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# Rapid Urbanisation and the Question to Food Security: A Case Study of Rajshahi City

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## Abstract

*As Bangladesh's administrative divisional unit and growth centre, Rajshahi city has experienced rapid urban expansion and infrastructural development. Every year about 0.46% of total agricultural land is lost in the Rajshahi district. It caused a decline in agricultural production, which may be treated as an indicator of an increasing threat to the long-run sustainable livelihood security of the people of this area. Thefood security status depends on the average kilocalorie (k.cal) per day consumed by all household members. This paper examines the pace at which urbanisation and infrastructural development are consequent upon rapid land-use change and its influence on food security in some parts of the Rajshahi district. For this purpose, a survey was conducted in the Rajshahi district covering three Upazilas andthe Rajshahi City Corporation (RCC) with 135 households. Spearman's Ranking Correlation Coefficient, Food Security Index and Binary Logistic Regression model, are employed to analyse the data. Spearman's Ranking Correlation Coefficient shows a direct negative*

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*correlation between urban extension and agricultural area contraction, but also the supervised classification of satellite imageries shows the rapid change of rural land use from 1977-2010. Descriptive analysis was carried out to describe the study area's socio-economic characteristics and determinants of food security. Using the recommended calorie required approach, this study revealed that 38.5% of the households were food secure, and 61.5% were food insecure. The shortfall/surplus index (P) showed that the food-secure households exceeded the calorie requirement by 30%, while the food insecure households fell short of the calorie requirements by 19%. Since the food security index value is 0 to 1, the mean value of FSI (0.39) indicates that households in the study are not food secure. Three factors are statistically significant: income of household head, household size, and farm size. The analysis found that change in land for urbanisation has a positive but insignificant impact on household food security status in the study area. Finally, the study area's major problems are the contraction of cropland by built-up area, increase in urban population, and infrastructural development. Addressing these problems, a new balance between urbanisation and the agricultural process is needed that must include both formal and informal planning in order to achieve the targets set by sustainable development goals (SDGs).*

***JEL Classification*** *O15 · O18 · R12 · R14*

***Keywords*** *Land-use Change · Food Security Index · Infrastructural Development · Urbanisation · Logistic Regression · Shortfall/Surplus Index* · SDGs

## Introduction

Urbanisation has become one of the greatest environmental challenges in the world today. Largely, urbanisation refers to the alteration of an agricultural economy to that of a manufacturing and service-oriented economy (Dewan et al., 2012). Globally, a strong trend of urbanisation has been observed since 1900 (Dewan et al., 2012). The world urban population rose from 13% (220 million) in 1900, to 29% (732 million) in 1950, and to 49% (3.2 billion) in 2005 (United Nations 2005). Gey van Oort (2008) showed that the urban area increases with time and gradually expands towards the rural area. According to United Nations, a year from 2009 to 2050, 1.86 billion more people will live in urban areas, and the level of urbanisation is expected to rise from 50 to 69%. Although urbanised land area comprises just 2% of the earth's surface, more than half of the world's population lives in urban areas (Deng et al., 2015).

Though, Bangladesh - a lower-middle-income country in South Asia - had 57.09 million urban populations in 2016. Although its urbanisation rate of 1.37 is lower than the rate of the lower-middle-income countries, the country is experiencing a fast pace of urbanisation. It is anticipated that by 2050, the country's share of the urban population will reach 56% (Roy et al., 2018). The process of urbanisation in Bangladesh is rapid and uneven. It is much more concentrated on the large cities of Bangladesh like Dhaka, Chittagong, Khulna and Rajshahi- account for over 60% of the urban population, up from 48% population in 1970. Most industrial activities and business services are concentrated in the largest cities (World Bank, 2015). The expanding urban populations of Bangladesh presents it with a considerable affordable housing challenge. To meet this challenge, the amount of developable urban land will require to expand by just over 7,000 km2 or almost 45 percent consideringconstanturban population density between 2010 and 2050. (world bank, 2015). As the impact of urbanisation creates not only positive externalities through technological innovation and shared information, such as outstanding economic growth, increasing industrial production, but also generates negative externalities such as problems in public safety, health, social equality(Baiet al., 2011; Wu et al., 2011). One of the major effects of urbanisation in developing countries is losing cultivable land due to infrastructural development.

Infrastructure is the heart of the financial and social advancement of an economy. There are two aspects of infrastructure, on the one hand, it boosts economic growth, offer mobility and social interaction, and on the other hand, it generates environmental pressure (Siddique & Mukherjee, 2017). The infrastructure built along with the expansion of cities occupies a large amount of land, which leads to asignificant decrease in the cultivable land (Islam and Hasan, 2013). Thus, rapid urbanisation and infrastructural development can be treated as a growing threat to food security and the environment.

The concept of food security has evolved, and the world has taken a more comprehensive view of food and nutrition in recent years. At the World Summit of Food Security in 2009, the definition of food security was extended and specified by adding that the "four pillars of food security are availability, access, utilisation, and stability" and stated that "the nutritional dimension is integral to the concept" (Habiba et al., 2015. Each of these four critical facets of food security can be studied in the milieu of the urban environment. rustic and urban settings. Food stability alludes to access to food at all times with no danger of losing access due to sudden stuns. Though Bangladesh is a country with a population of 160 million, increasing at a rate of 1.3%, adding about 2 million

labour force with the existing 72 million every year, agriculture is still the single most significant contributor to GDP. It provides 45% of total national employment and more than 70% of rural employment(Noman A.N.K & Ali K.J, 2014). However, Bangladesh is still dependent on food imports, and it has been on the rise in recent years. The achievement in the case of food security is not satisfactory till now. To improve the situation, Bangladesh has taken SDGs where the second goal is to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture.

As an administrative divisional unite and growth centre of Bangladesh, Rajshahi city gets rapid urbanisation in the northern region of Bangladesh, influenced by various physical driving factors in an average of 8.58% annual urbanisation rate (Ashaduzzaman,2017). The growth of the study area's population is 1.34%and meeting the demand of this large population will put enormous pressure on a food production system. The hasty growth rate of the population is responsible for the rapid expansion of infrastructures, which causes losses of agricultural land. Every year about 0.46% of total agricultural land is lost in the Rajshahi district (Islam, M. R., 2013). The resources required for agricultural production, such as land and water, are becoming meagre, which in turn hamper the food security of this region.

**Literature review**

Several pieces of research are done related to urbanisation, infrastructural development, and food security separately, especially in a developing country like Bangladesh, where rapid, haphazard, unplanned urbanisation is causing significant farmland loss. Yeh and Li (1999) examined the relationship between economic development and agricultural land loss in the Pearl River Delta, using Dongguan as a case study. They found that agricultural land loss has been much aggravated by land speculation due to the property bloom in the Pearl River Delta induced by the property boom in Hong Kong in the early 1990s. It was also related to other economic factors, such as rural industrialisation, the rise of localism, influence from Hong Kong, transport improvement, and lack of land management and monitoring system. They suggested an urgent need to develop a sustainable land development strategy to protect the fertile agricultural land from further unnecessary losses, primarily from land speculation. Seto and shepherd (2009) explained that urban land-use and land-cover changes significantly impact food production and climate. It is affected by the shape, size, and geometry of buildings and the differences in urban and rural gradients. Salan et al. (2018) have found a correlation between the two factors that land price increases with the

changing land use. As resources are limited, the land fulfilsindustrial, commercial, residential, and institutional needs. Alam (2018) revealed that speculating high profit from high land value encouraged developers and individual buyers to grab high productivity farmland, flood zones, lakes and canals. It results in the withering away of rivers, lakes, canals, ponds and ditches from megacity Dhaka which has many other adverse ecological, social and economic impacts. In the paper' Agricultural land conversion in the sub-urban area: A case study of Rajshahi Metropolitan city, Halim et al. (2013) observed that the land conversion from agriculture to non-agriculture allied in recent time is more than the last time due to gradually increasing land demand in housing and relevant services which invite adverse impact on agricultural land as well as its dependent population. They suggest taking integrated land-use planning to offer better options for fulfilling land demand both of housing and agricultural sectors.

Siddique & Mukherjee (2017) showed a direct negative correlation between urban extension and agricultural area contraction and the supervised classification of satellite imageries showing a rapid change of rural land use from 1996-2016. There is no match between future population growth and future yield rate of crops, and the Markov Chain Model further predicts that the cropland will decrease from 62.77% to 42.90%, and the built-up area will increase from 31.86% to 54.63% of the total area from 2016 to 2056.Rai et al. (2017) found that high population growth, rapid urbanisation, and infrastructure development have been directly associated with changing land-use patterns.

Ira Matuschke (2009) explained the challenges of rapid urbanisation in developing countries and the impact of rapid urbanisation on four dimensions of food security: availability, stability, safety, and access to food worldwide. Using GIS, Matuschke (2009) constructed a food density map of the world to identify the future food security hotspots.

Naab et al. (2013) highlight the land use planning response to urbanisation and explain its influence on food (in) security within the context of urbanisation. It also provides vivid information on how different policies can be taken to meet food security crises. The findings of this research bear similarity to the "losses of agricultural land due to infrastructural development on Rajshahi District of Bangladesh" (Islam and Hasan, 2013). Using Remote Sensing and GIS techniques, Islam and Hasan (2013) found out the losses of agricultural land due to infrastructural development from 1977-2010. In doing so, they analysed change detection and predicted the future availability of agricultural land.

Dewan and Yamaguchi (2009), usingGIS technique, satellite images, and socio-economic data between 1975 and 2003, found that substantial growth of

built-up areas in greater Dhaka resulted in a significant decrease in water bodies and cultivated areas land vegetation and wetlands. The urban land expansion has been primarily driven by elevation, population growth and economic development. Rapid urban expansion through filling low-lying areas and clearing vegetation resulted in many environmental impacts, including habitat quality. Acharya et al. (2002) studied the impact of urbanisation on sustainable agriculture in Malaysia. They discussed the changes in the economic structure of Malaysia due to urbanisation and its impact on natural resources—urban waste generation, air pollution, water pollution, land conversion and species extinction. David Satterthwaite et al. (2010) showed the relations between urban change, food demand and rural-urban linkages and introduced the concept of urban agriculture. Urban agriculture or urban farming is an act of cultivating, processing, and distributing food in or around a village, town, or city. Food security, nutrition, and income generation are key motivations for urban agriculture. Hossain and Noor (2016) focused on the significant challenges of climate change on agricultural development and food security issues in Bangladesh. They found that Climate change (especially in the case of precipitation and temperature) has a negative impact on crop production and all other sectors of agriculture, which may increase the risk of food security.

Food security is related to land use, nutrition, climate change, income, poverty and infrastructural development is linked with economic development and the environment. Hence, this study attempts to examine the pace at which urbanisation; infrastructural development is consequent upon rapid land-use change and its influence on food security in parts of the Rajshahi district.

**Objectives of the study**

The key objectives of the present study are:

1. To assess the rate of urbanisation in the selected parts of Rajshahi district,
2. To examine the extent to which rural land use is affected by urban extension and infrastructural development,
3. To investigate the rate of decrease of agricultural land and
4. To estimate the present food security of the study area

**Source of Data**

The research is based on both primary and secondary data. Primary data has been collected using a random sampling method from the households of Rajshahi city. Using a structured questionnaire, 135 surveys were conducted among the residents of the study area to identify the food security condition of the people.

Secondary data has obtained from the Bangladesh Bureau of Statistics, Economic Census – District Report, Rajshahi, from the year 1981-2011 to identify the rate of urbanisation. The increasing rate of urban population and the rise of the number of municipalities are calculated between 1971-2011.Land use data from 2000-2011 of Rajshahi district is followed to encounter the change of net cropped area and non-agricultural land use with the increasing urban population.

**Methodology**

Spearman's ranking Correlation Coefficient is calculated to understand the correlation among net cropped area, urban expansion, and urban population (Siddique & Mukherjee, 2017). Since it is a technique that can be used to summarise the strength and direction (negative or positive) of a relationship between two variables, the result of this coefficient will always be between 1 and minus 1(Gupta and Gupta, 2010).

$$r = 1 - 6*\frac{\sum d_i^2}{n^3 - n} \qquad (1)$$

Where, r = Spearman rank correlation
d_i= the difference between the ranks of corresponding variables
n= number of observations

For measuring the food security status of a household, we have analysedit in two stages. First, we constructed a food security index (Z) and determined each household's food security status based on the daily calorie intake method. Though there are variations in the definition of food security; Food security was defined by the World Food Summit (WFS) in 1974 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" (United Nations 1975). The most recent careful redefinition of food security is that negotiated in international consultation leading to the WFS in November 1996. According to WFS (1996) definition, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". This definition addresses four criticalfood supplies and security components: availability, stability, access, and utilisation (Schmidhuber and Tubiello2007). However, at the World Summit of Food Security in 2009, this definition was reconfirmed, and the concept was extended and specified by adding that the "four pillars of food security are availability, access, utilisation, and stability" and stated that "the nutritional dimension is integral to the concept" (Habiba et al., 2015).

The first measurement is related to the general availability of inadequate food amount. Both production and supply systems of food are distinctive in economic or climatic crises or cyclical events such as agricultural seasons. Food safety is connected to the quality of food and the final dimension, access to food, is related to the assets that people or their families possess to obtain food necessitated for a healthy living (FAO, 2008:1). These four critical facets of food security can be studied in the milieu of the urban environment and urban setting.

Moreover, second, we used the Logit regression model to estimate the food security status of the households (Babatunde etal., 2007). 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. This food security line is used in this study after converting all household members into adult equivalent units (Babatunde et al., 2007; Dev et al., 2017). The formula of Adult equivalent is:

$$ADEQ = [\![(A+0.5C)]\!] \hat{}(0.9) \quad (2)$$

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

If per capita Calorie intake is at least 2280 kcal, the household will be regarded as food secure, and those below 2280 kcal will be regarded as food insecure households (Dev et al., 2017). The formula of the food security index is as follows,

$$Z_i = \frac{Y_i}{R} \quad (3)$$

Where Z_i =Food security status of the ith household. When $Z_i \geq 1$, the ith household will be food secure ($Y_i \geq R$) and when $Z_i < 1$, the ith household will be food insecure ($Y_i < R$)
Y_i = Daily per capita calorie intake of ith household
R = Recommended per capita daily calorie intake (2280 kcal)
Based on thisZ_i, other related measures are calculated. They are the headcount ratio, shortfall/surplus index and the food insecurity gap.

***The Headcount Ratio (HCR) Index***

The headcount ratio measures the percentage of the population of householdsthat are food secure or insecure.

$$HCR = \frac{M}{N} \quad (4)$$

Where HCR = Headcount ratio
M = Total number of food-insecure households
N = The number of households in the sample

***The Shortfall/Surplus index***

The shortfall or surplus index (P) measures the extent to which the households are food insecure.

$$P = \frac{1}{M} \sum_{1}^{m} G_i \quad (5)$$

Where M = Total number of food-insecure households
G_i = Per capita calorie intake deficiency for an ith household where G_i = Y_i - R/R [Y_i is the actual calorie intake by household and R is the recommended intake.

Based on the household food security status, the Logit model is estimated to find the effects of the factors on food security at the household level. The implicit form of the model is expressed as:

$$Z_i = \beta X_i + U_i \quad (6)$$
$$= \beta_1 + \beta_2 X_1 + \beta_3 X_2 + \beta_4 X_3 + \beta_5 X_4 + \beta_6 X_5 + \beta_7 X_6 + \beta_8 X_7 + \beta_9 X_8 + U_i$$

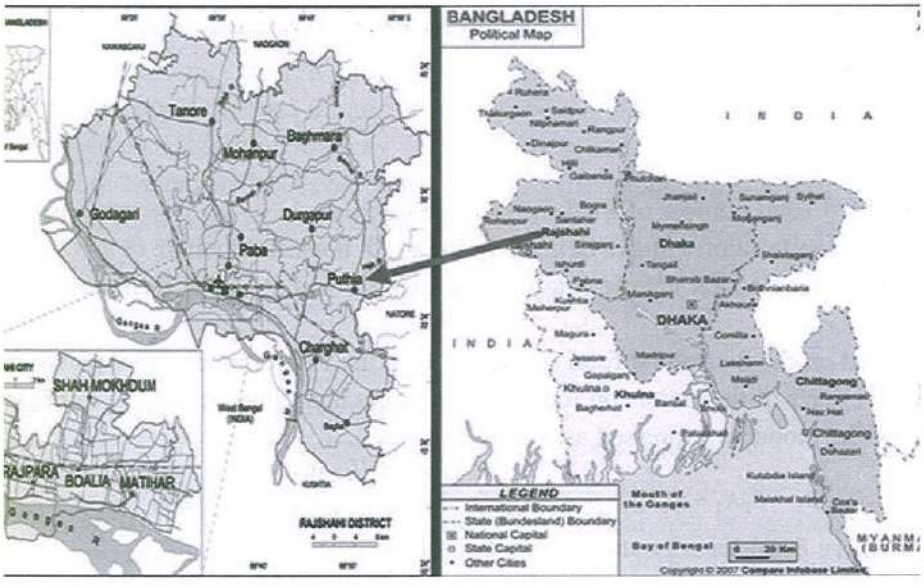
Where Z_i= Food security status of ith household
X_i = Vector of the explanatory variables
U_i = the error terms
β = Vector of the parameter estimates

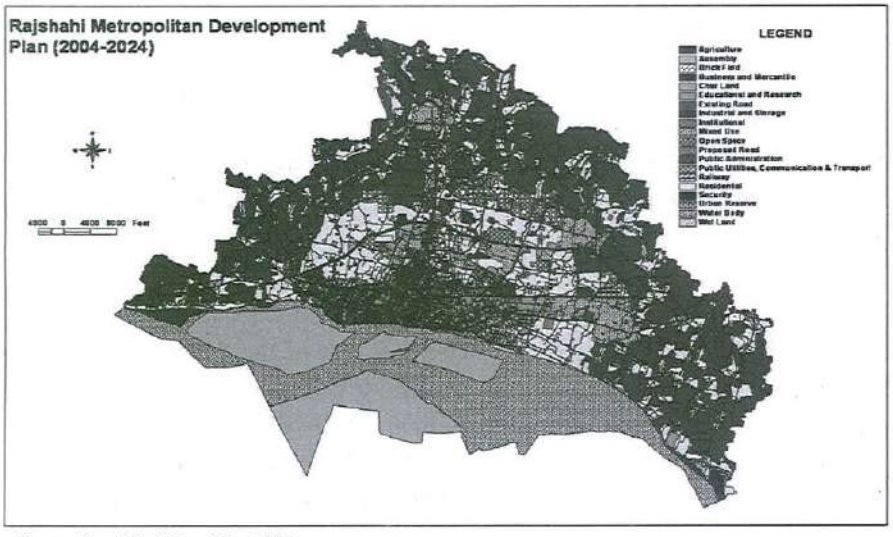
The dependent variable and the explanatory variables that we include in the model are Food Security (Z_i), Household Income (X_1), Farm Size (X_2), age of the household head (X_3), education of household head (X_4), Household size (X_5),Gender of household head (X_6), Period of road construction (X_7) and Change of land for urbanisation (X_8).

**Study Area**

Rajshahi, the capital city of North Bengal, is one of the fastest-growing cities of Bangladesh. The city today has grown into a commercial, educational, cultural and administrative centre of North Bengal. Rajshahi City Corporation area is 95.56 sq. km, located between 24 20' and 24 24' north latitudes and between 88 32' and 88 40' east longitudes. Paba Upazila bounds it on all sides. RCC lay on the

bank of Padma River, a major river of Bangladesh. It has a tropical monsoon climate and dries moderately. The average height from sea level is 18 m. It is surrounded by almost plain land and consists of many wetlands and agricultural land, characterised by many scattered informal settlements. Most of the significant roads surrounding open lands are developed and turned into non-built-up to the built-up area following the service generating areas. The population of




Source: Rajshahi Master Plan,2004

this area was 388,811 in 2001, 449,756 in 2011 and 743,000 in 2016. It signals that the population of the city was slowly increased, but the built-up area increased rapidly. The RCC suburbs are also experiencing rapid urbanisation, leading to satellite towns or municipalities around the city. Currently, the urban population in Bangladesh is around 35% and is projected to reach 40% in 2025, of which 5% will be in Rajshahi City Corporation (Ashaduzzaman, 2017).

The research considered some selected areasofRajshahiCity Corporation and its surrounding areas known as pre-urban areas, which will be included within the city corporation area soon. Areas under review to look into urbanisation effect in altering the rural land use with a possible threat to food security, we have chosen Meherchandi(Budhpara), Padma Abashik area, hyampurDashmari, City bypass area from RCC and KatakhaliPaurashava, NarikelBariafromPoba and Naohata as the surrounding area of Rajshahi City Corporation. All these areas have a recent history of rapid urbanisation and a decrease in cultivated areas. The study area was selected purposively, and the respondents of this research work were selected randomly.

**Discussions of Results**

Urbanisation and its effect on agriculture: Agriculture meets the demands of the rapidly growing urban population including (Satterthwaite et al., 2010). Urbanisation presents both opportunities and challenges for the farmers and farm-supporting sectors on the urban fringe (Wu et al., 2011). By affecting caloric requirements, food availability and female labour status, it influences the structure of food consumption and food production (Regmi and Dyck, 2001). Rapid urbanisation has also impacted the vagaries of food sufficiency and crisis and its multiplier effects on the escalating rate of poverty and insurgency in the cities (Ozden and Enwere, 2012). One of the significantadverse effects of urbanisation for developing countries is losing cultivated lands (Deng et al., 2009; Lu et al., 2011). At the same time, others claim that the infrastructural development and the expansion of cities occupy a large amount of land, which leads to a decrease in the cultivable land (Islam and Hasan, 2013; Deng et al., 2015). Agricultural land loss occurs around smaller cities more than bigger cities (Pandey and Seto, 2015). Besides, agricultural land shifts to non-agricultural uses for the rapid urbanisation(Rosenberger et al. 2002; Berry,1978).

Note: PSA = Paurashava area, OUA = other urban areas, CCA = City Corporation area& SMA = Statistical Metropolitan area

Source: Authors' calculation based on Bangladesh Population & Housing Census 2011, Zila Report: Rajshahi.

*Table 1: Urbanisation scenario in Rajshahi district*

| Thana/Upazila | Percentage of Urban population to Total population | | Area in sq. km | | Urban Status | | No. of Municipality | Net Cropped areas in acres |
|---|---|---|---|---|---|---|---|---|
| | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 | 2011 | 2011 |
| Bagha | 2.61 | 5.17 | 10.99 | 21.10 | PSA | PSA | 2 | 25054 |
| Baghmara | 4.11 | 4.47 | 26.58 | 26.58 | PSA+OUA | PSA+OUA | 2 | 66099 |
| Charghat | 4.13 | 4.49 | 18.73 | 18.72 | PSA | PSA | 1 | 26578 |
| Durgapur | 0.81 | 3.29 | 5.69 | 26.85 | OUA | PSA+OUA | 1 | 29886 |
| Godagari | 4.46 | 7.16 | 17.43 | 36.80 | PSA+OUA | PSA+OUA | 2 | 70273 |
| Mohanpur | 1.38 | 3.49 | 9.25 | 23.91 | OUA | PSA+OUA | 1 | 26550 |
| Poba | 31.09 | 10.03 | 280.42 | 49.59 | SMA | PSA | 2 | 38731 |
| Puthia | 1.54 | 3.01 | 7.83 | 16.83 | OUA | PSA+OUA | 1 | 30755 |
| Rajpara Thana | 14.35 | 16.07 | 25.19 | 24.86 | CCA | CCA | | |
| Shah Makhdum Thana | 2.88 | 3.14 | 12.87 | 17.77 | CCA | CCA | | 5300 |
| BoaliaThana | 22.72 | 25.88 | 38.56 | 36.66 | CCA | CCA | | |
| Motihar Thana | 6.13 | 7.28 | 20.56 | 17.89 | CCA | CCA | | |
| Tanore | 3.79 | 6.25 | 27.97 | 58.98 | PSA+OUA | PSA | 2 | 52710 |
| Total | | | 511.07 | 376.54 | | | | |

Note: PSA = Paurashava area, OUA = other urban areas, CCA = City Corporation area& SMA = Statistical Metropolitan area
Source: Authors' calculation based on Bangladesh Population & Housing Census 2011, Zila Report: Rajshahi.

Table 1 shows that the total urbanisation scenario of Rajshahi district in the years 2001 and 2011. Within ten years, there is an exponential rise in urban population and municipalities in all the areas. Our study area is limited to Rajshahi City Corporation (RCC) and a tiny part of Poba, Mohanpur andCharghatUpazilas, close to Rajshahi City Corporation. With the extension of RCC, these areas will face the impact of urbanisation to a greater extent. The study areas had little experience of growth in urban population up to 2001, but in 2011, the urban population increased to a considerable height, which signals the pace of urbanisation. Before 1991, these areas were very rural. Before 2001, there was no municipality in Poba, where at the end of 2011, the number of municipalities was two. Thus 175 sq. km. of its area was urbanised with the development of municipalities. The greatest extent of urbanisation in the study area took place from 2001 to 2011.Where non-agricultural land use increases, such as building construction, industry, roads, and infrastructure, urbanisation is vital to the loss of agricultural land (Siddique and Mukherjee, 2017).

*Table 2: Calculation of Spearman's Ranking Correlation Coefficient*

| Block | Urban area in Sq. Km. | Rank | Net Cropped area in acres | Rank | Difference of Rank (d) | $d^2$ |
|---|---|---|---|---|---|---|
| Charghat | 18.72 | 4 | 26578 | 2 | 2 | 4 |
| Mohanpur | 23.91 | 3 | 26550 | 3 | 0 | 0 |
| Poba | 49.59 | 2 | 38731 | 1 | 1 | 1 |
| Rajshahi City Corporation | 97.18 | 1 | 5300 | 4 | 3 | 9 |
| | | | | | | $\sum d^2 = 14$ |

Data Source: Bangladesh Population & Housing Census 2011, Zila Report: Rajshahi. (Computed by the Author)

Spearman's Ranking Correlation Coefficient: $r = 1 - 6*\frac{\sum d^2}{n^3-n}$ (1)

$= 1 - 1.4$

$= - 0.4$

Spearman's Rank Correlation Coefficient can be used as a method to compute the extent of urbanisation as a responsible factor in transforming rural land-use patterns (Siddique and Mukherjee, 2017).

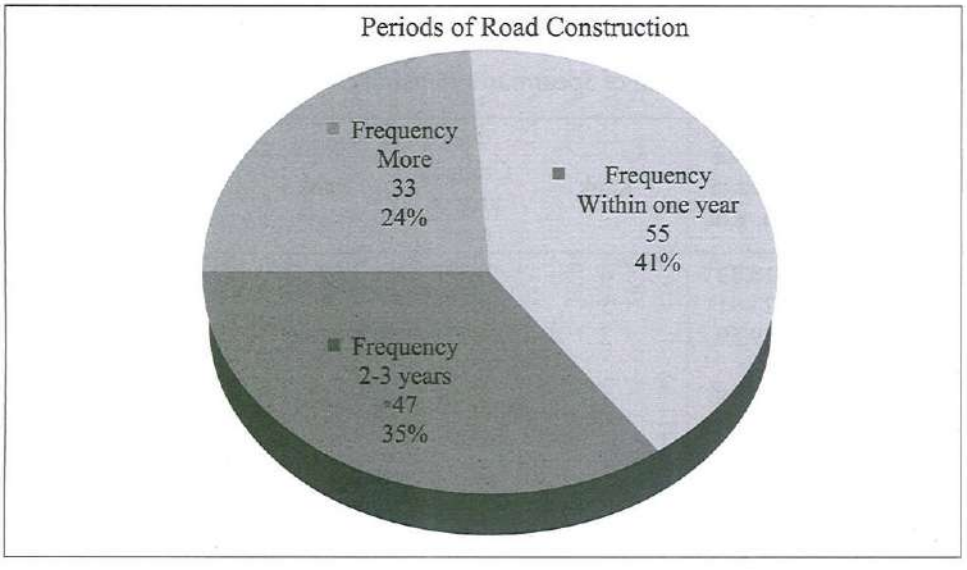
Data Source: Bangladesh Population & Housing Census 2011, Zila Report: Rajshahi. (Computed by the Author)

Spearman's Ranking Correlation Coefficient: r = 1 –
The result shows a strong negative relationship between the growth of the urban area and the net cropped area (Table 2).

**Infrastructural Development in the Study Area**

Infrastructural development and agricultural land losses are interrelated in a land-hungry country like Bangladesh. Due to the population growth, the demand for infrastructure use is increasing, and agricultural land is decreasing gradually (Islam & Hasan, 2013). According to the field survey, the average period of road construction of Poba, Mohanpur and Charghat Upazilas was 1.84 years, whereas construction within one year was 40.2%, between 2-3 years was 34.8%, and 25% was constructed more than three years ago.

Figure 1: Pie chart for the time of construction of roads in the study area




Most of the roads are built within one year, and many new projects are on the way. Within the city area, it may not create any problem for food production or food supply, but for the pre-urban areas like Katakhali Paurashava, Narikelbaria, it will hamper the production of food like rice, wheat and others since two or three years ago these lands were used fully for agricultural purposes. Besides, the remaining landowners of these areas are becoming more interested in orchards instead of rice and wheat. On the other hand, agricultural lands beside roads or highways are famous for non-agriculturaluses, reducing total cultivable land and food production.

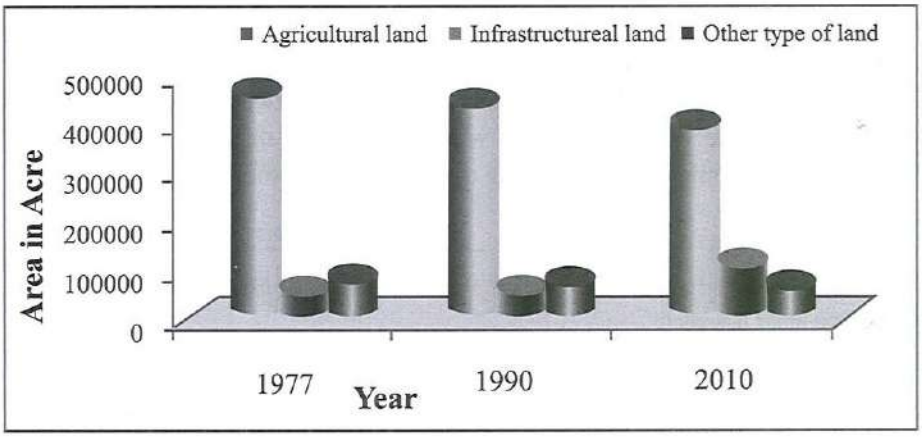
*Table 3: Land use change of Rajshahi District During 1977 to 2010*

| Land use pattern | Area in 1977 (in ha) | Area in 1990 (in ha) | Area in 2010 (in ha) | Changes area 1977-1990 (in ha) | Changes in % 1977-1990 | Changes area 1990-2010 (in ha) | Changes in % (1990-2010) | Changes area 1977-2010 (in ha) | Changes in % (1977-2010) |
|---|---|---|---|---|---|---|---|---|---|
| Agricultural | 186056.74 | 177564.6 | 159913.43 | 8492.10 | -4.65 | 17553.58 | -9.95 | 26143.25 | -14.05 |
| Infrastructural | 16161.36 | 2601723 | 47617.58 | 9859.98 | +60.98 | 21600.34 | +83.02 | 31455.27 | +194.63 |
| Orchard | 3781.95 | 3438.43 | 4499.55 | 343.34 | -9.08 | 1061.13 | +30.86 | 717.76 | +18.97 |
| Fallow land | 8666.05 | 6613.66 | 4482.09 | 2052.40 | -23.68 | 2131.58 | -32.22 | 4183.98 | -48.27 |
| Water bodies | 10235.95 | 10410.94 | 8428.13 | 134.61 | -1.32 | 1982.81 | -19.05 | 1807.81 | -17.66 |
| Char land | 2071.20 | 4393.17 | 5377.25 | 2321.97 | +112.1 | 984.07 | +22.40 | 2901.19 | +140.79 |
| River area | 6425.07 | 4951.13 | 3055.72 | 1392.97 | -22.94 | 3369.34 | -52.44 | 3369.34 | -52.44 |

Source: Landsat MSS-1977, TM-1990 and TM-2010 image analysis

Table 3 shows that the agricultural land is converting into another type of land use, especially for the infrastructural land (Islam & Hasan, 2013) and orchard. From 1977 to 2010, about 14.05% of agricultural land decreased, and infrastructural land increased by 194.43%.

Figure 2: Losses of Agricultural Land for Infrastructural Development




This bar diagram shows the losses of agricultural land due to infrastructural development. The agricultural lands of these areas have been decreasing, and the infrastructural area is increasing.

**Socio-economic description of households**: Among 135 respondents in the study area, there was no female head at the household level against 73.3% male

household heads and the age of most of the household heads is between 18-60 years.

Figure 3: Bar diagram of the age group of household head

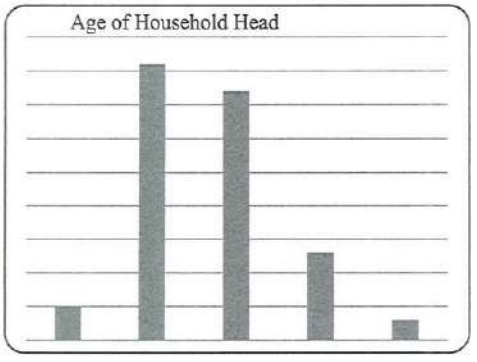
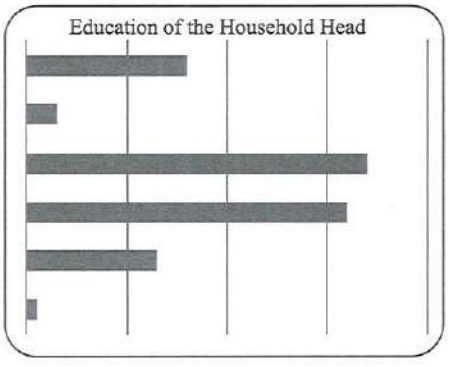



Figure 4: Level of Education of the household



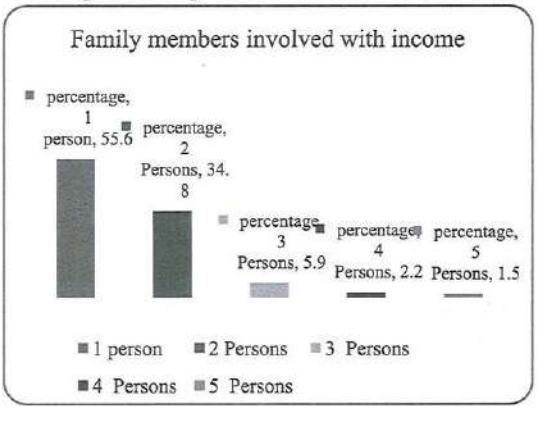

The education level in this area is low, which limits the better jobs. The household heads having an education are primary education 31.5%, secondary education 35.2%, vocational education 2.8%, higher education 14.8% and 13% of them can only sign their name. About 3% of the household head have no education at all.

Labour supply depends on the household size, which has tremendous implications on food security. If the number of earning or workable members is larger than the number of dependent people, then earning of the family will be more and agricultural production will increase. The average household size was 4.38, and almost 80.7% of households have members between 4 and 6 people. The average age of the household head was 40.68 years that means the majority (72.6%) of the population were young and belonged to the active age group.

Table 4: Size of the household

| Household Size | Frequency | Percentage |
|---|---|---|
| 1-3 | 23 | 17 |
| 4-6 | 109 | 80.7 |
| >6 | 03 | 2.2 |

Fig. 5: Earning members of the households

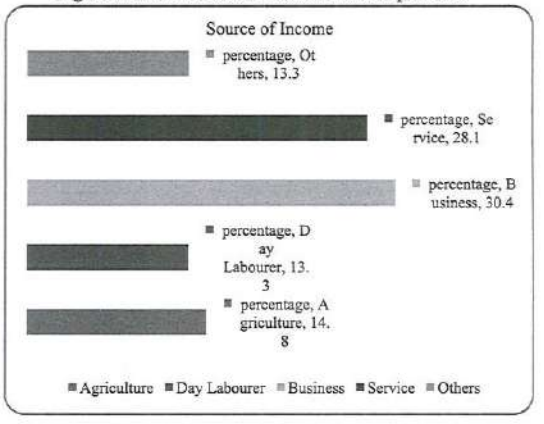


More than half of the families, only one member is involved in income as single families are more in urban areas. The percentage of two earning members is 34.8%, while three members earn 5.9%. Though the average farm size was 0.53 acres, 45.3% of people still had no agricultural land due to urbanisation. It is found that 91.4% of farmers cultivated between .00 and 2.00 acres of land, and only 5.8% cultivated more than 2.5 acres.

Table 5: Agricultural land afterurbanisation

| Area | Frequency | Percentage |
|---|---|---|
| 00-0.50 acres | 97 | 69.8 |
| 0.51-1.00 acres | 19 | 13.7 |
| 1.01-1.50 acres | 7 | 5.0 |
| 1.51-2.00 acres | 4 | 2.9 |
| 2.51-3.00 acres | 3 | 2.2 |
| 3.51-4.00 acres | 2 | 1.4 |
| >4.00 acres | 3 | 2.2 |

Figure 6: Main source of income of the respondents




The people in the study area mainly earn their income from agriculture, wage labour, business, service, and other sources like construction labour, truck, rickshaw, auto-rickshaw, van puller. Households were classified into five categories based on how they obtain their living, namely, agriculture, day labourer, business, service and others. Still, 18.8% of household members derived their livelihood by farming though they lost or sold their agricultural land or used it for non-agricultural purposes after urbanisation. About 30.4% of the households are engaged in petty business. The number of people who have no land to grow agricultural products working as day labourers to support their families was 13.3% in the study area. Urbanisation increased the opportunity for paid work and the development of other infrastructure. 28.1% of the respondent was engaged in service, and 13.3% of households were in other sources.

Present Food Security Status in the Study Areas

Bangladesh is one of South Asia's emerging economies and has been growing consistently over the last three decades, where one of the significant contributors in the agricultural sector. Though Bangladesh is a country with a population of 160 million, increasing at a rate of 1.3%, adding about 2 million labour force with the existing 72 million every year, agriculture is still the single most significant

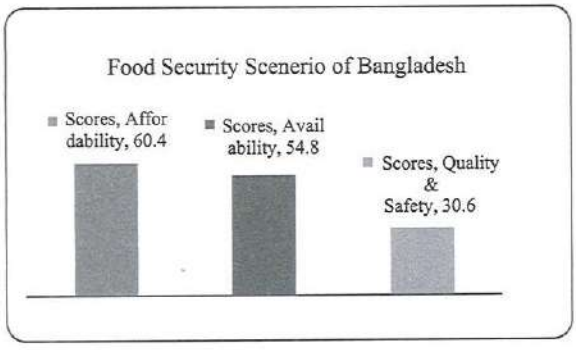
contributor to GDP(Noman and Ali, 2014). It provides 45% of total national employment and more than 70% of rural employment. However, Bangladesh is still dependent on food imports, and it has been increasing in recent years.According to the Global Food Security Index, 2019, the position of achieving food security of Bangladesh is the lowest in South Asian Countries. In the case of two core pillars of the index – food affordability and availability – Bangladesh did well with scores of 60.4 and 54.8, respectively. In the last pillars of the index – quality and safety of food, Bangladesh's performance is moderate (30.6) but needs improvement (Ali M, 2019).

Table 6: Ranking of South Asian Countries in food security

| Country | Score (GFSI) | Rank |
|---|---|---|
| Sri Lanka | 60.8 | 66th |
| India | 58.9 | 72nd |
| Pakistan | 56.8 | 78th |
| Nepal | 56.4 | 79th |
| Bangladesh | 53.2 | 83rd |

Source: Global Food Security Index, 2019

Figure 7: Condition of food security in Bangladesh, 2019




Based on the recommended daily calorie intake(R) of 2250 kcal, it was observed that 38.5% of the households were food secure, and 61.5% of the households were food insecure. Table 7 represents the summary statistics and food security indices among the sample households.

Only 39% of the study area populationmet the recommended calorie intake of 2250 kcal per day, whereas 61% could not. On the other hand, the shortfall/surplus index (P) measures the extent of deviation from the food security line (Babatunde et al., 2007), indicate that the secure food households exceeded the calorie requirement by 30%, while the food insecure households feel short of the calorie requirements by 19%.

**Regression results in the food security status of the households in the study area**

The estimation results of the logistic regression analysis are presented in Table 8. From the table, it is observed that three variables out of six included in the

*Table 7: Summary statistics of food security indices for the study area*

| Variables | Mean | | |
|---|---|---|---|
| Food Security Indices | Food Secure | Food Insecure | All |
| Recommended per capita daily calorie intake(R) is 2250 kilocalorie | | | |
| Percentage of household | 38.5 | 61.5 | 100 |
| Number of households | 52 | 83 | 135 |
| Age of household head | 38.02 | 42.82 | 80.84 |
| Household size (Adult equivalent) | 2.96 | 4.04 | 7.00 |
| Household monthly income | BDT 28,799 | BDT 20,688 | BDT 23,753 |
| Farm size | 0.582 acres | 0.499 acres | 0.539 acres |
| Food security index | | | |
| Mean | | | 0.39 |
| Std. Deviation | | | 0.49 |
| Per capita daily kilocalorie availability | 2927.282 | 1828.326 | 2254.122 |
| Shortfall/Surplus index(P) | 0.30 | 0.19 | |
| Head count ratio(H) | 0.39 | 0.61 | |

regression model are statistically significant, which are household size, income of the household and the agricultural farm size. However, age of household head, education of the household head and number of family members involved in income are not statistically significant. This result mainly explains the variations of present food security status in the Rajshahi district of Bangladesh.

*Table 8: Regression estimates for determinants of food security status of households*

| Variables | Coefficient | Std. Error | p>\|z\| |
|---|---|---|---|
| Age of household head | .0340801 | .0610132 | 0.567 |
| Household size | -4.62165 | 1.165843 | 0.000*** |
| Number of working members | -.0521318 | .8574834 | 0.952 |
| Education of household head | .0168017 | .0714723 | 0.814 |
| Household income | .002487 | .0008912 | 0.005*** |
| Farm size | .8439685 | .482866 | 0.080* |
| Period of Road construction | -.2510746 | .4509079 | 0.578 |
| Change in land for urbanization | .5783712 | .8327249 | 0.487 |
| Constant | 12.16389 | 3.672547 | 0.001*** |

Source: computed from the field survey data, 2019; Food security status
*** indicates significant at 1% level,
** indicates significant at 5% level & * indicates significant at 10% level.

To know the impact of the variables with one unit change, we have shown the marginal analysis of the variables, which are shown in table 9 and explained below the table.

*Table 9: Marginal Analysis*

| Variables | dy/dx | Std. error | p>\|z\| |
|---|---|---|---|
| Age of household head | .008511 | .01526 | 0.577 |
| Household size | -1.154194 | .29063 | 0.000*** |
| Number of working members | -.0130192 | .21418 | 0.952 |
| Education of household head | .004196 | .01786 | 0.814 |
| Household income | .0006211 | .00022 | 0.004*** |
| Farm size | .2107696 | .12089 | 0.081* |
| Year of Road construction | -.0627025 | .11255 | 0.577 |
| Change in land for urbanization | .1444403 | .20824 | 0.488 |

Source: computed from the field survey data, 2019; Food security status
*** indicates significant at 1% level, ** indicates significant at 5% level &
* indicates significant at 10% level.

Table 9 represents the impact of the variables on being food secured or not food secured. From the result, we can see the following:

**Household size:** This variable has a negative coefficient and is significant at a 1% level, which indicates that food security may decrease with the increase of household size. From Table 9, we can see that with a 1% increase in household size, the probability of being food insecure will rise by 1.15%. In other words, the small size of households is more likely to be food secure than the large size of households.

**Household income:** This variable was positive and significant at a 1% level, indicating that the higher the household income, the greater the probability that the household would be food secure. Since, with the increase of income, access to food also increases.If household income increases in one unit, the probability of food security will increase by .0006%.

**Farm size:** This variable was found positive and significant at the 10% level. It implies that having more agricultural land may increase the level of food security. If the farm size increases by one unit, the probability of being food secure will increase by0.211%.

**Other variables:** The age of the household head has a positive coefficient but is statistically insignificant, which indicates that the older the household head, the greater the probability that the household would be food secure. The coefficient of the number of working members of the households is negative and not significant.The negative coefficient was contrary to the expectations, and this

could be for seasonal employment or low payment at work since many households send their children to work at an early age, but the payment is given at a lower rate. The coefficient of the education of household heads was positive but not significant, which agrees with a priori expectation.Again, the period of road construction has a negative coefficient but is not significant. If the construction period becomes larger, food security is most likely to be negatively affected. The coefficient of change in land for urbanisation is positive but insignificant. That meansthe probability of a decrease in food security may occur due to a decrease in agricultural land for urbanisation.

**Conclusions and Policy Recommendations:** The paper's objective was to find out the relationship between urban expansion and the reduction of land under agriculture and its effect on food security. It is found that there is a profound impact of urbanisation on all dimensions of food security in the study area. The study area has experienced a rapid pace of urbanisation and infrastructural development within 33 years from 1977 to 2010. Consequently, the net cropped area of the selected places has declined, and non-agricultural land use has increased simultaneously. The growth and development of pre-urban and some urban areas of RCC are haphazard and unplanned, reducing the actual competency and return of the area.

This paper has shown that the socio-economic variables of the households are essential determinants of their food security or insecurity status. The paper showed that household size, household income and agricultural farm size are important determinants of food security. It also showed that most household heads are male, and about 73% are below 61 years old. It indicates that younger people are probably engaged with farm work to increase the productivity of agriculture. However, the majority of the households cultivated between .00-2.5 acres of land. The average Adult equivalent household size was approximately seven people, and almost 80.7% of the household was between 4 and 6 people. About 3% of the household heads have no education, and 13% of them can only sign their name.

The household head has education ranging from Primary Education 31.5%, Secondary education 35.2%, vocational Education 2.8% and higher Education 14.8%. The education level in this area is low, which limits the better jobs. The low level of education of households has an impact on their nutrition and food security. Since the study revealed that the education of the household head was positive, which though not significant but agrees with a priori expectation. Household income, one of the significant determinants of food security, was low in the study area. The average monthly income was BDT 23753, but Bangladesh's overall inflation rose to 6.05 percent in November 2019due, mainly to soaring

onion prices, where the country's average inflation rate was 5.47 percent until October 2019(Xinhua, 2019).

Using the food security index, the mean value of FSI (0.39) indicates that households in the study are not food secure. The impact of different factors on food security is analysed based on regression analysis, and it is found that income of household head, household size and farm size are significant factors that affect the food security of households in the study area. This result means that change in these factors results in changes in the status of food security of the households in the study area.

An essential consequence of urbanisation can be the establishment of a new balance with the agricultural processes. This new balance necessitates direct attention to several problems that must include both formal and informal planning. The significant problems in the study area are the lower yield rate, constant increase of population, contraction of cropland by built-up area, and infrastructural development. To deal with these problems, the modern agricultural system becomes essential.A highly productive and efficient system must simultaneously protect the environment by employing sensitive and efficient natural resources (Siddique and Mukherjee, 2017). The study provides the policy recommendations that existing master plans of the city should be appropriately implemented to reduce the agricultural land conversion, and high taxes can be imposed for converting agricultural land to non-agricultural purposes. Besides, supportive policies are needed to increase farm size as well as food production. Moreover, community-based health and nutrition-related education should be strengthened through direct educational support and awareness-raising programmes.

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