. From the review of available literature it is found that most of the existing studies are basically of survey type. Most of the studies carried out in Bangladesh have used production, import, and aid based data of food grains. Moreover, substantial analyses with strong quantitative tools are rare in earlier studies. In addition, most of the studies in the field of food security issues have been performed on other part of Bangladesh and few studies have been carried out in the North Western of Bangladesh. Again, most of the studies throughout the country have analyzed the food security at national level of Bangladesh and studies of food

security at household level are rare. Considering these, it is necessary to investigate the food security at household level in North Western part of Bangladesh

2.5 Conclusion

The main objective of this chapter is to survey the earlier studies on food security. This literature review successfully revealed the scope of further research study on food security issue. Methods used in different studies are also showed in this section. Specifically, the findings and major gaps of previous studies, under this overhead, show the way to move on. Hence, we have set our objective of quantitatively estimating the impact of influencing factors, like, education, farm size, household size, on the food security and at the same time, we will also try to estimate the potential of households' income factor for increasing such food security. Fulfillment of this objective will hopefully fill up the previous literature gaps and enrich the field of socioeconomic factors and food security with some interesting results as well.

CHAPTER THREE

FOOD SECURITY CONCEPTS AND THEORETICAL LINKAGES

3.1 Introduction

The purpose of this chapter is to analyze the relevant concepts, theories and the theoretical linkages concerning food security and related aspects. Food security encompasses three components- availability, access and utilization which are discussed in this chapter. Moreover, food security has also different meanings from global to household levels and there are supply side and demand side issues. These issues are directly and indirectly linked to food security. All of these are analyzed in this chapter.

This chapter is comprised of four sections. Section 3.2 provides the definition of all the components of food security. Section 3.3 broadly explains all of the causes and consequences of food insecurity with the help of some flow charts. At the end, section 3.4 provides a brief concluding comment.

3.2 Food Security Related Concepts

Food security may have different meanings to different people. Many definitions have been offered for food security in the literature. In core sense, food security may be defined as access by all people at all times to sufficient food for a healthy and productive life. This definitional framework implies that there are different components of food security, different degree of food insecurity and food security is also perceived at different levels as well. These are discussed below:

3.2.1 Definition of Food

Food is any substance consumed to provide nutritional support for the body. It is usually sources from plant or animal and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals etc. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, or stimulate growth. An adequate food intake, in terms of quantity and quality, is essential for healthy and productive life. Food items are generally comprised of nuts, pulses, fruits, cereals, vegetables, sugar cane, sugar beet, starchy roots, edible oils, livestock and livestock products (World Bank, 1991). The core food items in Bangladesh are rice, pulse, edible oil, wheat (coarse flour & flour), powered milk, salt, sugar, potato, chick pea/gram, fish & fish products, livestock and livestock products, onion, garlic, ginger etc (Muzaffar, 2009). However, the right to adequate food is both a freedom and an entitlement. Freedom denotes freedom from hunger and entitlement signifies entitlement to food that meets dietary needs, that is free from adverse substances, that is culturally acceptable, is available in large enough quantities, is physically and economically accessible and involves sustainable production for present and future generations.

3.2.2 Food Security

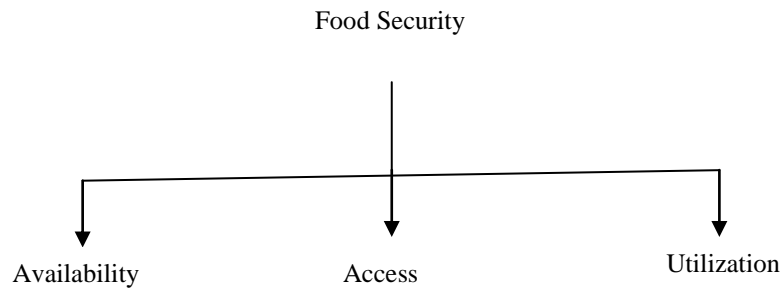
Food security is a complex issue and its definition has evolved over time. The question of food security has a number of dimensions that go beyond production, availability and demand for food. The initial focus on food security as a global concern was on the volume and stability of food supplies. In the 1974 World Food Summit, food security was defined as ‘availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices’ (FAO, 1983). In 1983, FAO expanded its concept to include vulnerable people securing access to available supplies, stating that food security meant ‘ensuring that all people at all times have both physical and economic access to the basic food that they need.’ Later, the 1996 World Food Summit redefined food security to take demand, vulnerability and nutritional aspects into account. At the summit, countries agreed that ‘food security exists when all

people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle'. In 2002, FAO again held that food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern (FAO, 2002). However, food security is defined as the ability of food-deficit countries, or regions, or households within these countries to meet target consumption levels on a year-to-year basis. Food security has two facts: First, real income may be too low normal or above-normal domestic production, and second, real income may fluctuate as the result of variations in domestic production of food and nonfood products or of import and export prices or both (Koester, 1986). Food security is the ability of a group (an individual, a family, a village, a nation etc.) to satisfy adequately food consumption needs for a normal and healthy life at all times (Sarris, 1989). Since then, several definitions have been provided by different organizations such as the World Bank, FAO and UNDP's Human Development Report. In general, food security is defined as economic access to food along with food production and food availability. Therefore only food availability cannot ensure food security, access to food is equally important.

3.2.3 Key Components of Food Security

There are three major components of food security such as food availability, food access and food utilization, which are hierarchical in nature. Food availability is necessary but not sufficient for food accessibility and access is necessary but not sufficient for utilization (Omonona and Agoi, 2007; Kuwornu *et al.*, 2013). These factors are interrelated.

Flow Chart 3.1: Components of Food Security



Food availability is a function of the combination of domestic food stocks, commercial food imports, food aid and domestic food production as well as the function of underlying determinants of each of these factors. Use of the term availability is often confusing since it can refer to food supplies available at both household level and aggregate (regional and national) level (Omonona and Agoi, 2007). Food availability refers to the existence of food stocks for consumption (Gregory *et al.*, 2005; Kuwornu *et al.*, 2013). Therefore, food availability is achieved when sufficient quantities of food are consistently available to all individuals within a country. Sufficient availability of food for a nation can be ensured through domestic production, net imports (commercial or food aid) and carry-over of stocks.

Food access is influenced by the aggregate availability of food through the impact of the latter on supplies in the market and on market prices (Omonona and Agoi, 2007). Food access is determined by physical and financial resources, as well as by social and political factors (Kuwornu *et al.*, 2013). However, food access is further determined by the ability of households to obtain food from their own production and stocks, from the market and from other sources. Therefore, food access is ensured when households and all individuals within them have adequate resources to obtain appropriate foods for a nutritious diet. Access depends upon income available to the households, on the distributional of income within the households and on the price of food.

Food utilization which is typically reflected in the nutritional status of an individual is determined by the quantity and quality of dietary intake, general childcare and feeding practices, along with health status and its determinants. Poor infant care and feeding practices, inadequate access to or the poor quality of health services are also major

determinants of poor health and nutrition (Omonona and Agoi, 2007). However, food utilization refers to ingestion and digestion of adequate and quality food for maintenance of good health. This means proper biological use of food, requiring a diet that contains sufficient energy and essential nutrients, as well as knowledge of food storage, processing, basic nutrition and child care and illness management (Kuwornu *et al.*, 2013). So, food utilization is the proper biological use of food, requiring a diet providing sufficient energy and essential nutrients, potable water and adequate sanitation. Effective food utilization depends in large measure on knowledge within the household of food storage and processing techniques, basic principles of nutrition and proper health care.

3.2.4 Food Insecurity

Global agriculture currently produces ample calories and nutrients to provide the entire world's people healthy and productive lives. However, food is not distributed equally across regions, countries, households and individuals. A substantial share of the world's supply of calories and nutrients is allocated to diets rich in animal protein. At the same time, many families have insufficient food to meet their basic needs and must be considered chronically food insecure. Food insecurity today has a devastating impact on families and the countries in which they live where the food insecurity make up a substantial portion of the total population, the impact of which can overwhelm a country's development opportunities. Food insecurity is the absence of food security and applies to a wide range of phenomena ranging from famine to periodic hunger to uncertain food supply (Bokeloh *et al.*, 2009). Food insecurity also refers to the inability of a household or individuals to meet the required consumption levels in the face of fluctuating production, price and income (Moharjan and Chhetri, 2006). Food insecurity is the absence of food security and applies to a wide range of phenomena ranging from famine to periodic hunger to uncertain food supply (Kuwornu *et al.*, 2013). Food Insecurity is the inability of a household or individuals to meet their daily required food consumption levels in the face of fluctuating production, food price and income. Food insecure people are unable to lead healthy and fully productive lives. The causes of food insecurity is long and multifaceted: they range from political instability, war and civil strife, natural disaster,

macroeconomic imbalances and trade dislocations to environmental degradation, poverty, population growth, gender inequality, inadequate education, and poor health. All, however, can be related in some fashion to two basic causes: insufficient national food availability and insufficient access to food by households and individuals (Smith *et al.*, 1999). Food insecurity is the lack of access to sufficient food and can be either chronic or transitory (Reutlinger, S., 1987). Therefore, food insecurity is defined as lack of access to sufficient food of choices of the people and purchasing power to acquire. Food insecurity may be both transitory and chronic.

3.2.5 Transitory Food Insecurity

Transitory food insecurity is defined as a temporary decline in a consumers' access to sufficient food because of instability in incomes, high prices, foodstuffs losses and disruption of food production due to war, natural disasters(floods, cyclones, droughts and earthquakes), disruption of distribution chains, change in government machinery and political instabilities. Transitory food insecurity takes place due to lack of entitlements to enough food of the households and improper distribution of food. During the last few decades the rate of growth of world food production was faster than the population growth. However, lack of entitlements and improper distribution of food did not help to eliminate starvation (Muzafar, 2009). Famine is defined as a situation of the most severe shortage of food during transitory food insecurity when victims cannot acquire any food of their choices due to lack of purchasing power and are deprived of receiving any humanitarian food aid (charitable food) from anywhere. The study of the world's worst famines reveals that instability (during booms or slumps) and high variation of food production and price of domestic food reduced income of the wage laborers or rendered them jobless who could not buy food owing to not having purchasing power, for example, the Great Bengal famines (1770 and 1943), the Bangladesh famines (1974) and Hidden Hunger (2008).

In Bangladesh silent famine/hidden hunger, 2008 has taken place due to ineffective government and absence of democracy. Before the occurrence of the situation the country faced two devastated floods and one severe cyclone (SIDR). The non-political caretaker government could not assess the requirement of food for the country. The

Government started with a stock of about 3.50 lakh metric tons of food at the beginning of the year. However, the situation was such that the government would require enhancing food reserve to 10-15 lakh metric tons. Perhaps, the political leaders could not compromise to run the government with such a low level of food reserve. Further, the caretaker government relied on India as the biggest supplier of rice for Bangladesh. But the instability of varying decisions of the Indian government for export of rice and interruption of the supply of rice by the Indian authority at the land ports raised the prices of rice in Bangladesh several times, the government could have diversified the importing countries and the required rice could be bought from Myanmar, Vietnam, Thailand and Cambodia. Some of the advisors of the Caretaker Government could not assess the severity of the food crisis with skills, wisdom and intelligence. It was believed that the uprising of general mass could not have been taken place in Bangladesh due to the state of emergency (Muzaffar, 2009).

3.2.6 Chronic Food Insecurity

Chronic food insecurity is defined as continuously inadequate diets of choices resulting from the lack of resources to produce or acquire enough food. The people affected by continuous inadequate diet easily expose to serious health risks usually caused by various diseases and parasites. The victims are deprived of forming human capital through schooling and training programmes due to lack of physical fitness, i.e. lack vigor, alertness and vitality required for the jobs. Inadequate human capital lowers productivity, which in turns depresses output and income. The lower levels of output and income make it more difficult for families and nations to extricate themselves from the cycle of poverty (Reutlinger, 1985). For example, chronic food insecurity took place in Ethiopia, Somalia and Sudan. Further continuous inadequate diet is also one of the main obstacles to human and overall economic development in Bangladesh (Muzafar, 2009).

3.2.7 Different Levels of Food Security

A person is food secure when he or she has access at all times to enough food for an active, healthy life. Accordingly, people are food secure when their consumption of food is sufficient, secure (not vulnerable to consumption shortfalls), and sustainable (Maxwell, 1996). Food security generally implies arrangements whereby people are assured a minimum adequate level of food grain supply in periods of normal as well as poor harvest. It can be defined at individual, household, national and global levels (Amiti, 1982).

Individual Food Security

At the individual level, food security means that all members of society have access to the food they need, either from the market, from their own production or from the public food distribution system (Clay *et al.*, 1988). Individual food security can be defined as one which has access to enough food ensure the minimum necessary food intake for individual members to lead a healthy life (IFAD, 1991). Individual food security is defined as an acceptable likelihood that each person's income is sufficient to satisfy food needs (Ballenger and Mabbs-Zeno, 1990).

Household Food Security

Increasing attention has been paid to household food security because of the growing understanding that expanded food production will not ensure that all families will be able to secure their food needs (Eicher and Staatz, 1990). Household food security depends substantially on household income and asset status (Jacobs, 2009). A household food security should be defined as one which has enough food available to ensure a minimum necessary intake by all members. The minimum is related to, among other things, body size, weight, sex, and nature of work and for women, pregnancy or lactation status (Alamgir, 1991). Household food security can be defined as a household having assured sets of entitlements- from food production, cash income, reserves of food or assets and/or government assistance programmes- such that in times of they need they will be able to maintain sufficient nutritional intake of physical well-being. There are three important elements in determining household security: the average level of household income, the magnitude and

probability of seasonal and annual fluctuations around the average and the value and form of stocks a household can maintain (Benson *et. al.*,1986).

National Food Security

Large amount of food at global level does not guarantee food security at national level (Kuwornu *et al.*, 2013). For example UNDP (1992) noted that calorie supply at global level in 1990 was over 110 percent compared to the total requirement. Yet in the same period, more than quarter of the world's population was short of enough food (UNDP, 1992). However, national food security was used to describe whether a country had access to enough food to meet dietary energy requirements of her citizens. To some it connotes self- sufficiency, which means a country produces enough food to meet its population's demand. But broadly, national food security measures the extent to which a country has the means to make available to its people the food needed or demanded, irrespective of whether the food is domestically produced or imported (Pinstrup-Andersen, 2009). At the national level, food security means the availability in the country of sufficient stocks of food to meet national needs until such time as stocks can be replenished from harvests or imports (Clay *et al.*, 1988). National food security is the sum of household and sub-national food security and more. National food security can be defined as assured national availability of food to meet current minimum requirements per capita during a reference period and also to meet any unexpected shortfall over a limited period say three months (Alamgir,1991). Food security at the sub-national level means the assured availability of food for individual households to draw on to meet their minimum consumption requirements during a given period (Alamgir, 1991).

Global Food Security

Global food security requires that a sufficient quantity of food be present to feed the World's people. Global food security is the assurance of an adequate food supply and/or access to it for all, both at national and sub- national levels (Alamgir, 1991). Global food security requires that a sufficient quantity of food be present to feed the world's people (Ballenger and Mabbs-Zeno, 1990). World food security includes the general attainment of food security in individual countries, and introduces the concept of collective or collaborative policy-making. As production changes, either stocks or

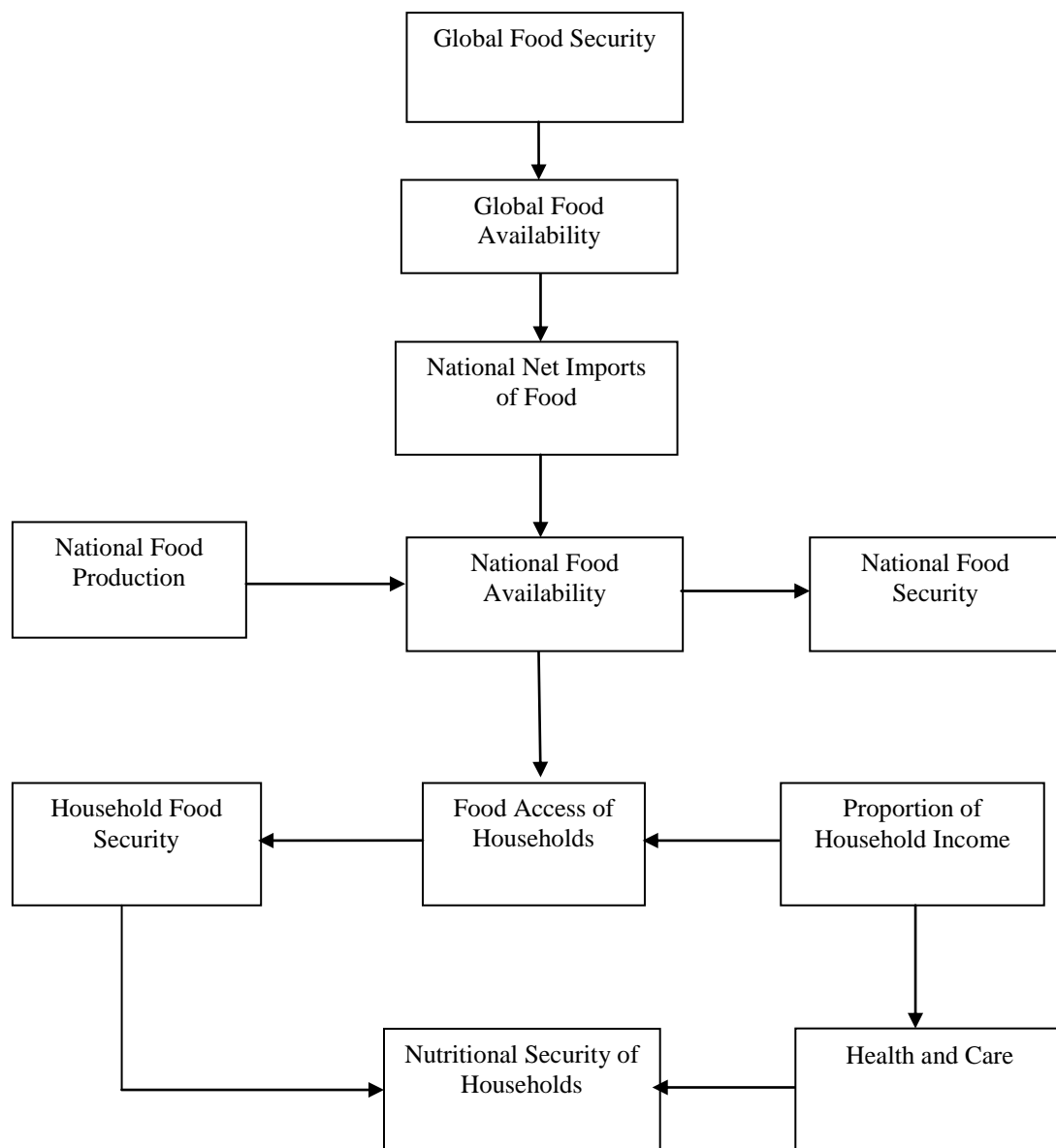
consumption (or both) have to vary in response. The extent of trade liberalization, commodity price agreement, food aid and the like are powerless to alter this reality (Amiti, 1982). World food security is the essence of the international aspect of the food problems of individual countries. It relates in part to the monitoring of global trends to give countries advance warning of problems which are likely to arise from shortages of raw materials and inputs into agriculture and to watch investment patterns in these supply industries as well as in agricultural output (Josling, 1975). Finally global food security implies universal access to an adequate food supply (IFAD, 1991).

A conceptual framework for food security is given in Flow chart 3.2, in which it is seen to be part of an overall process linking global and national food availability, households' access to food, and individuals' nutrition security (Smith *et al.*, 1999). The most macro level of the food security is global and national food availability. Global food availability is determined by total world food production. National food availability is determined by a country's own food production, its stocks of food, and its net imports of food (imports minus exports), including food aid in a given period. Still closer to food security is household access to food which, in addition to national food availability, is determined by a household's total income. Along with cash income, total income includes the value of goods produced (such as food) and services provided (such as child care) in households that do not enter the market, as well as in-kind transfers of goods and services. Access to food may be gained through (1) production or gathering of food, (2) purchase of food on the market with cash income, and/or (3) receipts of in-kind transfers of food (whether from other private citizens, national or foreign governments, or international institutions). Within households, individual food access is influenced by intra household food distribution decisions (Smith *et al.*, 1999).

As shown in Flow chart 3.2, a household's expenditures of full income for achieving food security compete with expenditures on other basic needs (e.g. health care, housing, and basic education) as well as non-necessities. A household or individual unable to meet all basic needs can be considered to be in absolute poverty (Frankenberger, 1996). Finally, at the most micro level of the food security equation is nutrition security, without which food security is not translated into an

active, healthy life. Nutrition security is defined as follows: ‘An individual is nutritionally secure when he or she has secure access to a nutritionally adequate diet and the food consumed is biologically utilized such that adequate performance is maintained in growth, resisting or recovering from disease, pregnancy, lactation, and physical work’ (Frankenberger *et al.*, 1997). In addition to food security, nutrition security has two other determinants. The first is ‘care’, or ‘the provision in the household and the community of time, attention, and support to meet the physical, mental and social needs of the growing child and other household members’ (ICN, 1992).

Flow Chart 3.2: Conceptual Framework for Food Security



Source: Adapted from UNICEF (1998), Smith *et al.* (1999)

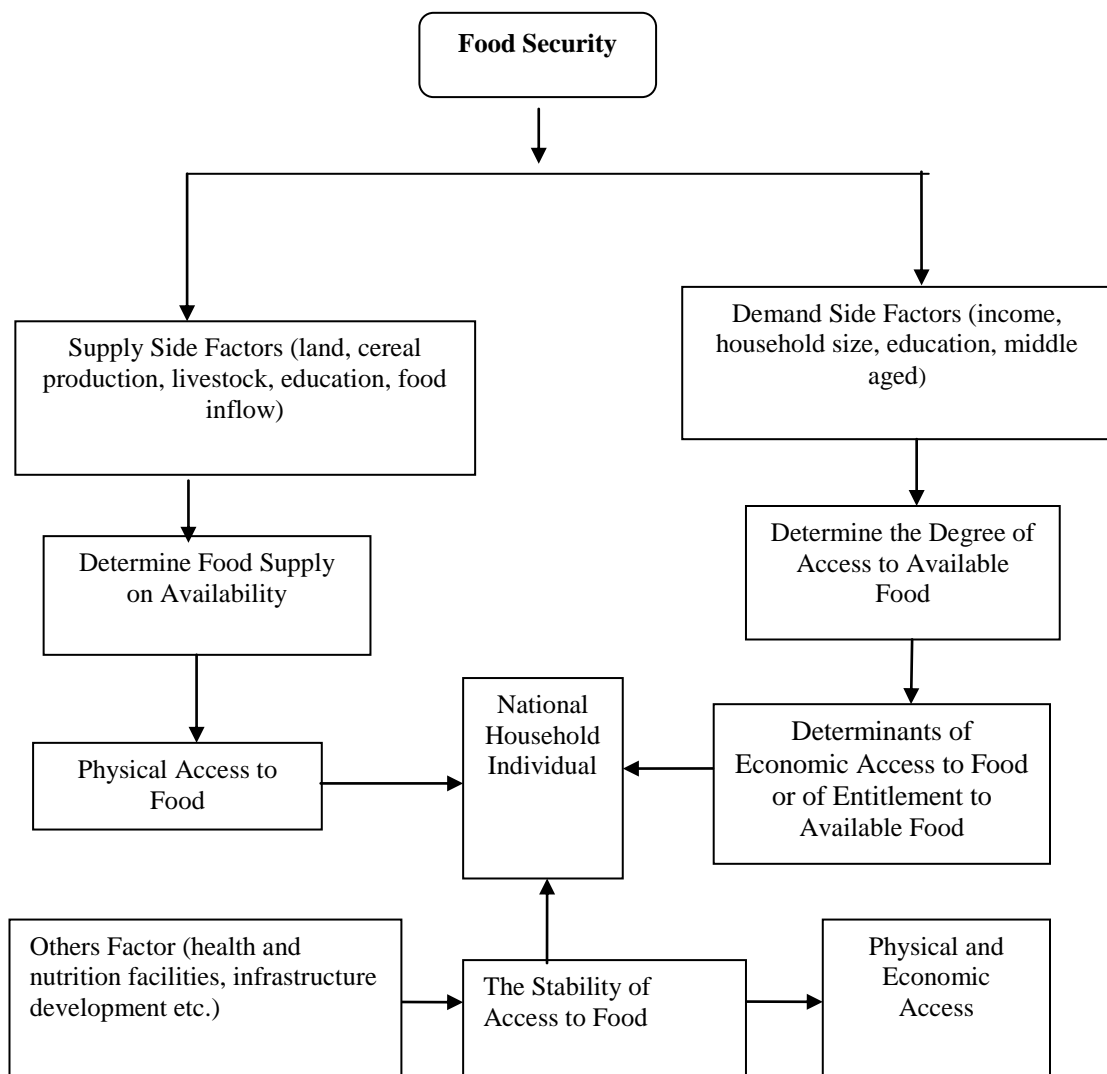
Examples of important child care behaviors are the timing and frequency of breast-feeding, the degree of stimulation and interaction with parents, investments in disease prevention and domestic hygiene, the use of health services and regular growth monitoring. The second non-food determinant of nutrition security is health. Poor health, or illness, affects nutrition security by depressing appetite, inhibiting the absorption of the nutrients in food and consuming calories and other nutrients while fighting off and recovering from illness, leaving less energy and nutrients available for growth and weight maintenance (Ramalingaswami *et al.*, 1996).

3.3 Factors Affecting Food Security

Economic accessibility to food is directly linked with the purchasing power of the people. It means, food availability in the market has no significance for food security for the people. For food security food price must be so that the people can purchase it. That means, food security is actually related with sufficient income or support that make food available. Income is a critical variable of the socially accepted sources of food provided in the market. The sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households. Households work to maintain a level of income necessary to raise families with a good quality of life. As a result it can determine the level of total expenditure as well as food expenditure. Availability of food is determined by domestic production, external trade and the efficiency of distribution through market and other channels. Bangladesh has made steady progress in the expansion of domestic food production. Domestic production is important for food security. So, investment in agriculture sector is important to increase food security. Production of food grain depends greatly on good harvest years. Food aid in Bangladesh has important role in promoting food security. This component of food flow is used for supporting people during natural calamities as well as the poor and disadvantaged in productive activities and building assets. This positively impact on the nutritional and health status of a considerable section of the population

The strongest link between food availability and food access is through the price mechanism, the rapidly growing cereal price contributes to negative shock to food access of the population. International NGOs like FAO explains that national food security can be ensured through increased availability of food in the local market. However, affordability is a function of price and earning. So, price of food grain and its fluctuation determine food availability of the poor. The age of household head in year is expected to have impact on his labor supply for food production. It is also expected to have impact on ability to seek and obtain off-farm jobs and income which could increase household income. Young people are stronger and are expected to cultivate larger-size farm than old people. The expected effect of age on food security could be positive or negative.

Flow Chart 3.3: Conceptual Framework for Food Security at National Level



Education is a social capital which could impact positively on household ability to take good and well-informed production and nutritional decisions. Some scholars have argued that spouse education could be more important in food security than household head's educational status. On the other hand, education level changed food consumption pattern and increase food demand. Household size is measured by the number of adult individual members of the household. Since food requirements increase with the number of persons in a household, and it will have negative impacts on food security. Land size is the total cultivated land which is directly used for the both cereal and non-cereal crops production. The larger the farm size, the higher is the production level. It is thus expected that nation/households with larger farm size are more likely to be food secure than those with smaller farm size. If cereal crops are produced, it raised food supply. On the other hand income level will increased, when produced others crop are produced.

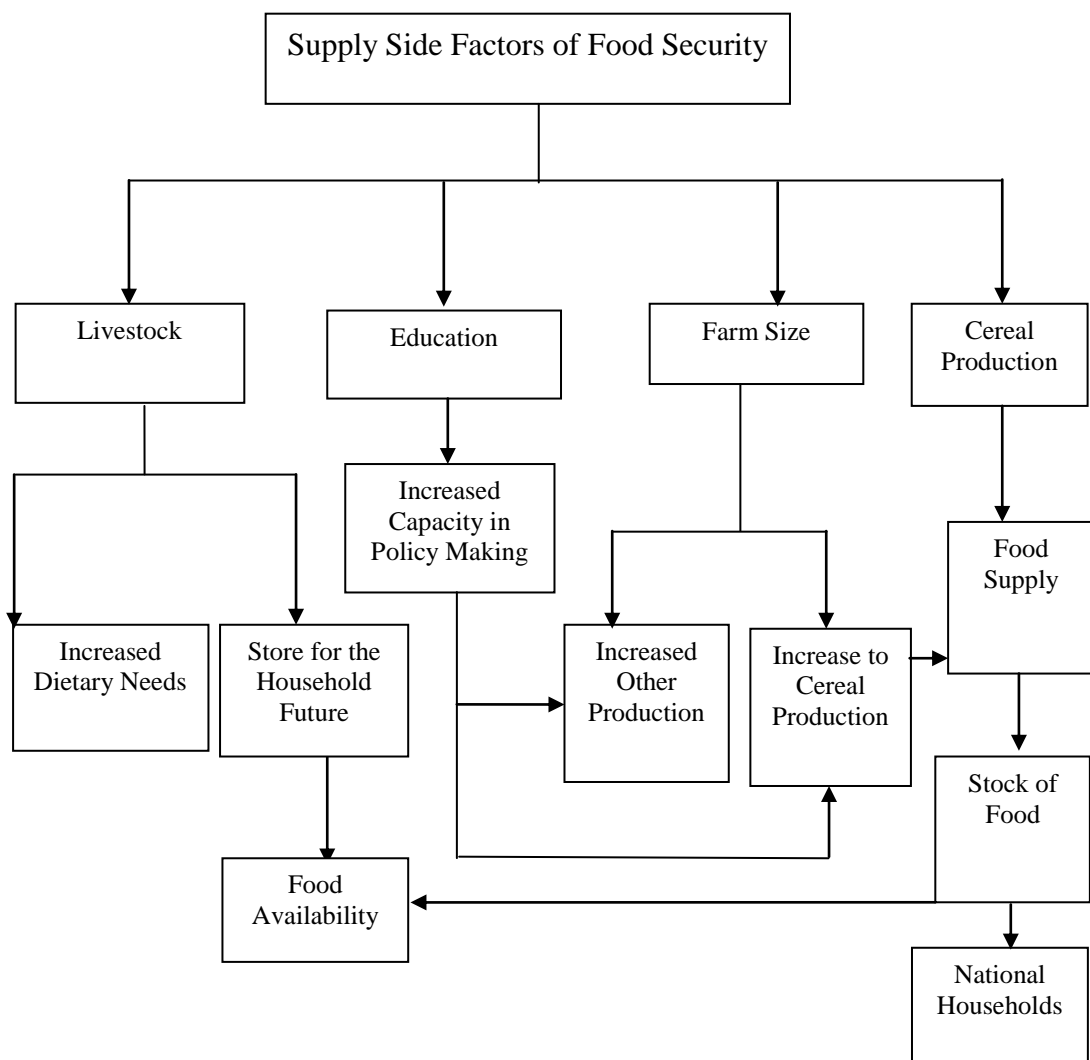
Flow chart 3.3 provides a structure for studying the food security and the relationship between variables and examines the issue of food security from the perspective of human resources development in Bangladesh. There are two broad groups of factors that determine food security such as supply side factors and demand side factors. Land, production, livestock, food inflow and education indicate the supply side factors while income, household size middle aged population and education are the determinants of demand side factors. The supply side factors determined of physical access to food at national, household and intra-household levels. On the other hand, the demand side factors determine the degree of access of countries, households and individuals to available food. However, the stability of both physical and economic access to foods is affected by another set of factors (Omonona and Agoi, 2007). The socio-economic characteristics and resources of individual households have been identified as basic factors influencing the food security status of households (Sanusi *et al.* 2006).

Flow chart 3.4 has been constructed with a view to identifying the linkage between the supply side factors and its resulting direct and indirect security in food impacts. This is necessary because there are many stages of food security which are affected by

the continuous influence of supply side factors in food and Flowchart 3.4 clearly depicts the interconnections among those impacts and their reasons.

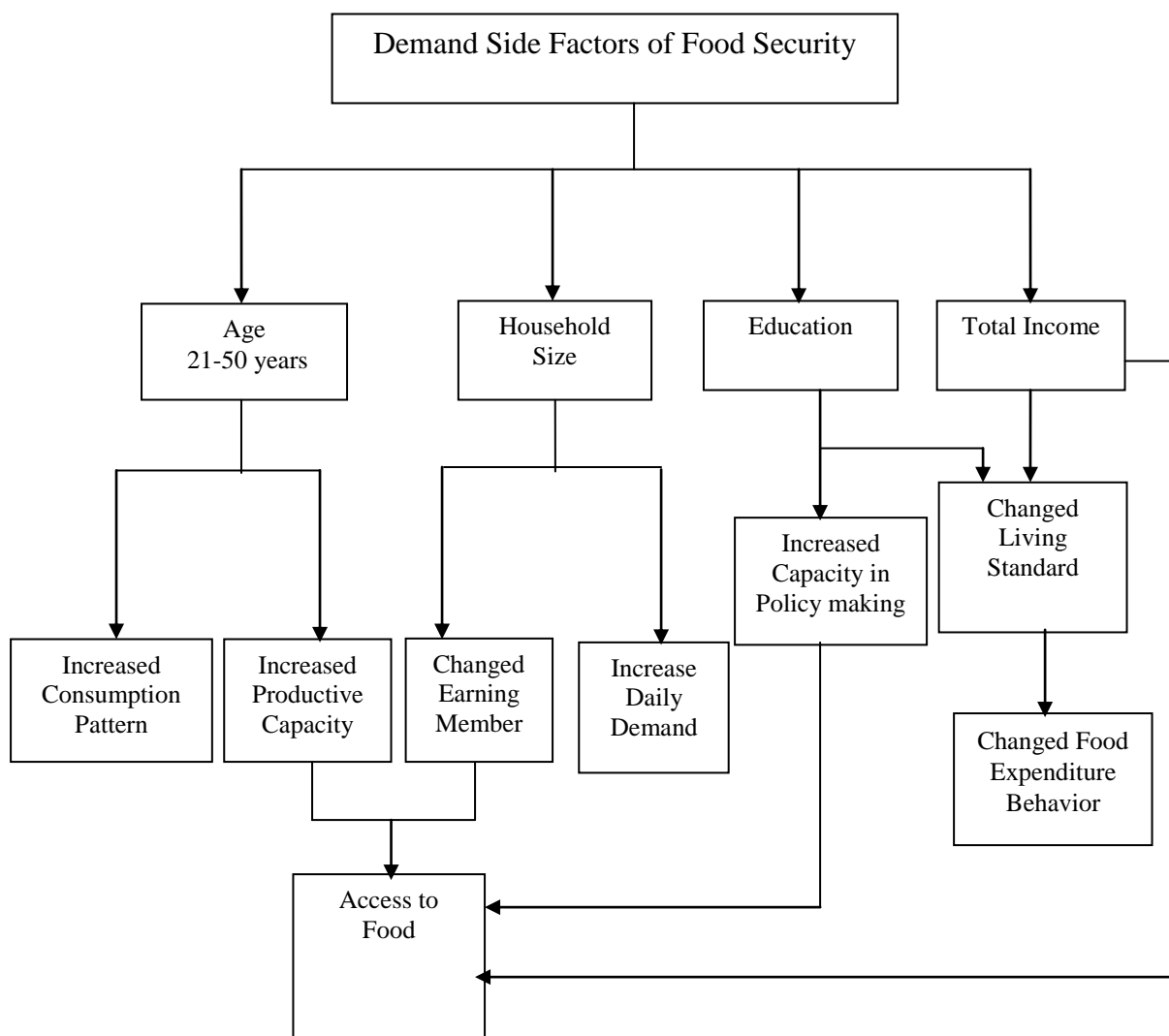
Farm size, livestock, cereal production and education have a greater positive effect on food security. Farm size is used for the cultivation of both cereal and non-cereal crops. When increases food supply as a result of using land for cereal production. It also increased stock of food in the household and national level. Education is a key factor which increased the capacity of the decision making in production process. This factor always has positively affected the food supply. And livestock is a major source of protein and energy in human body for a healthy and productive life.

Flow Chart 3.4: Linkages among Supply Side Factors



The process of linking demand side factors and food security is presented in Flow chart 3.5. There are many demand factors in food which directly or indirectly influence food security. This is necessary because there are many stages of food security which are affected by the continuous influence of demand side factors in food and Flowchart 3.5 clearly depicts the interconnections among those impacts and their reasons. Income is a key variable of the socially accepted sources of food provided in the market, which is directly related with food security.

Flow Chart 3.5: Linkages among Demand Side Factors



The sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households. Education is a social capital which changes food consumption pattern which increased food demand. However, educated person of a household has a positively role to play for access to food. Large household size

increase food demand and large number of earning member of a household increase the capacity of food access. Household size is measured by the number of adult individual members of the household. Food requirements increase with the number of persons in a household which has negative impacts on food security. Middle aged people have impact on ability to seek and obtain off-farm jobs and income which could increase household income.

3.4 Conclusion

From the above analysis of several significant concepts, it can be concluded that the relationship between different factors and its impacts on food security is complex and there are many forces that works in the interface. In this chapter, the food security is analyzed in detail and some other concepts relevant to food security relationship are also discussed to give a clear concept of the relation. The concept of food security–influencing factors suggests that the influencing factors are necessary to meet the growing food demand of the growing population.

CHAPTER FOUR

RESEARCH METHODOLOGY AND DATA DESCRIPTION

4.1 Introduction

This chapter discusses the methodology of the present study. Actually, methodology means the way of solving the research problems systematically. Research methodology consists of portrayal of the ways in which data has been collected, the techniques which are used for analyses, and the theoretical foundation and empirical design of the model used in this study. Actually, it helps to provide a guideline for the research. It includes the econometric techniques that estimate the impacts of socio-economic factors on food security. This chapter also provides a description of the explanatory variables and the dependent variable used in the study, and the ways and techniques of the collection of the required data.

This chapter includes seven principal sections. Section 4.2 describes the construction of Food Security Index (FSI) and the empirical model of the study. In section 4.3, the definitions and explanations of the variables (dependent and explanatory) have been discussed in detail. 4.4 section provides econometric theories related to model estimation. 4.5 section is organized in terms of the study area, method of sample selection and data collection procedure. This section describes the sample selection procedure, sample size and data collection sources. In section 4.6, a description of the collected data is given by analyzing the simple descriptive statistics of the data in tabular forms. Lastly, this chapter ends with a conclusion provided in section 4.7.

4.2 Empirical Approach for Analyzing Food Security

This study has analyzed the food security of rural households by employing a quantitative approach. To measure the food security status at household level in this research, some statistical techniques are applied such as adult equivalent unit, food security index, head count index, food shortfall or surplus index and squired food

insecurity gap index. Okwudilio *et al.*, (2006) used food security index to determine the food security status of each household based on the recommended daily calorie approach. This method (FSI) was also used by several studies (Omonona and Agoi, 2007; Babatunde *et al.*, 2007; Babatunde *et al.*, 2010; Kuwornu *et al.*, 2013; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Ahungwa *et al.*, 2013 and Iorlamen *et al.*, 2014).

In addition to measuring the food security status of households, this study tried to identify the factors that determine the food security condition of the households by applying the logistic regression model. In the earlier studies, various models were used to determine the factors influencing food security condition of the households and in those studies Cob-Douglas production function model (Ahmed and Garnett, 2011), Multiple regression model (Babatunde *et al.*, 2010), Probit regression model (Yusuf *et al.*, 2011) and Logistic regression model (Kuwornu *et al.*, 2013; Iorlamen *et al.*, 2013; Ramakrishna and Demeke, 2002; Babatunde *et al.*, 2007; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2014) were used.

Following Babatunde *et al.* (2007) and Adeniyi and Ojo (2013) this study employed the Logistic regression in investigating the factors affecting food security status of the sample households. The logistic regression model is used to identify and examine the determinants of food security among the households. It is chosen for this study because of the nature of the dependent variable, which is dichotomous and for the fact that it can estimate the probability of a certain event occurring (Der and Everitt, 2002; Adeniyi and Ojo, 2013). It also accommodates a lot of variables (discrete and continuous), which can be ranked in a hierarchy to show which variables strongly affect the response variable and the association between the independent variables (Adeniyi and Ojo, 2013). Logistic regression model is used due to its simplicity in the interpretations of the coefficients. The dependent variable in this case, food security status of household, is a binary variable which takes a value of one for food secured household and zero for food insecure households and it depends mainly on socio-economic aspects of the households. Therefore, to sort out which explanatory variables are most closely related to the dependent variable, some factors will be considered. Moreover, to investigate the food security status at national level calorie

based quantitative techniques provided by FAO is employed. The index and the empirical model that have used in the present study are explained below.

4.2.1 Food Security Index

For measuring food security status of households two methods have been widely used in earlier studies (Maxwell, 1996). The first method was used by Omonona (2007). The index that was used by Omonona is: Food security = (food expenditure of i^{th} household \div two-third of the mean per capita food expenditure of all study households). The second method was used by Fakiyesi (2001) and Olayemi (1998). As per this method, food security is measured in two ways. The first one is based on calorie consumption per equivalent male adult and second is based on age and sex without converting to equivalent adult by calorie consumption. Daily calorie intake method is better than food expenditure method because daily calorie intake method represents the actual food consumption pattern of households. Therefore, this study used the daily calorie intake method.

Food security status of each household is measure based on the food security line using the daily calorie intake recommended by FAO (2005). The average daily calorie requirement for a moderately active adult is 2850 kcal and a safe minimum daily intake should not fall below 80% of the above calorie requirement, which means that the minimum intake should be about 2280 kcal per adult equivalent per day. This food security line is used in this study after converting of all household members into adult equivalent unit (May, 1996; Swindale, 2005). The formula for converting all household members into adult equivalent is as follows.

$$ADEQ = (A + 0.5C)^{0.9} \dots\dots\dots(1)$$

Where,

ADEQ = Adult equivalent unit,

A = Number of adults above the age of 15 years,

C = Number of children below the age of 15 years in a household,

There are two steps to construct a food security index such as identification and aggregation (Keenan, 2001; Coates, 2006). Identification is the process of defining a minimum level of food necessary to maintain a healthy life and this is known as the food security line which is 2280 kcal. Aggregation is the process of deriving the food security statistics for the households. The household daily calorie intake is obtained from the questionnaire and from there the quantity of food consumed by the household is estimated in the 7 days period. The quantities are converted to gram and the calorie content is estimated by using the nutrient composition table of commonly eaten foods in Bangladesh (GoB, 2005; BIDS, 1997). Weekly per capita calorie is calculated by dividing estimated total household calorie intake by the family size (all adult equivalent) and to get the household's daily per capita calorie intake we divided the household's per capita calorie intake by seven (Babatunde *et al.*, 2007). A household whose daily per capita calorie intake is at least 2280 kcal is regarded as food secure, while those with less than 2280 kcal are food insecure. The food security index as applied in Fakiyesi (2001) is given by the formula as

$$F_i = Y_i / R \dots\dots\dots(2)$$

Where,

F_i = Food security index = Food security status of i^{th} household

Y_i = Daily per capita calorie intake of the i^{th} household

R = Recommended per capita daily calorie intake (2280 kcal per day per adult equivalent).

When, $F_i \geq 1$, the i^{th} household will be food secure [$Y_i \geq R$]

$F_i < 1$, the i^{th} household will be food insecure [$Y_i < R$]

A food secure household is that whose daily per capita calorie intake is above or on the recommended per capita daily calorie intake line. On the other hand, a food insecure household is that whose daily per capita calorie intake falls below the recommended per capita daily calorie intake line. Based on F_i , other related measures are calculated and these are the HCR (head count ratio), shortfall/surplus index (P), and the food insecurity gap (FAO, 2005; Fakiyesi, 2001; Olayemi, 1998).

4.2.2 The Headcount Ratio (HCR) Index

The head count ratio measures the fraction of the population who are food insecure and it is calculated as:

$$HCR = \frac{M}{N} \dots\dots\dots(3)$$

Where,

HCR = Head count ratio

M = total number of food insecure households

N = total study households

For example the calculated head count ratio (H) is 0.6990 for food secure households, indicating that 69.90% of households in the study area are food secure. For insecure households, the head count ratio is 0.3009, showing that only 30.1% of households in the study area are food insecure.

4.2.3 The Shortfall or Surplus Index (P)

A household may consume more or less than recommended calories which is necessary to lead a healthy life. The shortfall or surplus index measures the extent to which households are above or below the food security line. The shortfall or surplus index is measured by the following formula.

$$P = \frac{1}{M} \sum_{n=1}^m G_n \dots\dots\dots(4)$$

Where,

M = the number of insecure (or secure) households

G_n = Per capita calorie intake deficiency (or surplus) of the n^{th} household

$G_n = (Y_n - R)/R$ [Y_n is actual calorie intake by households and R is recommended intake].

For example, the calculated shortfall and surplus index of total study area are 0.0800 and 0.077 which indicate that the food insecure households falls below the food security line by about 8% and the food secure households lie above the food security line by 7.7%.

4.2.4 The Squared Food Insecurity Gap (SFIG)

Squared food insecurity gap measures the severity of food insecurity among households (Idrisa, 2008). The squared food insecurity gap can be calculated using the following formula.

$$SFIG = \sum \frac{(FIG_i)^2}{FIH} \dots\dots\dots(5)$$

Where,

SFIG = squared food insecurity gap

FIH = total number of food insecure households

For example, the calculated Squared Food Insecurity Gap value is 0.4612 indicating that the problem of food insecurity is 46.12% severe in the study area.

4.2.5 The Logistic Regression Model

Logistic regression analysis is a multivariate technique which allows for estimating the probability that an event occurs or not, by predicting a binary dependent outcome from a set of independent variables. When the dependent variable is binary, the linear probability model (LPM), Logit and Probit model can be used (Ramnathan, 1998; Green, 2000). Logit and Probit models are quite comparable; however the logistic has slightly flatter tails. Thus, the choice between the two is one of convenience and ready availability of computer programs. On this score, the Logit model is usually used in preference to the probit (Gujarati, 1995). Since the dependent variable is dichotomous, the present study has applied the Logistic regression model to analyze the relationship between the dependent and explanatory variables.

Let the probability that a household is food secure can be written as

$$P_i = E(Y=1/X_i) = \beta_1 + \beta_2 X_i$$

Where, X_i is the independent variable and $Y=1$ means that the households are food secure. Now, consider the following representation of food security status of the household as follow:

$$p_i = E(Y_i = 1/X_i) = \frac{1}{1+e^{-(\beta_1+\beta_2 X_i)}} = \frac{1}{1+e^{-Z_i}} \dots\dots\dots(6)$$

Where,

$$Z_i = \beta_1 + \beta_2 X_i$$

This equation (1) is known as the (cumulative) logistic distribution function. Here Z_i ranges from $-\infty$ to $+\infty$; P_i ranges between 0 and 1; P_i is non-linearly related to Z_i (i.e. X_i), thus satisfying the two conditions required for a probability model. In satisfying this requirement, an estimation problem has been created because P_i is non-linear not only in X_i but also in the β 's. This means that one cannot apply OLS technique to estimate the parameters. Here P_i is the probability of being food secure of households and is given by

$$p_i = \frac{1}{1+e^{-Z_i}} \dots\dots\dots(7)$$

Then $(1-P_i)$, the probability of not being secures in food of households and is given by

$$1 - p_i = \frac{1}{1+e^{Z_i}} \dots\dots\dots(8)$$

Therefore, it can be written,

$$\frac{p_i}{1 - p_i} = \frac{1}{\frac{1+e^{-Z_i}}{1+e^{Z_i}}}$$

$$\frac{p_i}{1 - p_i} = e^{z_i} \dots\dots\dots(9)$$

Where, $\frac{P_i}{1-P_i}$ is the odds ratio in favor of being food secure of household, i.e. the ratio of the probability that a household will be secure in food to the probability that the household will not be secure in food.

To find an appropriate function, it is natural to start with our earlier logistic function and modify it. Taking natural log the logistic function (9) can be written as

$$L_i = \ln[P_i/1-P_i] = \beta_1 + \beta_2 X_i \dots \dots \dots (10)$$

That is, the log of the odds ratio is not only linear in X_i but also linear in the parameters. L_i is called the Logit.

4.2.6 Empirical Specification

Based on the household food security index (F_i), the logit model is estimated to find the effects of the factors of food security at the household level. The model used food security status of households as a dichotomous dependent variable. The empirical relationship between dependent variable and explanatory variables is specified using the following relationship.

$$L_i = \ln[P_i/1-P_i] = \beta_1 + \beta_2 TMHI + \beta_3 AHH + \beta_4 ESHH + \beta_5 HS + \beta_6 FS + \beta_7 GHH + \beta_8 OL + \beta_9 QCP + \mu_i \dots \dots \dots (11)$$

Where,

L_i is the log odds ratio in favor of being a household secure in food,

TMHI = total monthly household income,

AHH = age of household head,

ESHH = education level of household head,

HS = household size,

FS = farm size of the household,

GHH = gender of household head,

OL = owned livestock,

QCP = quantity of cereal production.

β_1 is constant, $\beta_2, \beta_3, \dots, \beta_9$ are regression coefficients and u_i is the random error term. The coefficients of the regression model are estimated by applying the maximum likelihood estimation (MLE) technique.

4.3 Measurement of Dependent and Explanatory Variables

In this section the units of the variables and their measurement procedure is discussed. The dependent variable was dichotomized with a value of 1 if the household is food secure and 0 otherwise.

Table 4.1: Description of Variables Using in the Logit Model

Variables		Type	Measurement
Dependent variable	Food Security Status	Dummy	1 if household is secure in food, 0 otherwise
Explanatory variables	Total monthly household income	Continuous	Amount of money earned by the family members in a month (BDT)
	Education level of household head	Continuous	Formal education of household head (years of schooling)
	Age of household head	Continuous	Age of the household head (years)
	Household size	Continuous	Total number of members in the family in terms of adult equivalent
	Farm size	Continuous	Amount of land under cultivation (acre)
	Gender of household head	Dummy	1 if household head is male, 0 otherwise
	Livestock owned	Dummy	1 if household has livestock, 0 otherwise
	Quantity of cereal production	Continuous	Amount of cereal production (quintal)

The explanatory variables were the monthly household income, farm size, quantity of cereal production, age, education, household size, gender, and livestock. The basis for the selection of variables to examine empirically the factors of food security was the earlier studies (Ramakrishna and Demeke, 2002; Okwudilio *et al.*, 2006; Babatunde *et al.*, 2007; Omonona *et al.*, 2007; Babatunde *et al.*, 2010; Ahungwa *et al.*, 2013; Yusuf *et al.*, 2011; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Kuwornu *et al.*, 2013;

Iorlamen *et al.*, 2014). Based on these studies, expected signs were also hypothesized for the selected variables. Table 4.1 lists definitions of variables and measurement methods. The explanation of the dependent variable and the explanatory variables included in the model are described below:

Food Security Status of Household

The food security line used in the present study is the recommended daily per capita calorie intake of 2280 kcal suggested by FAO (2005). A food secure household is that whose daily per capita calorie intake is on or above the recommended per capita daily calorie intake. On the other hand, a food insecure household is that whose daily per capita calorie intake fall is below the recommended per capita daily calorie intake. The dependent variable is food security status of households in the present study which is constructed using the recommended daily calorie intake by the households. The dependent variable takes the value of 1 if a household is food secure and 0 otherwise.

Total Monthly Household Income

Total monthly household income refers to the total earnings of household in a month from farm and off-farm sources (Babatunde *et al.*, 2007). According to Arene and Anyaeji (2010), the more household head engages in gainful employment, the higher he/she earns income and the greater the chances of being food secure. The income is expected to boost household's food production and access to more food. The basis for the selection of variable to examine empirical factors of food security is the earlier studies(Babatunde *et al.*,2007; Okwudilio *et al.*, 2006; Omonona *et al.*, 2007; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Iorlamen *et al.*, 2014; Babatunde *et al.*, 2010). The expected effect of this variable on food security is positive. This variable is denoted by TMHI in this study.

Age of Household Head

The age of household head is expected to have impact on his or her productive activities of earned income. It is also expected to have impact on ability to seek and obtain off-farm jobs and income which could increase household income. Again, the

age of household head is expected to impact on his or her labour supply for food production (Babatunde *et al.*, 2007). On the other hand, Arene and Anyaeji (2010) found older household heads to be more food secure than the younger household heads. However, young and energetic household heads are expected to cultivate larger farms compared to the older and weaker household head (Kuwornu *et al.*, 2013). Some earlier studies have found that age of household head is important in food security of household (Okwudilio *et al.*, 2006; Babatunde *et al.*, 2007; Omonona *et al.*, 2007; Babatunde *et al.*, 2010; Adeniyi and Ojo, 2013; Ahungwa *et al.*, 2013; Iorlamen *et al.*, 2013; Yusuf *et al.*, 2011; Kuwornu *et al.*, 2013; Iorlamen *et al.*, 2014). Thus, the expected effect of age on food security could be positive or negative. This variable is denoted by AHH in the study.

Educational Status of Household Head

Education is a human capital which helps one to get better job and an educated one earns more income compared to an uneducated one. With more income a household can afford more food for family (Babatunde *et al.*, 2007). Moreover, an educated household head can arrange balanced and nutritional diet for his/her family. Moreover, education influences access to knowledge, increases opportunities of income, development of nutritional status and access to benefits and resources. According to Shaikh (2007), the educated individuals have capacity to process and apply the information passed on to them. An increase in public education not only increases their returns but also improves their productivity as well as contributes positively to the national growth (Kuwornu *et al.*, 2013). Some earlier studies (Ramakrishna and Demeke, 2002; Babatunde *et al.*, 2007; Shaikh, 2007; Okwudilio *et al.*, 2006; Omonona *et al.*, 2007; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Yusuf *et al.*, 2011; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Iorlamen *et al.*, 2014; Babatunde *et al.*, 2010) have found that education is important in food security of household. Thus, education of household head could have positive effects on food security status of household. In the present study educational status of household head is expressed by ESHH.

Household Size

Generally household size means total members of the household. However, a household may comprise of children, middle aged and adult members and the consumption of all of them are not same. Some earlier studies (Babatunde *et al.*, 2007; Ramakrishna and Demeke, 2002; Omonona *et al.*, 2007; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Yusuf *et al.*, 2011; Iorlamen *et al.*, 2014; Babatunde *et al.*, 2010) have found that household size is important in food security of household. Therefore, household size is measured in terms of adult equivalent unit. This variable is denoted by HS.

Farm Size

Farm size is the total area of land cultivated to food and cash crops by the households, measured in acres. Positive relationship has been established between farm size and improvement in household's income and food security (Kuwornu *et al.*, 2013). The per capita land holding is one of the important factors ensuring food security to the households. Generally, the per capita farm land holding has been declining due to an increase in population and due to land tenure policies. This variable is used by Ramakrishna and Demeke (2002). The larger the farm size of the household, the higher is expected level of food production. The basis for the selection of this variable to examine empirically factors of food security is the earlier studies (Babatunde *et al.*, 2007; Ramakrishna and Demeke, 2002; Adeniyi and Ojo, 2013; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010). It is thus expected that households with larger farm size are more likely to be food secure than those with smaller farm size, all other things being equal (Babatunde *et al.*, 2007). The expected effect on food security is positive. Farm size in the present study is denoted by FS.

Gender of Household Head

Gender of household head is looked at in the role played by the individuals in providing household's needs including acquisition of food. Female headed households have higher dependency ratios which hinders household capacity to allocate labor to on-farm or other income-generating activities (Kuwornu *et al.*, 2013). The gender of household head is expected to have impact on the household labor supply for food

production. Men have advantage and are expected to cultivate larger-size farm than women (Babatunde *et al.* 2010). Some earlier studies (Okwudilio *et al.*, 2006; Omonona *et al.*, 2007; Yusuf *et al.*, 2011; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Iorlamen *et al.*, 2014; Babatunde *et al.*, 2010) have found that gender issue is important in food security of households. Therefore, gender of household head is coded as 1 for male and 0 for female. The expected effect of this variable is positive. Gender of household is expressed by GHH.

Livestock Owned

Livestock ownership refers to the total number of livestock of the household. The larger the farm size, the higher is the production level. The livestock is very important in assuring food security in the household. An increase in the livestock population enables the people to be food secure either through the income earned or by direct by consumption (Ramakrishna and Demeke, 2002). This variable is used by Ramakrishna and Demeke (2002). It is thus expected that households with large number livestock are more likely to be food secure than those with small number of livestock. The expected effect on food security is positive. Livestock is denoted by OL.

Quantity of Cereal Crops from Own Production

This is the total quantity of food output by the household from their own farm measured in kilogram grain equivalent. According to Babatunde *et al.*, 2007, it consists of both food and cash crop outputs. Cash crops are included because they can be sold and money realized from their sale could be used to purchase food for household consumption. The quantity of household owned cereal production increases the probability of food security (Babatunde *et al.*, 2007; Ramakrishna and Demeke, 2002; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010). Thus, the expected effect of the variable on food security is positive. This variable is denoted by QCP.

4.4 Estimation Issues

The coefficients of logistic regression model are estimated by maximum likelihood

method because the logistic regression model does not follow the equal variance of the disturbances and normality condition of the disturbances (0, 1). The maximum likelihood method is a large sample method. So, the coefficient estimates are consistent (approach the population parameters as the sample size increases) and has an approximate normal distribution (0, 1) in most cases. For small data sets or data sets in which the average value of Y is close to zero or one, the method of maximum likelihood can provide poor results.

4.4.1 Likelihood Ratio Test

Likelihood ratio test, introduced by Neyman and Pearson, is used for testing a hypothesis. This test is a generally large sample test based on the ML (Maximum likelihood) method. Likelihood ratio tests also have been used to compare two nested models. If the sample size is large, the test statistic will be distributed as a chi-squared random variable with degree of freedom equal to the difference in the number of parameters between the two models.

Suppose we would like to test the following hypothesis

$$H_0 : \beta_i = 0$$

$$H_1 : \beta_1 \neq 0$$

The likelihood ratio statistic

$$\begin{aligned} \lambda_{LR} &= -2 \ln \left(\frac{RLF}{ULF} \right) \dots \dots \dots (12) \\ &= 2 \{ \ln(ULF) - \ln(RLF) \} \end{aligned}$$

where RLF = restricted log-likelihood function

and ULF = unrestricted log-likelihood function

Null hypothesis is rejected if $\lambda_{lr} \geq \chi^2_{(TA)}$

4.4.2 R-Squared in Logistic Regression

When the researcher analyzes data with a logistic regression, there is a problem with the use of conventional R^2 type measures in which the explained variables Y are probabilities and the actual values Y are either 0 or 1.

R-squared computed as in linear regression model should not be used in Logistic regression model. This is because in logistic regression model the nature of dependent variable is qualitative and takes value 1 and 0. R-squared measure seeks to make a statement about the percent of variance explained in the linear regression model. But the variance of a dichotomous or categorical dependent variable depends on the frequency distribution of that variable. So, logistic regression does not provide any measure of R squared in which R square of OLS range from 0 to 1 but McFadden (pseudo) R-squared does not range from 0 to 1. Logistic regression model calculates a (pseudo) McFadden R-squared. Even R-squared of Logistic regression model does not measure goodness of fit but rather attempts to measure strength of association. Because they cannot calculate minimum variance, so goodness of fit does not hold. For this reason R-squared of logistic regression model has been termed as (pseudo) McFadden R-squared. In this situation the higher pseudo R-squared indicates that the model better predicts the outcome. Various alternative forms of R-squared have been used in the analysis of logistic regression model.

4.4.3 Estimation of the Model and Other Econometric Issues

The functional relationship between the dependent variable in terms of food security status and the considered independent variables such as the total monthly income, age of household head, education status of household head, household size, farm size, owned livestock, gender of household head and quantity of cereal production are specified in the earlier section in Equation (10) as a Logistic regression model. Since we are using cross section data, multicollinearity problem might arise. So, we have calculated partial correlation coefficients for the variables used in the model to check the multicollinearity which is shown in Table 4.2.

Table 4.2: Correlation Matrix of Explanatory Variables

	TMHI	AHH	ESHH	HS	FS	OL	GHH	QCP
TMHI	1							
AHH	0.36	1						
ESHH	0.17	-0.25	1					
HS	0.36	0.42	-0.02	1				
FS	0.19	0.18	0.21	0.26	1			
OL	0.10	.15	0.13	0.19	0.22	1		
GHH	-0.077	-0.04	0.03	-0.26	-0.05	-0.19	1	
QCP	0.16	0.18	0.20	0.25	0.48	0.23	-0.08	1

Source: Author's own calculation

In the table TMHI, AHH, ESHH, HS, FS, OL, GHH and QCP stand for total monthly household income, age of household head, education status of household head, household size, farm size, owned livestock, gender of household head and quantity of cereal production respectively. It is seen from Table 4.2 that the values of correlation coefficients of the variables are very low and less than 0.5. Therefore, multicollinearity among variables does not appear to be a serious problem in the model. As a result, there is no problem for the estimation of model.

4.5 Selection of the Study Area and Sample

The present study mainly relies upon primary data collected from the households of the northern part of Bangladesh. With a view to fulfilling the objectives of the present study of determining the food security status, identifying the factors having influence on food security and drawing a comparison among the different households belonging to different living standard and different socioeconomic characteristics, the sample has been selected in such a way that it covers all such households. All the issues pertaining to the selection of sample and collection of data are discussed below:

4.5.1 Selection of the Study Area

The results of this study represent the real picture of the households' food security. For this reason the researcher selects the study area and the respondents carefully. For

selecting the sample area the researcher has to take into account all the difficulties and complexities inherent in conducting the research work. As was mentioned, three districts (Natore, Naogaon and Rajshahi) have been chosen as the study area. These districts have a total of 28 upazila of which 6 are selected randomly. The selected upazila are Gurudaspur and Natore Sador in Natore, Mohadevpur and Mandha in Naogaon, Paba, Puthia are in Rajshahi and 2 Unions are separately selected from each upazila. All these upazilas are inhabited by various categories of households in terms of income, land and other socioeconomic characteristics.

4.5.2 Sample Size

Data are collected from 12 villages of the 3 districts. Random sampling method is used for the research purpose. A total of 180 respondents are the study samples.

Table 4.3: Sample Distribution and Techniques

Category of Study Respondents & Study Areas	Number of Sample	Sample Technique
District	3	Purposive
Upazila	6	Random
Union	12	Random
Village	12	Random
Household	180	Random

A multistage sampling technique is used to select the households that are interviewed. The first stage involves the selection of districts from which households interviewed are selected. This is done using purposive sampling techniques where the districts are grouped into northern part of Bangladesh. The second stage involved selection of upazilas, unions and villages is visited using simple random sampling. This is achieved with the help of district's recorded information. The second stage involved a random selection of two upazilas from each of the three selected districts giving a total of six upazilas and two unions from each of the six selected upazilas then a village is selected for the selected unions

The third and final stage is the selection of the households that are interviewed. Households are selected using simple random sampling, and data regarding their information about socio-economic characteristics, food production, food

consumption, and others are obtained for analysis. The population for the study comprised the farm-households and non-farm households of northern part from the three districts of Bangladesh. In the last stage, 180 households are selected from the earlier 12 villages sampled for the study, that is, 15 household per village.

4.5.3 Description of Study Area

The area in which the thesis study has been conducted is Rajshahi Division, one of the seven administrative divisions in Bangladesh consisting of 8 districts (Population Census, 2001). The area of the division is 18153km² and total of population is 18484858 in the year 2011 as well as total households of this area is 3559958 with an average household size of 4.1 (Population Census, 2011).

Table 4.4: Area, Population and Number of Household by Selected Districts

Area Name	Total Area(sq.km)		Total population		Number of Households	Size of Household
	Value	%	Value	%		
Rajshahi	2425	13.35	2595197	14.04	289953	4.0
Natore	1900	10.47	1706673	9.23	713255	4.0
Nogaon	3436	18.92	2600157	14.07	713064	3.9
Rajshahi Division	18153	100	18484858	100	4474803	4.1

Source: Population and Housing Census 2011, BBS

A major portion of our total food grain comes persistently from this area as the land-type is very suitable for this type of grain cultivation. This area has been selected purposively in order to reveal the population's living standard which remains convenient for the researcher. Within the areas under Rajshahi Division three districts have been chosen randomly to inspect the food security status of the households belonging to these randomly chosen in twelve unions in six upazilas in the selected districts. Among all these unions, study population or the respondents in terms of households are also selected randomly. In the following segments a brief description of the study area along with the districts are presented. From each district almost equal numbers of upzilas have been selected randomly. From each upzila several socio-economic characteristics of households have been chosen purposively to maintain the variation of income, education level, farm and other attributes. For this

reason, from each upzilas almost equal numbers of unions have been selected randomly.

Rajshahi District

Rajshahi District is in the northwestern Bangladesh. The river Padma, one of the major rivers of Indian subcontinent runs by Rajshahi city. The administrative district was established in 1772. Rajshahi Municipality was established in 1876, one of the first few in Bangladesh. Rajshahi became a Municipal Corporation in 1987 and finally a metropolitan city corporation in 1992.

Table 4.5: Study Area of Rajshahi District

Upzila	Union	Village
Paba	Horiyan	Boro Mollikpur
	Parila	Tabaria
Puthia	Jewpara	Kanaipara
	Puthia Union	Krishnapur

Rajshahi has been regarded as the bread-basket of Bangladesh. Recent agricultural modernizations with the much-lauded Barendra project has increased crop-diversification, allowed farmers to access better analysis of their farmland's chemical composition, and generally allowed farmers to grow as many as three crops every year instead of the usual one crop. It has 9 Upzilas and from Rajshahi district, four Unions are selected randomly, which are in Table 4.5, with their corresponding Upzilas. The head quarter of Harian Union is 10 kilometers east from zero point of Rajshahi metropolitan city and Parila Union is 13 kilometers away from Rajshahi zero point under the Paba Upazila. On the other hand, Jewpara union of Puthia Upizila is around 32 kilometers north-east from Rajshahi zero point and the head quarter of puthia Union is around 30 kilometers east from zero point of Rajshahi district.

Table 4.6 shows names of the unions of Rajshahi district in the first column, then its total land and cultivated land. Total population and number of households, name of main cereal crops which are produced and its corresponding literacy rate also are displayed here in the last four columns.

Table 4.6: Study Area Characteristics of Rajshahi District

Name of Unions	Total Land (acre)	Cultivated Land (acre)	Total Population	No. of Households	Name of Produced Cereal Crops	Literacy Rate
Horiyan	13187	9019	28042	5428	Paddy, Wheat	60
Parila	7901	5930	38276	8727	Paddy, Wheat, Maize	45
Jewpara	9500	6513	40441	7034	Paddy, Wheat, Maize	67.74
Puthia	8320	5950	20040	3002	Paddy, Wheat	65

Source: Population and Housing census-2011, BBS and Field Survey

We see that almost 68 percent land of Horiyan union in Rajshahi district is cultivated area and it produces three major cereal crops which contributed to fill up required food demand. Similarly the percentage of cultivated area of Parila, Jewpara and Puthia unions are 75 percent, 69 percent and 72 percent of the total land respectively; which means almost the whole area of those unions is utilized for cultivation. Literacy rate is almost 60 to 68 percent in these unions except in Parila union. Therefore it is reasonable to select those area for our study.

Natore District

Until 1821, Natore was the head quarter of Rajshahi district. In 1845 Natore Mahakuma was established and it became a full fledged district in 1984. Most part of Natore district is plain land. [Chalan Beel](#), the largest beel in [Bangladesh](#) is in partly in Natore district and [Lalpur](#) is the lowest Average annual rainfall area of Bangladesh. The literacy rate is 65% and it has 7 upzilas (including Noldanga upzila). From Natore district, four unions are selected randomly, which are in Table 4.7, with their corresponding upzilas.

Table 4.7: Study Area of Natore District

Upzila	Union	Village
Gurudaspur	Nazirpur	Dudgari
	Khubjipur	Bilsha
Natore Sador	Piprul	Patul
	Boro Horispur	Paikordol

The head quarter of Piprul Union is situated in the 10 kilometers north of Natore Zero point under the Natore Sador upzila. The Piprul union is a big union by area. Kaliganj

is a village of center Halti Beel and Patul is a village of East Halti Beel of this Piprul union under the Natore Sador upzila have been chosen purposively. The Boro Horispur Union is situated around 2 kilometers south of Natore Zero point. The Nazirpur Union is situated in the around 6 kilometers west of Zero point of Gurudaspur Upzila. The Khubjipur Union is situated around 4 kilometers north of the head quarter of Gurudaspur Upzila. Villages chosen from the Nazirpur Union are situated in the south-west of Chalan Beel and Villages chosen from the Khubjipur Union are situated in the central part of Chalan Beel.

Table 4.8 shows that almost 70 to 78 percent area of total area of each union of Natore district is cultivable land and produce mainly staple crops. The literacy rate is almost 60 to 68 percent in each union of Natore district except in Khubjipur union. From the list of households supplied by the respective union council, we have selected households or our respondents randomly. From each village of Rajshahi district, almost 10-15 households have been interviewed through a well structured questionnaire. All over 60 respondents have been interviewed from this district.

Table 4.8: Study Area Characteristics of Natore District

Name of Unions	Total Land (acre)	Cultivated Land (acre)	Total Population	No. of Households	Name of Produced Cereal Crops	Literacy Rate
Nazirpur	10678	7718	49239	10397	Paddy, Wheat, Maize, Pulse	52.47
Khubjipur	5562	5018	18571	4500	Paddy, Wheat, Maize, Pulse	49.69
Piprul	9905	7151	29693	7021	Paddy, Wheat, Maize	54.28
Boro Horispur	10910	8237	37350	8860	Paddy, Wheat, Maize	63

Source: Population and Housing census-2011, BBS and Field Survey

Naogaon District

At present Naogaon District is considered the bread basket of Bangladesh. It is the central part of Borendra Region, with an area of about 3,435.67 square kilometers (1,326.52 sq mi), about 80% of which is under cultivation. The soil of the area is a fertile inorganic clay called [dhoyass](#). The total population of the area is about 26 [lac](#) and there are 7.1 lac households, and most of the people of the district are farmers. The literacy rate is 44.39%. Crops grown in the district include paddy, jute, wheat,

maize, sugar cane, potato etc. The total production of paddy and wheat in 2009-2010 was 1358432 metric tons, including a surplus of 826835 metric tons (BBS, 2011). Today it is the top listed district in the context of rice production and has the highest number of rice processing mills. From Naogaon district, four unions are selected randomly, which are in Table 4.9 with their corresponding upzilas.

Table 4.9: Study Area of Naogaon District

Upzila	Union	Village
Mohadevpur	Vimpur	Rojoypur
	Chergapur	Durgapur
Mandha	Valain	Boiidapur
	Mainam	Mainam

The Head quarter of Vimpur union is 10 kilometers west from the Naogaon zero point. Rojoypur is a big village by area of this union under the Mohadevpur upzila. Chergapur union is 30 kilometers from Naogaon city zero point and attached with Mohadevpur upzila. On the other hand, Mainam union is 25 kilometers west of the Naogaon city zero point and .around 5 kilometers west of Patnitala. Valain unions of Mandha upzila is 27 kilometers north-west of Naogaon town zero point respectively.

Table 4.10 shows that approximately 70 to 90 percent land of the total land of each union is cultivated area. From Naogaon district, we have selected those unions which have vast cultivated land .Naogaon district produces highest proportion of total rice production in the country. On the other hand, union-wise picture of this district is also similar. Each union, which we have chosen for our study has greater portion of cultivated lands, literacy rate is 50 to 65 percent. From the list of households of each village, supplied by the respective Union Council of Naogaon district, we have randomly chosen a sample of 10-15 farmers for interview. By this way, samples of 60 households have been interviewed from this district.

Table 4.10: Study Area Characteristics of Naogaon District

Name of Unions	Total Land (acre)	Cultivated Land (acre)	Total Population	No. of Households	Name of Produced Cereal Crops	Literacy Rate
Valain	7559.58	6041.76	23001	6230	Paddy, Wheat, Maize	52.47
Mainam	6304.98	4988.88	22077	5968	Paddy, Wheat, Maize	49.69
Bhimpur	9386	7577	30073	7050	Paddy, Wheat	54.28
Chragpur	10003.5	7196	37021	9892	Paddy, Wheat, Maize	63

Source: Population and Housing census 2011, BBS and Field Survey

4.5.4 Selection of the Respondents

For selecting the respondents of the study, complete lists of households for the chosen upazilas are collected from the local administrative office. Using the lists, the respondent households are selected following a random sampling procedure. These respondents are the heads of the respective households who are interviewed during the data collection period. A total of 180 households are selected for interview for the study in equal proportions from these upazilas.

4.5.5 Techniques of Data Collection

Definitely data collection is the important task of the study. Both the primary and secondary data have been used in this study. However, this study is mainly based on data collected from primary sources. The primary data are collected from the respondents in the study area through a structured questionnaire. However, data from secondary sources are also used in this study.

For the collection of data a well structured questionnaire, on the basis of the research objectives, has been prepared. Accordingly our survey is collected data on many dimensions of household's socio-economic status. For example, household head's name, age, education level, sex, household's income, land, cereal crops production, livestock, credit and many other relevant things are included. Particularly, the questionnaire is designed with a view to fulfilling the requirements of the variables

that have been employed in our selected regression model. Here it is important to note that, in order to construct a food security index FSI, the questionnaire also covers all questions of the nutrient calorie content of every food items consumed.

Besides collecting primary data, secondary data have been also collected through reviewed documents and relevant literature. Theoretical information and estimated results of earlier empirical studies have been collected through reviewing various articles, published and unpublished study reports and other kinds of relevant reports that were available in the libraries and on the internet for this study

4.6 Description of Data

Data have been coded directly on questionnaires and then entered into personal computer. As a first step of analysis the collected data has been classified and tabulated based on different attributes. After having all 180 data from the three districts the minimum and maximum values of all the along with the descriptive statistics are calculated.

4.6.1 Description of Data for Total Study Area

For the research study data has been collected directly from 180 respondent household heads. Table 4.11 shows the basic characteristics of the collected data which is in general called as the descriptive statistics of the data. From the table it is found that average daily calorie intake of the households in the study area is 2233 kcal with the maximum kcal as 3678 and minimum kcal as 1621. Average monthly income of the households in the study area is 6354 Tk with the maximum income as Tk 24000 and minimum as Tk 2000. There is a huge difference between these two margins. The average age of the household head is 41.39 years. Maximum 65 years old household head is associated with the study and minimum aged household head is 21 years old. The education index shows the situation of literacy level in the study area as on an average household head is class 4. Maximum level of education of the head is the master's level and minimum is just no formal education. Average household size is 3.47 with maximum size of 12 and minimum of 2. Maximum farm size of the

household is 8.25 acre and minimum is no cultivated land, whereas average farm size is 0.60 acre. Maximum produce of cereal crops of the households is 320.90 quintal and minimum is no production whereas average household production is 19.32 quintal of cereal crops.

Table 4.11: Descriptive Statistics of the Data of All Study Area

Variables	Mean	Max.	Min.	SD
Per Capita Daily Calorie Availability (kcal)	2233	3678.0	1621.0	595.8
Total Monthly Household Income (BDT)	6354	24000.0	2000.0	4286.7
Age of Household Head (years)	41.39	65	21	12.2
Educational Status of Household Head (years of schooling)	4.19	16	0	3.6
Household Size (per person)	3.47	12.0	2.0	1.2
Farm Size (acre)	0.60	8.3	0.0	1.2
Quantity of Cereal Production (quintal)	19.32	320.9	0.0	37.9

Source: Author's own calculation

4.6.2 Naogaon District

Table 4.12 shows the basic characteristics of the collected data in Naogaon district. From the table it is found that average daily calorie intake of the households in the study area is 2279 kcal with the maximum kcal as 3678 and minimum kcal as 1722.

Table 4.12: Descriptive Statistics of the Data in Naogaon District

Variables	Mean	Max.	Min.	SD
Per Capita Daily Calorie Availability (kcal)	2279	3678.00	1722.00	458.45
Total Monthly Household Income (BDT)	4784.7	12000.00	2500.00	2007.68
Age of Household Head (years)	39.40	65	21	10.51
Educational Status of Household Head (years of schooling)	3.96	14	0	3.27
Household Size (per person)	3.24	6.00	2.00	1.06
Farm Size (acre)	0.82	8.25	0.0	1.41
Quantity of Cereal Production (quintal)	28.14	320.90	0.0	49.02

Source: Author's own calculation

Average monthly income of the households in the study area is Tk 4784.7 with the maximum income as Tk 12000 and minimum as Tk 2500 The average age of the household head is 39.40 years. Maximum 65 years old household head is associated with the study and minimum aged household head is 21 years old. The education level

of average household head is class 5. Maximum level of education of the head is the BA level and minimum is just no formal education. Average household size is 3.24 with maximum of 6 and minimum of 2. Maximum farm size of the household is 8.25 acre and minimum is no cultivated land, whereas average farm size as .82 acre. Maximum produce of cereal crops of the households' is 320.90 quintal and minimum is no production whereas average households production is 28.14 quintal of cereal crops.

4.6.3 Natore district

For the research study, data has been collected directly from 60 respondent household heads in Natore district and Table 4.13 shows the basic characteristics of the collected data in this district. From the table it is found that average daily calorie intake of the households in the study area is 2150 kcal with the maximum kcal as 3302 and minimum as 1621.

Table 4.13: Descriptive Statistics of the Data in Natore District

Variables	Mean	Max.	Min.	SD
Per Capita Daily Calorie Availability (kcal)	2150	3202.00	1621.00	352.82
Total Monthly Household Income (BDT)	7321.5	24000.00	2000.00	5027.13
Age of Household Head (years)	40.42	65	25	11.67
Educational Status of Household Head (years of schooling)	4.42	16.00	0	4.15
Household Size (per person)	3.68	12.00	2.00	.97
Farm Size (acre)	0.41	4.62	0.0	.91
Quantity of Cereal Production (quintal)	12.16	156.72	0.0	26.51

Source: Author's own calculation

Average monthly income of the households in the study area is Tk 7321.5 with the maximum income as Tk 24000 and minimum as Tk 2000. There is a huge difference between these two margins. The average age of the household head is 40.42 years. Maximum 65 years old household head is associated with the study and minimum aged household head is 25 years old. The education index shows the situation of literacy level in the study area as on an average household head is class 4. Maximum level of education of the head is the master's level and minimum is just no formal education. Average household size is 3.68 with maximum of 12 and minimum of 2.

Maximum farm size of the household is 4.62 acre. and minimum is no cultivated land, whereas average farm size .41 acre. Maximum produce of cereal crops of the households is 156.72 quintal and minimum is no production whereas average households production is 12.16 quintal of cereal crops.

4.6.4 Rajshahi district

Table 4.14 shows the basic characteristics of the collected data in Rajshahi district with 60 households. From the table it is found that average daily calorie intake of the households in the study area is 2270 kcal with the maximum kcal as 3678 and minimum as 1151.

Table 4.14: Descriptive Statistics of the Data in Rajshahi District

Variables	Mean	Max.	Min.	SD
Per Capita Daily Calorie Availability (kcal)	2270	5678.00	1636.00	718.41
Total Monthly Household Income (BDT)	6956	24000.00	2500.00	4706.84
Age of Household Head (years)	43.85	65	25	13.93
Educational Status of Household Head (years of schooling)	4.2	16	0	3.47
Household Size (per person)	3.48	9.00	2.00	1.38
Farm Size (acre)	0.58	6.60	0.0	1.10
Quantity of Cereal Production (quintal)	17.67	199.25	0.0	33.01

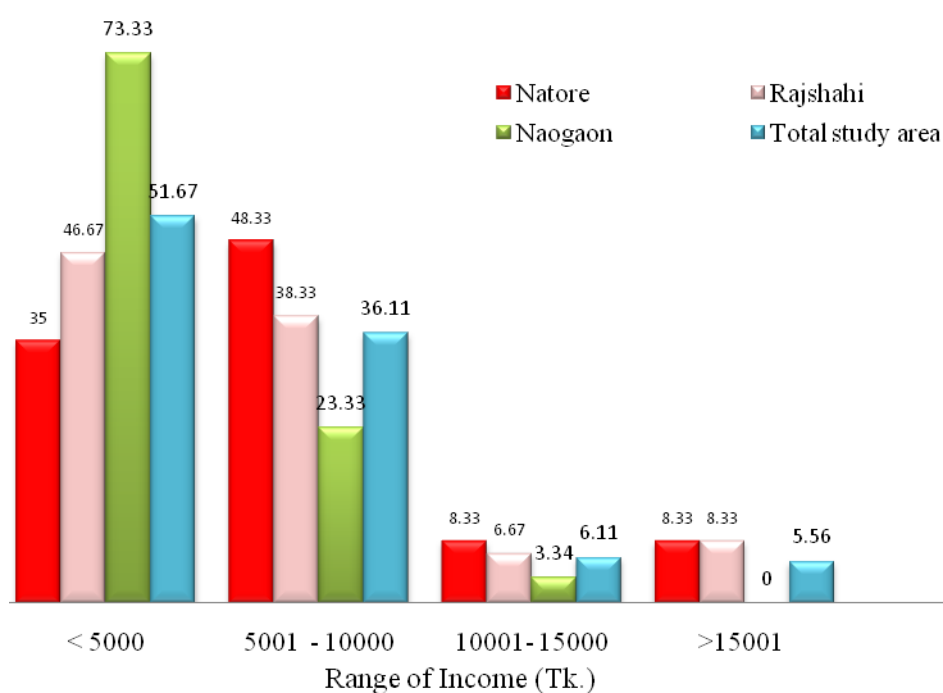
Source: Author's own calculation

Average monthly income of the households in the study area is Tk 6956 with the maximum income as Tk 24000 and minimum as Tk 2500. There is a huge difference between these two margins. The average age of the household head is 44.85 years. Maximum 65 years old household head is associated with the study and minimum aged household head is 25 years old. The education index shows the situation of literacy level in the study area as on an average household head is class 4. Maximum level of education of the head is the master level and minimum is just no formal education. Average household size is 3.48 with maximum of 9 and minimum of 2. Maximum farm size of the household is 6.60 acre. and minimum is no cultivated land, whereas average farm size is .58 acre. Maximum produce of cereal crops of the households is 199.25 quintal and minimum is no production whereas average households production is 17.67 quintal of cereal crops.

4.6.5 Distribution of Households by Income

The distribution of households on the basis of their monthly income is presented in Figure 4.1. The frequency of households is the highest in the low income category earning less than Tk 5000. In this category represents 51.67% of the households. For the middle income group, earning Tk 5001-15000 they constitute 42.22 percent while those in the higher income group (above 15001 Tk) represent 6.1 cent.

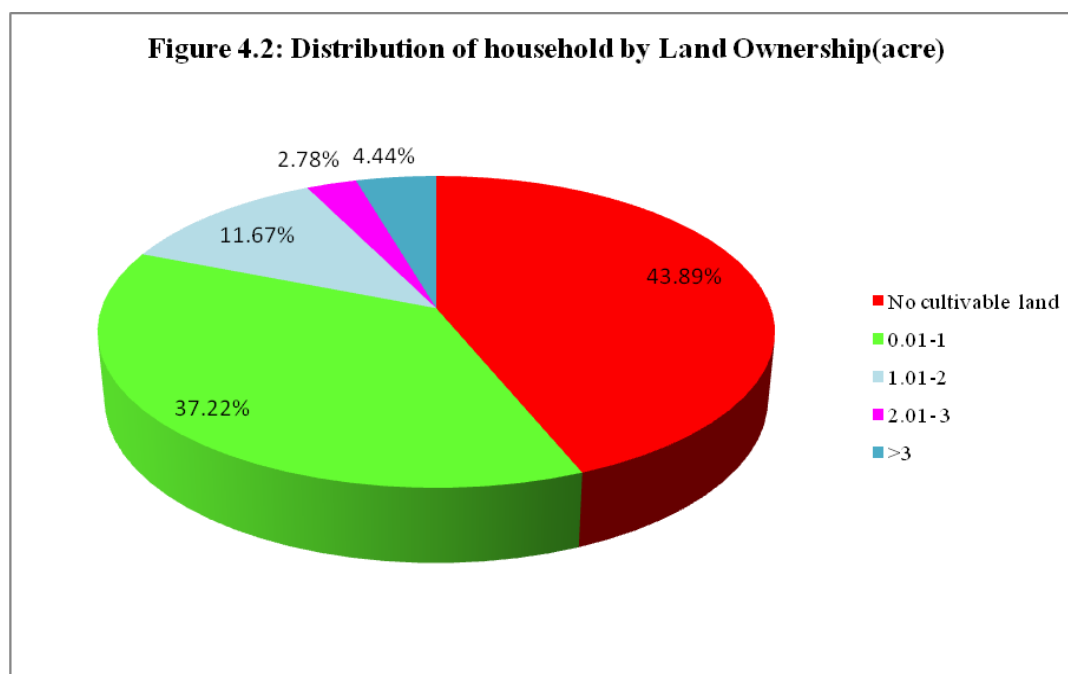
Figure 4.1: Percentage Distribution of Household by Income



In Natore district, 21 households are in the low income group whereas corresponding figure in Rajshahi and Naogaon districts are 28 and 44. In the middle income group, there are 34, 27 and 16 households in Natore, Rajshahi and Naogaon districts respectively. And high-income groups constitute 5 households in Natore and Rajshahi districts separately.

4.6.6 Distribution of Households by Land Ownership

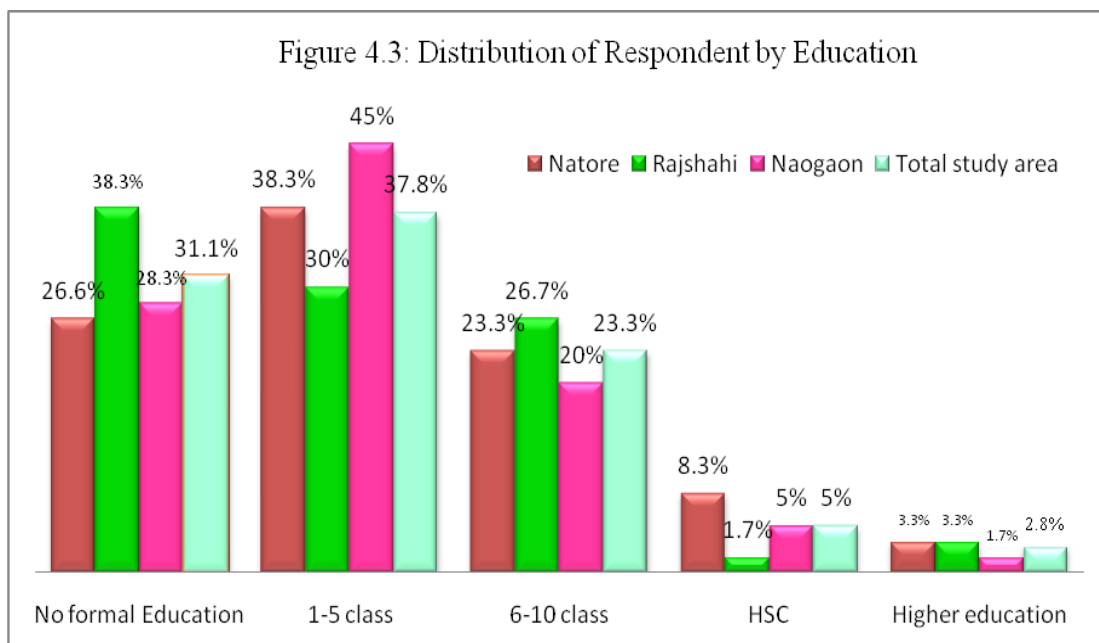
The distribution of households on the basis of their farm is presented in Figure 4.2. In the study area, the highest proportion of the household has no cultivated land which represents 79 numbers of the households.



It is seen that households with farm size 0.01-2 acre, constitute 48.89% households while those having above 2 acre represent 22.7% households. When looked at in a disaggregated way some variations are found. Moreover, 15 households have no cultivated land in Naogaon district whereas 31 and 33 households in Rajshahi and Natore districts have no cultivated land.

4.6.7 Distribution of Households by Education

The distribution of household head's educational status in the study area has been presented in Figure 4.3. It is found that household heads with no formal education and primary education constitute 68.9 percent of the households; those with secondary education constitute 23.3 percent while 5 and 2.8 percent of the household heads have higher secondary and higher education, respectively, in the study area.



Looking at district-wise, it is seen that in Natore district, 64.9% of the household heads belong to no formal education and primary education status, while 68% and 73.3% households respectively Rajshahi and Naogaon districts. In the general, 37.8 percent household heads fall in primary education where above higher secondary level is only 2.8 percent.

4.6.8 Distribution of Households by Size

Distribution of family size in study area has been shown in Table 4.15. Household sizes which range between 1-3, 4-6 and greater than 7 constitute 44.44, 52.78 and 2.78 percent, respectively, in the study area. In Natore district, 31 households have 1-3 members, 25 households have 4-6 members and 4 households have a household size greater than 7 members.

Table 4.15: Distribution of Households by Size (adult equivalent unit)

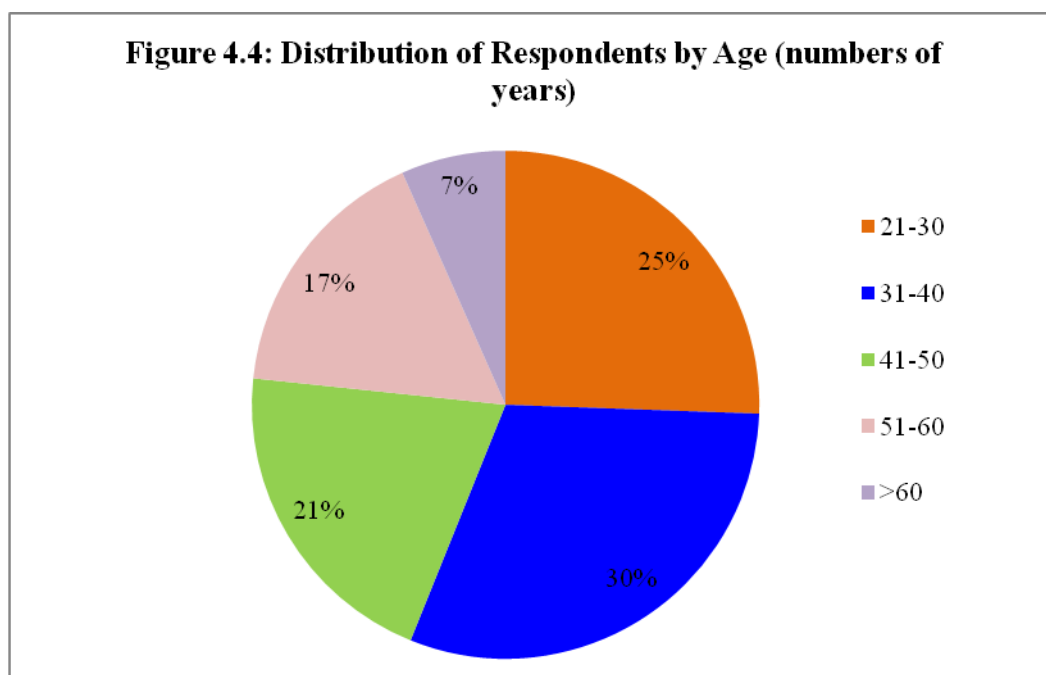
No. of Members	Natore	Rajshahi	Naogaon	Total Study Area
1-3	31	27	22	80
4-6	25	32	38	95
>7	4	1	-	5
Total	60	60	60	180

Source: Author's own calculation

In Rajshahi district, household sizes which range between 1-3, 4-6 and greater than 7 members constitute 27, 32 and 1 household respectively. Household sizes which range between 1-3 and 4-6 constitute 22 and 38 households in Naogaon district.

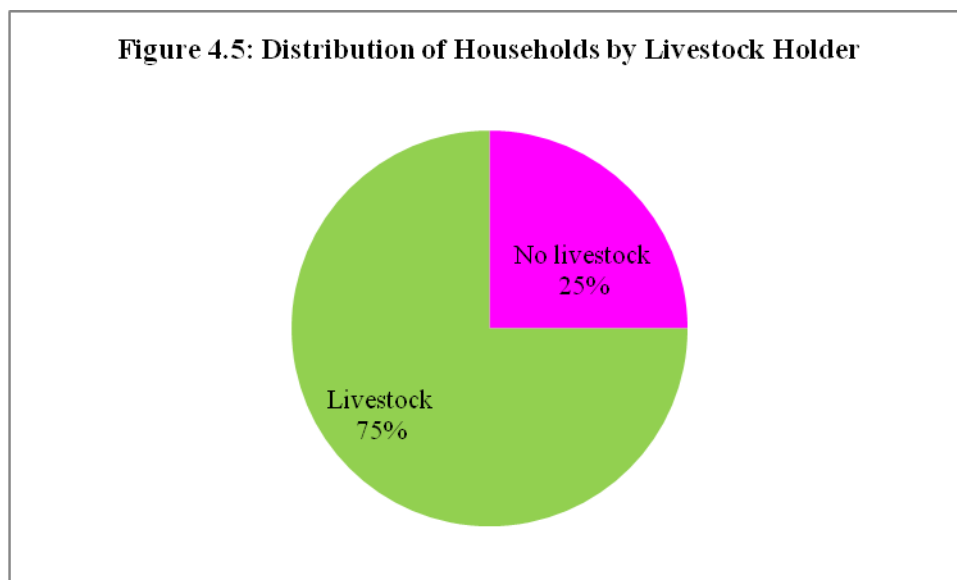
4.6.9 Distribution of Households by Age

The Figure 4.4 shows the distribution of households by age in the study area. From Figure 4.5 it is observed that household head within the age range of 21-40 years constitute relatively high frequencies which is 99 and 69 households are in the middle age groups (41-60 years). In general, a major proportion of household heads fall within the age range 31-40 years (54 households).



4.6.10 Distribution of Households by Livestock Ownership

The livestock is very important in assuring food security in the household. An increase in the livestock population enables the people to be food secure either through the income earned or by direct by consumption. Figure 4.5 shows that the distribution of households on the basis of their livestock. In the study area, the highest proportion of its household has fallen in livestock which represents 135 households, while those in no livestock represents 45 households.



Similarly, the highest proportion of its household has livestock which represents 36, 47 and 52 households respectively in Natore, Rajshahi and Naogaon districts.

4.6.11 Distribution of Households by Cereal Production

The distribution of households on the basis of their cereal production is as follows Table 4.16. From Table 4.16 it is observed that most of the households are in no production of cereal crops which represents 44.44 percent of the households in the study area.

Table 4.16: Distribution of Household by Own Cereal Production of All Study Area

Quantity of Cereal Production (quintal)	Natore District	Naogaon District	Rajshahi District	All Study Area	
	Frequency	Frequency	Frequency	Frequency	%
No Cereal Production	34	15	15	80	44.45
1-20	15	14	12	41	22.78
21-40	5	18	8	31	17.22
41-60	3	8	3	14	7.78
61-80	2	1	5	4	4.44
>80	1	4	1	6	3.33
Total	60	60	60	180	100

Source: Author's own calculation

For the low production level (1-20quintal), they constitute 22.78 percent where the middle (21-60 quintal) and higher (above 60 quintal) production level represent .25 and 7.77 percent of household in the study area. It is also observed that most of the households are in no production of cereal crops in Natore and Rajshahi districts exceptional Naogaon district.

4.7 Conclusion

This chapter, research methodology and data description, discusses the methodology of obtaining the overall objectives of the study and analyses the data collected to prove the rational of the study. It is found that logistic regression model is appropriate to investigate the food security pattern of households. The estimation process and other econometric issues related to the estimation and relevant data issues are described as well as the procedure of selecting the study area and the respondents to satisfy the purpose of the study in this chapter.

CHAPTER FIVE

FOOD SCENARIO IN BANGLADESH

5.1 Introduction

Bangladesh is one of the poorest and most densely populated countries in the world. Though Bangladesh is the fourth rice producing country in the world, it is very difficult for her to meet the increasing food needs of her quickly growing population. Slow economic growth, deficit in food production and low per capita income have contributed to the decrease in food intake causing malnutrition in Bangladesh. Besides, very often the price hike of the basic foods is causing sufferings to the people of low and middle-income groups. About 60% of the rural children are malnourished, and the infant mortality rate in Bangladesh is about 35 per 1000 live births. Furthermore, considerable social and gender disparity, increasing economically vulnerable population, growing urban-rural social and economic differences, and food deficit have worsened the problem of food security of the country. In these backdrops, the scenario of food security is analyzed in this chapter.

This chapter comprises of six sections. Section 5.2 provides food security concern in Bangladesh. The following section 5.3 broadly explains food availability in Bangladesh with the help of production, food inflow and total food demand. Section 5.4 is organized in terms of access to food in Bangladesh. This section describes the household income and expenditure, price, inflation and public distribution systems.. Section 5.5 provides utilization of food with the help of source of food value, per capita per day food intake, energy and protein. Lastly, this chapter ends with a conclusion provided in section 5.6.

5.2 Food Security Concern in Bangladesh

Being a country of 160 million people with only a per capita income US\$ 1190 (GoB, 2014), poverty alleviation is a core challenge for Bangladesh. For this, Bangladesh needs to accelerate the growth and productivity of its agriculture, improve the quality of social services, ensure proper functioning of its community and rural institutions and expand the rural support infrastructures. Academically food security is defined as physical and economic access of the people to the required amount of food from the viewpoint of healthy nutrition. Economic accessibility to food is directly linked with the purchasing power of the people. It means, food availability in the market has no significance for food security for the people. For food security food price must be reasonable so that people can purchase it. That means, food security is actually related with sufficient income or supports those make food available.

Poverty along with unemployment and low earning of income is the most important cause of food insecurity. Hence, poverty alleviation is the most significant way to ensure sustainable national food security. Food security at national level requires ensuring adequate supply of food to market. The solution may be the increase of domestic production and/or importing food to meet the total requirement of the population. The capacity to import food in turn depends on export earnings, foreign exchange reserves, value of essential non-food import and debt services obligations. However, a country can export her surplus food production. But in the final analysis, it can be generalized that increase of domestic production is better solution to meet the food demand and factors associated with socio-economic development are also those that influence national food security status (Omonona and Agoi, 2007). Food security at the household level needs establishment of an economic system that ensures equitable and justified income distribution. Poverty could be only alleviated if the general people have the access to required amount of food through their own income. National food security is a function of the ability of the country's production, marketing, trade and institutional systems to provide a continuously adequate supply of food to inhabitants even in times of adverse domestic production and international conditions. Therefore, it depends on such critical factors as internal food production, income generation and distribution, foreign exchange earning capacity, provision on

availability of storage and transportation, distribution facilities for meeting seasonal and emergency food needs plus other factors that may affect the maintenance and improvement of per capita food consumption(Amiti, 1982).

5.3 Food Availability in Bangladesh

Availability of food is determined by domestic production, external trade and the efficiency of distribution through market and other channels. Bangladesh has made steady progress in the expansion of domestic food production. Net food grain production increased from less than 10.0 million tons in the early 1970s to more than 30.0 million tons in fiscal year 2012-2013. This growth in production has been achieved through expansion of irrigation facilities, spread of modern varieties and increase of cropping intensity (Talukder, 2005).

5.3.1 Production of Food in Bangladesh

Domestic production of food in any country is important to ensure food security. Investment in agriculture increases the production of food which helps the country to make secure in food. Though production of food grain depends greatly on good harvest years, Bangladesh demonstrates a steady increase in the production of food grain since its independence. The production has increased from 11 million metric tons in the 1970s to more than 35 million metric tons in the recent years. Rice, wheat, potato, maize, vegetables, oil seeds, pulse, sugarcane etc. are main food crops in Bangladesh. The production pattern of different food crops of the country are analyzed below.

Rice Production in Bangladesh

Rice is the staple food of about 160 million people of Bangladesh. Rice sector provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow

rice. About 75% of the total cropped area and over 80% of the total irrigated area is planted with rice (paddy). Thus, rice plays a vital role in the livelihood of the people of Bangladesh (BRRI, 2011). In Bangladesh, food security is strongly linked with the production, import and price stability of rice. Every people of the country consume about 400 grams of rice per day on average. The production of rice of Bangladesh is shown in Table 5.1.

Table 5.1: Total Rice (Aus, Aman and Boro) Production and Yield of Bangladesh

Year	Production ('000'metric ton)				Yield (ton/ha)			
	Aus	Aman	Boro	Total	Aus	Aman	Boro	Total
1971-72	2341	5695	1738	9774.0	0.78	1.05	2.01	1.28
1975-76	3229	7045	2286	12560.0	0.94	1.22	1.99	1.38
1979-80	2809	7303	2427	12539.0	0.93	1.22	2.11	1.42
1983-84	3222	7843	3350	14415.0	1.03	1.31	2.39	1.58
1987-88	2993	7690	4731	15414.0	1.07	1.38	2.44	1.63
1991-92	2179	9269	6807	18255.0	1.14	1.63	2.58	1.78
1995-96	1676	8790	7220.6	17686.6	1.09	1.56	2.62	1.76
1999-00	1734	10306	11027	23067.0	1.28	1.81	3.02	2.04
2003-04	1831.8	11520.5	12837.1	26189.4	1.52	2.03	3.26	2.27
2007-08	1507	9662	17762	28931.0	1.64	1.91	3.85	2.47
2011-12	2750	13300	18700	34750.0	2.29	2.36	3.91	2.85

Source: Various issues of BBS

From Table 5.1 it is found that total production of rice in Bangladesh was 9774 thousand metric ton in 1971-72 which has increased to 34750 thousand metric ton in 2011-12. From the table it is also found that the total rice production has increased continuously from 1971-72 to 2011-12. Table 5.1 also revealed that yield of rice per hectare has also increased from 1.28 ton/ha in 1971-72 to 2.85 ton/ha in 2011-12.

Wheat Production in Bangladesh

The second staple food of the people of Bangladesh is wheat. The production of wheat has declined from 1475 thousand metric ton in FY 1987-88 to 1260 thousand metric ton in 2013 (USDA, 2013). Besides this production, Bangladesh is used to receive substantial amount of wheat as food aid from developed countries. Commercial import of wheat has however, increased despite growth in domestic production. The import has recently exceeded 3 million ton. It appears that although Bangladesh has achieved self-sufficiency in rice production, the country is not yet

self-sufficient in wheat production. The production of wheat in Bangladesh from FY 1987-88 to 2011-12 is shown in Table 5.2.

Table 5.2: Production of Wheat in Bangladesh

	Cultivated Area ('000' acre)	'000' metric ton
1987-88	1475	1048
1990-91	1480	1004
1993-94	1574	1131
1996-97	1749	1454
1999-00	2057	1840
2002-03	1746	1503
2005-06	1183	735
2008-09	975	844
2011-12	885	995

Source: Various issues of BBS

Production of Others Food Item in Bangladesh

Besides producing rice and wheat Bangladesh produce some other food crops and food items such as potato, maize, barley, pulse, oil seeds, vegetables, spices, fish, meat, milk, egg, fruits and sugar etc. The production of others food items is shown in Table 5.3.

Table 5.3: Production of Others Food Items('000' metric ton)

Other Food Items	Production in Different Years								
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cereal Production	276.8	264.89	277.87	289.57	311.21	328.96	341.13	360.65	376.46
Potato	39.08	48.56	41.61	51.67	66.48	52.68	79.30	82.26	82.05
Maize	2.41	3.56	5.22	9.02	13.46	7.30	8.87	15.52	19.54
Barley	1	4	1	1	1	1	1	1	1
Pulses	3.33	3.16	2.79	2.71	2.05	1.96	2.21	2.32	2.40
Oil seeds	4.06	11.80	5.95	6.25	6.42	3.37	3.77	3.97	4.08
Vegetables	17.14	16.75	17.91	18	20.37	20.85	22.28	22.90	23.63
Spices	6.09	10.00	11.82	14.05	13.68	11.03	12.40	14.73	17.56
Fish	21.02	22.15	23.29	24.40	25.63	27.01	28.99	30.62	32.62
Meat	9.1	10.6	11.3	10.4	10.40	10.84	12.64	12.79	23.32
Milk	19.9	21.4	22.7	22.8	26.50	22.86	23.65	18.91	34.63
Egg(lac number)	47800	56230	54220	53690	56532	46920	57424	42110	73038
Fruits	17.25	43.23	93.22	33.21	32.54	31.69	35.64	33.43	32.68
Sugar	11.91	10.66	13.33	16.24	16.38	7.99	6.22	10.03	6.93

Source: GoB,2013

From Table 5.3 it is found that the production of potato has increased from 39.08 thousands metric ton in 2004 to 82.05 thousand metric ton in 2012 and the production of maize has increased to 19.54 thousand metric ton in 2012 from only 2.41 metric ton in 2004. Table 5.3 also reveals that the production of vegetables, spices, fish, meat milk, egg etc has increased over time in Bangladesh. On the other hand, the production of pulse, oil seeds, sugar, and fruits has sometimes increased and sometime it has declined.

5.3.2 Food Inflow in Bangladesh

The country can ensure food security for her population either producing more food in the country or through import from abroad. Bangladesh has little possibility to increase agricultural production rapidly unless it takes a very dynamic supporting strategy for its agriculture. It also faces a rapid decrease in food aid flow and a sharp increase in the import of the food to meet the production gap in the country. Food aid and food import in Bangladesh have important role in promoting food security. This component of food flow is used for supporting people during natural calamities as well as the poor and disadvantaged in productive activities and building assets. This positively effects on the nutritional and health status of a considerable section of the population. For Bangladesh food aid remains as essential source of food. In Bangladesh it accounted for overwhelming share of total food inflow.

Table 5.4: Inflow of Food from Abroad ('000' metric ton)

Year	Rice		Wheat		Total Food Crops		Total
	Food Aid	Import	Food Aid	Import	Food Aid	Import	
1987-88	192	398	1595	732	1787	1130	2917
1990-91	10	-	1530	37	1540	37	1577
1993-94	-	74	654	238	654	312	966
1996-97	10	24	608	325	618	349	967
1999-00	5	428	865	806	870	1234	2104
2002-03	4	1552	238	1414	242	2966	3208
2005-06	34	498	160	1870	194	2368	2562
2008-09	30	573	98	2312	129	2884	3013
2011-12	9	514	106	1661	115	2281	2290

Source: MoFDM (2013)

From Table 5.4 it is found that in recent years total food aid has decreased drastically. As is seen from the table, the volume of food aid in different years did not follow any

specific trend. Highest flow was 1787 thousand metric ton in 1987-88. Table 5.4 also shows that the highest food inflow (aid and import) in Bangladesh was 3208 thousand ton in 2002-03 and the lowest food inflow was 966 thousand metric ton in 1993-94.

However, over the last three decades food grain production in Bangladesh has increased. It has more than doubled - rice and wheat net production has increased from around 10 million metric ton in the early 1970s to 25 million metric ton by the early 2000s. Stock of food grains also stood higher at 9.87 lakh metric ton at the end of February 2014 which included 7.80 lac metric ton of rice and 2.07 lac metric ton of wheat (MoFDM).

5.3.3 Demand for Food in Bangladesh

Bangladesh has currently 160 million people, which is growing at the rate 1.37% annually (BBS, 2013). Around 75% of the population lives in rural areas and depend primarily on agriculture for their livelihood. The per capita income of the population is US\$ 1190 (GoB, 2014). The people spend nearly 67% of their income on food, especially on cereals.

Table 5.5: Demand for Food Grain in Bangladesh ('000' metric ton)

Year	Population (million)	Consumption Requirement of Food Grain
2003	135	22351
2004	137.54	24549
2005	139.78	24949
2006	141.8	25309
2007	143.91	25686
2008	145.93	26046
2009	147.86	26391
2010	149.69	26717
2011	151.6	27058
2012	153.26	27355

Source: BBS

Note: Population figures are adjusted by population census, 2001, Per capita intake has been calculated 453.6gms until FY02-03 and 489gms thereafter

The uncontrollable population growth is one of the crucial problems of the country that led to the decrease in per capita and household land availability of the people. Moreover, there is very little scope to expand arable land. Nearly 90% of the

cultivated land is used for food grain production, but still Bangladesh remains one of the vulnerable countries of the world in terms of food security. Because of limited arable land and other natural resources, high population density (about 1015 per sq. km.), low per capita income, slow GDP growth and periodic fatal natural calamities, it becomes a huge challenge for Bangladesh to ensure food security for her population. Table 5.5 shows consumption requirements of food grain for Bangladesh. We know that when population increased, food demand also increased. Total population stood at 153.26 million in 2012 and this was 13.5 percent higher compared to the total population in 2003. Similarly, consumption requirements of food grain is 22.29 percent higher compared to the same period.

5.4 Access to Food in Bangladesh

After China and India, Bangladesh holds the third largest poor population, with over 45 million people having inadequate food resources, leading to stunted growth and reduced mental and physical capacities. While Bangladesh is nearly self-sufficient in rice production, food security remains as an important goal. Currently, 43% of children under-five in Bangladesh are stunted due to continuous malnourishment as a result of poor feeding habits and lack of access to nutritious foods. The average Bangladeshi diet lacks diversification with 75% of calories consumed coming from rice. Rice is the staple food that alone constitutes the lion's share (96%) of total food grain produced in Bangladesh.

The access to domestically produced food is a key issue affecting basic survival, nutrition, national security, and stability, making agricultural growth vital to addressing these challenges. Though the number of people in the world suffering from hunger and poverty has risen to more than one billion, Bangladesh has made significant progress in boosting national food production. However, a large part of the population still lacks access to sufficient, safe and nutritious food. Ensuring that everyone has food security is, therefore, a high priority for the Government of Bangladesh. Households may also lack the necessary assets or access to credit to overcome the periods of hardship. They may also remain outside the food assistance programmes that would provide them with cash or income to supplement their food

acquisition capacity. People's access to food is influenced by their income and expenditure pattern, wholesale and retail prices, inflation etc.

5.4.1 Income and Expenditure Pattern in Bangladesh

Income is essential to meet the food demand for living. The sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households ensuring food. Households work to maintain a level of income necessary to raise families with a good quality of life which determined the level of total expenditure as well as food expenditure.

Table 5.6: Monthly Household Income, Food Expenditure and Consumption (Tk)

Items	2010			2005			2000		
	National	Rural	Urban	National	Rural	Urban	National	Rural	Urban
Monthly Income	11479	9648	16475	7203	6095	10463	5842	4816	9878
Average Consumption Expenditure (Tk)	11003	9436	15276	5964	5165	8315	4537	3879	7125
Food Expenditure	52.53	57.45	44.68	44.55	49.61	35.90	42.40	47.75	32.13

Source: HIES (2010); BBS(2010)

Table 5.6 shows that the average household monthly income in Bangladesh was Tk 5842 and it increased to Tk 7203 in 2005 and to Tk 11479 in 2010. The average monthly consumption expenditure was Tk 4337 in 2000 and it increased to Tk 5964 in 2005 and Tk 11003 to 2010. From Table 5.6 it is also found that households spent 42.40% of their average monthly income to purchase food in 2000 and this food expenditure increase to 44.55% in 2005 and 52.53% in 2010. This result indicates that food expenditure in Bangladesh has been increasing over times.

5.4.2 Average Wholesale and Retail Price of Rice and Wheat

Consumption of food items is highly dependent on the availability food, its price level and food habits also. Seasonal variations in prices of food items, especially in case of cereals, fruits and vegetables are obvious. Therefore, increase or decrease of quantity consumed may be considered in the light of these factors. Food consumption in

Bangladesh has increased over time. However, it may be that expenditure has increased because of increasing real consumption of food or it may be that the price of food has increased the expenditure. Moreover, increase in food price limits the access of poor people to food. Therefore, it is necessary to investigate the price of food.

Table 5.7 shows that the average wholesale prices of rice and wheat were Tk 1474 and Tk 1249 per quintal in 2005, respectively. However, the price of rice increased to Tk3007 per quintal in 2011 and the price of wheat increased to 2128 per quintal in 2013.

Table 5.7: Average Wholesale Price of Rice and Wheat (Tk/Quintal)

Year	2005	2006	2007	2008	2009	2000	2011	2012
Rice	1474	1580	1701	2500	2427	2218	3007	2610
Wheat	1249	1390	1735	2703	2092	1628	2128	2013

Source: FMPU, Ministry of Food and Disaster Management, GoB (2013)

Retail price influences the consumption level at household level. From Table 5.8 it is observed that the average retail prices of rice and wheat have also increased in Bangladesh over the years. The average retail price of rice has increased from Tk 25.92 per kg in 2011 to Tk29.98 per kg in 2012. Again, Table 5.8 also indicates that retail price of wheat increased to Tk 25.36 per kg in 2012 from Tk 22.94 per kg in 2010.

Table 5.8: Average Retail Price of Rice and Wheat(Tk/kg)

Year	2010	2011	2012
Rice	31.42	25.92	29.98
Wheat	22.94	22.83	25.36

Source: FMPU, Ministry of Food, GoB (2013)

From the wholesale and retail prices table, it is also found that prices of rice and wheat increase in normal year. If purchasing power of the population is increased, food consumption is also stable or increased in this situation. As a result, food security at the national level is also achieved.

5.4.3 Food Price Inflation

Inflation rate measured by the consumer price index showed an upward trend in 2003-04 to 2011-12 periods which has been mainly driven by increasing money supply, increased in global food prices increase an aggregate demand. Food inflation in Bangladesh is shown in Table 5.9. In 2003-04 food price index and food inflation in Bangladesh at national level were 146.5 and 6.93%. However, these indices and rate of inflation increased to 295.88 and 10.47% in 2011-12. The food inflation scenario is not similar in rural and urban Bangladesh. From Table 5.9 it is found that food inflation rate was higher in urban areas (10.47%) compared to rural areas (9.73%) in 2011-12.

Table 5.9: Food Price Inflation in Bangladesh

Year	National		Urban		Rural	
	Food Price Index	Food Inflation	Food Price Index	Food Inflation	Food Price Index	Food Inflation
2003-04	146.5	6.93	149.6	7.8	145.22	6.55
2004-05	158.08	7.91	161.14	7.71	158.82	7.99
2005-06	170.34	7.76	174.18	8.09	168.77	7.62
2006-07	184.18	8.12	189.06	8.54	182.18	7.96
2007-08	206.79	12.28	213.73	13.05	203.93	11.94
2008-09	221.64	7.14	229.6	7.43	216.38	7.09
2009-10	240.55	8.53	252.21	9.85	235.76	7.96
2010-11	267.83	11.34	276.82	7.76	264.15	12.03
2011-12	295.88	10.47	310.38	12.2	289.82	9.73

Source: BBS(2007, 2012)

5.4.4 Public Distribution System

Poverty and food insecurity are interlinked. The poor do not only have adequate purchasing power to secure their access to food, but sometimes they suffer due to disturbances in the food distribution system. Social safety nets in Bangladesh play an important role to income and employment generation for the poor as well as contribute to distribution of food to the poor section of people. The largest safety net programs in Bangladesh are food based. The Public Food Distribution System (PFDS) supplies food grains to various food-based safety nets, which account for around three-quarters of its total food distribution (Ahmed *et al.*, 2010). Public distribution system of food is a government-sponsored chain of shops entrusted with the work of

distributing basic food commodities to the needy sections of the society at very cheap prices. Mainly, rice and wheat are distributed by the public distribution system in Bangladesh.

The public food distribution system can be categorized in accordance with the specific objective that each program is designed to achieve. For example, programs are designed to develop infrastructure, provide education incentive to the poor, mitigate disaster consequences, or provide livelihood support to disadvantaged groups such as the aged and the disabled. In short, there are two categories such as priced channels and non-priced channels of the public food distribution system in Bangladesh (Alwang, 1991). The government has recently made some changes in the targeted channels.

Table 5.10: Food Grain Distribution by Category ('000' metric ton)

Year	Total Distribution			Sales			Non-sales		
	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total
2002-03	530	1604	2134	144	116	260	386	1488	1874
2003-04	588	495	1434	316	326	642	456	335	791
2004-05	1102	265	1367	389	116	505	713	149	863
2005-06	1008	237	1245	226	120	346	782	117	899
2006-07	1288	192	1480	579	126	705	709	66	775
2007-08	1309	251	1561	419	92	510	891	160	1050
2008-09	1757	372	2129	355	90	445	1402	281	1683
2009-10	1305	653	1958	487	103	590	818	550	1367
2010-11	1569	722	2292	1210	267	1477	359	455	814
2011-12	1411	684	2095	513	345	858	898	339	1237
2012-13	1487	600	2087	231	411	642	1256	189	1445

Source: FMPU, Ministry of Food, GoB(2013)

Table 5.10 shows that public distribution through the priced channels such as EP, OP, LE, OMS, FPC and non priced channels such as FFW, TR, VGD, VGF, FFE, GR. It is found that the proportion of public distribution through the non priced channels is higher than the priced channels from 2003 to 2013.

Priced Channels of Distribution

The priced channels consist of the following: Essential Priorities (EP), Other Priorities (OP), Large Employers(LE), Open Market Sales(OMS), Fair Price Card (FPC) that sell food grains to the general population at subsidized prices. Essential Priorities are

for the armed forces, Bangladesh Rifles, Police, Ansars (paramilitary group), and jail staffs. Other Priorities is covering government employees outside of the Statutory Rationing areas such as jail and hospital inmates, students' hostels, and so forth. Large Employers is providing food subsidies for targeted people working for employers of more than 10 employees. In Bangladesh, Large Employers for industrial and tea garden workers. Open Market Sales is a system through which the government releases its stocks of foods directly into the rice and wheat markets when there is any sharp increases in market prices (it is the government's principal means of influencing market prices). Fair Price Card means a document issued under an order of Government for the purchase of essential commodities from the fair price shop which has also been licensed to distribute essential commodities under an order of Government to the FPS holders under Targeted PFDS (Ahmed *et al.*, 2004). And others include Modified Rationing, providing subsidies for the poor outside the Statutory Rationing areas, Flour Mills, allotting wheat to designated mills at subsidized rates (Alwang,1991).Priced channel's distribution of food grain is presented in Table 5.11.

Table 5.11: Priced Channel's Distribution of Food Grain ('000' metric ton)

Year	EP	OP	LE	OMS	FPC	Other	Total
2002-03	210	12	14	2	14	8	260
2003-04	222	19	12	252	0	138	642
2004-05	239	18	10	238	0	0	505
2005-06	248	19	10	18	51	0	346
2006-07	260	19	15	408	0	2	705
2007-08	210	21	12	268	0	0	510
2008-09	219	22	10	194	0	0	445
2009-10	246	21	15	259	6	43	590
2010-11	253	21	17	1186	0	0	1477
2011-12	259	21	15	563	0	0	858
2012-13	259	21	17	344	0	0	642

Source: FMPU, Ministry of Food, GoB(2013)

Table 5.11 shows that in public distribution through the priced channels, the proportion of public distribution through the priced channels is higher through OMS from 2004 to 2013. Essential Priority is also a frequently used channel through which government distribute food grains to the general people.

Non priced Channels of Distribution

The non priced channels serving the poor include Food-for-work (FFW), Test Relief (TR), Vulnerable Group Development (VGD), Food for Education (FFE), Vulnerable Group Feeding (VGF), Gratuitous Relief (GR) and other programs. Food-for-work (FFW) and Test Relief (TR) distribute Food grains (rice and wheat) as wage payment to both male and female workers in labor-intensive public works programs. Vulnerable Group Development (VGD) program exclusively targets poor women and provides a monthly food ration to them for 24 months continuously (Ahmed *et al.*, 2010). Although the test relief program was introduced in the mid-1970s, it has evolved over time to integrate food security with development objectives. Food for Education (FFE) program distributes monthly food grain rations to poor households if they send their children to school. Food for Education program includes Primary Education Spend (PES) program, School Feeding (SF) program, Female Secondary School Assistance Program (FSSAP). Data of the Food for Education is available in 2003 after that this program is fully converted to Cash for Education and the Food for Work is partially converted to cash programme (Titumir, 2006).

Table 5.12: Non-Priced Channel's Distribution of Food Grain ('000' metric ton)

Year	FFW	TR	VGD	VGF	GR	FFE	Other	Total
2002-03	698	90	206	464	74	287	55	1874
2003-04	310	109	175	64	40	0	94	791
2004-05	146	124	204	214	72	0	104	863
2005-06	233	174	244	128	36	0	84	899
2006-07	125	149	163	230	32	0	78	775
2007-08	154	76	268	419	38	0	95	1050
2008-09	395	368	279	507	43	0	92	1683
2009-10	374	367	272	248	67	0	39	1367
2010-11	128	177	264	114	33	0	98	814
2011-12	327	326	282	159	50	0	93	1237
2012-13	382	380	260	255	49	0	118	1445

Source: FMPU, Ministry of Food, GoB (2013)

Vulnerable Group Feeding (VGF) and Gratuitous Relief (GR) programs are designed as a mechanism for mitigating the consequences of disasters like floods, cyclones, and other natural calamities. Unlike other programs, these programs have no pre-set criteria or conditionality for participation. They are relief programs that try to help the poor cope during times of natural disaster and smooth their consumption. Other

programs include the Old-Age Allowance Scheme; Allowance for Widowed, Deserted, and Destitute Women; Honorarium Program for Insolvent Freedom Fighters; Fund for Housing for the Distressed; Fund for Rehabilitation of Acid Burnt Women and Physically Handicapped; and Allowance for the Distressed and Disabled Persons. Non-Priced Channel's Distribution of food grain has been presented in Table 5.12. The table shows that in public distribution through the non-priced channels, the distribution is highest through FFW from the first to last recorded year. Second and third highest distribution is made through the VGD and the VGF channels, respectively. From the analyses provided in Table 5.11 and Table 5.12, it is the key message is revealed that the public food distribution systems in Bangladesh has been evolved to relief oriented long-term development objectives rather than priced channels.

5.4.5 Trends of HCR and DCI Poverty and Access to Food

Poverty is a bar to access food and other basic needs which are essential for life. It is documented that an adult person in Bangladesh requires a minimum of 832 grams of food a day, which is converted to 2122 kcal energy (GoB, 2005). Direct Calorie Intake (DCI) method is used to determine whether an individual/family lives below or above a certain poverty threshold. These thresholds are predetermined for Bangladesh, *e. g.* 2122 kcal for upper poverty line and 1805 kcal for lower poverty line. The first threshold (upper poverty line) is used to determine poor and non-poor. If daily food intake of an individual falls below the lower poverty line, then the individual is termed as ultra/hardcore poor. The DCI method allows estimation of the magnitude of food poverty based upon one's food intake.

Table 5.13: Trends of Poverty Based on Head Count Ratio and DCI Method

Year	Population below poverty line					
	National		Rural		Urban	
	Million	%	Million	%	Million	%
Absolute poverty line: Daily less than 2122 kilocalorie food intake						
2010	-	31.5	-	-	-	-
2005	56.0	40.0	41.2	39.5	14.8	43.2
2000	55.8	44.5	42.6	42.3	13.2	52.5
1995	55.3	47.5	45.7	47.1	9.6	49.7
Hardcore poverty line: Daily less than 1805 kilocalorie food intake						
2010	-	17.0	-	-	-	-
2005	27.0	19.5	18.7	17.9	8.3	24.4
2000	24.9	20.0	18.8	18.7	6.0	25.0
1995	29.1	25.1	23.9	24.6	5.2	27.3

Source: BBS (2000, 2012)

5.5 Utilization of Food in Bangladesh

Improving availability of and access to food are necessary but not sufficient conditions to ensure that people will be secured of food for leading an active and healthy life. In recent times there has been increasing concern over utilization of food which is governed by a number of factors such as people's food preference, general health condition and the overall environment under which food is prepared and consumed. A more important objective of food consumption is to improve and maintain nutritional status. A relatively greater volume of food may mean lower level of nutrition, while the same volume consumed by different persons may yield varying levels of nutrition depending on what composition of food people eat, given their status of health and sanitation and other physical and socioeconomic environment. Food preference plays an important role in the determination of nutritional outcome of food intake. This is analyzed in the subsequent sections.

5.5.1 Source of Food Value

Every food item has its own calorie, protein and other nutritional values which are essential for health. Nutritional values vary considerably among food items. That is why, people like to take food items in combination to balance their calorie, protein and other nutritional needs. But, in Bangladesh a large segment of the population fails to take necessary food items at the required level, mostly because of the fact they do

not have enough income to buy or produce food at the required level. Table 5.14 shows that the source of food value from the different food groups. Vegetables products are the main sources of energy, protein and fats. Animal products are second source of these food values. This result indicates that contribution of these food sources in Bangladesh has been increasing over times.

Table 5.14: Source of Food Value from the Food Groups

Food Groups	Energy(calories)		Protein (grams)		Fats (grams)	
	2006-07	2008-09	2006-07	2008-09	2006-07	2008-09
Vegetable products	2432.4	2919.6	54.2	54.8	40.9	43.5
Animal products	133.9	135.4	17.3	18	6.0	5.7
Fruits	48.7	46.4	1.9	1.7	0.6	0.3
Spices	42.3	42.7	1.4	1.3	0.6	0.6

Source: Own calculations using data from BBS (2012)

5.5.2 Per Capita Food Intake Per day for Poor and Non poor Groups

The incidence of poverty based on daily calorie intake is measured to understand the extent of food poverty in Bangladesh. The households with daily calorie intake of less than or equal to 1600 kcal is considered as extreme poor. The households that consume 1601 kcal to ≤ 1805 kcal per day are considered as hardcore poor. Again, the households which consume 1806 kcal to ≤ 2122 kcal is considered as absolute poor and the household which consume more than 2123 kcal of food daily is non poor. It is documented that an adult person in Bangladesh requires a minimum of 832 grams of food a day, which is converted to 2122 kcal energy (GoB, 2005). The suggested food combination was 397 grams of rice, 40 grams of wheat, 40 grams of pulse, 58 grams of milk, 20 grams of oil, 12 grams of meat, 48 grams of fish, 27 grams of potato, 150 grams of vegetables, 20 grams of sugar, and another 20 grams of fruits. Cereals, largely rice, are the main food in Bangladesh. Nearly two-thirds of the daily diet of Bangladeshi people consists of rice, some vegetables, a little amount of pulses and small quantities of fish when available. Milk, dairy products and meat are consumed only occasionally and in a very small amount (Jahan and Hossain, 1999). More than four-fifths of the rural people's in Bangladesh comprises 62% cereal diet followed by non-leafy vegetables, roots and tubers (Frongillo, 2003). The consumption of protein

and micronutrient-rich foods like fish, meat, eggs, milk, dairy products, fats and oil is often low at rural poor areas in Bangladesh (Lalita *et al.*, 2007).

Average per capita per day intake of major food items in grams have been presented in Table 5.15. From Table 5.15, it is observed that the average quantity of rice intake has decreased to 416.01 grams in 2010 from 439.63 grams in 2005 at the national level. In addition at the same time consumption of wheat has increased to 26.09 grams in 2010 from 12.08 grams in 2005. Moreover, the total consumption of these two staple food items combined is 442.10 grams in 2010 and 451.72 grams in 2005 showing a decrease of 2.11% per capita per day during this period.

Table 5.15: Per Capita Food Intake Per day in Poor and Non poor Groups (grams)

Food Items	2010			2005
	Poor	Non-poor	Total	Total
Rice	406.19	420.52	416.01	439.64
Wheat	20.36	28.73	26.09	12.08
Pulses	10.15	16.22	14.30	14.19
Potato	63.44	73.78	70.30	63.30
Vegetables	141.80	177.25	166.10	157.02
Edible Oil	14.20	23.41	20.50	16.45
Fish	31.16	57.81	49.5	42.14
Meat	5.77	25.19	19.07	15.22
Egg	3.40	9.02	7.20	5.15
Milk & Milk Product	12.18	43.63	33.72	32.40
Fruits	20.46	56.00	44.70	32.54
Sugar/Gur	3.32	10.88	8.40	8.08
Total	732.43	942.44	875.89	838.21

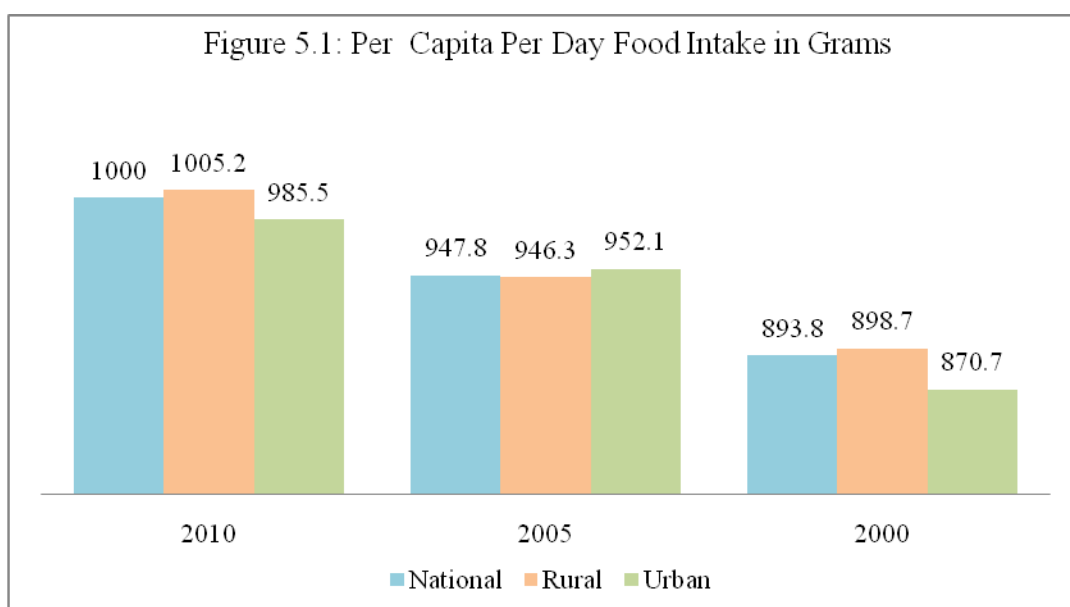
Source: Own calculations using data from BBS (2012)

In case of potato, per capita per day intake has increased to 70.52 grams in 2010 from 63.30 grams in 2005. Other items which show increased consumption in, compared to 2005, are vegetables, fruits, fish, meat, egg, milk and sugar. Increase of consumption of non-cereal items is a good sign for health of the people as for the economy.

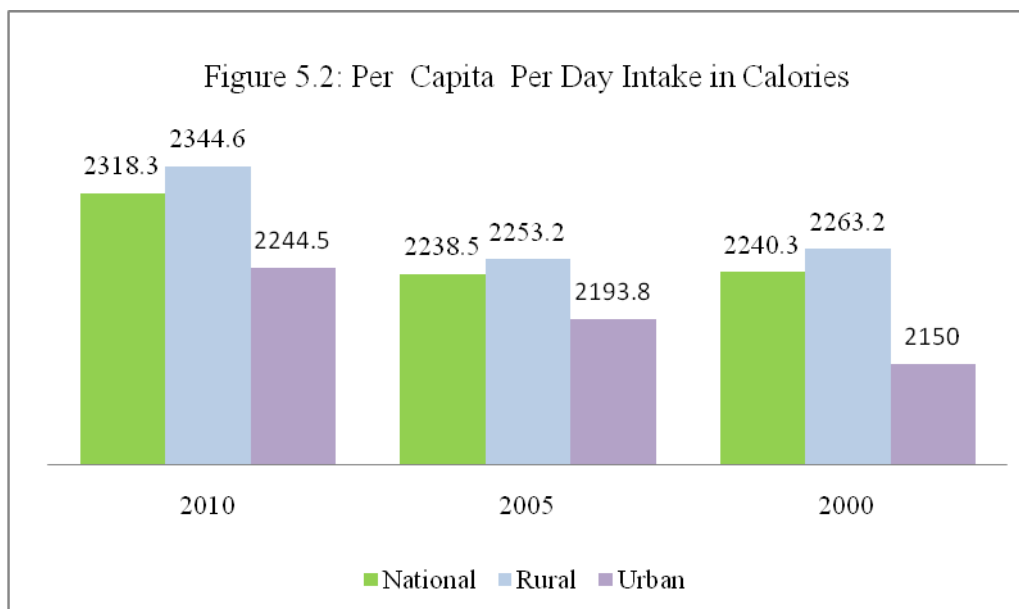
5.5.3 Per Capita Per Day Total Food Intake

Improving nutritional status has a significant impact on survival as well as physical and cognitive development and productivity and thus an essential for economic development. Food safety situation also needed to improve significantly to improve

food utilization and nutrition component of food security. In developing countries, people deprive most of their nutrients from plant sources. Cereals, being the staple food are the highest providers particularly energy. However, energy is also obtained from other non-cereal carbohydrate rich food (roots, tubers and plantains), oil (vegetable sources), and proteins (mainly plant sources). For efficient utilization of energy, the internationally recognized norm is that no more than 60-65% of energy should come from carbohydrates (around 55% from cereals), 10-15% from proteins and 25-30% from fat. Otherwise, imbalances can occur in the use of energy (Yusuf and Islam, 2006).

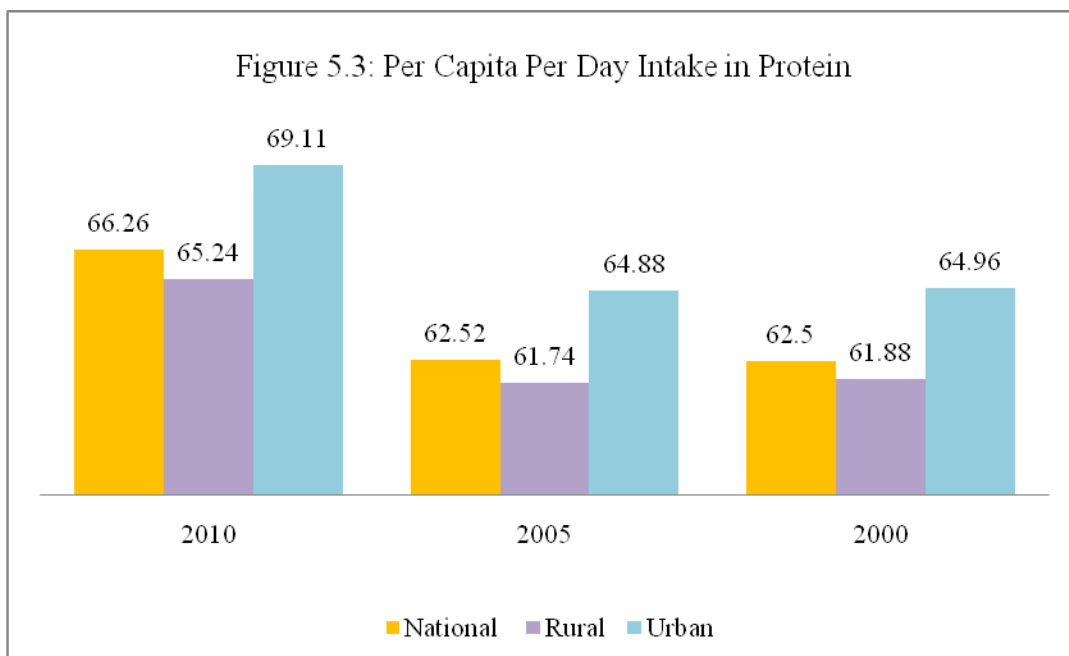


Per capita per day intake of food items have been presented in Figure 5.1. It can be observed from the table that per capita per day intake of food items has increased to 1000 gm in 2010 from 947.8 gm in 2005 showing an increase of about 5.51% at the national level. The rates of increase in rural and urban areas are 6.22% and 3.51% respectively in 2010 with respect to 2005. The rates of increase at the national, rural and urban areas from 2000 to 2005 were 6.1%, 5.3% and 9.3% respectively.



Per capita per day intake of calorie in different years have been presented in Figure 5.2. The overall calorie intake per capita per day significantly increased to 2318.3 kcal in 2010 from 2238.5 kcal in 2005 reversing the general decreasing trend found in previous year. Its increasing trend is observed both in the rural and urban areas. In the rural area, it has increased to 2344.6 kcal in 2010 from 2253.2 kcal in 2005 showing an increase of 4.06% during this period. In the urban area it has increased to 2244.5 kcal per capita per day in 2010 from 2193.8 kcal in 2005 showing an increase of 2.312% per capita per day. Significant increase of per capita per day calorie intake might be due to changing food habit as well as due to increase in overall quantity of food consumption.

Figure 5.3 provides the graphical presentation of per capita per day protein intake in grams. Per capita per day protein intake (in grams) has significantly increased in 2010 although it did not change in last two periods. At the national level, it has increased to 66.26 gm per capita per day in 2010 from 62.52 gm per capita per day in 2005 showing an increase of 5.98% during this period. In the rural area, per capita per day protein intake has increased to 65.24 gm in 2010 from 61.74 gm in 2005. In the urban area, the same has increased to 69.11 gm in 2010 from 64.88 gm in 2005.



It is observed that the total food intake in 2000 is 893g/person/day, of which cereal intake is 476gm in the national level. By energy, cereals contributed 74.4% of total dietary energy of 2240kcal. Obviously, the intake of cereals is as always too high and the diet with lower quantities of non-cereal items is not only deficient of energy (by about 5% taking 2344 as the requirement) but also highly imbalanced and deficient in vitamins and minerals. However, about 75% of energy comes from cereals when according to FAO the proportion ideally should be around 55%. Consumption of such diet would produce physiological deficiencies of both energy and protein, leading to protein-energy malnutrition as well as micronutrient malnutrition.

5.6 Conclusion

Bangladesh has made substantial progress in enhancing food security by increasing production of rice wheat, maize, potato and vegetables. Bangladesh government has also given importance to increase production of non-cereal crops, especially high-value crops in accordance with the market growth. Fish, meat, milk and egg production has also increased significantly over the last ten years. Food safety is an important global issue with international and public health implications. It is needed not simply for export, but also for supplying safe food to the domestic consumers, Food safety has been concern of the present government with necessary policies and measures.

CHAPTER SIX

DISCUSSION OF EMPIRICAL RESULTS

6.1 Introduction

In this chapter, the results of empirical estimations based on primary and secondary data on the issue of food security both at national and at household levels in Bangladesh are analyzed. The chapter provides a discussion of the results found from calculated food security index and the empirical relationship between food security index and its socio-economic determinants. The food security status at national and household level has been analyzed using food security index. The Logistic Regression model is used to measure the effects of considered factors that influence the level of food security of households in the study area.

This chapter is presented in five sections. In section 6.2 food security scenario at national level has been discussed. Food security scenario at household level has been in section 6.3. The results based on food security index have been explained from different aspects in this section. Additionally, results derived from the logistic regression model which shows the expected relationship between food security status and some socio-economic factors have been explained and discussed for total study area and for each district in section 6.3. A comparison of regression results of the three districts has also been included in section 6.4 with a view to understanding the food security pattern of households of those areas. This chapter ends with a conclusion in section 6.5.

6.2 Discussion of Food Security in Bangladesh at National Level

National food security is used to describe whether a country has access to enough food to meet dietary energy requirements of her citizens. To some it connotes self-sufficiency, which means a country produces enough food to meet its population's

demand. National food security measures the extent to which a country has the means to make available to its people the food needed or demanded, irrespective of whether the food is domestically produced or imported (Kuwornu *et al.*, 2013). In spite of the progress made in improving availability in the last decade, a large proportion of poor households in the country still have inadequate access to sufficient food. Although per capita daily calorie intake has increased substantially in the last decade owing to more availability of food, the number of undernourished people has also increased and the recent food price increases has also triggered an increase in hunger in Bangladesh. Calorie intake has been found to have a strong linkage with both human health and productivity. In addition, calorie intake is the main determinant of under nutrition and malnutrition among the people. It is needed for growth and assimilation of micronutrients among children. Inadequate supply of calorie lowers productivity, hinders learning and increases the risk of diseases.

6.2.1 Food Availability at the National Level

At the national level food security means the availability of sufficient stocks of food in the country to meet domestic demand and at the individual level. It means that all members of the society have access to the food they need, either from their own production, from market and/or from the government's transfer mechanism. However, when the national level food security is achieved, in terms of food availability, individuals and groups in the country can face the food shortages because they do not have the means to access to food. The availability of food at national level in Bangladesh is shown in Table 6.1.

Table 6.1 shows net production in different years in first row which net production come from the total production of rice and wheat minus 12% for seed, feed and harvest lost (MoFDM). Subsequently, total food requirement in different years reflect higher demand from 2004 to 2013. National availability is the sum of net domestic production, imports and public distribution minus internal procurement which is shown in the 8th column and per capita per day availability shows the last column which continuously follows upward trend although increase in population. From

Table 6.1 it is found that Bangladesh has made steady progress in the expansion of domestic food production. The net production of food grain has increased from 24 million metric ton in 2004 to more than 30 million metric tons in 2013. We know when population increases, food demand also increases. As a result, consumption requirement for food grain is 25.81 percent higher in 2013 compared to 2004.

Table 6.1: Food Grain (Rice and Wheat) Availability and Requirement in Bangladesh ('000'metric ton)

Year	Net Production	Food Requirement	Food Gap	Private Import	Public Distribution	Internal Procurement	National Availability	Per Capita Availability (gram/day)
1	2	3	4=2-3	5	6	7	8=2+5+6-7	9
2004	24698	22682	2016	2480	987	843	27322	544
2005	23520	24949	-1429	2982	1367	899	26970	529
2006	24539	25309	-770	2265	1245	945	27104	524
2007	25250	25686	-436	2209	1480	1140	27799	529
2008	26202	26046	156	2916	1329	1217	29230	549
2009	28306	26391	1915	2217	2129	1483	31169	578
2010	29179	26717	2462	2899	1964	805	33237	608
2011	30371	27058	3313	3109	2293	463	35310	638
2012	30617	27355	3262	1138	1667	1114	32308	578
2013	30885	28537	2348	1418.7	2090	1404.8	32988.9	588

Source: BBS and unpublished data from FPMU, Ministry of Food, GoB. Food requirement (per capita intake) has been calculated 489gms thereafter

However, it is found that in recent years total private import has decreased drastically. As is seen from the Table 6.1, the volume of private import in different years did not follow any specific trend. Table 6.1 also shows that the highest private import in Bangladesh is 3109 thousand metric tons in 2011 and the lowest food inflow was 1138 thousand metric tons in 2012. The total public distribution of food grain has increased from 0.98 million metric ton in 2004 to more than 2.09 million metric tons in 2013. However, it is found that internal procurement has been increased significantly in recent years. Net national food availability increased from about 27 million tons in 2004 to more than 32.0 million tons in 2013. And per capita per day availability (gram) also rose from 544 grams to 588 grams whereas per capita food grain requirement is 489 grams (MoFDM, 2012). Thus, per capita food availability has also increased in this period despite increase in population. This growth in production has been achieved through expansion of irrigation facilities, spread of modern varieties and increase of cropping intensity.

6.2.2 Food Availability: Self Sufficiency Level of Major Food Items in Bangladesh

The core food items in Bangladesh are rice, wheat, pulses, edible oil, potato, fish, milk, meat, vegetables etc (Muzaffar, 2009). Self sufficiency level of food items is an important indicator in ensuring food security at national level. The notion of food self-sufficiency is understood as domestic production equivalent to aggregate requirement corresponding to certain stipulated per capita consumption requirement of food grains. Whether or not this requirement corresponds to standard nutritional norm is not very precisely known.

For Bangladesh food security is synonymous with achieving self-sufficiency in rice production and stabilization in rice prices. The country has made good progress in increasing rice production through technological progress, facilitated by private sector investment in small scale irrigation. But, it is difficult to sustain the progress made in view of the growing pressure of population on scarce land resources. Domestic food grain production remains susceptible to floods and droughts thereby perpetuating the threat of major production shortfalls, inadequate food availability, and vulnerability from fluctuation in prices. The availability of other foods has not increased, and the progress in nutritional outcome has remained slow.

Table 6.2: Self Sufficiency Level of Major Food Items in Bangladesh ('000' metric ton)

Food Items	2012			2010			2008		
	Net Production	Food Requirement	SS Level	Net Production	Food Requirement	SS Level	Net Production	Food Requirement	SS Level
1	2	3	4=2/3	5	6	7=5/6	10	11	10/11
Food Grain	30617	27355	111.9	29179	26717	109.2	26202	26046	100.6
Potato	74.03	41.38	178.9	72.21	39.92	180.9	59.78	39.40	151.7
Pulses	2.16	6.13	35.24	1.99	5.91	33.67	1.85	5.83	31.73
Oil Seeds	4.04	30.65	13.18	3.4	29.57	11.50	5.78	29.18	19.81
Vegetables	21.33	25.28	84.38	20.08	24.39	82.33	18.37	24.07	76.32
Fish	29.60	73.56	40.24	26.19	70.97	36.90	23.13	70.04	33.02
Meat	21.29	18.39	115.8	11.44	17.74	64.49	9.4	17.51	53.68
Milk	31.59	88.89	35.54	21.35	85.75	24.90	23.9	84.63	28.24
Fruits	29.66	30.65	96.77	32.14	29.57	108.7	29.34	29.18	100.6
Sugar	6.24	30.65	20.36	5.6	29.57	18.94	14.78	29.18	50.65

Source: Own Calculations using data from BBS

The level of self sufficiency of major food items (food grain, potato, pulses, oil seeds, vegetables, fish, meat, milk, fruits and sugar) of Bangladesh are presented in Table 6.2. From Table 6.2 it is observed that in food grain, potato and meat production Bangladesh have achieved self sufficiency level whereas in fruit and vegetables production near sufficiency level is achieved in 2012. However, in case of pulses, oilseed, fish, and milk and sugar production our self sufficiency level are on critical level in these years. Food grain, pulses, vegetables and fish production gradually increased while meat production has sharply increased at the sufficiency level but sugar production has decreased continuously from 2008 to 2012.

6.2.3 Food Access: Food Expenditure Scenario of Bangladesh

Food access depends upon income available to the households, on the distribution of income within the households and on the price of food. The sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households for ensuring food.

Table 6.3: Food Expenditure Scenario in Bangladesh (Tk)

National							
Year	Average Household Income	Average Household Expenditure on Food (% of average household income)	Required Per Capita Food Expenditure Per Day	Household Size	Required Food Expenditure of the Household Per Month	Gap/Surplus of Food Expenditure	Access Gap in %
1	2	3	4	5	6=(4*5)*30	7=3-6	7/6*100
2000	5842	2477(35.90)	27.50	5.18	4273.5	-1796.5	-42.04
2005	7203	3209(44.55)	33.00	4.85	4728.75	-1519.75	-32.14
2010	11479	6030(52.53)	52.37	4.50	7069.95	-1039.95	-14.71
Rural							
2000	4816	2299.85(47.75)	27.50	5.19	4281.75	-1981.9	-46.29
2005	6095	3023.59(49.61)	33.00	4.89	4841.1	-1817.51	-37.54
2010	9648	5542.71(57.45)	52.37	4.53	7117.08	-1574.37	-22.12
Urban							
2000	9878	3174.19(32.13)	27.50	5.13	4232.25	-1058.06	-25.00
2005	10463	3755.89(35.90)	33.00	4.72	4672.8	--916.91	19.62
2010	16475	7361.50(44.68)	52.37	4.41	6928.55	-432.95	-6.25

Source: Author's own calculation using BBS data

During the last fifteen years the monthly household expenditure has risen at national level and this has increased both in rural and urban areas. The household expenditure has scaled up mainly due to the higher food expenditure. The food expenditure

scenario in Bangladesh at the national level and rural- urban level is shown in Table 6.3. The food expenditure has climbed up from Tk. 2477 to Tk. 6030 at national level, Tk 2299 to Tk 5542 in rural areas and from Tk 3174 to Tk 7361 in urban areas during the period of 2000 to 2010 in Bangladesh. However, food expenditure has increased at a faster rate than that of income. During the period of 2000 to 2010, the monthly household income has increased with a growth rate of 18.20%. At the same time, the monthly household food expenditure has risen with a growth rate of 19.72%.

From Table 6.3 it is also found that at the national level, actual food expenditure did not exceed the required food expenditure in different years. This means there is a problem of access to food in the country although the access gap is gradually declining. This pattern is almost same at both rural and urban level but access gap of the urban level has quickly been declining than rural level.

6.2.4 Food Access: Division Wise Food Expenditure Scenario of Bangladesh

Food expenditure by the households differs across regions in Bangladesh. Division wise actual food expenditure scenario in Bangladesh is shown in Table 6.4. It is found that food expenditure scenario is not similar in all divisions because the income and other socioeconomic characteristics of households in all divisions are not similar.

From Table 6.4 it is observed that at the national level required food expenditure of households per month was Tk 7069. Food expenditure gap was Tk 1039 and access gap was 14.71% in 2010 in Bangladesh. Table 6.4 shows that the average household size in Sylhet division was 5.50 persons in 2010 whereas this was 4.26 and 4.15 in Khulna and Rajshahi divisions, respectively, in the same year. The required food expenditure of households in Sylhet division per month was Tk 8641 in 2010 which was Tk 6520 in Rajshahi division and Tk 6693 in Khulna division. The food expenditure and access gap in Sylhet division were 2612 and 30.23% respectively. This rate was 490.07 and 7.52% in Rajshahi divisions, 662.89 and 9.90% in Khulna division. These figures were higher in Sylhet followed by Chittagong, Barisal, Dhaka, Rangpur, Khulna, and Rajshahi Divisions.

Table 6.4: Division Wise Food Expenditure Scenario of Bangladesh (Tk)

Food Consumption Indicators	Year		
	2000	2005	2010
National			
Household Size	5.18	4.85	4.50
Required Food Expenditure of the Household Per Month	4273.5	4728.75	7069.95
Gap/Surplus of Food Expenditure	-1796.5	-1519.75	-1039.95
Access Gap in %	-42.04	-32.14	-14.71
Barisal			
Household Size	5.44	4.97	4.56
Required Food Expenditure of the Household Per Month	4488	4920.3	7164.22
Gap/Surplus of Food Expenditure	-2011	-1711.9	-1134.22
Access Gap in %	-44.81	-34.79	-15.83
Chittagong			
Household Size	5.86	5.42	4.97
Required Food Expenditure of the Household Per Month	4834.5	5365.8	7808.37
Gap/Surplus of Food Expenditure	-2357.5	-2156.8	-1778.37
Access Gap in %	-48.76	-40.20	-22.78
Dhaka			
Household Size	5.00	4.69	4.39
Required Food Expenditure of the Household Per Month	4125	4643.1	6897.13
Gap/Surplus of Food Expenditure	-1678	-1434.1	-867.13
Access Gap in %	-40.68	-30.89	-12.57
Khulna			
Household Size	5.07	4.71	4.26
Required Food Expenditure of the Household Per Month	4182.75	4662.9	6692.89
Gap/Surplus of Food Expenditure	-1705.75	-1453.9	-662.89
Access Gap in %	-40.78	-31.18	-9.90
Rajshahi			
Household Size	4.77	4.53	4.15
Required Food Expenditure of the Household Per Month	3935.25	4484.7	6520.07
Gap/Surplus of Food Expenditure	-1458.25	-1275.7	-490.07
Access Gap in %	-37.06	-28.45	-7.52
Rangpur			
Household Size	-	-	4.28
Required Food Expenditure of the Household Per Month	-	-	6724.31
Gap/Surplus of Food Expenditure	-	-	-694.31
Access Gap in %	-	-	-10.33
Sylhet			
Household Size	-	5.57	5.50
Required Food Expenditure of the Household Per Month	-	5514.3	8641.05
Gap/Surplus of Food Expenditure	-	-2305.3	-2611.85
Access Gap in %	-	-41.81	-30.23

Source: Own calculation using data from BBS and GoB (2005)

6.2.5 Food Access: Food Expenditure Pattern in the Sample Districts

The present study has analyzed the actual food expenditure pattern of selected districts which is shown in Table 6.5. Table 6.5 shows that the average household size in Rajshahi district was 4.10 persons in 2010 whereas this was 3.95 and 4.05 in Naogaon and Natore districts respectively in the same year. The required food expenditure of households in Rajshahi district per month was Tk 6441 in 2010 which was Tk 6205 in Naogaon district and Tk 6362 in Natore district. The food expenditure and access gap in Rajshahi district were 411 and 6.39% respectively. This rate was 189 and 2.99% in Naogaon district, and 332 and 5% in Natore district.

Table 6.5: Actual Food Expenditure Pattern in the Sample Districts (Tk)

Food Consumption Indicators	Year	
	2000	2010
Rajshahi		
Household Size	4.91	4.10
Required Food Expenditure of the Household Per Month	4050.75	6441.51
Gap/Surplus of Food Expenditure	-1573.75	-411.51
Access Gap in %	-38.85	-6.39
Naogaon		
Household Size	4.71	3.95
Required Food Expenditure of the Household Per Month	3885.75	6205.85
Gap/Surplus of Food Expenditure	-1408.75	-185.85
Access Gap in %	-36.25	-2.99
Natore		
Household Size	4.64	4.05
Required Food Expenditure of the Household Per Month	3828	6362.96
Gap/Surplus of Food Expenditure	-1351	-332.96
Access Gap in %	-35.29	-5.23

Source: Own calculations using data from BBS, 2001 & 2011

However, from the district wise analysis it is found that there are substantial food expenditure and access gaps in all the three study districts and the food expenditure gap is highest in Rajshahi district followed by Natore and Naogaon districts. On the other hand, the food access gap is higher in Rajshahi district followed by Natore and Naogaon district.

6.2.6 Food Utilization: Per Capita Food Intake Per Day in Bangladesh at National Level by Items of Food

The final pillar of food security is food utilization, refers to ingestion and digestion of adequate and quality food for maintenance of good health. In order to achieve food security, the food ingested must be safe and must be enough to meet the physiological requirements of each individual. Per capita food intake per day is essential to ensure nutritional requirement of body. Intakes of food according to food items by the households per capita per day for the year 2010 have been presented in Table 6.6.

Table 6.6: Per Capita Food Intake Per day in Bangladesh in 2010 (gram)

Food Items	Average Consumption			Required Food Intake
	National	Rural	Urban	
Rice	416.01	441.6	344.20	421
Wheat	26.09	23.3	33.6	40
Pulses	14.30	13.2	17.2	40
Potato	70.30	71.5	66.7	27
Vegetables	166.10	170	155.0	150
Edible Oil	20.50	18.3	26.6	20
Fish	49.5	45.8	59.9	48
Meat	19.07	14.07	33.3	12
Egg	7.20	5.80	10.9	50
Milk & Milk Product	33.72	31.8	39.2	58
Fruits	44.7	42.6	50.4	20
Sugar/Gur	8.40	7.4	11.3	20
Total	875.89	885.37	848.3	906

Source: Own calculations using data from BBS, 2012

Table 6.6 reveals the detailed explanation of food consumption by households considering major food items. Rice is the main food item and average per capita per day intake of rice was 416.01 gm in 2010 in Bangladesh, which was 441.6 gm in rural areas and 344.20gm in urban areas. The second important food item was observed to be vegetables and the consumption rate was about 166.10 gm. per capita per day at the aggregate level. The next important food item was potato followed by fish, fruits, edible oil, wheat, meat, pulses, sugar, and egg.

6.2.7 Food Utilization: Per Capita Calorie Intake of Households in Bangladesh at National Level

Food energy intake is measured by the unit of kilo calorie. Every food item has its own calorie value and these are different from each other. Total calorie intake is derived from total consumption of food for all food items and is presented in terms of per capita per day basis. Average daily per capita intake of calorie for all food items is shown in Table 6.7.

Table 6.7: Per Capita Calorie Intake of Households in Bangladesh

Year	National		Rural		Urban	
	Calorie Intake(kcal/c ap/day)	Food Security Index	Calorie Intake(kcal/c ap/day)	Food Security Index	Calorie Intake(kcal/c ap/day)	Food Security Index
2000	2240.3	0.982	2263.2	0.992	2150	0.942
2005	2238.5	0.981	2253.2	0.988	2193.8	0.962
2010	2318.3	1.02	2344.6	1.03	2244.5	0.984

Source: Own calculations using data from BBS

Improving availability of and access to food are necessary but not sufficient conditions to ensure that people will be secured with food for leading an active and healthy life. The overall average daily per capita calorie intake by households was observed to be 2240.3 kcal in 2000 which increased to 2318.3 kcal in 2010. It is also found that the statistics of the food security status at the different levels is shown in the Table 6.7. The value of food security index is 1.02 (above the threshold of 1) at the national level that is found to be food secure in 2000. The value of food security index of the rural level is also found to be 1.03 (above the threshold of 1) and the value of food security index of the urban level is found to be 0.98 (below the threshold of 1) in 2000. Using the food security index measures at national level we are just food secured on the average since 2010 compared to earlier years. The studies showed that calorie intake was relatively higher for the rural people compared to urban people.

6.3 Discussion of Food Security in Bangladesh at Household level

Ensuring food security for all is one of the major challenges in Bangladesh today. Despite the impressive achievements in food grains production during the last few decades, food security at households and individual levels remains a major concern for the Government. Different aspects and condition of food security at household level are described in this section.

6.3.1 Per Capita Food Intake Per day in the Sample Households

To analyze food security status at household level individual data on food consumption have been collected from the study area and efforts have been given on identifying whether an individual household is food secured. A food secure household is that whose daily per capita calorie intake is on or is above the recommended 2280 kcal per capita daily calorie intake (FAO, 2005). On the other hand, a food insecure household is that whose daily per capita calorie intake falls below the recommended 2280 kcal per capita daily calorie intake (FAO, 2005). Consumption of food according to food items by the study households per capita per day are presented in Table 6.8.

Table 6.8: Per Capita Food Intake Per day in the Study Area (gram)

Food Items	All Households	Food Secured Households	Food Insecured Households
Rice	441.23	451.85	434.47
Wheat	44.87	51.72	40.51
Pulses	36.28	48.56	28.46
Potato	38.72	52.08	30.21
Vegetables	174.54	200	158.33
Fish	36.43	46.23	30.19
Meat	6.46	8.54	5.13
Egg	27.96	43.24	18.24
Fruits	9.26	13.33	6.67
Sugar	15.77	17.56	14.63
Oil	15.04	20.33	11.67
Milk and Milk Products	28.64	52.53	13.43
Total	875.2	1005.97	791.94

Source: Author's own calculation

From Table 6.8 it is revealed that the rice is the main item of foods of both food secured and insecure households in the study area. It is found that average per capita per day intake of rice was 441.23 gm in the study area, which was 451.86 gm in food secured households and 434.47 in food insecure households. Thus, food secured households consume more rice than food insecure households. The second important food item of households in the study area was observed to be vegetables and the consumption rate was about 174.54 gm per capita per day in total study households. The next important food item was wheat followed by potato, fish, pulse, milk and milk product, egg, sugar, oil, fruits, and meat.

The per capita food intake per day is not same in all three study districts. Therefore, the present study calculated per capita food intake per day of the households for the study districts separately which are shown in Table 6.9. From Table 6.9 it is found that the per capita food intake per day is highest in Naogaon district followed by Rajshahi and Natore district.

Table 6.9: Per Capita Food Intake Per Day in the Study Area (gram)

Food Items	Rajshahi			Natore			Naogaon		
	All House-Holds	Food Secured House-holds	Food Insecured House-holds	All House -Holds	Food Secured House-holds	Food Insecured House-holds	All House -Holds	Food Secured House-holds	Food Insecured House-holds
Rice	451.9	470.7	438.46	430.9	436.5	428.77	449.15	464.95	435.33
Wheat	43.77	49.14	39.94	43.38	47.7	41.67	44.56	49.51	40.23
Pulses	34.53	44.13	27.68	32.53	41.51	28.98	35.48	44.39	27.68
Potato	30.47	32.29	29.17	33.91	40.63	31.25	33.27	34.38	32.29
Vegetables	180.6	200	166.67	171.76	195.83	162.25	186.11	208.33	166.67
Fish	41.67	53.77	33.02	34.18	49.06	28.3	42.01	56.6	29.25
Meat	6.05	8.55	4.27	4.39	6.84	3.42	5.93	6.84	5.13
Egg	32.72	47.3	22.3	20.53	29.73	16.89	31.08	47.3	16.89
Milk and Milk Product	30.35	47.76	17.91	25.50	52.24	14.93	30.05	50.75	11.94
Fruits	14.72	16.67	13.33	11.89	16.67	10	9.78	13.33	6.67
Sugar	16.61	20.73	13.66	16.30	18.05	15.61	17.40	20	15.12
Oil	14.96	21.11	10.56	14.22	19.56	12.11	15.82	20.44	11.78
Total	898.29	1012.1	816.97	839.54	954.28	794.18	900.64	1016.82	798.98

Source: Author's own calculation

Again, per capita food intake is not same for food secure and food insecure households. Table 6.9 reveals that per capita food intake per day of food secured households is high in Naogaon district followed by Rajshahi and Natore districts. On the other hand, per capita food intake of food insecure households is higher in

Rajshahi district followed by Naogaon and Natore districts. Again, from the disaggregated analysis it is found that households of all districts receive most of the calories from the consumption of rice and vegetables.

6.3.2 Food Security Condition of Households by Income

Income is an important factor behind food security of households. An individual with more income may consume more food than an individual with less income. The food security status of households by income in the study area is shown in Table 6.10. From Table 6.10 it is observed that most of the food insecure households are in the income group of less than Tk 5000 in the study area

Table 6.10: Food Security Condition of Households by Income (Tk)

Income Range	Total Households	Food Secured Households	Food Insecured Households	Daily Mean Calorie Intake	FSI
≤5000	93	7	86	2065.46	0.91
5001 - 10000	65	41	24	2325.61	1.02
10001- 15000	11	11	0	2480.09	1.09
15001 - 20000	6	6	0	2777.17	1.23
≥20001	5	5	0	2855.4	1.25

Source: Author's own calculation

Table 6.10 also reveals that the value of food security index is lower for households who earn income less than or equal Tk 5000 per month whereas the value of food security index is higher for households who earn income above Tk 20000 per month. Thus, it is clear that a household with lower income have lower level of consumption.

6.3.3 Food Security Condition of Households by Land Ownership

Land is a fixed asset of a household. Bangladesh is an agrarian country. Most of the people in Bangladesh are farmers and they cultivate their land to grow food crops which ensure their food demand. The household who have more land can grow more crops to meet food demand for their families. Therefore, ownership of land may influence the level of food security. Food security condition of households by land ownership is shown in Table 6.11.

Table 6.11: Food Security Condition of Households by Land (acre)

Farm Size	All Households	Food Secured Households	Food Insecured Households	Daily Mean Calorie Intake	FSI
No cultivable land	79	26	53	2165.63	0.95
0.01- 1	67	21	46	2207.27	0.97
1.01- 2	21	10	11	2324.57	1.02
2.01- 3	5	5	0	2432.2	1.07
>3	8	8	0	2649	1.16

Source: Author's own calculation

Table 6.11 shows that the households with more land have more daily mean calorie intake than the households with low land. Again, it is found that the value of food security index is higher for the households which have more land. Most of the food insecure households are in the range of land ownership of 0.01 acre to 2 acres. Thus, it is clear from the study that land ownership influences the food security status of households.

6.3.4 Food Security Condition of Households by Education

Education is a human capital which helps one to get better job and an educated one earn more income compared to an uneducated one. With more income a household can afford more food for family. Moreover, an educated household head can arrange balanced and nutritional diet for his/her family.

Table 6.12: Food Security Condition of Households by Education (years of schooling)

Educational Status	All Households	Food Secured Households	Food Insecured Households	Mean Daily Calorie	FSI
No formal Education	56	10	46	2120.25	0.93
1-5 class	68	19	49	2177.54	0.96
6-10 class	42	29	13	2374.62	1.04
HSC	9	7	2	2356.44	1.03
Higher Education	5	5	0	2678.4	1.17

Source: Author's own calculation

From Table 6.12 it is observed that most of the food secured households are in the education range of 6 to 10 class in the study area. Table 6.12 also reveals that the

value of food security index is higher for individuals who have higher education level. Thus, it is clear that an individual with higher education have higher level of consumption.

6.3.5 Food Security Condition of Households by Household Size

Actually household size means total members of the household. However, a household may comprise of children, middle aged and adult members and the consumption of all of them are not same.

Table 6.13: Food Security Condition of Households by Household Size (adult equivalent unit)

Household Size	All Households	Food Secured Households	Food Insecured Households	Daily Mean Calorie Intake	FSI
1-3	80	42	38	2307.8	1.01
4-6	95	28	67	2189.75	0.96
7-9	3	0	3	1850	0.81
>9	2	0	2	1548	0.68

Source: Author's own calculation

From Table 6.13 it is observed that most of the food secured households are in the household size range of 1 to 3 in the study area. Table 6.13 also reveals that the value of food security index is higher for individuals who have 1 to 3 family members. Thus, it is clear that an individual with smallest household size have higher level of consumption.

6.3.6 Food Security Condition of Households by Cereal Production

This is the total quantity of cereal crops by the household from their own farm measured in kilogram grain equivalent. The food security status of households by quantity of cereal production in the study area is shown in Table 6.14.

Table 6.14: Food Security Condition of Households by Cereal Production (quintal)

Quantity of Cereal Production	All Households	Food Secured Households	Food Insecured Households	Daily Calorie Intake	FSI
No cereal production	80	26	54	2168.11	0.95
1 - 20	41	12	29	2221.34	0.97
21 - 40	31	10	21	2200.48	0.97
41 - 60	14	9	5	2349.71	1.03
61 - 80	8	8	0	2507.00	1.10
>80	6	5	1	2575	1.13

Source: Author's own calculation

From Table 6.14 it is observed that most of the food insecure households are in no production of cereal crops in the study area. Table 6.14 also reveals that the value of food security index is lower for individuals who have not produced cereal crops in the cultivated land. Thus, it is clear that an individual with higher cereal production have higher level of consumption.

6.3.7 Overall Level of Food Security of the Sample Households

To assess whether a household is food secured the food security index is calculated using statistical formula of food security introduced by Fakiyesi (2001) which is a fair representation of the extent and dimension of food security or insecurity of the sample households in the study area. A detailed analysis of food security status of the sample households has been given in this section. A comparison of food security status of household of different districts has also been explained in this section.

Food Security Index: Total Food Secure and Insecure Households in the Study Area

On the basis of recommended daily calorie intake of 2280 kcal suggested by FAO (2005), total households are classified into food secure and insecure which is represented in Table 6.15. From the table it is observed that 70 of total households in the study area are food secured whereas 110 are food insecure. This figures vary for three study districts also. From Table 6.15 it is found that in Naogaon district food secured and food insecure households are respectively 28 and 32. Again, in Natore

district only 17 households are food secure and 43 are food insecure. In Rajshahi district food secure and food insecure households are 25 and 35, respectively.

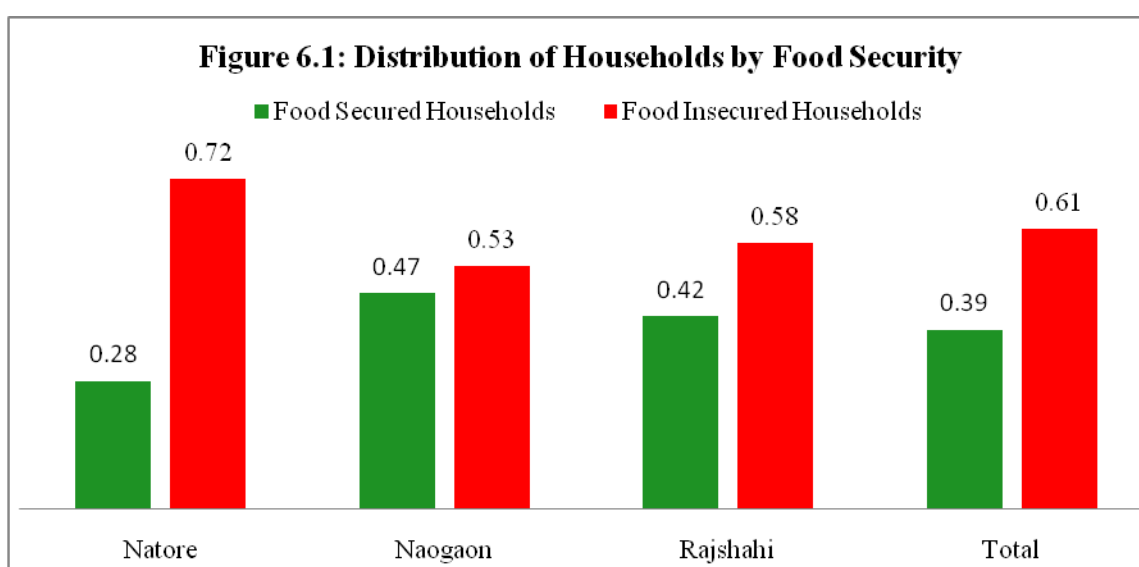
Table 6.15: Total Food Secured and Insecured Households in the Study Area

Region	Food Secure Households	Food Insecure Households
Natore	17 (0.28)	43 (0.72)
Naogaon	28 (0.47)	32 (0.53)
Rajshahi	25 (0.42)	35 (0.58)
Total Study Area	70 (0.39)	110 (0.61)

Source: Author's own calculation

Note: The figure in the parenthesis indicates the percentage

In Figure 6.1 proportion of households which are food secure and food insecure is shown. From the figure it is observed that the ratio of all sample food insecure households is 0.61 which indicates that 61% households in the study area are food insecure implying that more than three-fifths of the total households in the study area are subsisting on less than recommended daily per capita calorie requirement, while the proportion of food secure household is 0.39 which indicate that 39% of total sample households (less than two-fifths) are subsisting above recommended daily per capita calorie requirement. However, this scenario is different for three study districts. Therefore, the headcount ratio index is also calculated for all the sample districts.



From Figure 6.1 it is found that in Naogaon district the proportion of food insecure and food secure households are 0.53 and 0.47 respectively. It is also seen that 53%

households in Naogaon district is food insecure and 47% households is food secure. Again, in Natore district the head count ratio of food secure and insecure households are 0.28 and 0.72 indicating that 28% households are food secure whether 72% households are food insecure. The results of head count ratio of food secure and insecure households of Rajshahi district are 0.42 and 0.58. This result means that 42% households of Rajshahi districts is food secure and 58% is food insecure. Thus, from the results of head count ratio it is observed that the most food insecure district is Natore followed by Rajshahi and Naogaon districts.

Food Security Index: Food Security Status of Sample Households in the Study Area by District

Based on the level of consumption of food it is possible to find whether a household is secured in food. On the basis of field survey data collected from three districts of northern Bangladesh a food consumption index is calculated which enabled us to understand whether an individual is secured in the availability of food. Table 7.2 presents the mean of food consumption of an individual of sample households in the study area measured in kcal.

Table 6.16: Status of Food Security of Sample Households in the Study Area by District (kcal)

Region	Mean Calorie Intake	FSI
Naogaon	2279	0.999
Natore	2150	0.942
Rajshahi	2270	0.996
Total Study Area	2233	0.979

Source: Author's own calculation

From Table 6.16 it is found that the mean value of food security index is 0.979 in the study area whereas the value of food security index is 0.942, 0.996 and 0.999 of the Natore, Rajshahi and Naogaon districts for the sample households. From Table 6.16 it is found that the average per capita calorie intake in the area is 2233 kcal Based on the recommended daily calorie intake of suggested by FAO (2005) an individual is secured in food if he/she can consume 2280 kcal per day. Therefore, it is clear that study individuals of sample households are insecure in food on the average. Again, from the disaggregated analysis it is observed that the average calorie intake of

individuals of the household of Natore district is 2150 kcal indicating that the individuals of the district are not secured in food on an average. The mean calorie intake of the individuals of Naogaon district is 2279 kcal which indicates that the households of the districts are almost secured in the availability of food. The daily mean calorie intake of individuals of the households of Rajshahi district is 2270 kcal which is lower than the daily calorie intake suggested by FAO. Therefore, the people of Rajshahi district are insecure in food on an average. The national daily calorie intake of the people of Bangladesh is 2318.3 kcal (BBS, 2010). However, from Table 6.16 it is observed that the daily mean calorie intake is also lower than national daily calorie intake in all districts. Table 6.16 also revealed that the daily mean calorie intake is higher in Naogaon district followed by Rajshahi and Natore. It may be the agricultural production is higher in Rajshahi and Naogaon district compared to Natore district. Therefore, the people of Rajshahi and Naogaon district may consume more food than Natore district on an average.

Daily Mean Calorie Intake of Food Secured Households in the Study Area

The daily calorie intake of food secured households is higher compared to food insecure households. Therefore, the daily mean calorie intake is measured separately for food secured and food insecure households. The daily mean calorie intake of food secured households is given in Table 6.17.

Table 6.17: Daily Mean Calorie Intake of Food Secured Households (kcal)

Region	Mean Consumption	FSI
Natore	2337	1.03
Naogaon	2500	1.010
Rajshahi	2520	1.11
Total Study Area	2467	1.08

Source: Author's own calculation

From Table 6.17 it is observed that the average calorie intake of food secured households in the study area is 2467 kcal. However this mean calorie intake is 2520 kcal for Rajshahi district, 2500 for Naogaon district and 2337 kcal for Natore district. From Table 6.17 it is also found that the mean value of food security index is 1.08 in the study area whereas the value of food security index is 1.03, 1.01 and 1.11 of the

Natore, Rajshahi and Naogaon districts for the food secured households. Thus, it is found that the people of food secured household of Rajshahi district consume more calories compared to Natore and Naogaon districts. This is consistent with the results represented in Table 6.17.

Daily Mean Calorie Intake of Food Insecured Households in the Study Area

The households whose members consume 2250 kcal or less than 2250 kcal of food daily are considered as food insecured households. The daily mean calorie intake of food insecured households are presented in Table 6.18.

Table 6.18: Daily Mean Calorie Intake of Food Insecured Households (kcal)

Region	Mean Consumption	FSI
Natore	2075	0.91
Naogaon	2085	0.914
Rajshahi	2092	0.92
Total Study Area	2083	0.913

Source: Author's own calculation

Table 6.18 shows that the average calorie intake per day is less than 2280 kcal. The mean calorie intake of food insecured household in the study area is 2083 kcal. This figure is lowest for Natore (2075) compared to 2085 kcal for Naogaon and 2092 kcal for Rajshahi. From Table 6.18 it is found that the mean value of food security index is 0.913 in the study area whereas the value of food security index is 0.91, 0.914 and 0.92 of the Natore, Rajshahi and Naogaon districts for food insecured households. This result suggests that the people who live below the benchmark of kcal intake to be secured in study area cannot afford enough food for their families because of not having enough family income earned from farm, off farm and non-farm sectors.

6.3.8 Disaggregated Analysis of Calorie Intake by the Households

The incidence of poverty based on daily calorie intake is measured to understand the extent of food poverty in the study area. The households with daily calorie intake of less than or equal to 1600 kcal is considered as extreme poor. The households that

consume 1601 kcal to ≤ 1805 kcal per day are considered as hardcore poor. Again, the households which consume 1806 kcal to ≤ 2122 kcal is considered as absolute poor and the household which consume more than 2123 kcal of food daily is free from poverty. Table 6.19 provides the scenario of the sample households in the light of the above classification.

Table 6.19: Disaggregated Analysis of Calorie Intake by the Households

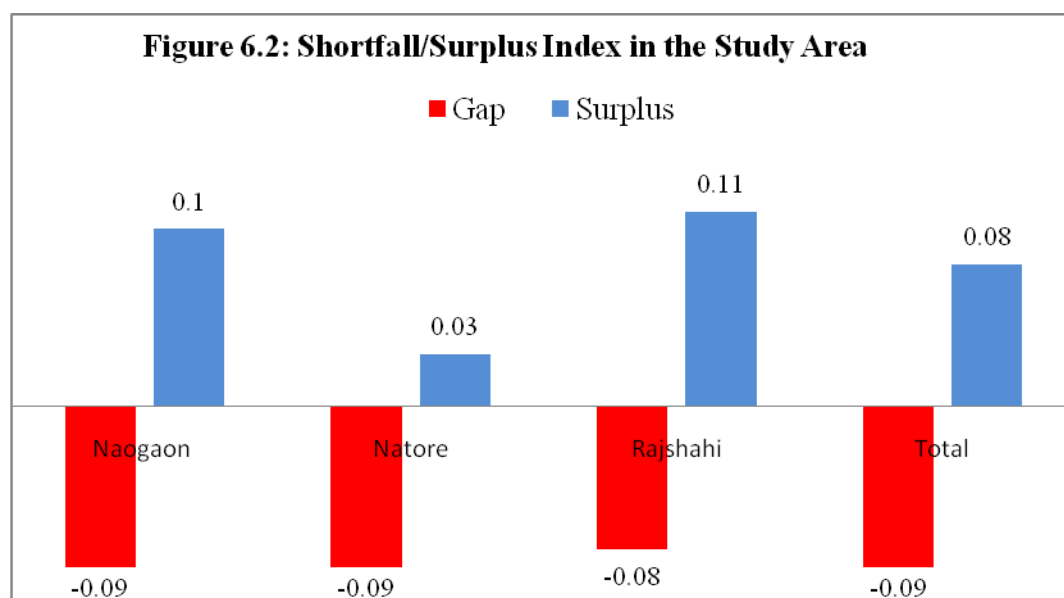
Study Area	Per Person Calorie (≤ 1600)	Per Person Calorie (1601 to ≤ 1805)	Per Person Calorie (1806 to ≤ 2122)	Per Person Calorie (≥ 2123)
Natore	2	3	16	39
Naogaon	-	4	12	44
Rajshahi	1	3	14	42
Total Study Area	3 (1.7%)	10 (5.6%)	42 (23.33%)	125 (69.44%)

Source: Author's own calculation

From Table 6.19 it is found that there are 3 households in the study area who are living below the extreme poverty line whereas 10 households are living below the hardcore poverty line and another 42 households are living below the absolute poverty line. Table 6.19 also reveals that there are 125 households in the study area who are not living below the poverty line. However, the incidence of food poverty is not same for all study districts. The table 6.19 shows that there are 2 households in Natore district who are extremely poor. Table 6.19 also shows that there are 3 and 16 households who are hardcore and absolute poor respectively. In Natore district 39 household in are living above the poverty line. In case of Naogaon district it is found that there is no household fall in extreme poverty group, 4 fall in hardcore poverty group, 12 fall in absolute poverty group and 44 households belong to are above the poverty group. In case of Rajshahi district it is found that there is one household in extreme poverty group, 3 are in hardcore poverty group, 14 are in absolute poverty group and 42 are households are above the poverty line.

6.3.9 Shortfall/ Surplus Index in the Study Area

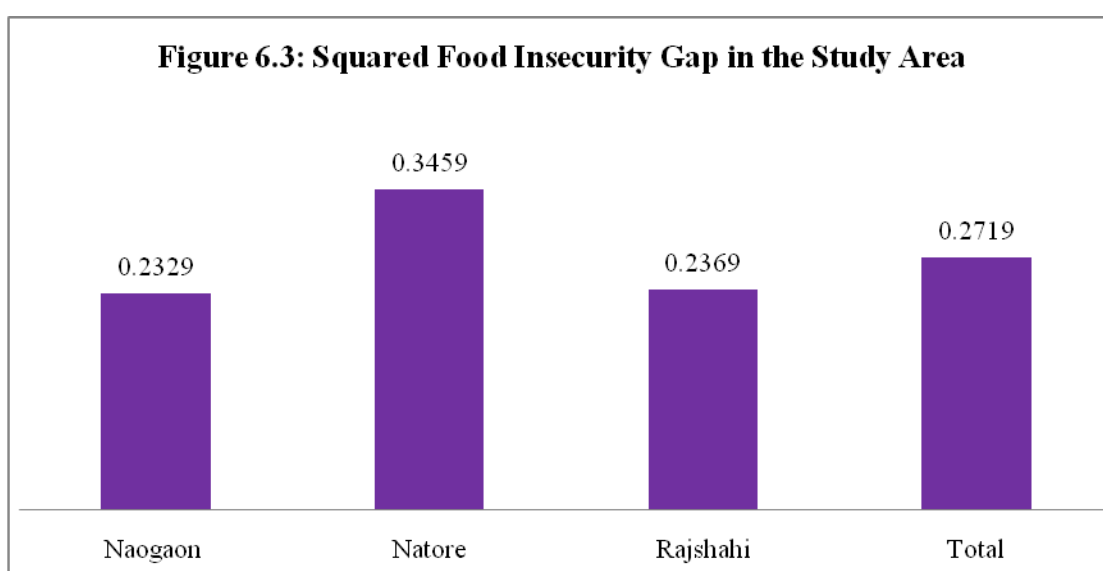
Shortfall index measures the extent to which households are below the food security line. Shortfall index is also a measure of total food insecurity gap. Surplus index measures the extent to which households are above the food security line.



The shortfall and surplus index of food secure and insecure households of the study area are represented in Figure 6.2. The shortfall and surplus index of total study area are 0.09 and 0.08 which indicate that the food insecure households falls below the food security line by about 9% and the food secure households lie above the food security line by 8%. In case of Natore district, the calculated shortfall index is 0.09 and surplus index is 0.03 indicate which the food insecure households falls below the food security line by about 9% and the food secure household exceed the food security line by only 3%. From Figure 6.2 it is found that in Naogaon district the food insecure household fall below the food security line by 9% whereas food secure households stay above the food security line by 10%. Again, in Rajshahi district the food insecure households fall below the food security line by about 8%, while the food secure households exceed the food security line by 11% which is higher than that of other two districts.

6.3.10 Severity of Food Insecurity in the Study Area

Squared food insecurity gap measures the severity of food insecurity among households (Idrisa, 2008). Figure 6.3 shows that squared insecurity gap which indicates severity of food insecurity among the food insecure households in the study area. The calculated squared insecurity gap is 0.2719 indicating that the 27.19% households have been facing severe food insecurity in the study area. 23.29%, 34.59% and 23.69% are the values of calculated squared food insecurity gap in the study districts- Naogaon, Natore and Rajshahi, respectively.



6.3.11 Analysis of Regression Results: The Determinants of Food Security at Household Level

In this section, empirical results based on the econometric estimation are discussed. Specially, estimation results on the basis of the Logistic regression equation (Equation 11, Chapter 4) are presented and analyzed here, with a sample size of 180. To explore the influence of the key factors on food security status, this analysis is done in three phases. Firstly, all the collected data are considered together and the regression equation is estimated. Secondly, all the sample households are divided into three categories with respect to study districts and regression is run separately for all districts. Thirdly, regression results of all Natore, Naogaon and Rajshahi districts are

taken together and comparison is made to view if any significant variations are found in the results. The estimation of regression results has been done using the Statistical Software Eviews (version 4.0) and SPSS (version 16)

Regression Results with all Households

The estimation results of the regression for all households are presented in Table 6.20. From the table, it is observed that four variables out of eight included in the regression model are statistically significant which are- total monthly income, quantity of cereal production, educational status of household and farm size. However, age of household head, household size, gender of household head and owned livestock are not statistically significant. Table 6.20 revealed that McFadden R-squared is 0.709 which means that 71% of variation in food security is explained by the considered explanatory variables. The obtained log likelihood ratio is -70.665 and LR statistic for the goodness of fit of the model is 99.23774 and significant at the 1% level which confirms the overall significant of the model. The explanation of each estimated coefficient which is significant is given below.

Table 6.20: Regression Result of All Sample Area

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-3.5159**	1.2417	-2.8315	0.0046
TMHI	0.0006***	0.0001	4.1376	0.0000
AHH	-0.0164	0.0222	-0.7391	0.4598
ESHH	0.1124*	0.0626	1.7951	0.0726
HS	0.2161	0.2611	0.8277	0.4078
FS	0.2891**	0.1200	-2.4072	0.0171
GHH	-0.5921	0.4840	-1.2231	0.2213
OL	-0.4657	0.8751	-0.5321	0.5946
QCP	0.1342***	0.0497	2.6974	0.0070

Log likelihood -70.6658; LR statistic (8 df.) 99.2377 and Probability (LR stat) 0.0000;
McFadden R-squared 0.7096

Source: Author's own calculation.

Note: *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

Total monthly income: From Table 6.20 it is found that the coefficient (0.0006) of the variable 'monthly income' is positive and statistically significant at 1% level. This result indicates that the higher the income of a household the higher is the probability that the household would be secured in the consumption of food. This may be an

increase in household income helps it to afford more of food for the family which make the family secured in food. This result is consistent with Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Arene and Anyaeji, 2010; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010; Iorlamen *et al.*, 2014, who revealed positive and significant relationship between household income and food security.

Educational status of household head: Education increases household's knowledge about the availability, accessibility and safety of food. Thus, an educated household is more informative about the consumption of food. From the regression it is found that the coefficient of education (0.1124) is positive and statistically significant at 10% level. This indicates that comparatively educated households are more likely to be secured in food. It may be besides getting more information, an educated individual can earn more income to afford his/her daily necessities to live. This result suggest that education has direct impact on food security status as households with relatively higher level of education strive better than those with lower level of education, agreeing with the findings of Adeniyi and Ojo (2013) and Ramakrishna and Demeke (2002).

Farm size: The coefficient of farm size is significant at 5% level and the value of the coefficient is 0.2891. This positive result indicates the households with large farm are more likely to be secured in food and the households with small farm are less likely to become secure in food. The result of the study is in line with the findings of Adeniyi and Ojo, 2013; Babatunde *et al.*, 2010, who found that large farm size, improves the food security status of households.

Quantity of cereal production: The coefficient of the variable quantity of own cereal production (0.1342) is positive and statistically significant at 1% level indicating that the households which produce more cereal crops are more likely to have security in food. An increase in household production increases more purchasing power or direct consumption of food for the family which make the family secured in food in the study area. The finding of the study is also consistent with Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010 who obtained the same result among the households in different areas.

Others variable: Age of household head, household size, gender of household head and owned livestock are not statistically significant. Since the coefficients are non-zero, it means that these variables also may have some influence on food security status. However, since they are not statistically significant, they do not bear any significant meaning.

Regression Results for the Households of Naogaon District

The food security status and other socio-economic and farm level characteristics of Naogaon district are not same as those of others district. Therefore, in addition to the overall regression analysis, we have run a separate regression for Naogaon district. The regression results of Naogaon district are shown in Table 6.21.

Table 6.21: Regression Result for Naogaon District

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.6615	2.7990	-0.2363	0.8132
TMHI	0.0005	0.0003	1.6236	0.1044
AHH	-0.0583*	0.0352	-1.6547	0.0980
ESHH	0.0262	0.1310	0.2000	0.8414
HS	-0.6979*	0.4200	-1.6616	0.0966
FS	0.2973*	1.3963	-1.6453	0.0999
GHH	-0.8667	1.0520	-0.8239	0.4100
OL	-0.0694	1.6681	-0.0416	0.9668
QCP	0.0998**	0.0478	2.0863	0.0370

Log likely

hood -30.680; LR statistic (8 df.) 20.142 and Probability (LR stat); 0.009; McFadden R-squared 0.427

Source: Author's own calculation.

Note: *** Significant at 1% level; *Significant at 5% level; * Significant at 10% level

From the table it is found that four variables out of 8 included in the model are statistically significant and the significant variables are age of household head, household size, quantity of owned cereal production and farm size. However total monthly income, educational status of household, gender of household head and owned livestock are not statistically significant. Therefore, they do not bear any significant meaning. The value of Log Likelihood Ratio is -30.68 which is significant at the 1% level, indicating that the fitness of the model is good. The analyses of the significant variables are given below.

It is found that age of household head is a significant factor that influences food security status of the household in Naogaon district. The coefficient of the variable 'age' is negative and statistically significant at 10% level reflecting that household head with higher age are less likely to be food secure compared to those with lower age. It may be an old individual loss cannot work hard to earn more income. That is why he/she cannot arrange enough food for the family which is necessary for healthy survival. This may be as a result of the fact that the ages less than 50 years are more energetic and agile to do farm work, seek off-farm income generating activities to improve the welfare and food security of their households (Ahungwa et al., 2013). However, this result is also in line with the findings of Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Babatunde *et al.*, 2010; Iorlamen *et al.*, 2014, who found that younger people, improves the food security status of households.

The coefficient of the variable household size is negative (-0.69) but statistically significant at 10% level, implying that as the household size gets larger, the probability of food security decreases. In other words, large size households are more likely to be food insecure than small size households. The family size of the households has influenced food insecurity negatively (Ramakrishna and Demeke, 2002). The result of the study is in line with the findings of Adeniyi and Ojo, 2013; Babatunde *et al.*, 2010; Iorlamen *et al.*, 2013; Yusuf *et al.*, 2011; Iorlamen *et al.*, 2014, who found that large household size increases the food insecurity status of households.

Farm size means the amount of land that a farmer household cultivates to produce grains. This variable is important because it affects the food security status of the family. A household with more cultivable land can produce more crops which ensure food for the family. The coefficient farm size is positive (0.2973) and statistically significant at 10% level implying that as the farm size gets larger, the probability of a household being more secure in food increases. In other words, households with large farm size are more likely to be secured in food compared to households with small farm size and this result is consistent with Babatunde *et al.*, 2010; Adeniyi and Ojo, 2013, who found that large farm size increases the food insecurity status of households.

The coefficient of the variable quantity of own cereal production (0.99) is positive and statistically significant at 5% level indicating that the higher the production of cereal crops of a household the higher is the probability that the household would be secured in food. The result also showed that the quantity of cereal production for the study area influences food security among households and thus agreeing with view of Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010.

Regression Results for the Households of Natore District

The regression results for the households of Natore district is given in Table 6.22. From the table it is found that only four variables are statistically significant which are total monthly income, educational status of household, gender of household head and farm size. However, age of household head, household size, quantity of owned cereal production and owned livestock are not statistically significant in case of Natore district. The explanation of the coefficient of statistically significant variables is given below.

Table 6.22: Regression Result for Natore District

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.3052	2.8675	0.1064	0.9152
TMHI	0.0016***	0.0005	2.7179	0.0066
AHH	0.0656	0.0570	1.1495	0.2503
ESHH	0.3535***	0.1407	2.5110	0.0120
HS	-0.8195	0.6448	-1.2708	0.2038
FS	8.3880*	4.5286	1.8521	0.0640
GHH	2.0232**	1.0332	-1.9581	0.0502
OL	-0.9857	1.6787	-0.5871	0.5571
QFOCP	-0.2121	0.1408	-1.5061	0.1320

Log likelihood -21.16; LR statistic (8 df) 29.19 and Probability (LR stat); 0.000;
McFadden R-squared 0.608

Source: Author's own calculation.

Note: *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

In the regression the coefficient (0.0016) of the variable ‘monthly income’ is positive and statistically significant at 1% level indicating that the higher the income of a household the higher is the probability that the household would be secured in the consumption of food. An increase in household income helps it to purchase more food for the family which make the family secured in food in this district. This result suggests that household income has direct impact on food security status as households with relatively high income strive better than those with less income and thus agreeing with the findings of Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Arene and Anyaeji, 2010; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013, Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010; Iorlamen *et al.*, 2014.

Farm size increases household’s ability for food security and the coefficient of farm size is statistically significant in the logit model for food security in Natore district. The coefficient of farm size (8.3880) indicates that the owner of the large farm is more likely to be food secure and large farm size are more likely to be food secure than small size farms in this area. This result suggest that farm size has direct impact on food security status as households with relatively large farm size strive better than those with small farm size agreeing with the findings of Adeniyi and Ojo, 2013; Babatunde *et al.*, 2010.

Education increases household’s ability and knowledge for food security and an educated household is more informative of food consumption. The coefficient of education (0.3535) is positive and statistically significant at 1% level indicating that comparatively educated household are more likely to be food secure. In other words, an educated household head of a family is more likely to be food secure than an uneducated head’s family. The result also showed that the higher education in the study area influences food security among households agreeing with view of Adeniyi and Ojo, 2013; Ramakrishna and Demeke, 2002.

The gender of household head has positive coefficient that is statistically significant at 10% level. This result indicates that a household with male headed are more likely to

be secured in food compared to the households with female headed, agreeing with view of Babatunde *et al.*, 2010.

Regression Results for the Households of Rajshahi District

The regression results of Rajshahi district are presented in Table 6.23. From the table it is found that total monthly income, quantity of owned cereal production and farm size are statistically significant. However, age of household head, educational status of household, household size, gender of household head and owned livestock are not statistically significant.

Table 6.23: Regression Result for Rajshahi District

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-10.2593	7.6404	-1.3427	0.1793
TMHI	0.0015***	0.0005	2.6535	0.0080
AHH	-0.0161	0.0530	-0.3046	0.7607
ESHH	0.0741	0.2376	0.3119	0.7550
HS	0.6008	0.7106	0.8455	0.3978
FS	11.9347*	6.7315	-1.7729	0.0762
GHH	0.3104	1.3213	0.2349	0.8142
OL	-1.5949	6.5908	-0.2419	0.8088
QFOCP	0.5279*	0.2611	2.0217	0.0432
Log likelihood -12.03646; LR statistic (8 df.) 58.83788 and Probability (LR stat); 7.87E-10; McFadden R-squared 0.7096				

Source: Author's own calculation.

Note: *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

In the above table it is seen that the coefficient (0.0015) of the variable monthly income is positive and statistically significant at 1% level indicating that the higher the income of a household the higher is the probability that the household would be secured in the consumption of food. An increase in household income helps it to purchase more food for the family which make the family secured in food in this district. However, this result is consistent with Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Arene and Anyaeji, 2010; Adeniyi and Ojo, 2013; Iorlamen *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010; Iorlamen *et al.*, 2014, who revealed positive and significant relationship between household income and food security. The coefficient of the variable 'farm size' is statistically significant in the logit model

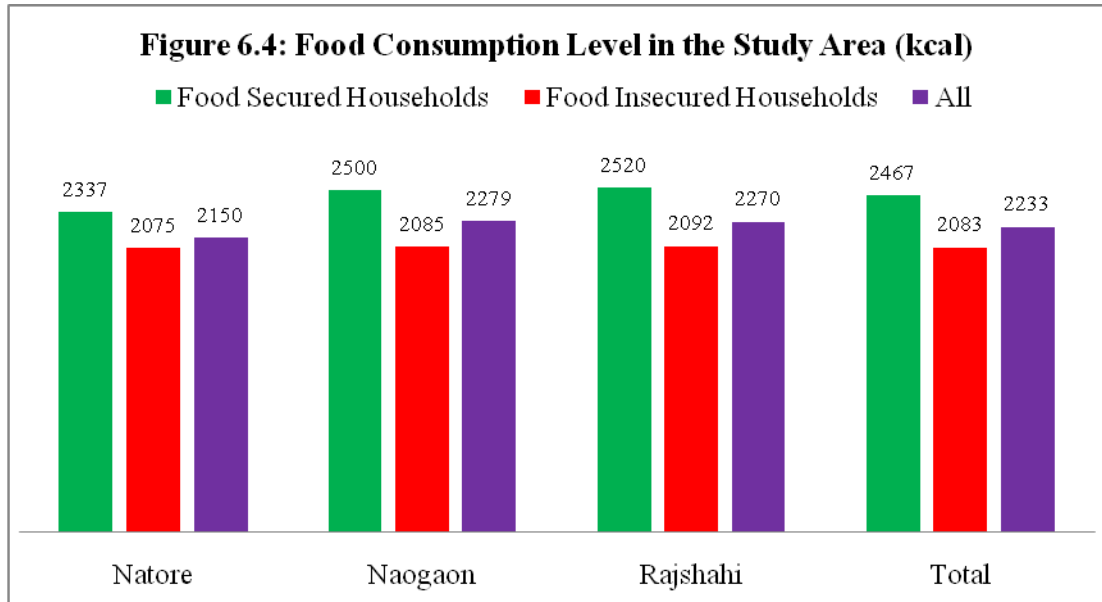
for food security in Rajshahi district. The coefficient of farm size (11.9347) indicates that the owner of the large farm is more likely to be food secure and large farm size are more likely to be food secure than small size farms. The result of the study is in line with the findings of Adeniyi and Ojo, 2013; Babatunde *et al.*, 2010, who found that large farm size improves the food security status of households.

The coefficient (0.5279) of the variable quantity of own cereal production is positive and statistically significant at 1% level indicating that the higher production of a household the higher is the probability that the household would be secured in the supply of food. An increase in household production increases more purchasing power or direct consumption of food for the family which make the family secured in food in this district. This result suggest that cereal production has direct impact on food security status as households with relatively higher cereal production strive better than those with lower cereal production, agreeing with the findings of Babatunde *et al.*, 2007; Kuwornu *et al.*, 2013; Ahungwa *et al.*, 2013; Babatunde *et al.*, 2010.

6.4 Comparison of Results

6.4.1 Comparison of the Level of Food Consumption in the Study Area

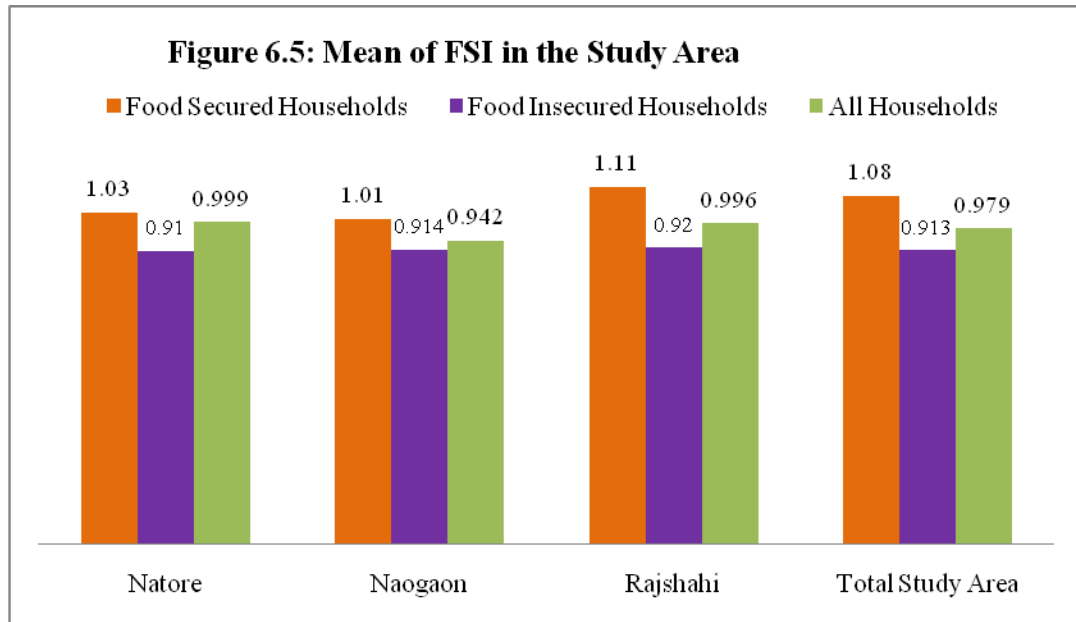
The consumption level of food is not the same by the people in all sample districts. A comparison of the level of food consumption in sample districts is shown in Figure 6.4. From the figure it is found that the average mean calorie intake of all sample households in the study area is 2223 kcal whereas the mean calorie intake is 2467 kcal for food secure households and 2083 kcal for food insecure households. Figure 6.4 also shows that in case of all households the mean calorie intake is higher in Naogaon district followed by Rajshahi and Natore districts. However, this result is different for food secure and insecure households.



The mean calorie intake of food secure households is higher in Rajshahi district compared to Naogaon and Natore districts. Again, the consumption level of food insecure households is also higher in Rajshahi district than Naogaon and Natore districts. Thus, it is observed that the average calorie intake of both food secure and food insecure households is higher in Rajshahi district compared to Naogaon and Natore districts.

6.4.2 Comparison of the Value of Food Security Index in the Study Area

It is found that majority of the households in the area are food insecure as most of them subsist below the food security line which is 2280 Kcal in this study. Using the recommended calorie approach, it is discovered that 61% of the population are food insecure. On the basis of data analyzed to inquire about the food security status of the households is presented in Figure 6.5.



The food security status (Fi) is calculated and the mean of FSI of all households is also found to be 0.979 (below the threshold of 1) whereas the mean of FSI is 0.93 for insecure households and 1.08 for secure households in the study area. The mean of FSI of food secure households is higher in Rajshahi district compared to Natore and Naogaon districts. Again, the consumption level of food insecure households is also higher in Rajshahi district than Naogaon and Natore districts. Thus, it is observed that the mean of FSI both food secure and food insecure households is higher in Rajshahi district compared to Naogaon and Natore districts.

6.4.3 Comparisons of Regression Results

A comparative analysis of food security determinants in all three districts is provided in Table 6.24. This is necessary because, analysis of the relative scenario of food security pattern in Rajshahi, Naogaon and Natore districts is justified at this point of our study so that we can get an overview of our calculated results and can observe the ability pattern of the households of selected areas.

Table 6.24: Comparison of Regression Results

Variable	Total Study Area	Naogaon	Natore	Rajshahi
		District	District	District
Coefficient				
C	-3.5159	-0.6615	0.3052	-10.2593
TMHI	0.0006***	0.0005	0.0016***	0.0015***
AHH	-0.0164	-0.0583*	0.0656	-0.0161
ESHH	0.1124*	0.0262	0.3535***	0.0741
HS	0.2161	-0.6979*	-0.8195	0.6008
FS	0.2891**	0.2973*	8.3880*	11.9347*
GHH	-0.5921	-0.8667	2.0232**	0.3104
OL	-0.4657	-0.0694	-0.9857	-1.5949
QCP	0.1342***	0.0998**	-0.2121	0.5279*

Source: Author's own calculation

The regression results show that explanatory variables can create an impact on the food security in all three districts. The coefficient of the variable monthly income is positive and statistically significant at 1% level in Natore and Rajshahi district indicating that the households of higher income level have the higher probability of being secured in the consumption of food but this coefficient of those positive is not significant in Naogaon district.

The coefficient of the variable 'age' has negative sign and statistically significant at 10% level in Naogaon district reflecting that household head with higher age are less likely to be food secure compared to those with lower age than other two districts. For other districts 'age' did not appear significant. The coefficient of education is positive and statistically significant in only Natore district indicating that educated households of Natore district are more conscious about food consumption than the households of Rajshahi and Naogaon district.

The coefficient of the variable household size is negative and statistically significant in only Naogaon district, implying that as the household size gets larger, the probability of food security decreases in this district than the households of Rajshahi and Naogaon district. The coefficient of the variable farm size is positive and statistically significant in all study area, comprising three districts implying that as the farm size gets larger, the probability of food security increases. In other words,

households with large farm are more likely to be food secure than small size households.

The coefficient of the variable quantity of owned cereal production is positive and statistically significant in Naogaon and Rajshahi districts, indicating that an increase in household production increases more purchasing power or direct consumption of food for the family which make the family secured in food.

6.5 Conclusion

In this study, two stages method for statistical analysis is used. Firstly, using the food security index measures at national level we are just food secured on the average since 2010 compared to 2005 and the mean of FSI (0.979) is nearly food secured in the household level. Secondly, the impact of food security is based on regression analysis of income, age, education, household size, livestock, land and production for household. From Table 6.20 it is observed that food security status of the household, the total monthly income, quantity of own cereal production, educational status of household and farm size are significant. To investigate this food security-impact factors relationship, required methodology has been successfully applied. We have regressed food security index on various factors with the help of log likelihood method, which allow us to find an in-depth quantitative relationship between the food security and influencing factors.

CHAPTER SEVEN

MAJOR FINDINGS AND POLICY SUGGESTION

7.1 Introduction

In this chapter, major findings of the study are summarized. The findings are summarized based on the research objectives undertaken for this study aiming to understand the present situation of food security in Bangladesh both at national and household levels. Moreover the contribution of some social and economic factors on the level of food security at household level is estimated using econometric technique. Finally, on the basis of the findings of the study, some policies are suggested in the context of availability of food, access to food, and utilization of food.

This chapter is organized as follows. Section 7.2 provides the summary and major findings of the study. Section 7.3 gives some policy suggestions, and conclusion is given in section 7.4. The limitation of this study and further research scopes are explored in the last section of this chapter.

7.2 Major Findings of the Study

The Bangladesh Government has identified food security as an important factor contributing to its socio-economic stabilization and development. Bangladesh has made a steady progress in the expansion of food production. However, because of increasing population pressure there has been an extensive use of land to meet the growing demand for food. Despite the growth in food production and its availability, food insecurity is still a major problem mainly because of the lack of purchasing power and lack of access to food, especially for the ultra poor community. This research focused on the availability of food, access to food, and nutrition of food as essential element of the concept of food security. To investigate the status of food security in Bangladesh both at national and household levels, and to explore the empirical relationship between the level of food security and some socio-economic

characteristics of households, this study has set up some specific objectives, which are mentioned in chapter one.

Chapter one of the present study is an introductory chapter that presents the overview of food security in Bangladesh and provides clear idea about the research problem along with the justification of the study. In this chapter, the researcher tries to find out the scope for the study in the context of Bangladesh and settled several research questions by identifying the fundamental problems related with the food security in Bangladesh. The study progresses with comprehensive review of earlier literature and empirical studies in second chapter where researcher has substantiated the need for the present study. This chapter helps the researcher to understand about the earlier analyses of food security from different dimensions or aspects. It also highlights the methods of analyzing the issues of food security used by different researchers.

In earlier studies, researchers have mostly studied the food security status in the household level. Moreover, it has been observed that most of those early studies are of survey types and their analyses are based upon simple statistical techniques. However, few studies have been done empirically to analyze and estimate the extent of food security. A detail review of the earlier studies on food security issue concludes that obviously there is a direct relationship between the level of food consumption and socioeconomic factors, and estimating such relationship is relatively a new approach and this would enrich the documentation of food security-household related literature.

The discussion of some conceptual issues regarding food security both at national and household levels, and some factors of food supply and demand for food with their impacts on food security is presented in chapter three. The definition of food security reveals that availability of food, access to food and utilization of food are three major components of food security. Food security is directly and indirectly related to each of these components of food security. In addition, this chapter established the theoretical linkage between food security, and some demand and supply side factors of food. This chapter has also identified the factors of food security. Through reviewing the earlier literature, it has become feasible to identify the gaps inherent in these studies.

In chapter four, the methodology and empirical design that has been adopted for the present study and the data analysis has been depicted in order to measure the level of food security, and the relationship between the level of food security and key factors of food security. In the literature review, gaps have been found regarding to econometric and non-econometric techniques in analyzing the relationship between the extent of food security at household level and key factors of food security. In the methodology chapter these aspects have been considered and according to the specific gaps appropriate measures have been taken. A multiple regression model has been applied to investigate the contribution of key factors to the level of food security. The level of food security is measured using food security index (F_i). The index is calculated on the basis of different types of food that sample households eat daily. Basically, in this chapter, the selection and development of our dependent and explanatory variables have been finalized and subsequently it shows the way to fulfill our third objective of identifying the factors influencing the level of food security at household level in the rural areas of Bangladesh.

In chapter five, the overall food security status of Bangladesh in terms of availability, access and utilization of food has been analyzed and it is been found that Bangladesh has made substantial gains in the last two decades in economic and social indicators. Despite these improvements, Bangladesh remains a food insecure country in terms of access to food and utilization of food. Food security situation in Bangladesh has improved, especially on the availability side. Considering income and food expenditure of household it is found that the households lacked to achieve the ability of food expenditure which is necessary to meet food requirement for the members of their households. Therefore, by describing and analyzing the condition of legal framework and existing regulatory institutions together with the current food security scenario, chapter five, evaluates the fact that food security aspects require urgent attention in Bangladesh. Thus, the first objective of the present study is achieved.

In chapter six, the empirical results of this study are analyzed. In this chapter, the level of food security in Bangladesh both at national and household level is calculated using food security index (F_i). The obtained results show that Bangladesh is secured in food at national level in terms of availability of food. However, in terms of access

to food and nutrition of food Bangladesh is still insecure in food. From the results of food security at household level it is found that 47% households of Naogaon district is food secured followed by 42% in Rajshahi district and 28% in Natore district. Afterward, by analyzing the regression results it is found that monthly income, quantity of cereal production by households, level of education of household head and farm size are significant factors that affects the level of food security of households in the study area. Thus, the second and third objectives of the present study are achieved.

As a final part of this study, the major findings have been analyzed with respect to the considered objectives and are summarized below. Some other relevant and interesting findings have also been mentioned here with our major findings.

- It is observed that Bangladesh has made steady progress in the expansion of domestic food production. Net national food grain availability increased from about 27 million tons in 2004 to more than 32.0 million tons in 2013. Thus, the per capita food availability has also increased despite increase in population. This growth in production has been achieved through expansion of irrigation facilities, spread of modern varieties and increase in cropping intensity.
- The domestic production of rice and potato appear to have become adequate to meet the consumption requirement. Bangladesh has achieved self sufficiency in food grain production since 2008. However, the country is in deficit in the production of other food items and could not achieve self sufficiency in the production of pulse, oil seed, vegetables, fish, milk, sugar etc. except meat and fruits.
- The food expenditure per family has climbed up from Tk 2477 to Tk 6030 at national level, Tk 2299 to Tk 5542 in rural areas and Tk 3174 to Tk 7361 in urban areas during the period of 2000 to 2010 in Bangladesh. However, food expenditure has increased at a faster rate than that of income. During the period of 2000 to 2010, the monthly household income has increased with a growth rate of 18.20%. At the same time, the monthly household food expenditure has risen with a growth rate of 19.72%.

- Food expenditure scenario is not similar in all division of Bangladesh, because the income and other socioeconomic characteristics of households in all division are not similar. It is observed that the required food expenditure of households per month in Bangladesh was Tk 7069 with food expenditure gap of Tk 1039 and access gap of 14.71% in 2010 in Bangladesh.
- Considering income and food expenditure of households it is found that the households lack to achieve the ability of food expenditure which is necessary to purchase food for the members of the household. The required food expenditure of households in Rajshahi district per month is Tk 6441 in 2010 which is Tk 6205 in Naogaon district and Tk 6362 in Natore district. The food expenditure and access gap in Rajshahi district were 411 and 6.39% respectively. This rate was 189 and 2.99% in Naogaon district, and 332 and 5% in Natore district. However, from the district wise analysis it is found that there are substantial food expenditure and access gaps in all the three study districts and the food expenditure gap is highest in Rajshahi district followed by Natore and Naogaon districts.
- Rice is the main food item of the people in both rural and urban areas of Bangladesh. Average per capita rice intake per day is 416.01 gm in Bangladesh, which is 441.6 gm in rural areas and 344.20 gm in urban areas. Vegetables is found as the second important food item in the country the consumption rate is about 166.10 gm per capita per day at the aggregate level. The next important food items are found as potato followed by fish, fruits, edible oil, wheat, meat, pulse, sugar, and egg in the country.
- The average daily per capita calorie intake by households is found 2240.3 kcal at national level in 2000 which increased to 2318.3 kcal in 2010. The study shows that the per capita calorie intake is relatively higher among the rural people compared to the urban people.
- Average per capita rice intake per day is found 441.23 gm in total study area which is 451.86 gm in food secured households and 434.47 gm in food insecure households. Thus, food secured households consume more rice than food insecure households. The second important food item of households in

the study area is vegetables and the per capita vegetables intake is 174.54 gm per capita per day in all study households. The next important food item is wheat followed by potato, fish, pulse, milk and milk product, egg, sugar, oil, fruits, and meat. The per capita food intake of households in all three study districts is not same and this is dissimilar in food secured and food insecure households. It is found that the per capita food intake per day of food secured households is high in Naogaon district followed by Rajshahi and Natore districts. On the other hand per capita food intake of food insecure households is higher in Rajshahi district followed by Naogaon and Natore districts.

- The access to food depends on the level of household income. The households with higher income can purchase more food and the households with lower income can purchase less amount of food. The present study shows that the households with monthly income of less or equal to Tk 5000 are food insecure and the households with monthly income of more than Tk 5000 are food secured in the study area. The households with more income can consume more food compared to the households with low income in the study area.
- The calorie intake received in case of all sample households is not same. It is found that there are 1.7% households who can manage less than or equal to 1601 kcal of food, 23.33% households can manage 1601 to 1805 kcal of food and rest 69.44% households can manage 1806 to 2122 kcal of food per day. Thus, it is clear that 30% households cannot meet daily food requirement for their family members.
- From the analysis of food security at household level in the study area it is found that per capita food intake per day in the study area is 875.2 gm and this is 1005.97 gm in food secure households and 791.94 gm in food insecure households. The average calorie intake of all sample households in the study area is 2233 kcal whereas the average calorie intake is 2467 kcal for food secured households and 2083 kcal for food insecure households. Again, the per capita food consumption is different in three study districts. The average calorie intake is higher in Naogaon district followed by Rajshahi and Natore districts.

- It is found that majority of the households in the area are food insecure as most of them subsist below the food security line which is 2280 kcal in this study. Using the recommended calorie approach, it is observed that 39% of total households in the study area are food secured whereas 61% are food insecure. This figure is different for three study district. It is found that in Naogaon district food secured and food insecure households are respectively 47% and 53%. Again, in Natore district only 28% households are food secured and 72% are food insecure. In Rajshahi district food secured and food insecure households are 42% and 58% respectively. However, the mean of FSI of all households is also found to be 0.979 whereas the mean of FSI is 0.93 for insecure households and 1.08 for secured households in the study area. The mean of FSI of food secured households is higher in Rajshahi district compared to Natore and Naogaon districts. Again, the consumption level of food insecure households is also higher in Rajshahi district than Naogaon and Natore districts. Thus, it is observed that the mean of FSI both food secured and food insecure households is higher in Rajshahi district compared to Naogaon and Natore districts.
- The food shortfall and surplus index of total study area are 0.09 and 0.08 which indicate that the food insecure households falls below the food security line by about 9% and the food secured households lie above the food security line by 8%.
- There are some factors that affect the level of food security of households in the study area. From the analysis of regression results it is found that monthly household income, level of education of household head, farm size, quantity of cereal production are significant factors that affect the food security of households in the study area. This result means that change in these factors may change in the status of food security of households in the study area. However, some different insights are found in the results regression results run separately in case of Natore, Rajshahi and Naogaon districts. In Natore district household income, level of education of household head, farm size, quantity of cereal production and gender of household head are significant factors that affect food security. In Naogaon district the significant factors are age of household head, education of household head, farm size, and cereal

production. On the other hand the significant factors of food security in Rajshahi district are total monthly household income, farm size, and quantity of cereal production.

7.3 Policy Suggestions

Although food production has increased, Bangladesh has yet to achieve comprehensive food security that resolves the problems of inadequate food intake and chronic malnutrition among poor people. Solving these problems require concerted action by the government, the private sector and individual households. Continuous efforts need to be made in developing and diffusion of improved crop varieties and natural resource management to generate adequate supply of food to meet the needs of the growing population. A more efficient public food grain distribution system can make a significant contribution to the food security of vulnerable households who lack means to access food. Appropriately targeted income transfers, credit programs and insurance mechanisms in times of crisis may generate high payoffs in reducing poverty and improving food security. These interventions should be part of a broader social protection strategy.

The last objective of this study is to recommend some policies aiming at improving the food security situation of the country especially at household level in the rural areas. In this connection re-evaluation of some aspects of food production, distribution and consumption might be needed. The policy suggestions generated from the study findings might be useful to policy makers as well as decision-makers of the relevant authority. Following our previous discussion it can be said that the responsible food related activities should be re-considered so that we can produce food crops intensively in order to feed the growing population with increased purchasing power and proper distribution process. Policy should be constructed ensuring food availability, access to food and nutrition of food. However, it is difficult to ensure higher food consumption for all without the help of appropriate policy structure. Therefore, this study would make the following policy suggestions for improving the food security condition both at national and household level in Bangladesh.

(1) For increased production, farmers should have easy access of getting quality seeds, fertilizers and credit support with improved cultural practices in their fields. Supports should be continued for the marginal farmers to enhance agricultural production and supportive policies needed for agriculture inputs to these farmers.

(2) The government should ensure development of trade-supportive and market-friendly regulatory environment to improve market structure and encourage increased production.

(3) Biotechnology, plant protection measures, crop diversification, as well as agricultural diversification with improved technology to the farmers are very important for sustainable agriculture development. And commercial and homestead promotion of poultry and fruits/vegetables.

(4) For quality assurance, the government should promote Good Agricultural Practice (GAP) in production and in supply chain management, focus agricultural research on dietary quality (research on non-cereal crops). Sanitary and Phytosanitary (SPS) measures should also be ensured during production, processing and marketing.

(5) Targeted safety net programmes for the poor and ultra poor should be continued and made more effective. For this reason, a comprehensive and unified food safety policy should be formulated, unified administrative system should be established and a unified food safety law should be enacted.

(6) Food ordinances, food regulations and other relevant Acts should be updated from time to time in view of the changing requirements arising out of scientific and technical developments.

(7) Food production should be mentioned along its every step. Food safety practices should be inspected from the farm to the dining table. Management of food practices should undertake from the beginning of the supply chain that mean the producer to the end of the supply chain i.e. the constraint.

(8) Community based health and nutrition education should be strengthened. Expansion of community based nutrition programme should be considered with utmost importance. However, transferring knowledge about balanced diet and its usefulness to the household, especially to the mother. And incorporation of calorie intake and other issues in the text books at school level.

(9) Government should strengthen policies on grain reserves in order to control food prices during scarcity and subsidize farm inputs and availability to boost food production and thus lower food prices.

(10) The household heads should be educated on the need to control family size through radio and television advertisement, massive campaigns and to be self-empowered without necessarily depending on government as a way of enhancing their income and economic condition of their households.

(11) Supports should be expanded for income generating activities for the rural poor and looking into intra-household discrimination in food allocation.

Therefore, the present study has sought to provide a comprehensive and systematic analysis of food security scenario in national and household level, incorporating several dimensions of food security assessment. In so doing, the research aimed to join together the different strands of the theoretical literature on food security measurement. By combining index and quantitative-based measures of food consumption in the same study and exploring the relationship between access to food and food consumption, the study makes an attempt to provide a direction which future research should take up. The results of the study have important policy implications which provide useful framework for decision making in the field of food security policy. On the whole, improvising on existing theoretical models in the literature and using relevant analytical and econometric techniques, this research has provided a holistic rather than a piecemeal approach to this complex problem.

7.4 Limitation of This Study and Scope for Further Research

The food security index represents the condition of household members as a group, not necessarily the condition of any particular person in the household. The US standard food security measure reflects the household's situation over the last 12 months or 30 days before the interview (although the core module can be adapted to other survey periods. A household that experienced food insecurity at some time during the past year or other period), and therefore is considered food insecure, may in fact be food secure at the time of the interview. Furthermore, it was very difficult to collect precise and reliable data on income because respondents were reluctant to reveal the exact income, because they do not have any proper account of their income. Some of the respondents did not co-operate frankly. Most of the time they neglected to answer the question, the reason was that many government or non-government organizations and researchers had conducted various types of researches in the past but did not do anything for them.

Future research should be extended to include an urban sample to allow for valid comparisons with a rural sample. Future research should consider developing a more refined questionnaire for constructing the food security scale and the possibility of developing this self-reported perception-based measure of food security in the context of the diverse cultural settings in different regions of Bangladesh. It is also important to allow for an assessment of the impact of recent food price inflation on the country's food security at the household level, using more recent data. In the context of developing the food security index, future research should consider the gender aspect of the problem. Future research should include the utilization component in any analysis on food security, especially in the rural context. It is important to check how well the self-reported measure correlates with nutritional status another widely used food security indicator.

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APPENDIX-1

Table 1: Summary of Food security Indices for Households in the Study Area

Variables	Food Secured Households		Food Insecured Households		All Households	
	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2529	-	2077	-	2252	-
Total Monthly Household Income(BDT)	7520	-	5612	-	6354	-
Age of Household Head(years)	42.74	-	40.53	-	41.39	-
Educational Status of Household Head(years of schooling)	4.86	-	3.77	-	4.19	-
Household Size(per person)	3.41	-	3.50	-	3.47	-
Farm Size(in acre)	1.06	-	0.31	-	0.5998	-
Livestock (0 = no, 1= yes)	-	0 = 25.93 1 = 74.07	-	0 = 23.22 1 = 76.78	-	0 = 24.28 1 = 75.72
Gender of Household Head(0=female.1=male)	-	0 = 3.58 1 = 96.42	-	0 = 6 1 = 94	-	0 = 5 1 = 95
Amount of Cereal Production(in quintal)	33.73	-	10.15	-	19.32	-

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280 kilocalorie suggested by FAO

Table 2: Summary of Food Security Indices for Households in Naogaon District

Variables	Food Secured Households		Food Insecured Households		All Households	
	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2596	-	2081	-	2321	-
Total Monthly Household Income(BDT)	5636	-	4040	-	4784.7	-
Age of Household Head(years)	37.85	-	40.76	-	39.40	-
Educational Status of Household Head(years of schooling)	4.51	-	3.48	-	3.96	-
Household Size(per person)	3.04	-	3.42	-	3.24	-
Farm Size(in acre)	1.21	-	0.47	-	0.82	-
Livestock (0 = no, 1= yes)	-	0 = 17.141 = 82.86	-	0 = 8 1 = 92	-	0 = 12.27 1 = 87.73
Gender of Household Head(0=female,1=male)	-	0 = 2.86 1 = 97.14	-	0 = 4 1 = 96	-	0 = 3.47 1 =96.53
Amount ofCereal Production(in quintal)	42.45	-	15.58	-	28.11	-

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280kilocalorie suggested by FAO

Table 3: Summary of Food Security Indices for Households in Natore District

Variables	Food Secured Households		Food Insecured Households		All Households	
	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2251	-	2058	-	2112	
Total Monthly Household Income(BDT)	10095	-	6225	-	7321.5	-
Age of Household Head(years)	44.65	-	39.45	-	40.42	-
Educational Status of Household Head(years of schooling)	6.1	-	3.75	-	4.42	-
Household Size(per person)	3.7	-	3.67	-	3.68	-
Farm Size(in acre)	.95	-	0.21	-	0.41	-
Livestock (0 = no, 1= yes)	-	0 = 55 1 = 45	-	0 = 22.50 1 = 92.50	-	0 = 29 1 = 61
Gender of Household Head(0=female,1=male)	-	0 = 10 1 = 90	-	0 = 7.50 1 = 92.5	-	0 = 8.21 1 = 91.79
Amount of Cereal Production(quintal)	25.60	-	6.85	-	12.16	-

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280 kilocalorie suggested by FAO

Table 4: Summary of Food Security Indices for Households in Rajshahi District

Variables	Food Secured Households		Food Insecured Households		All Households	
	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2643	-	2098	-	2325	
Total Monthly Household Income(BDT)	7880	-	6297	-	6956	-
Age of Household Head(years)	46.92	-	41.65	-	43.85	-
Educational Status of Household Head(years of schooling)	4.4	-	4.05	-	4.2	-
Household Size(per person)	3.64	-	3.37	-	3.48	-
Farm Size(in acre)	.99	-	0.28	-	0.58	-
Livestock (0 = no, 1= yes)	-	0 = 16, 1 = 84	-	0 = 25.71 1 = 74.29	-	0 = 21.67 1 = 78.33
Gender of Household Head(0=female,1=male)	-	1 = 100	-	0 = 5.71 1 = 94.29	-	0 = 3.33 1 = 96.67
Amount of Cereal Production(in quintal)	29.48	-	9.24	-	17.67	-

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280 kilocalorie suggested by FAO

Table 5: Summary of Food Secured Household in the Study Area

Variables	Naogaon District		Natore District		Rajshahi District		All Secured Households	
	Mean	%	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2596	-	2251	-	2643		2529	-
Total Monthly Household Income(BDT)	5636	-	10095	-	7880	-	7520	-
Age of Household Head(years)	37.85	-	44.65	-	46.92	-	42.74	-
Educational Status of Household Head(years of schooling)	4.51	-	6.1	-	4.4	-	4.86	-
Household Size(per person)	3.04	-	3.7	-	3.64	-	3.41	-
Farm Size(in acre)	1.21	-	.95	-	.99	-	1.06	-
Livestock (0 = no, 1= yes)	-	0=17.14 1 =82.86	-	0 = 55 1 = 45	-	0 = 16 1 = 84	-	0 = 25.93 1 = 74.07
Gender of Household Head(0=female,1 =male)	-	0 = 2.86 1 =97.14	-	0 = 10 1 = 90	-	1 = 100	-	0 = 3.58 1 = 96.42
Amount of Cereal Production (quintal)	42.45	-	25.60	-	29.48	-	33.73	

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280 kilocalorie suggested by FAO

Table 6: Summary of Food Insecured Household in the Study Area

Variables	Naogaon District		Natore District		Rajshahi District		All Insecured Households	
	Mean	%	Mean	%	Mean	%	Mean	%
Per Capita Daily Calorie Availability(kcal)	2081	-	2058	-	2098	-	2077	-
Total Monthly Household Income(BDT)	4040	-	6225	-	6297	-	5612	-
Age of Household Head(years)	40.76	-	39.45	-	41.65	-	40.53	-
Educational Status of Household Head(years of schooling)	3.48	-	3.75	-	4.05	-	3.77	-
Household Size(per person)	3.42	-	3.67	-	3.37	-	3.50	-
Farm Size(in acre)	0.47	-	0.21	-	0.28	-	0.31	-
Livestock (0 = no, 1= yes)	-	0 = 8 1 = 92	-	0=22.5 1=92.5	-	0 =25.7 1 =74.29	-	0=23.22 1 =76.78
Gender of Household Head(0=female,1 =male)	-	0 = 4 1 = 96	-	0=7.50 1=92.5	-	0 = 5.71 1 = 94.29	-	0 = 6 1 = 94
Amount of Cereal Production (quintal)	15.58	-	6.85	-	9.24	-	10.15	-

Source: Author's own calculation; Note: The secure and insecure households are classified based on per capita daily calorie intake 2280 kilocalorie suggested by FAO

Table 7: Distribution of Household by Monthly Income of All Study Area

Monthly Income (in Tk)	Food Secured Households		Food Insecured Households		All Households	
	Frequen cy	%	Frequency	%	Frequency	%
	<5000	35	50	58	52.73	93
5001-10000	22	31.44	44	40	66	36.67
10001-15000	4	5.71	7	6.36	11	6.11
15001-20000	4	5.71	1	0.91	5	2.78
>20001	5	7.14	0	0	5	2.78
Total	70	100	110	100	180	100

Source: Author's own calculation

Table 8: Distribution of Household by Monthly Income of Rajshahi District

Monthly Income (in Tk)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	<5000	11	44	17	48.57	28
5001-10000	9	36	14	40	23	38.33
10001-15000	1	4	3	8.57	4	6.67
15001-20000	3	12	1	2.86	4	6.67
>20001	1	4	0	0	1	1.66
Total	25	100	35	100	60	100

Source: Author's own calculation

Table 9: Distribution of Household by Monthly Income of Natore District

Monthly Income (in Tk)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	<5000	4	23.54	17	39.53	21
5001-10000	6	35.29	23	53.49	29	48.33
10001-15000	2	11.76	3	6.98	5	8.33
15001-20000	1	5.88	0	0	1	1.67
>20001	4	23.53	0	0	4	6.67
Total	17	100	43	100	60	100

Source: Author's own calculation

Table 10: Distribution of Household by Monthly Income of Naogaon District

Monthly Income (Tk)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
<5000	20	71.43	24	75	44	73.33
50001-10000	7	25	7	21.88	14	23.33
10001-15000	1	3.57	1	3.12	2	3.34
Total	28	100	32	100	60	100

Source: Author's own calculation

Table 11: Distribution of Household by Family Size of All Study Area

Household Size (per person)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
1-3	37	52.86	58	52.74	95	52.78
4-6	30	42.86	50	45.45	80	44.44
7-9	2	2.86	1	0.91	3	1.67
>9	1	1.43	1	0.91	2	1.11
Total	70	100	110	100	180	100

Source: Author's own calculation

Table 12: Distribution of Household by Family Size of Rajshahi District

Household size (per person)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
1-3	12	48	20	57.14	32	53.33
4-6	13	52	14	40	27	45
7-9	-	-	1	2.86	1	1.67
Total	25	100	35	100	60	100

Source: Author's own calculation

Table 13: Distribution of Household by Family Size of Natore District

Household size (per person)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
1-3	8	47.06	17	39.53	25	41.67
4-6	6	35.30	25	58.14	31	51.67
7-9	2	11.76	-	-	2	3.33
>9	1	5.88	1	2.33	2	3.33
Total	17	100	43	100	60	100

Source: Author's own calculation

Table 14: Distribution of Household by Family Size of Naogaon District

Household size (per person)	Food Secured		Food Insecured		All	
	Households		Households		Households	
	Frequency	%	Frequency	%	Frequency	%
1-3	17	60.71	21	65.63	38	63.33
4-6	11	39.29	11	34.37	22	36.67
Total	28	100	32	100	60	100

Source: Author's own calculation

Table 15: Distribution of Household by Household Head Educational Status of All Study Area

Educational Status of Household Head (year of schooling)	Food Secured		Food Insecured		All	
	Households		Households		Households	
	Frequency	%	Frequency	%	Frequency	%
No Formal	18	25.71	25	22.73	43	23.89
1-5 class	35	50	70	63.64	105	58.33
6-10 class	10	14.29	10	9.10	20	11.11
HSC	4	5.71	3	2.71	7	3.89
Higher Education	3	4.29	2	1.81	5	2.78
Total	70	100	110	100	180	100

Source: Author's own calculation

Table 16: Distribution of Household by Household Head Educational Status of Rajshahi District

Educational Status of Household Head (year of schooling)	Food Secured		Food Insecured		All	
	Households		Households		Households	
	Frequency	%	Frequency	%	Frequency	%
No Formal	8	32	12	34.29	20	33.33
1-5 class	11	44	18	51.43	29	48.33
6-10 class	5	20	4	11.43	9	15
HSC	-	-	-	-	-	-
Higher Education	1	4	1	2.86	2	3.34
Total	25	100	35	100	60	100

Source: Author's own calculation

Table 17: Distribution of Household by Household Head Educational Status of Natore District

Educational Status of Household Head (year of schooling)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Formal	2	11.76	10	23.25	12
1-5 class	7	41.18	28	65.13	35	58.33
6-10 class	3	17.65	4	9.30	7	11.67
HSC	3	17.65	1	2.33	4	6.67
Higher Education	2	11.76	-	-	2	3.33
Total	17	100	43	100	60	100

Source: Author's own calculation

Table 18: Distribution of Household by Household Head Educational Status of Naogaon District

Educational Status of Household Head (year of schooling)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Formal	8	28.27	3	9.38	11
1-5 class	17	60.72	24	75	41	68.33
6-10 class	2	7.14	2	6.25	4	6.67
HSC	1	3.57	2	6.25	3	5
Higher Education	-	-	1	3.12	1	1.67
Total	28	100	32	100	60	100

Source: Author's own calculation

Table 19: Distribution of Household by Own Cereal Production of All Study Area

Quantity of Cereal Production (quintal)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Cereal Production	19	27.14	61	55.45	80
1-20	12	17.15	29	26.36	41	22.78
21-40	19	27.14	12	10.91	31	17.22
41-60	9	12.86	5	4.55	14	7.78
61-80	6	8.57	2	1.82	8	4.44
>80	5	7.14	1	0.91	6	3.33
Total	70	100	110	100	180	100

Source: Author's own calculation

Table 20: Distribution of Household by Own Cereal Production of Rajshahi District

Quantity of Cereal Production (quintal)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Cereal Production	9	36	22	62.86	31
1-20	5	20	7	20	12	20
21-40	4	16	4	11.43	8	13.33
41-60	2	8	1	2.86	3	5
61-80	4	16	1	2.86	5	8.33
>80	1	4	-	-	1	1.67
Total	25	100	35	100	60	100

Source: Author's own calculation

Table 21: Distribution of Household by Own Cereal Production of Natore District

Quantity of Cereal Production (quintal)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Cereal Production	5	29.41	29	67.44	34
1-20	5	29.41	10	23.26	15	25
21-40	3	17.66	2	4.65	5	8.33
41-60	1	5.88	2	4.65	3	5
61-80	2	11.76	-	-	2	3.33
>80	1	5.88	-	-	1	1.67
Total	17	100	43	100	60	100

Source: Author's own calculation

Table 22: Distribution of Household by Own Cereal Production of Naogaon District

Quantity of Cereal Production (quintal)	Food Secured Households		Food Insecured Households		All Households	
	Frequency	%	Frequency	%	Frequency	%
	No Cereal Production	5	17.86	10	31.24	15
1-20	2	7.14	12	37.5	14	23.33
21-40	12	42.86	6	18.75	18	30
41-60	6	21.43	2	6.25	8	13.33
61-80	-	-	1	3.13	1	1.67
>80	3	10.71	1	3.13	4	6.67
Total	28	100	32	100	60	100

Source: Author's own calculation

APPENDIX- 2

Research Questionnaire for M. Phil Thesis (Food Security Data)

Serial No-

Name of the enumerator:	Date:
Name of the household head:	
Relation with the household head:	
Village:	Union:
Police Station:	District:

1. Family Income-Expenditure Data:

1.1 Family Demography and Livelihood

1. Name of the member	2. Relation with the Household head	3. Sex	4. Age	5. Marital status	6. Educational qualification	7. Occupation Main/Subsidiary	8. Monthly average income
1.							
2.							
3.							

Code: 3. Sex - 1= male, 2= female, 3= others

5. Marital status - 1= unmarried, 2= married, 3= widow, 4= w

6. Educational qualification - 0=illiterate, 1= class 1-class 5, 2=class6- class10, 3= S.S.C. , 4= H.S.C., 5= undergraduate, 6= post-graduate

7. 1= farmer, 2= smith/potter/weaver, 3= rickshaw-puller/van puller, 4= shop-keeper/businessman, 5= service holder, 6= others

1.2 Consumption Expenditure: Weekly Food Expenditure

List of consumer goods	Quantity (unit)	Price (taka)	Kilo calorie	List of consumer goods	Quantity (unit)	Price (taka)	Kilo calorie
Rice				Oil/ghee			
Flour				Milk			
Potato				Sugar/ jaggery			
Lentil				Vegetables			
Fish				Fruits			
Meat				Spices			
Egg				Others			

1.3 Could any of the members of the hh not afford at least one meal in last 12 months? Yes No

If the answer is yes, then how many times a year for how many days
 If the answer is yes, which member of the hh in which months could not afford at all or had food deficit?

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	October	Nov.	Dec.

2. Family Asset Details:

2.1 Land Possession

Land type (%)	Own land	Land in rent	Land seized /by other means	Land rented out	Land seized by others
1. Homestead					
2. Cultivable land					
3. Orchard					
4. Others					
5. Total land					

2.2 Crop Production Data:

Name of the crop	Rice (Aman/Boro)	Wheat	Maze	Vegetables	Others
Per bigha (per mon)					
Price (per mon)					
Cost (per mon)					
Net income					

2.3 Other Assets

Domestic animal/ birds (at present)	Quantity	Value (taka)	Agricultural tools (at present)	Quantity	Value (taka)
1. Cow/buffalo			1. Irrigation tools		
2. Goat/sheep			2. Power tiller		
3. Duck/chicken			3. Harvester		
4. Others			4. others		

Non-agricultural equipments/vehicles	Quantity	Value (taka)	Manufacture equipments and raw	Quantity	Value (taka)

(at present)			materials		
1. Cow/buffalo cart 2. Boat/engine boat 3. Rickshaw/van 4. Bicycle 5. Others			1. Workshop 2. Paddy/wheat mill 3. Other instruments 4. Materials & inventory 5. Others		
Non-manufacture structure/goods	Quantity	Value (taka)	Others (if any)	Quantity	Value(taka)
1. Retail shop 2. Storage 3. Others			1. Solar panel 2. Battery 3. Television 4. Others		

3. Family yearly net income and expenditure (accounts of last year)

Income sources	Amount (taka)	Expenditure details	Amount (taka)
1.Cultivation		1.Food	
2.Forestry		2.Education	
3.Fishery		3.Treatment	
4.Poultry and livestock sale		4.Outside disbursement	
5.Business/trade/manufacture		5.House building/repair/in rent	
6.Labour sale(agriculture/non-agriculture)		6.Poultry/livestock purchase	
7.Service		7.Agricultural implements	
8.Rent/mortgage		8.Business/trade investment	
9.Outside receipt		9.Loan repayment	
10.Loan		10.Social and religious festival expenses	
11.Others		11.Others	

4. Economic and social data:

4.1 Do you receive loan from any source? Yes No

If yes, then loan details

Sources	Amount	Interest rate	Maturity period	Installment type
1. Relatives 2. Village Mahajan 3. NGOs 4. Government 5. Bank/insurance				

4.2 Do you use fertilizer on land under cultivation? Yes No

If yes, mention the amounts used (in last year)

Land amount	Fertilizer	Price per kg (taka)
Total=	Total=	Total=

4.3 Do you have sanitation facility? Yes No

If yes, then what is it made of ? sanitary others

5. Food security status:

5.1 Food security status changes after transforming agricultural land into non-agricultural piece (compared with last year account)

1. Reduction in food security (%)

2. Improvement in food security (%)

3. Unchangeable food security

5.2 Three principle reasons behind the reduction in food security (if applicable)

First Second Third

Reasons , Code: 1= reduction in cultivable land, 2= reduction in yield, 3= reduction in active member number, 4= family size increase, 5= food price increase, 6= increased education and treatment expenses, 7= natural disaster, 8= no use of necessary modern equipments, 9= land fertility reduction

5.3 Three principle factors for the improvement in food security (if applicable)

First Second Third

Factors, Code: 1= increase in yield, 2= non-agricultural income increase, 3= new agricultural investment, 4= wage increase, 5= earning member number increase, 6= outside income increase, 7= commercial farm establishment, 8= business expansion

5.4 Suggestions

Overall food security improvement suggestions

1).....

2).....

3).....

Thank You for Your Cooperation