

Analysis of the Impact of Income Diversification Strategies on Food Security Status of Rural Households in Bangladesh: A Case Study of Rajshahi District

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Abstract: The strategy of income diversification has significant implication on the food security status of the rural farming households in Bangladesh. Income diversification has been identified as essential strategy for raising income and reducing rural poverty. The level and type of income diversification depends on the accessibility and availability of different income sources. Similarly the status of food security depends on average Kcal per day consumed by all members of a household. This paper examines the impact of income diversification on food security status of the rural farming households in Rajshahi district. For this purpose a survey was conducted in district Rajshahi of Northern Bangladesh covering three Upazilas with 138 households. The Simpson Index of Diversity (SID), 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 three upazilas – Puthia, Paba and Mohonpur. The Simpson Index of Diversity (SID) is used to measure the extent of income diversification and the Food Security Index is used to measure the household food security status. The results of SID revealed that diversification of income sources ($SID = 0.25$) is very low and the value of the food security index is 0 to 1. It is also found that the mean value of FSI is 0.91 for the food insecure households whereas 1.06 is the mean value of FSI of food secure households. Three factors are found to be statistically significant which are age of household head, educational status of household and household size. The analysis found that income diversification has positive but insignificant impact on household food security status in the study area. Finally, the obtained results have important policy implications which imply that programs targeted to engage people in other income generating activities would augment their income sources which are made to increase the food security status of household level in Bangladesh.

Keywords: Income Diversification, Food Security Index, Rural Households, Logistic Regression, Northern Bangladesh

1. Introduction

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 [57]. 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. Bangladesh is blessed with alluvial soils and huge water resources of upstream flow, rainfall and groundwater. This has contributed to development and expansion of agriculture in the country. However, imbalance in availability of water in different seasons is a barrier for its proper utilization in crop farming though with an expansion of groundwater irrigation system, a huge amount of food grain production in dry season has promoted the country to

reach at a level of its self-sufficiency under favorable climate [5]. Bangladesh has an advantage of growing diversified crops in summer, monsoon and winter seasons but the climate often becomes unfavorable [45]. The crop farming became intensified with expansion of groundwater irrigation and the cropping pattern remarkably changed after adoption of rice in winter season. Gradually rising pressure on groundwater became an issue for food security of ever growing population in the country. Moreover, this lower riparian country of Ganges-Brahmaputra-Meghna basin faced a paradoxical situation of too much and too little water in different seasons. Therefore, adoption of new crops with larger income diversification opportunity has important policy implications to uphold the food security status of the rural households.

At the national level, agriculture sector employs about 51% of the total labor force of the country and provides over 90% of the rural employment [10]. 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 [11]. 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 [12]. As a remedy to these problems integrated rural development strategy along with the Green Revolution technologies have been adopted in last several years aiming to reduce poverty through increasing agricultural productivity in rural areas. However, this approach has seen limited success and little attention was given on income diversification and their impacts on rural household food security.

In most cases income diversification and food security are closely related. Income diversification can be achieved by producing a variety of crops or pursuing off-farm employment. In case of the rural based developing countries, in addition to a rapid economic growth, a sustained and widespread growth in rural household income through diversification of crops as well as adopting off-farm activities is a necessary condition for any developmental strategy for rural areas [44]. Income diversification also refers to an increase in the number of sources of income or the balance among the different sources [35].

Food Security is a situation in which people do not live in hunger or fear of starvation. Two commonly used definitions of food security come from the UN's Food and Agriculture Organization (FAO) and the United States Department of Agriculture (USDA): Food security exists when all people at all times have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO). Food Security for a household means access by all members at all times to enough food for an active, healthy life. Food security includes the minimum

availability of nutritionally adequate and safe foods, an assured ability to acquire acceptable foods in socially acceptable ways (USDA).

After independence, significant changes in the volume and pattern of production has been observed which is manifested by a manifold increase in production of different crops as well as introduction of many new crops along with some new varieties existing in Rajshahi region. Moreover, over the past years farmers have been cultivating many new crops with rotation in the same land. It was found that crop diversification has happened in an unplanned and unscientific ways which would not bring any benefit for the rural households. Converting the crop land to ponds or orchards has reduced the production of cereal crops which is acts as a barrier for achieving food self-sufficiency. To solve this problem more critical study is needed to identify the appropriate diversification of crops which will be helpful for future generation.

Focusing specifically on Rajshahi district it is learnt that agriculture, livestock and some farm related activities are the important sources of income for the people, especially for the landless and small landowners. Most of the households in the developing countries like Bangladesh derive the bulk of their income from a single source (Broad Agriculture Sector) but at present in rural areas of Bangladesh, diversification into non-farm income sources is growing over time but still the share of this income is not accountable. It has found that an average non-farm income share to total income is 42% in Africa, followed by 40% in Latin America and 32% in Asia [53]. In Bangladesh, non-farm income source in rural areas did not expand everywhere and for this reason the share of non-farm income in Bangladesh is less than 32 percent. There is no substantial analysis found as to why non-farm income share is less in Bangladesh compared to that in Africa and Latin America. The development of new income sources has direct as well as indirect impact on improving the condition of food security status of the rural households. Some households diversify their income through switching from farm to non-farm sources (for example, agriculture to garments sector) or within the farm sources (for example, crop cultivation to livestock or fish cultivation) for their livelihood.

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\$ 1314.

It is increasingly believed that diversification of income

sources of the households and widening of crops options by the farmers during cultivation have positive impact on the food security level of rural households [3]. Evidence from various studies also indicates that if households have diversified sources of income it increases their total monthly income and this has a positive impact on food security level of the households. Diversification of income sources has been put forward as one of the strategies that households employ to minimize household income variability and to ensure a minimum level of income diversification which reduces poverty and enhances the national food security as well as the security of rural farmers [6].

The objectives of the study are to examine the contribution of income diversification strategy on household food security and to identify the factors influencing the food security status of households.

2. Literature Review

Extended studies have been done on different aspects and issues of income diversification and food security. The literatures are found to focus mainly on measuring the level of household food security and investigating the determinants of food security [8; 27; 39; 7; and 58], discuss the issue of poverty, inequality and gender aspects of food security [28; 34; 48; 31; 37; 15; 43; 46; 26; 49]. It showed that most households were involved in income diversification activities such as petty trading, mat making and tailoring [54; 4]. It examined the effects of income diversification on poverty reduction [40; 55; 20; 2; 19; 17; 38]. They focused on empirical relationship between income diversification and its welfare impacts on rural household. Again, it studied the impact of income diversification strategy on household food security [3; 33]. The available literatures which the researcher has reviewed are synthesized in the following sections.

The previous study examined the determinants of income diversification in rural farming households in Konduga local Government Area of Borno State [4]. Both descriptive and multiple regression analysis were employed to achieve the objectives of the research. The result show that age, educational level of households head and ownership of assets influence income diversification while household size, access to loan and marital status did not. This also shows that most households were involved in income diversification activities such as petty trading, matting and tailoring. To enhance income diversification, it is important to improve rural infrastructure in terms of provision of electricity and improving access to markets. It is found that there are two aspects of diversification [54]. They used a Tobit model to evaluate the determinants of non farm income diversification. This shows the socio-economic status and the access to formal financial markets have a positive impact on income. As a measure of diversification they applied the Shannon Equitability index, which increases with the number of income source and their evenness. They also shows the access to social capital and the occurrence of crop failure

both have a positive impact on the Shannon Equitability index, whereas the socio-economic status and the distance to roads have a negative influence.

The study examined the determinants of income diversification among rural households using cross sectional data collected from Fedis District of Eastern Hararghe zone, Ethiopia [40]. Multinational logit model was used to pinpoint factors influencing households' participation in non-farm activities while the determinants of non-farm income were analyzed by Tobit model. Participation in non-farm employment activities and the level of income derived are found to be influenced by human capital related variables (gender and age of household head, number of economically active family members, education level of household head and presence of children attending school), livelihood assets (livestock holding, size of cultivated land), livelihood diversifying strategy (crop based diversification through number of crops grown harvested) and infrastructure related variable (proximity to market). The results imply that these factors need to be considered by policy makers in the planning of agricultural and non agricultural initiatives in this study area.

Earlier study examined the food security status of farming households. The study applied a multistage random sampling technique to obtain a sample of 134 farm households [39]. The study exposed 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. It was examined the factors influencing food security status of rural farming households [8]. 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 shortfall or surplus 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. The study investigated physical and economic access to food in rural Bangladesh [15]. It 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. It was explored the nutritional status and food security of farm households under different land use patterns in Bangladesh [50]. 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. The study of the progress of food and nutrition security in Bangladesh

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 [28].

It was found a link between food insecurity status of farming households in Osun State of the southwestern Nigeria to their income diversification strategies [3]. Households were classified into four categories based on how they obtain a living. Descriptive statistics, Cost of Calorie Function (COC) and Analysis of Variance (ANOVA) were used to analyze the data. Income diversification strategies have significant influence on food insecurity at $\chi^2 < 0.001$. Households that depend more on off farm income ranked the best, The head count ratio shows that 82% of individuals in this group are food secure while 18% are food insecure. Results have shown that food insecurity among farming households in the study area was influenced by Income diversification strategies. General Household Survey-panel data that adopt the World Bank Living Standard Measurement Survey (LSMS) technique was used to look at the impact of non-farm income generating activities on food security status among the rural household in Nigeria [33]. A nationally representative sample of 3380 rural households was explored in this study. The results of the descriptive statistics showed that 66.64% of the households were engaged in farming as their main occupation. Chi-square analysis and t-test revealed that diversified households were relatively food secure than undiversified at 0.05% level of significance. The propensity score matching technique that takes care of selection bias and probit regression analysis was employed to analyze the impact of participation in non-farm income generating activities on food consumption expenditure and food security. The result suggested that diversified households had a high probability of being food security than undiversified households.

3. Methodology

The present study mainly relies upon primary data collected from the households of three upazilla Puthia, Paba and Mohanpur from Rajshahi district in Bangladesh. With a view to fulfilling the objectives of the present study of determining the impacts of income diversification on food security status of households and 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.

To identify the factors influencing the food security status of the households, we carry out a two-stage of analysis. First, we construct Simpson Index of Diversity using income sources and food security index (Z) and second, we use a Logistic regression model to estimate the food security status of households as a function of a set of independent variables including income diversification.

3.1. The Simpson Index of Diversity

It is generally found that the researchers have measured the level of income diversification using different measuring indices. Shannon equitability index [54] and Composite Entropy Index (CEI) [1] were used as a measure of diversification. Herfindal Index of Diversification was used to identify the level of income diversification [19]. Some studies used Simpson index of diversity (SID) [50; 18; 30; 29; 32]. Thus, this study used the Simpson index for measuring the level of income diversification in the rural households of the study area. The Simpson index is expressed as follows;

$$SID = 1 - \sum P_i^2 \quad (1)$$

Where, P_i = proportion of income coming from source i

The value of SID always falls between 0 and 1. In case of income, if there is just one source of income $p_i = 1$ so $SID = 0$. As the number of sources increase, the shares of p_i declines, as does the sum of the squared shares, so that SID approaches 1. If there are k sources of income, then SID falls between zero and $1-1/k$. The closer the SID is to zero, the more the specialization, and the further it is from zero, implies the more diversification.

3.2. Food Security Index

For measuring food security status of households two methods have been widely used in earlier studies [41]. The first method is called expenditure method the index is: Food security = (food expenditure of i^{th} household \div two-third of the mean per capita food expenditure of all study households) [48]. The second method is called calorie intake method [21; 47]. 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 measured based on the food security line using the daily calorie intake recommended [22]. 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 [42; 56]. The formula for converting all household members into adult equivalent is as follows.

$$ADEQ = (A + 0.5C)^{0.9} \quad (2)$$

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.

There are two steps to construct a food security index such as identification and aggregation [36; 16]. 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 [23; 9]. 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 [8]. 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 [21] is given by the formula as

$$F_i = Y_i / R \quad (3)$$

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 [21; 22; 47].

The Headcount Ratio (HCR) Index

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

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

Where, HCR = Head count ratio

M = Total number of food insecure households

N = Total study households

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.

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

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]

3.3. The Logistic Regression Model

Logistic regression analysis is based on 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 models can be used [52; 24]. The Logit model is usually used in preference to the probit [25]. Since the dependent variable is dichotomous, the present study has applied the Logistic regression model to analyze the relationship between the dependent (food security index) and explanatory variables (determinants of food security).

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 household is food secure. The formulation of the regression starts as follows:

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

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

This equation (Equation 5) is known as the (cumulative) Logistic distribution function. Here p_i is the probability of the i^{th} household being food secure, and $(1-p_i)$, is the probability of the household not being secure in food

It can be written that,

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

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

Where, is the odds ratio in favor of being food secure of a household, i.e. the ratio of the probability that a household is secure in food to the probability that the household is not secure in food.

To find an appropriate function, it is convenient to start with the earlier logistic function and modify it. Taking natural log the logistic function, Equation 6 can be written as

$$L_i = \ln[p_i / 1 - p_i] = \beta_1 + \beta_2 X_i \quad (8)$$

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. As Z_i ranges from $-\infty$ to $+\infty$, p_i ranges between 0 and 1 and p_i is non-linearly related to Z_i (i.e. X_i), one cannot apply OLS

technique to estimate the parameters. Therefore, the Maximum Likelihood method is used to estimate the parameters of the model.

3.4. Empirical Specification

Based on the household food security index (F_i), the logit

$$L_i = \ln[P_i / 1 - P_i] = \beta_1 + \beta_2 ID + \beta_3 AHH + \beta_4 ESHH + \beta_5 HS + \beta_6 FS + \beta_7 GHH + \beta_8 OL + \mu_i \quad (9)$$

Where, L_i is the log odds ratio in favor of being a household secure in food, (ID) income diversification, (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 μ_i is the random error term. The coefficients of the regression model are estimated by applying the maximum likelihood estimation (MLE) technique.

3.5. Selection of the Study Area and Collection of Data

A multistage sampling technique is used to select the households that are interviewed. The first stage involved the selection of *upazila* from which respondent households are selected. This is done by using purposive sampling technique, where the districts are grouped into northern part of Bangladesh. The second stage involved the selection of unions and villages from the selected districts using simple random sampling. This is achieved with the help of recorded information by the districts. This stage involved a random selection of three *upazilas* from the selected districts, giving one union from each of the three selected *upazilas*, giving a total of nine villages and finally, three villages from each selected union. The selected *upazilas* are *Puthia* (*Puthia* union), *Paba* (*Horian* union) and *Mohanpur* (*Mougasi* union) of Rajshahi district. The third and final stage is the selection of the households which are interviewed. For collecting the data, a multistage random sampling technique is used. Sources from the district level office of agriculture showed that, about 90% of the households in the study area depend on farming. After listing the farmers in each village, a total of 138 respondents were randomly selected from the villages using simple random sampling procedure. During the data collection, a well structured questionnaire was used where questions were focused on the above mentioned variables.

4. Results and Discussion

4.1. Income Diversification Strategies and Food Security Status of the Respondents

The people in the study area mainly earn their income from farming, petty trading, wage labor, service, construction labor, and truck, rickshaw, van puller etc. However, most of

the 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.

the people in the study area are involved in agriculture. Households were classified into five categories based on how they obtain their living. Five income diversification strategies were identified among the households, namely, farming, petty business, wage labor, service and others (truck driving, rickshaw and van pulling etc). Majority of the households 59.42% household members derived their livelihood by farming. About 15.94% of the households are engaged in petty business. The people who have no land to grow agricultural products support their family by wage labor. It is found that 11.59% members of the households in the study area earn income through wage labor. Another important source of income is service in public and private organization but the percentage is very low that is 7.97%. In addition, driving vehicles, pulling rickshaw, and van are also found as income sources of the study household. Around 5.08% members of the study households earn income as truck driver, and rickshaw and van puller.

Table 1 shows household food security status by income diversification strategies in three selected Upazilas. According to the above table household that have more diversified sources of income are more food secured. The level of diversification has three different categories. 0.00-0.30 indicates low diversification, 0.31-0.60 indicates moderate diversification and 0.61-1.0 indicates high diversification. The households who fall in the low diversification zone among them 31 (0.41%) are food secured where 44 (0.59%) are food insecure. Similarly in the moderate diversification zone 23 (0.47%) are food secured and 26 (0.53%) are food insecure. But in case of higher diversification the rate of food secured household 11 (0.79%) is higher than the food insecure household 3 (0.21%). Among the total sample household about 65 (0.47%) households are food secured where 75 (0.53%) households are food insecure. This is because the average value of income diversification index in the study area is 0.25 which is very low.

4.2. Household Food Security Status by Income Diversification Strategies

The shortfall and surplus index of food secured and insecure households of the study area are also represented in Table 1. The shortfall and surplus index of total study area are 8.90 and 6.30 which indicate that the food insecure households falls below the food security line by about 8.90% and the food secured households lie above the food security line by 6.30%. In case of Puthia Upazilla, the calculated

shortfall index is 11.00 and surplus index is 6.90 which indicate that the food insecure households fall below the food security line by about 11% and the food secured household exceed the food security line by only 6.90%. From Table 1 it is found that in Paba Upazilla the food insecure household fall below the food security line by 3.60% whereas food secured households stay above the food security line by 5.40%. Again, in Mohanpur Upazilla the food insecure households fall below the food security line by about 5.7%, while the food secured households exceed the food security line by 5.8%.

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 Upazilla 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 1 presents the mean of food consumption of an individual of sample households in the study area measured in kcal.

From Table 1 it is found that the mean value of food

security index is 0.98 in the study area whereas the value of food security index is 0.97 and 1.01 of the Puthia, Paba and Mohanpur Upazilla for the sample households. From Table 1 it is found that the average per capita calorie intake in the area is 2240.93 kcal. Based on the recommended daily calorie intake of suggested [22], 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 almost secured in the availability of food on the average. Again, from the disaggregated analysis it is observed that the average calorie intake of individuals of the household of Puthia Upazilla is 2204.13 kcal indicating that the individuals of the upazillas are not secured in food on an average. The mean calorie intake of the individuals of Paba Upazilla is 2303 kcal which indicates that the households of the upazillas are insecure in the availability of food. The daily mean calorie intake of individuals of the households of Mohanpur Upazilla is 2300 kcal which is lower than the daily calorie intake suggested by FAO. Therefore, the people of Mohanpur are insecure in food on an average.

Table 1. Upazilawise Households Food Security status by Income Diversification Strategies.

	LD (0.00-0.30)	MD (0.30-0.60)	HD (0.61-1.00)	Total
Puthia				
Food Secured Household (HCR)	20 (0.42)	11 (0.38)	6 (0.67)	37 (0.43)
Food Insecured Household (HCR)	28 (0.58)	18 (0.62)	3 (0.33)	49 (0.57)
Total	48	29	9	86
Mean Kcal (Value of FSI)				2204.13 (0.97)
Mean Kcal of Food Secured Household (Value of FSI)				2436.57 (1.07)
Mean Kcal of Food Insecured Household (Value of FSI)				2028.61 (0.89)
Surplus Index (Shortfall Index)				6.90% (11.00%)
Paba				
Food Secured Household (HCR)	7 (0.44)	7 (0.54)	2 (1)	16 (0.52)
Food Insecured Household (HCR)	9 (0.56)	6 (0.46)	0	15 (0.48)
Total	16	13	2	31
Mean Kcal (Value of FSI)				2303 (1.01)
Mean Kcal of Food Secured Household (Value of FSI)				2402.31 (1.05)
Mean Kcal of Food Insecured Household (Value of FSI)				2059.75 (0.90)
Surplus Index (Shortfall Index)				5.40% (3.60%)
Mohanpur				
Food Secured Household (HCR)	4 (0.58)	5 (0.83)	3 (1)	12 (0.57)
Food Insecured Household (HCR)	7 (0.42)	2 (0.17)	0	9 (0.43)
Total	11	7	3	21
Mean Kcal (Value of FSI)				2300 (1.01)
Mean Kcal of Food Secured Household (Value of FSI)				2413 (1.06)
Mean Kcal of Food Insecured Household (Value of FSI)				2149.33 (0.94)
Surplus Index (Shortfall Index)				5.8% 95.7%
Total Sample Household				
Food Secured Household (HCR)	31 (0.41)	23 (0.47)	11 (0.79)	65 (0.47)
Food Insecured Household (HCR)	44 (0.59)	26 (0.53)	3 (0.21)	73 (0.53)
Total	75	49	14	138
Mean Kcal (Value of FSI)				2240.93 (0.98)
Mean Kcal of Food Secured Household (Value of FSI)				2323.78 (1.06)
Mean Kcal of Food Insecured Household (Value of FSI)				2078.11 (0.91)
Surplus Index (Shortfall Index)				6.30% (8.90%)

Source: Author's Own Calculation

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 1. From Table 1 it is observed that the average calorie intake of food secured households in the study area is 2323.78 kcal. However this mean calorie intake is 2436.57 kcal for Puthia Upazilla, 2402.31 for Paba Upazilla and 2413 kcal for Mohanpur Upazilla. From Table 1 it is also found that the mean value of food security index is 1.06 in the study area whereas the value of food security index is 1.07, 1.05 and 1.06 of the Puthia, Paba and Mohanpur Upazilla for the food secured households.

The households whose members consume 2250 kcal or less than 2250 kcal of food daily are considered as food insecure households. Table 1 shows that the average calorie intake per day is less than 2280 kcal. The mean calorie intake of food insecure household in the study area is 2078.11 kcal. This figure is lowest for Puthia (2028.61) compared to 2069.75 kcal for Paba and 2149.33 kcal for Mohanpur. From Table 1 it is found that the mean value of food security index is 0.91 in the study area whereas the value of food security index is 0.89, 0.90 and 0.94 of the Puthia, Paba and

Mohanpur Upazilla for food insecure households. This result suggests that the people who live below the benchmark of kcal intake in study area cannot afford enough food for their families because of not having enough family income sources earned from farm, off farm and non-farm sectors.

4.3. Regression Results

The estimation results of the logistic regression analysis are presented in Table 2. This result mainly justifies the relation between income diversification and household food security in Rajshahi district of Bangladesh. From the table, it is observed that three variables out of seven included in the regression model are statistically significant, which are age of household head, educational status of household and household size. However, income diversification, farm size, gender of household head and owned livestock are not statistically significant. Table 2 revealed that R-squared is 0.5215 which means that 52% of variation in food security is explained by the considered explanatory variables.

Table 2. Regression Result of All Sample Area.

Variable	Coefficient	Std. Error	t-value	Prob.
C	-.52849	.20909	-2.53	0.013
ID	.08428	.15253	0.55	0.582
AHH	.01153***	.00348	3.31	0.001
ESHH	.02766***	.00848	3.26	0.001
HS	.11244***	.03512	3.20	0.002
FS	.04812	.02973	1.62	0.108
GHH	.07852	.15604	0.50	0.616
OL	-.08168	.08438	-0.97	0.335
R-squared=0.5215, Adj. R-squared =0.4950				

Source: Author's own calculation.

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

One of the important findings of this study is that income diversification has positive but insignificant impact on household food security in Rajshahi District. This is contrary to the prior expectation. The reasons are, firstly, the study is conducted in rural areas of Rajshahi district, where the people have no idea about extent and strategy of income diversification, so that, the average value of income diversification is very low in the study area. Secondly, most of the people of the study area are working in the agricultural sector and it is the major sources of income of the people. Due to lack of industrial and service sectors, there is limited scope to diversify their sources of income.

5. Conclusion and Recommendation

Income Diversification is considered as the most important strategy for raising income and food security status in Bangladesh. From the above findings it is clear that income diversification has significant impacts on households' food security status in Rajshahi District. However, the extent of income diversification is comparatively low in the study area.

The reason behind this is that most of the people living in the rural area are vulnerable as they depend only on agriculture related activities for their livelihood and they are subject to different types of risks (natural disaster) like drought, scarcity of irrigation water, non-availability of other income sources, etc. Although, forestry, gardening, fish culture, livestock rearing and petty business are the new sources of income emerged to the rural households, these activities are mostly run by the rich farmers. Using the food security index, the mean value of FSI (0.98) indicates that households in the study are not food secure. Secondly, the impact of different factors on food security is analyzed on the basis of regression analysis and it is found that age of household head, educational status of household and household 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. However, income diversification has positive but insignificant impact on household food security that is contrary to the prior expectation. The reasons are, firstly, the people have no idea about extent and strategy of income diversification, so that, the

average value of income diversification is very low. Secondly, most of the people of the study area are working in the agricultural sector and it is the major sources of income of the people. Therefore, for increasing the extent of income diversification, the study provides the policy recommendations that government should continue its efforts to generate income earning opportunities in the rural areas and support the farmers to enhance agricultural production through supportive policies needed for agricultural inputs to these farmers. Moreover, community based health and nutrition related education should be strengthened through direct educational support as well as awareness raising programmes. Food security related social safety net programmes should also be carried out.

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