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ASSESSING FOOD SECURITY FOR THE PEOPLE OF CHITTAGONG HILL TRACTS (CHT): CHALLENGES TO ATTAIN SDG 1 AND SDG 2

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ABSTRACT

The food security issue in Bangladesh's Chittagong Hill Tracts (CHT) has persisted since its independence. This region faces challenges in ensuring a stable and reliable food supply for its population. This research aimed to evaluate the food security of the Chittagong Hill Tracts (CHT) population and the challenges of achieving the Sustainable Development Goals (SDGs) in 2020–2021. 120 farmers were chosen for selection in the districts of Khagrachari, Rangamati, and Bandarban in the Chittagong division for direct interview. Besides descriptive analysis, binary logistic and multinomial logistic regression models have determined food security conditions and factors affecting food security. Cobb-Douglas type stochastic frontier revenue function was used to estimate revenue efficiency. Enterprise development and income generation have significantly contributed to increasing food security. The daily intakes of food, calories, and protein per person are 1128 g, 2443 kcal, and 79 g, respectively. Improved food consumption, calorie intake, and protein intake were directly related to enterprise development and income generation. Increased land size and income increased food security. Increased expenditure on food items and decreased family size also increased food security. The business sector offered the highest income (BDT 64792), followed by agriculture (BDT 53972). Enterprise development and income generation have improved other food security and economic indicators. A significant level of revenue can be increased by allocating all scarce resources among crops and enterprises. Focus group discussion revealed that the government's safety net program should be expanded to include all marginalized and vulnerable individuals to achieve food security. Overusing land and forest resources and adopting shifting cultivation were the key reasons for the landslide, soil erosion, and siltation of lakes and water bodies. During the monsoon, soil erosion, soil nutrition, and topsoil erosion were accelerated, which harmed livelihood and food security. Alternative enterprises for income generation could be developed to discourage the shifting cultivation of local people. The government could attract international development partners to invest in that area under the umbrella of a private-public partnership program. There is sporadic infighting between rival factions of tribal people, which is considered to be a hindrance to regular movements of essential commodities and a risk to attaining SDGs. Political dialogue among the rival factions in connivance with government policymakers and law-enforcing agencies may reduce the above problem.

Keywords: Food security, Income, CHT, SDGs

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I. INTRODUCTION

Poverty reduction and food security studies have gained momentum with the Sustainable Development Goals 1 and 2 (SDGs 1 and 2) of the United Nations (UN). SDG 1 proclaims no poverty, which states “end poverty in all its forms everywhere,” and the SDG 2 proclaims zero hunger, which states “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture.” Before eradicating food insecurity, we need to measure the extent of food security that are exist in the demographically disadvantaged areas of developing countries like Bangladesh. The CHT is one of the five hardest-to-reach regions in terms of lack of water and sanitation, electricity, healthcare facility, available food and livelihood, education, communication and other civic amenities. These five regions including south-western coastal belt, north-western river erosion areas, haor area, and north-eastern tea garden areas are considered as the CHT. However, the CHT is rather severe in terms of essential amenities among the above-listed five regions. Situated in the southeast of the country, the Chittagong Hill Tracts (CHT) constitutes the only large hill region in Bangladesh. The CHT spans roughly 13,184 square kilometers, of which 92% is highland, 2% is medium highland, 1% is medium lowland, and 5% is made up of homesteads and bodies of water. The CHT has 1598231 residents in total, of whom 53% identify as tribal and the remaining 47% as nontribal (Chowdhury, 2014).

These people's primary source of income is agriculture. There are extremely few, and in some cases, nonexistent, alternatives for nonfarm income. The most marginalized group of people in Bangladesh are the tribal groups living here. The predominant farming method in this area is still shifting agriculture, or jhum, which is mostly unaffected by various policies and initiatives that support agricultural land use patterns (Majumder et al., 2012). Tribal populations are consequently experiencing food insecurity, and shifting agriculture has resulted in the indiscriminate destruction of forests for food, which has negatively impacted the environment. The CHT has a wonderful landscape with the existence of uneven hills, creating a mountain ecosystem, lakes, trees, and plants rich in biological and cultural diversity and diversified flora and fauna. Eleven tribal and one non-tribal group of people with multiple ethnicities and cultures have been living there. The Chakma, Marma, Tripura, Tanchangya, Mro, Lushai, Khumi, Chak, Khyang, Bawm, and Pankhua are the eleven indigenous ethnic groups that make up the CHT. Upland farmers often utilize unsustainable land use techniques to suit their living needs. In essence, uplands are ensnared in a never-ending cycle of devastation to the environment, food insecurity, and poverty. Upland land use practices harm downstream livelihoods and the resource base, in addition to degrading the resource base itself. Reductions in carbon sequestration, biodiversity, and the ecosystem's capacity to control stream flow are examples of broader environmental effects.

Chittagong's hilly soils have a generally low agricultural potential for field crops, although can range from low to high for tree crops (Majumder et al., 2012). Crop productivity is highest on level or moderately sloping ground with deep soils. Most steep land is used for rain-fed food production because irrigation is impractical. In addition to being inherently vulnerable to erosion, steep soils run the danger of suffering significant degradation as a result of poor agricultural practices. Threats to the forest ecosystems in the CHT also originate from the recent large-scale cultivation of tobacco, which requires massive volumes of fuel wood for curing. Furthermore, this regional ecology is being threatened by deforestation. Plans and programs must be created and supported in light of the current issues influencing sustainable development. The primary issue has been one of national integration ever since Bangladesh's independence in 1971. Compared to other parts of Bangladesh, this location is actually distinct and separated in terms of geography, ecology, and the environment. The inhabitants of this area have faced several kinds of significant issues since the beginning. In this regard, ethnicity, or Adibashi, Bengali or Bangladeshi, was the first step. Another issue was the Bengali population's settlement in tribal areas. Unintentionally, national integration should be viewed as a requirement for a powerful country. It is nearly impossible for the nation to flourish overall if the nation-building issue is not resolved (Salam and Aktar, 2014). In addition, there is periodic violence between competing tribes, which is thought to be a barrier to the regular flow of necessities and the achievement of the SDGs. Given the context, The indicators for the sustainable development of the CHT could be efficient mobilization of scarce resources through agricultural practices and environmental soundness, economic growth in terms of income and employment, clean water development and use, sanitation and healthcare facilities, infrastructure development, energy development and use, quality education, creation of effective market and harmony between tribal and non-tribal people living there.

Food security is related to environmental vulnerability and climate change. Food security is the assurance of physical and economic access to sufficient food by all people at all times to maintain an active and healthy life. FAO (1996) defined the objective of food security as assuring to all human beings the physical and economic access to the basic foods they need. Food security and sufficiency are attained when there is enough food (in terms of quantity, quality, safety, and sociocultural acceptability) available and accessible for everyone to use satisfactorily at all times in order to lead active and healthy lives. Put another way, in order to achieve food security, there must be a sufficient amount of physical food supplies available overall, households must have adequate access to these supplies through their own production, the market, or other sources, and the use of these supplies must be appropriate and acceptable in terms of society and culture in order to meet each person's unique dietary needs (Riely et al., 1999). Thus, 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 underlying determinants of each of these factors. Food access is a function of physical environment, social environment and policy environment. On the other hand, food utilization is a function of quality of care (e.g. general health care), quantity and quality of dietary intake, health status and its determinants.

Food processing increase the food security condition of people by making available all food items especially perishable food throughout the year. People of the CHT produces some fruits like banana, pineapple, jackfruit, papaya, mango, malta, orange, guava etc. abundantly. These fruits accrue huge losses during pick season due to the absent of food processing industries. Now-a-days, several government social safety net programs, micro credit programs are going on to reduce extreme poverty. On the other hand, different small scale enterprises in the CHT are started. This study attempts to evaluate current socio-economic status of the household level in the CHT and find out best enterprises for employment generation and evaluating impact of the different influential factors on poverty reduction and food security for sustainable development.

To address the environmental issues for the Bangladesh, the government has developed National Environment Management Action Plan (NEMAP) in 2005. Natural hazards and disasters, industrial pollution, energy, water resource management, forests and biodiversity, land resources, fisheries and livestock, agriculture, housing and urban development, health and sanitation, education and awareness, and transportation and communication are all included in the design of NEMAP. The Sustainable Environment Management Program (SEMP), a US $ 26 million "umbrella" program, was implemented by the Ministry of Environment and Forestry (MoEF) in 1998 to introduce a portion of NEMAP focused on green initiatives. The program ran until 2006. With the involvement of numerous government departments, non-governmental organizations (NGOs), civil society organizations (CSOs), and international organizations like the International Union for Conservation of Nature (IUCN), the SEMP was exceptional in the field of environmental protection. Additionally, the SEMP created the NEMAP-CHT environment plan for the CHT and, as a follow-up, created a malaria eradication model for Rangamati and medicinal plants in Khagrachari. A donor consortium was able to provide additional funding for the CHT region as a result of the SEMP initiatives in the region.

Environmental change is a global problem and it happens due to various endogenous and exogenous factors for which the government has little to control over it. Nevertheless, the government can minimize the negative effect on the ecology and environment by encountering dumping effect and also by controlling endogenous factors through the implementation of various projects. The government has implemented a very few environmental projects so far in which most of the money has been spent in the development of conceptual framework and capacity development (GoB, 2015).

Like government agencies, few local NGOs along with national NGOs have been working in the CHT to address environment problem in addition to their regular activities of livelihood management. TAHZINGDONG is such non-profit, non-government organization working on environment and socio-economic development in the CHT. It works with the most disadvantaged communities for improving their livelihood who mostly depend on forest and natural resources. Another name for TAHZINGDONG is the CHT Community Managed Natural Forest Promotion, Restoration, and Conservation Organization. With the cooperation of communities that depend on the forest, the group is a pioneer in the Bandarban Hill district, having taken the initiative to protect and preserve the Village Common Forest (VCF) or Community Conserved Area (CCA). Additionally, the group hopes to save, maintain, and reintroduce the threatened forest species (flora and fauna combined). A few foreign organizations are also on guard in the CHT to assist NGOs and government institutions in their endeavors. A number of organizations, including the Asian Development Bank, UNDP, and USAID, have been working to improve the local population's nutritional status, livelihood management, poverty alleviation, etc.

Though they have significantly greater social mobility than women in the plain’s regions, indigenous women are nonetheless just as disenfranchised overall as women in the plains. The majority of indigenous are women living in rural areas work incredibly hard since they must care for their families, tend to their farms, and frequently travel considerable distances to gather firewood and water. Indigenous women are not entitled to inherit immovable property, with the exception of some Marma. They are also terribly underrepresented in structured, elective regional and local government bodies as well as in traditional systems, with the exception of union and municipality councils, where seats are legally allotted for them. As a result, hill and Bengali women alike should be extremely concerned about the state of social, economic, and political disempowerment (Halim, 2002).

Objective

The main objective of this study is to assess the degree of food security among residents of the CHT and the likelihood that the SDGs will be achieved. The specific objectives of the study are three folds**:**

i) identify the major influential factors related to enhance livelihood and food security;
ii) to estimate the revenue efficiency by measuring major economic indicators;
iii) to find out the strength, weakness, opportunity and threats of the sustainable economic development of “Chittagong Hill Tracts”.

II. METHODOLOGY

Data

Primary data on agricultural operations was collected from the 120 farmers who were chosen for selection in the districts of Khagrachari, Rangamati, and Bandarban in the Chittagong division through structured pretested questionnaires with the help of trained enumerators during January to July 2022. At first three sampling frames each of 200 households from every district were formed with the help of local elite personnel. That is, total population size of three districts was 600. From every district 40 respondents were selected from a population of 200 considering the practical situation. As a consequence, 120 houses in all were chosen at random from the research region using a basic random sampling technique. In addition to a field survey, six focus group discussions were held in order to gather detailed and thorough data. Six Key Informant Interviews (KII) have been carried out.

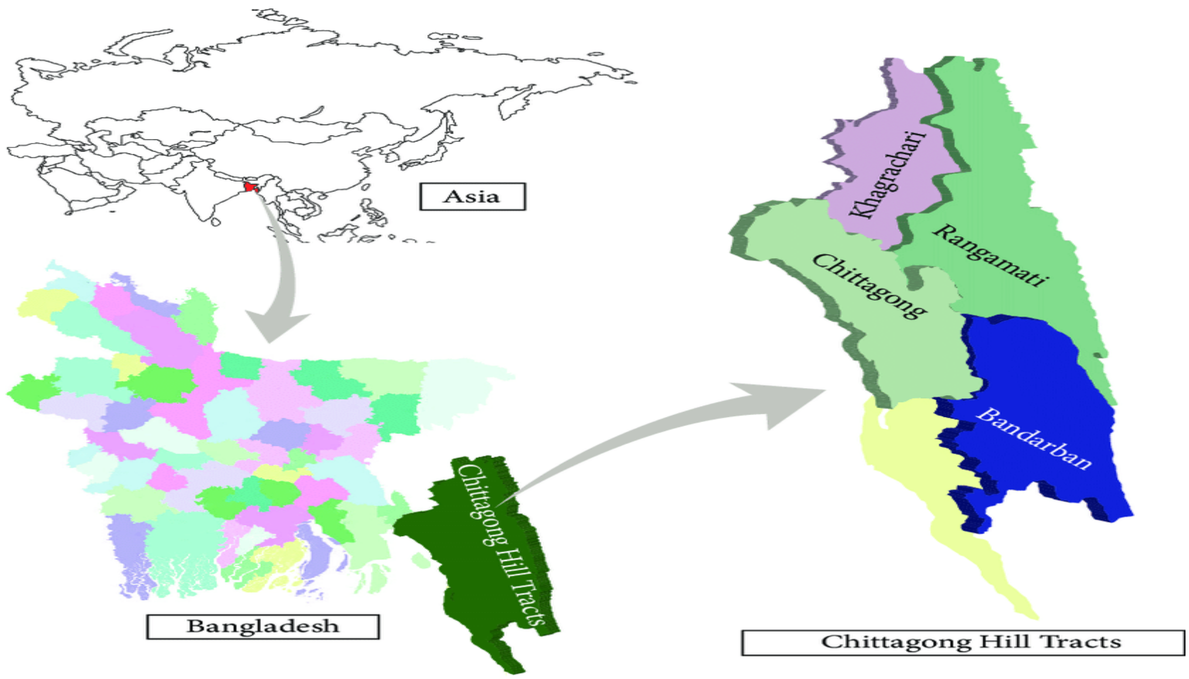

Figure 1. Geo map of Chittagong Hill Tracts showing the selected districts

In this study, both descriptive and inferential analyses have been carried out to achieve the three objectives. Together with calculating averages, percentages, and ratios of some of the indicators included in the objectives, descriptive analysis, such as tabular and graphical analysis, has been carried out.

Food security measurement with functional analysis

Food security and factors affecting food security have been estimated using binary logistic and multinomial logistic regression models. Logistic regression and multinomial logistic regressions in the following forms have been used.

Binary logistic regression model

Consider food security as an example of a dichotomous dependent variable. If Y = 1, then the household has enough food, and Y = 0 otherwise. Given an independent variable, X, the logistic regression model's form is as follows (Gujarati, 2007).

$$F = p(Y = 1/X) = \frac{e^{\beta_o + \beta_1 X}}{1 + e^{\beta_o + \beta_1 X}}$$

And

$$1 - p = p(Y = 0/X) = \frac{1}{1 + e^{\beta_o + \beta_1 X}}$$

$$\therefore Logit\ L_1 = \log\left[\frac{p}{1-p}\right] = \beta_o + \beta_1 X$$

For more than one independent variables-

$$Logit\ L_1 = \beta_o + \sum_{i=1}^{k} \beta_1 X_{i1} \quad ....(1)$$

l = 1, 2, ... k, and i = 1, 2, ..., n

Factors influencing livelihood of households

When a way of life improves people's well-being and that of future generations while maintaining the natural environment and resource allowing people to recover and cope with shocks and pressures (like natural disasters and economic or social upheavals), it is considered sustainable. An attempt has been made to transcend traditional definitions and approaches to the eradication of food insecurity using the idea of sustainable livelihood (SL). Livelihood activities and skills are fundamental for improving livelihood opportunities, decreasing poverty, enhancing employability, and promoting sustainable development. Revenue, income, expenditure, food consumption, and calorie and protein intakes per capita ~~or~~ on a household basis are some indicators of food security.
Income function

$$Y_i = \beta_0 + \beta_1 pI_A + \beta_2 pI_T + \beta_3 pI_B + \beta_4 pI_{Tou} + \beta_5 pI_s + \beta_6 D_{1i} + \beta_7 D_{2i} + e_i \ ....(2)$$

Where, Y_i=Total household income, pI_A= per capita income from agriculture, $pI_T = per\ capita\ income\ from\ transport,$ pI_B=per capita income business, pI_{Tou} = per capita income from tourism, pI_s= per capita income from service, D_1= 1 for income in Bandarban and 0 otherwise, and D_2=1 for income in Khagrachari and 0 otherwise, β_0, $\beta_1, \beta_2 \ldots \beta_7$, are parameters which are estimated.

Income functions in double-log function

$$lnY_i = \beta_0 + \beta_1 lnpI_A + \beta_2 lnpI_T + \beta_3 lnpI_B + \beta_4 lnpI_{Tou} + \beta_5 lnpI_s + \beta_6 D_{1i} + \beta_7 D_{2i} + e_i \ ....(3)$$

Factor affecting household yearly expenditure

$$Y_i = \beta_0 + \beta_1 pE_F + \beta_2 pE_C + \beta_3 pE_E + \beta_4 pE_T + \beta_5 pE_L + \beta_6 pE_H + \beta_7 pE_S + \beta_8 pE_O + \beta_9 pE_C + \beta_{10} pE_P + \beta_{11} pE_V + \beta_{12} pE_{Or} + \beta_{13} pE_S + \beta_{14} pE_W + \beta_{15} pE_T + \beta_{16} pE_F + \beta_{17} pE_E + \beta_{18} D_{1i} + \beta_{19} D_{2i} + e_i \ ....(4)$$

Where Y_i=Total household expenditure, pE_F= per capita expenditure from food item, pE_C = per capita expenditure from clothing, pE_E = Per capita expenditure from education, pE_T = per capita expenditure from treatment, pE_L= per capita expenditure from land purchase, pE_H= per capita expenditure from house purchase, pE_S= per capita expenditure from savings, pE_O= per capita expenditure from other, pE_C = per capita expenditure from cattle purchase, pE_P= per capita expenditure from poultry purchase, pE_V= per capita expenditure from vehicle purchase, pE_{Or} = per capita expenditure from ornament, pE_S= per capita expenditure from sanitation, pE_W= per capita expenditure from water, $pE_T = per\ capita\ expenditure\ from\ transport$, pE_F= per capita expenditure from festival, pE_E = per capita expenditure from electricity and gas, D_1= 1 for Bandarban and 0 otherwise D_2=1 for Khagrachari and 0 otherwise.

Stepwise regression analysis was carried out for income and expenditure functions.

Multinomial logistic regression model

Both stepwise and total regression analyses were carried out for the income function, whereas only stepwise regression was carried out for expenditure. Y has three values in a multinomial logistic regression: Y=0 indicates food insecurity, where per capita intake of calories will be less than 1805 Kcal; Y=1 indicates relatively food security, where per capita intake of calories will be less than 2122 Kcal but more than 1805 Kcal; and Y=2 indicates food security, where per capita intake of calories will be more than 2122 Kcal. Similar to logistic regression, a multinomial logistic regression model will be evaluated with the reference category of food security.

Let j = 1, 2...J represents the J exhaustive and mutually exclusive categories that make up the response variable. For the response variable, the jth category is used as the reference category. Any category can be the jth category since the category's ordering is arbitrary, which makes the reference category equally arbitrary. Let there are also k predictor variables, denoted by X_1, $X_2,\ldots,X_k$.

The multinomial logistic regression model is then specific in log odds form as:

$$\ln \frac{P_1}{P_2} = \beta_{I0} + \sum_{i=1}^{k} \beta_{i1} X_1, \quad i \neq 1, 2,..,J \quad \ldots..(5)$$

where $\sum_{i=1}^{j} P_j = 1$

Daily per capita calorie intake function

Linear calorie intake function

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + U_i \ldots\ldots\ldots\ldots(6)$$

Log-linear calorie intake function

$$\ln Y_i = \beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + U_i \ldots\ldots\ldots\ldots(7)$$

Where Y = daily per capita calorie intake (kcal), X_1 = daily per capita rice consumption (g), X_2 = per capita monthly income (BDT), X_3 = family size, X_4 = age of farmer (year) and X_5 = education (years of schooling), Note: education is used without log in the model.

Daily per capita protein intake function

Linear protein intake function

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5 X_5 + U_i \ldots\ldots\ldots\ldots(8)$$

Log-linear protein intake function

$$\ln Y_i = \beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + U_i \ldots\ldots\ldots\ldots(9)$$

Where Y = daily per capita protein intake (g), X_1 = daily per capita rice consumption (g), X_2 = daily per capita meat consumption (g), X_3 = daily per capita fish, milk, and egg consumption (g), and X_4 = total land size, X_5= family size.

Sustainable Development Goals (SDGs) have been ascertained through the activities of government, non-government organizations, and international development partners that were engaged there with a view to eradicating poverty, ending hunger, and achieving food security for the hilly people. Besides these, some test statistics like the Wald test, t-test, χ^2-test and F-test were performed.

Revenue efficiency estimation through functional analysis

The Cobb-Douglas type stochastic frontier revenue function was estimated in double log form as below:

$$\ln Y_i = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 EDU + V_i - U_i \quad \ldots\ldots\ldots\ldots(10)$$

Where Y= Total income from the crop sector, X_1 = land area in decimals, X_2 = fertilizer in kg, X_3 = human labour (man-days), X_4 = pesticide in grams, EDU =education of farm operators (Years of schooling),

β_1, β_2, β_3, β_4, β_5 are the parameters to be estimated, and V_i are assumed to be independently and identically distributed random errors, having (0, σ_v^2) distribution; and the U_i are non-negative one-sided random variables, called technical inefficiency effects, associated with the technical inefficiency of production of the farmers involved. It is assumed that the inefficiency effects are independently distributed with a positive half-normal distribution ($U \sim \lvert N(0,\sigma_u^2) \rvert$).

The model for the technical inefficiency effects in the stochastic frontier of equation (i) is defined by

$$U_i = \delta_0 + \delta_1 AGE_i + \delta_2 EDU_i + \delta_3 FAMSZ_i + W_i \qquad (11)$$

Where AGE represents the age of farm operator, EDU represents the education of farm operator (Years of schooling), $FAMSZ_i$ represents family size and the W_i are unobservable random variables that are assumed to be independently distributed with a positive half- normal distribution (Table 1).

Table 1: Description of variables of Cobb-Douglas stochastic frontier revenue function

Name of the variables	Parameters
Stochastic production frontier model:	
Constant	β_0
Land area in decimal	β_1
Fertilizer in kg	β_2
Human labour (man-days)	β_3
Pesticide in gram	β_4
Education of farm operator (year of schooling)	β_5
Technical inefficient effect model:	
Intercept	δ_0
Age	δ_1
Education	δ_2
Family size	δ_3
Variance parameters:	
	σ^2
	γ

III. RESULTS AND DISCUSSION

Household profile

The average age of farmers, family size, and dependency ratio have no significant variations among districts. The average education was 7.54 years at the aggregate level, with significant variation among the three districts. This findings is also in the line of Chakma (2024) who found

56% of the children dropped after primary education. The average family size was 5.40 people which conformed to the national average. The highest education level was observed in Rangamati district, while literacy rate was highest (71.37%) in Bandarban district. The literacy rate was 64.47% at the aggregate level, and there were significant differences among the districts. Khagrachari district was found to be disadvantaged in terms of education level and literacy rate, with the burden of a higher family size and dependency ratio (Table 2).

Table 2. Socio-economic characteristics of farm household

District	Age (Year)	Education (Year of schooling)	Family size (No.)	Literacy rate (%)	Dependency ratio
Khagrachari	42.72	6.17	5.67	59.96	0.68
	(12.11)	(4.02)	(1.38)	(18.95)	(0.16)
Rangamati	37.72	8.62	5.12	62.09	0.63
	(12.74)	(4.38)	(1.34)	(23.67)	(0.14)
Bandarban	38.52	7.82	5.40	71.37	0.62
	(12.33)	(4.78)	(1.56)	(19.99)	(0.15)
Total	39.66	7.54	5.40	64.47	0.64
	(12.49)	(4.48)	(1.44)	(21.38)	(0.15)
F-value	1.88	3.22*	1.47	3.35*	1.81

Figures in the parentheses indicate standard deviations. ** and * indicate significances at 0.01 and 0.05 probability level, respectively.

Household income

Farmers living in the study areas earned income from eight sectors. These were agriculture, including livestock and fisheries, transport, rickshaw and van, business, tourist-related businesses, service, government donations, and other sources (Figure 2). Compared to the study of Shan et al. 2020, total income per farm was the highest in Bandarban district (BDT 269125) followed by that in Khagrachari district (BDT 192152.50) and Rangamati district (BDT 184757.72), respectively whereas the total income per farm at the aggregate level was BDT 215345.07. Income from business, service, and other sources showed significant variations among the districts.

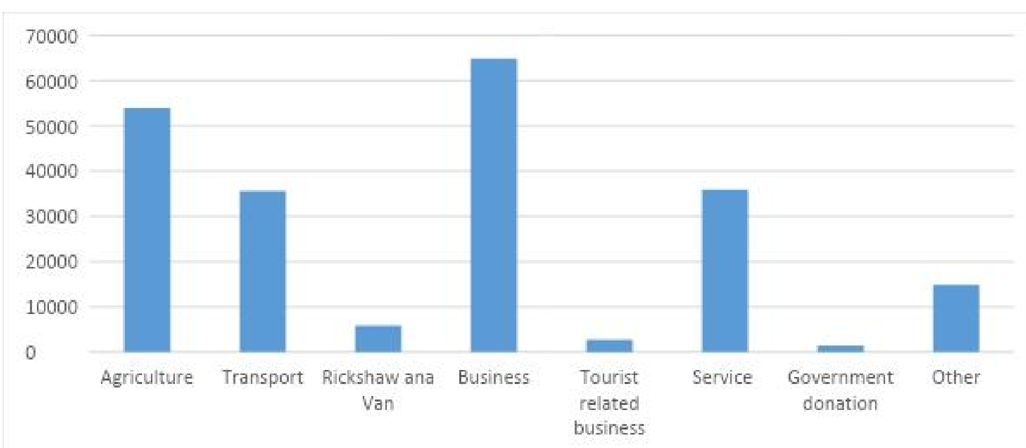

Figure 2. Income of farm household from different sectors (BDT)

Stepwise linear regression of income

Stepwise linear regression of income has produced four models. Significant F values show that all of the models, both in linear and log-linear forms, were well fitted to the data. The fourth model fits the data the best. The growth of commerce, transportation, services, and agriculture was accompanied by a large increase in daily per capita income (Table 3).

Table 3. Stepwise linear regression of income

	Coefficient	Standard Error	t-value
Constant	88030.19	9291.26	9.48^{**}
per capita income from business	3.46	0.23	14.96^{**}
per capita income from transport	3.52	0.32	11.14^{**}
per capita income from service	3.09	0.32	9.82^{**}
per capita income from agriculture	3.03	0.42	7.18^{**}

Stepwise log-linear regression of income

Stepwise log-linear regression analysis has produced four models, all of them are well fitted to data. Fourth model is the best model which accommodated four independent variables. It indicates that income increased with the increase in from service, transport and business. It also indicates that household's income is the highest in Bandarban region (Table 4).

Table 4. Stepwise log linear regression of income

Variables	Coefficients	Standard error	t-value
Constant	11.696	0.078	149.57^{**}
Dummy(1 for Bandarban and 0 for otherwise)	0.334	0.092	3.62^{**}
Log of per capita income from service	0.054	0.010	5.35^{**}
Log of per capita income from transport	0.032	0.010	3.09^{**}
Log of per capita income from business	0.029	0.010	3.00^{**}

Household expenditure

The research revealed that households spent an average of BDT 177247.67 a year on 17 distinct expense sectors (Figure 3).

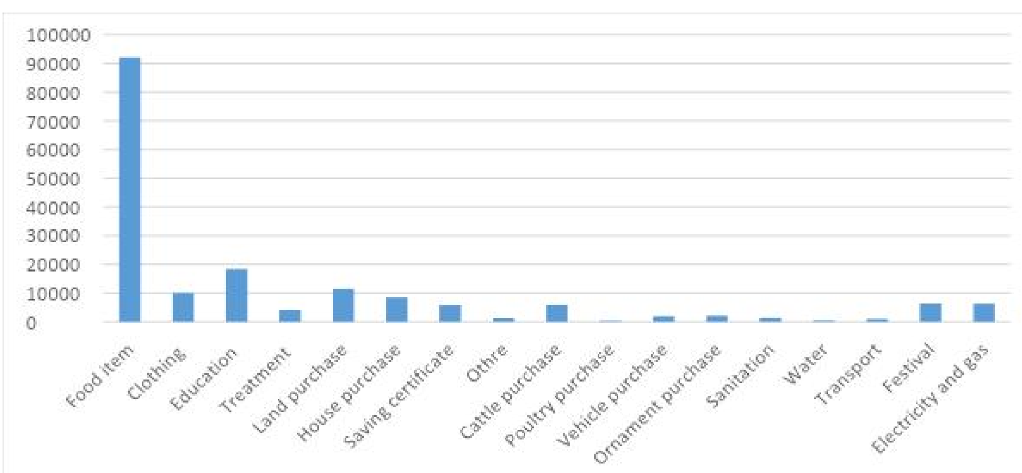

Figure 3. Yearly expenditure of farm household in different cost sectors (BDT)

The areas that incurred expenses included food, apparel, healthcare, education, land acquisition, home repair or purchase, savings certificates, vehicles, ornaments, livestock, water, transportation, festivals, electricity/gases, and other related areas. Food cost (BDT 92158.33) was the largest cost component followed by cost of education, land purchase, cost of clothing, cost of house repairing, cost of festival, and cost of electricity/gases, respectively. The cost items like cost of food, education, festival, electricity and gas and total family expenditure varied significantly among districts (appendix 2)

Stepwise linear regression of expenditure

Stepwise linear regression of expenditure has produced nine models. As indicated by significant F values, every model was well fitted to the data. The model that fits best is the ninth one. The cost of education, land, housing, food, water, saving certificates, poultry, and vehicles all increased daily per capita expenditure and contributed to a large increase in spending (Table 5). It was observed that per capita or household's expenditure was significantly higher in Bandarban district compared to other districts.

Table 5. Stepwise linear regression of expenditure

Model	Coefficients	Std. Error	t-value	p-value
(Constant)	85034.9	9401.439	9.045	.000
Per capita cost of education	7.433	1.011	7.351	.000
Per capita cost of land purchase	5.628	.501	11.224	.000
Per capita cost of house	3.307	.495	6.684	.000
Dummy 1 (1 for Bandarban and 0 for otherwise)	35101.5	8641.203	4.062	.000
Per capita cost of food	1.531	.501	3.052	.003
Per capita cost of water	50.971	13.350	3.818	.000
Per capita cost of saving certificate	3.448	1.222	2.821	.006
Per capita cost of poultry purchase	-47.312	19.750	-2.396	.018
Per capita cost of vehicle purchase	6.144	2.954	2.080	.040

Food consumption status of farm household

The daily food intake per family per capita based on several food categories (appendix 3). Rice was the most important staple food in terms of the highest daily per capita consumption. Daily per capita consumption of rice was 446.61 g whereas daily per capita consumption of leafy vegetables was 108.47 g at the aggregate level. Other important food items in terms of higher amounts of daily per capita consumptions were respectively potato (97.58g), total meat (75.38 g), fruits (53.04 g), brinjal (47.80g), soybean (44.66 g), onion (42.96 g), wheat (40.18 g), lentil (36.43 g), milk (30.16 g), sugar (21.42 g), egg (20.92 g), muri (14.42 g), fish (14.42g), chili (11.21 g), garlic (10.97 g), ginger (5.08g), turmeric (3.91 g), other spices (2.69) at the aggregate level. Nevertheless, Table 8 demonstrates that, as shown by substantial F-values, there were notable regional differences in the daily per capita consumptions of milk, onion, garlic, chili, turmeric, ginger, and other spices, wheat, muri, brinjal, lentil, soybean oil, fish, and other spices. Daily per capita consumption of all food items was the highest in Rangamati district (1169.50 g) followed by that in Bandarban district (1148.14 g) and Khagrachari district (1067.43 g), respectively. The overall daily per capita food intake was 1128.35 g (Figure 4).

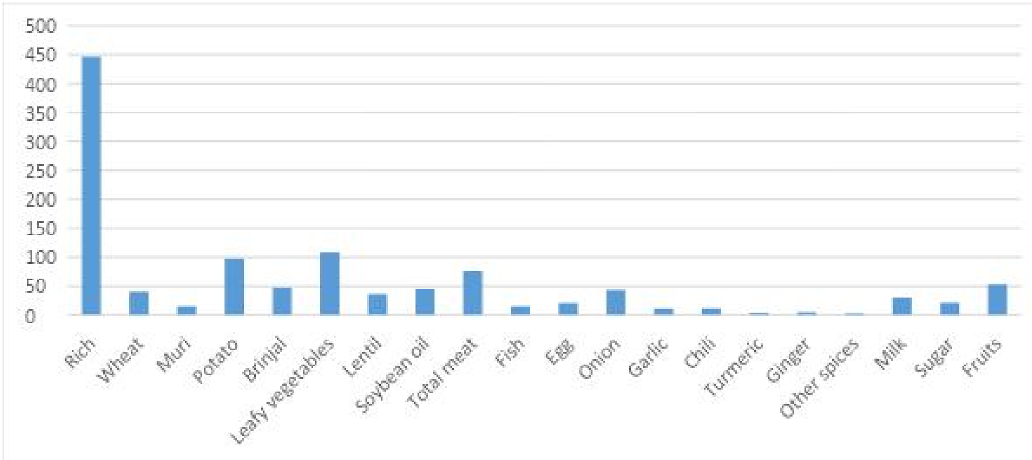

Figure 4. Daily per capita consumption of different food items

Intake of calorie by farm households

One of the main sources of calories for the nation's population is rice. In other words, rice predominates in cuisine. At the aggregate level, it was shown that rice alone produced 1451.49 Kcal per capita. At the aggregate level, soybean oil ranked second in terms of per capita energy providers (190.71 Kcal), behind wheat (130.19 Kcal), lentil (119.85 Kcal), meat (102.51 Kcal), potato (89.78 Kcal), sugar (79.92 Kcal), muri (46.88 Kcal), fruit (46.15 Kcal), egg (36.81 Kcal), leafy vegetables (32.54 Kcal), chili (26.67 Kcal), onion (19.98 Kcal), milk (19.90 Kcal), fish (15.29 Kcal), garlic (15.03 Kcal), brinjal (11.47 Kcal), ginger (4.67 Kcal), and other spices (3.54 Kcal), in that order.

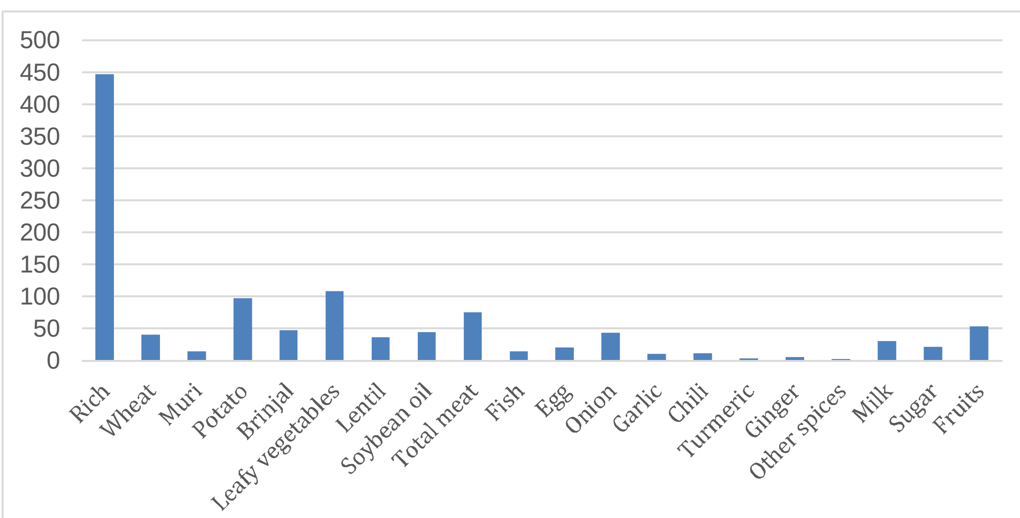

Figure 5. Daily per capita calorie intake of different food items

The overall daily per capita calorie consumption from all food products was 2443.21 Kcal, which was in line with Rahman and Islam's (2012) findings. The total daily intake of calories per person from all dietary products is comparable to the Wikipedia report. In Bangladesh, daily per capita calorie intake was recorded to be 2250 Kcal (Wikipedia, 2015). The daily per capita calorie intake was the highest in Rangamati district (2542.23 Kcal) followed by that in Bandarban district (2484.46 Kcal) and Khagrachari district (2302.95 Kcal), respectively (Figure 5).

Calorie intake function

Increased consumption of rice led to a considerable rise in per capita calorie intakes, as demonstrated by both linear and log-linear models. In a similar vein, daily calorie intake increased dramatically with per capita monthly income. It was found that the per capita calorie intake increased by 4 units for every unit increase in rice consumption. On the other hand, the log-linear calorie intake model indicates that a 1% rise in rice consumption corresponded to a 0.67 percent increase in calorie intake. In a similar vein, there was a 0.02 unit rise in per capita calorie intake for every unit increase in per capita monthly income. Family size did, however, considerably lower the amount of calories consumed per person (Table 6).

Table 6: Daily per capita calorie intake function

Variables description	Linear model		Log-Linear Model	
	Coefficient	Std. error	Coefficient	Std. error
Intercept	846.14**	185.17	3.64**	0.229
Rice consumption	4.03**	0.19	0.67**	0.034
Per capita monthly income	0.02*	0.01	0.034	0.019
Total family size	-85.92**	19.06	-0.21**	0.04
Age	3.52	2.02	0.040	0.03
Education	4.14	5.94	0.003	0.002
Adjusted R^2	0.863		0.845	
F-value	151.30**		130.58**	

** and * indicate significances at 0.01 and 0.05 probability level, respectively.

Intake of protein by farm households

An essential component of the human diet is protein. Dietary protein deficiencies lead to a host of disorders and slow down the growth and development of the body. Foods higher in protein are more expensive than those with lower protein content. Keeping one's health is a sign of food security. Food refers to nourishing food in the context of food security. The protein content of rice was 22.33 g, with the next biggest amounts coming from meat (15.07 g), soybean (11.17 g), vegetables (9.22 g), lentil (7.28 g), wheat (4.86 g), egg (2.51 g), and fish (1.44 g), in that order. According appendix 5 9, the districts with the greatest daily per capita protein intake were Rangamati (83.45 g), Bandarban (80.08 g), and Khagrachari (72.11 g).

Protein intake function

It was found that daily per capita intakes of protein were considerably enhanced with increased consumption of meat, rice, and other animal proteins. A 1percent increase in per capita rice consumption resulted in a 0.37 percent increase in per capita protein intake in the log-linear protein intake function. Comparably, a 1 percent increase in the per capita consumption of meat raised the intake of protein by 0.20 percent, while a 1 percent increase in the per capita consumption of fish, milk, and eggs increased the intake of protein by 0.05 percent. On the other hand, a larger family drastically decreased the amount of protein consumed per person (Table 7).

Table 7: Daily per capita protein function

Variables description	Linear model		Log-Linear Model	
	Coefficient	Std. error	Coefficient	Std. error
Intercept	33.89**	6.95	1.55**	0.31
Daily per capita rice consumption	0.09**	0.008	0.37**	0.04
Daily per capita meat	0.23**	0.03	0.20**	0.02
Daily per capita fish, milk and egg consumption	0.057*	0.02	0.05*	0.01
Land area in decimal	0.12	0.05	0.01	0.01
Total family size	-3.65**	0.79	-0.31**	0.05
Adjusted R^2	0.810		0.782	
F-value	102.548**		86.253**	

** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Estimation of binary and multinomial logistic regression models

Based on the findings of binary logistic regression, it was possible to dramatically reduce the farmers' likelihood of food security by 0.287 times for every unit increase in family size. Once more, the binary logistic regression demonstrated that, on average, a one-unit rise in the total cost of all food consumed might result in a 1.003-fold increase in the likelihood of food security for the population (Table 8). On the state of food security, however, the effects of education, land area, and monthly per capita income were null.

Table 8. Logistic regression estimates of the effects of different determinants on food security

Independent variables	Coeff.	Std. error	t-value	P-value	Odds Ratio (OR)
Education	-.009	0.067	.020	0.888	0.991
Family size	-1.24**	0.324	14.872	0.000	0.287
Total land size	-.009	0.014	0.383	0.536	0.992
Weekly family food	.003**	0.001	20.540	0.000	1.003
expenditure	0.000	0.000	2.555	0.110	1.000
Per capita monthly income	-.040	1.851	0.000	0.983	0.961
Constant					

** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Three levels of food security were used to estimate the multinomial logistic regression model, with the reference category being food secure. According to Table 14, multinomial logistic regression analysis shows that a one-unit increase in total land area and monthly per capita income can, on average, reduce the likelihood of food insecurity by 0.995 times (p~<0.01) and 1.00 times ($p<0.01$), respectively, when compared to a food secure condition. Once more, the multinomial logistic regression shows that, on average, a 1 unit increase in total land size could result in a substantial drop in the likelihood of relatively food security—by 1.017 times (pˁ0.01)—when compared to a situation of food security. However, it also demonstrated that the risk of relatively food security could be significantly reduced by 0.999 times (p~<0.01) with an average 1 unit increase in per capita monthly income compared to the food security condition (Table 9).

Table 9. Multinomial logistic regression estimates of determinants on food security

Three level of food security	Independent variables	Coeff.	Std. error	t-value	P-value	Odds Ratio (OR)
Food insecure	Education	-1.215	2.378	.261	0.610	1.027
	Family size	0.027	.086	.097	0.756	5.996
	Total land size	-1.791**	0.444	16.306	0.000	0.995
	Weekly family	-0.005	0.020	.060	0.807	0.996
	food expenditure	-0.004**	.001	18.259	0.000	1.000
	Per capita monthly income	0.000	0.000	0.490	0.484	
	Constant					
Relatively food secure	Education	-.010	2.090	.000	0.996	.987
	Family size	0.013	.077	.027	0.870	2.510
	Total land size	-0.920**	.347	7.017	0.008	1.017
	Weekly family	0.017	0.015	1.233	0.267	0.998
	food expenditure	-0.002**	0.001	10.254	0.001	.999
	Per capita monthly income	-0.001	0.000	3.250	0.071	
	Constant					

Reference category is food secure. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Estimation of Cobb-Douglas stochastic revenue function and inefficiency effect model

Cobb-Douglas Using the statistical software Frontier 4.1, the stochastic frontier revenue function and the household revenue inefficiency effect models were computed concurrently. In order to determine the factors influencing output and to estimate the revenue efficiency particular to a farm, the stochastic frontier revenue function was employed. On the other hand, factors in the revenue inefficiency effect model indicate which factors are responsible to increase or decrease of revenue inefficiency. It was found that whereas education had a significantly negative impact on revenue growth, total land area, fertilizer, and labor man days had a significantly beneficial impact in the stochastic frontier model (Table 10). Age and education showed expected (negative) indications in the revenue inefficiency impact model, meaning that as these characteristics increased, revenue inefficiency fell. Put otherwise, we can state that as these parameters rose, revenue efficiency also increased (Table 14). Nevertheless, the effects of revenue inefficiency rise with family size. There were significant consequences of revenue inefficiency in households, as indicated by the significant Γ value and the significant generalized likelihood ratio test.

The frequency distribution of farm-specific revenue efficiency estimates from Cobb-Douglas stochastic frontier revenue function (appendix 6). It reveals that the farm-specific revenue efficiency varies from 1.15% to 91% for households in the CHT. The maximum farm-specific revenue efficiency has been observed to be in the range of 71-80% for households in the CHT. The mean revenue efficiency estimated from the Cobb-Douglas stochastic revenue function is 56% which implies that 44% revenue could be increased by optimally using all limited resources among all enterprises of households in the CHT.

Table 10. Maximum likelihood (ML) estimation of revenue function and inefficiency effect models

Name of the variables	Parameters	ML Estimates (std. error)
Stochastic cost frontier model:		
Constant	β_0	6.271** (0.43)
Total land area	β_1	0.45507** (0.13)
Fertilizer in (Kg)	β_2	0.2918* (0.12)
Labor man days	β_3	0.4528* (0.16)
Pesticide (g)	β_4	0.1782 (0.12)
Education	β_5	-0.0495** (0.0144)
Inefficiency effect model:		
Intercept	δ_0	16.4143 (22.21)
Age	δ_1	-0.094 (0.1204)
Education	δ_2	-1.2092 (1.159)
Family size	δ_3	0.7030 (0.933)
Variance parameters:		
	σ^2	20.3771 (22.39)
	Γ	0.9948** (0.0064)
Log likelihood function		-130.97
Generalized Log-likelihood Ratio (LR) test		41.0304

Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

IV. CONCLUSIONS AND POLICY IMPLICATION

This study sought to assess food security for the inhabitants of Chittagong Hill Tracts (CHT) and identify possible obstacles to reaching the Sustainable Development Goals (SDGs). The results reveal that the growth of enterprises and income generation has notably improved food security in CHT. Enhanced food consumption, calorie intake, and protein intake were strongly linked to these economic developments. The business sector offered the highest income followed by agriculture, service and transport sectors, respectively. In addition, enterprise development and income generation have improved some other food security and economic indicators of people. These indicators were income, savings, and expenditure on education, permanent assets, ornament, housing, and employment opportunity. Judicious distribution of all limited resources among all crops and businesses can result in a notable increase in revenue.

An increase of land size and income significantly increases food security. Similarly, increased expenditure on food items and decrease in family size increase the food security of people in the CHT. The government should take steps and create facilities so that people in that area can develop their own enterprises and run their businesses without hindrance from natural and human, induced calamities. Family size can be reduced through education and family planning with a view to increasing livelihood and food security. In addition, the government safety net program should be extended to encompass all marginalized and vulnerable people with a view to achieving food security.

The CHT has experienced landslides, soil erosion, and siltation of lakes and water bodies. These events have been attributed to the overuse of land and forest resources brought on by the rapid increase in population and the adoption of shifting cultivation, followed by the cultivation of root crops like ginger and turmeric on sloping lands. The monsoon season accelerated the processes of soil erosion, soil nutrition, and top soil erosion, which drastically reduced the production of basic foods and had a negative impact on the food security and standard of living of the CHT's impoverished indigenous population. People had been practicing shifting cultivation by burning plants and trees in the hilly areas, which caused landslides, soil erosion, and environmental degradation. In that case, tobacco cultivation could be completely stopped as it has a serious negative impact on the environment. To discourage the shifting cultivation of the local people, alternative enterprise for income generation could be developed. That would require huge investment from the government, which the government could not afford alone. However, the government could attract the international development partners to invest in that area, or under the umbrella of private-public partnership program, the development of alternative income sources could be achieved.

In addition, there is sporadic in fighting between rival factions of tribal people, which is considered to be a hindrance ~~of~~ regular movements of essential commodities and also to attaining the SDGs.

Other problems are the diversity of language and culture among the ethnic groups, geographical remoteness, lack of access to quality education, extreme poverty, a lack of general health care facility, and a lack of water and sanitation facilities. To eradicate the aforementioned issues, a robust policy tool is required to institutionalize the development activities of international development partners, NGOs, and government agencies in a comprehensive and long-lasting manner.

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Appendix

Absolute poverty line:

$\ln Y_i = 7.052 + 0.000327X$
$= 7.052 + 0.000327 \times 2122$
$= 7.745894$
$Y = Exp(7.745894)$
= Tk. 2312.06

Hard core poverty line:

Again, $\ln Y_i = 7.052 + 0.000327X$
$= 7.052 + 0.000327 \times 1805$
$= 7.642235$
$Y = Exp(7.642235)$
= Tk. 2084.39

Table 1: Daily per capita total linear of income function

Variables description	Linear model		Log-linear model	
	Coefficient	Std. error	Coefficient	Std. error
Intercept	74513.51**	11966.25	11.47**	0.36
Per capita income from agriculture	2.93**	0.43	0.02**	0.04
Per capita income from transport	3.57**	0.32	0.03	0.01
Per capita income from business	3.54**	0.28	0.03**	0.01
Per capita income from tourist	1.66	1.57	0.02	0.02
activities	3.03**	0.32	0.06	0.01
Per capita income from service	13352.68	14571.86	0.34	0.10
Dummy1(1 for Bandarbon and 0 otherwise)	24307.32	14449.85	0.01	0.11
Dummy2(1 for Khagrachari and 0 otherwise)				
Adjusted R^2	0.748		0.280	
F-value	51.562**		7.614**	

Note: Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Table 2. Yearly average expenditure of farm households in different cost sectors (BDT)

Cost Sector	District				
	Khagrachari	Rangamati	Bandarban	Total	F-value
Food item	78425.00 (23321.48)	89275.00 (31496.83)	108775.00 (38647.97)	92158.33 (33939.64)	9.37**
Clothing	8925.00 (4344.98)	9900.00 (5490.32)	11450.00 (7561.54)	10091.67 (5991.23)	1.83
Education	21117.50 (22983.19)	11485.00 (13635.31)	22510.00 (25041.17)	18370.83 (21535.75)	3.22*
Treatment	3997.50 (4915.83)	2960.00 (3288.27)	5212.50 (7437.68)	4056.67 (5517.94)	1.69
Land purchase	18000.00 (54358.73)	3675.00 (13857.12)	12750.00 (56304.01)	11475.00 (45886.77)	0.998
House purchase	16050.00 (64009.19)	7450.00 (28641.86)	2000.00 (5970.01)	8500.00 (40706.78)	1.216
Saving Certificate	5755.00 (11385.77)	3862.50 (11223.25)	7610.00 (18815.76)	5742.50 (14218.12)	0.691
Other	575.00 (1824.16)	225.00 (831.66)	3010.00 (13364.09)	1270.00 (7835.61)	1.51
Cattle Purchase	6737.50 (13719.25)	2750.00 (7591.32)	7950.00 (22266.39)	5812.50 (15749.09)	1.20
Poultry Purchase	360.00 (828.59)	227.50 (723.59)	462.50 (1173.35)	350.00 (925.82)	0.644
Vehicle Purchase	1550.00 (8082.74)	2125.00 (6783.04)	2125.00 (7586.04)	1933.33 (7444.73)	0.08
Ornament Purchase	2000.00 (5647.78)	2875.00 (7240.16)	1500.00 (4113.77)	2125.00 (5788.37)	0.57
Sanitation	1637.50 (4215.34)	787.50 (3018.93)	1575.00 (4431.17)	1333.33 (3923.82)	0.58
Water	782.50 (2665.05)	365.00 (1613.97)	242.50 (685.71)	463.33 (1841.03)	0.94
Transport	1261.00 (2461.23)	385.00 (1005.76)	1262.50 (3002.12)	969.50 (2332.98)	1.91
Festival	4912.50 (6452.87)	5350.00 (6261.60)	8737.50 (9412.88)	6333.33 (7647.25)	3.10*
Electricity and Gas	3369.50 (4438.95)	5727.50 (5943.88)	9690.00 (5864.79)	6262.33 (6013.92)	13.69**
Total family Expenditure	175455.50 (108068.03)	149425.00 (57387.93)	206862.50 (93776.92)	177247.67 (91350.98)	4.18*

Note: Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Table 3. Daily per capita average consumption of different food items

Food consumption	District				
	Khagrachari	Rangamati	Bandarban	Total	F-value
Rice	420.28 (121.67)	463.50 (152.21)	456.06 (135.11)	446.61 (137.06)	1.14
Wheat	38.71 (36.73)	29.76 (35.65)	52.07 (38.29)	40.18 (37.73)	3.70*
Muri	22.90 (20.05)	10.34 (17.65)	10.002 (15.71)	14.42 (18.73)	6.74**
Potato	99.20 (52.34)	107.18 (58.46)	86.38 (45.08)	97.58 (52.52)	1.61
Brinjal	51.88 (31.32)	49.62 (30.64)	41.91 (17.37)	47.80 (27.32)	1.48
Leafy vegetables	115.71 (89.65)	100.62 (61.97)	109.07 (51.87)	108.47 (69.38)	0.47
Lentil	37.60 (18.91)	46.97 (56.62)	24.71 (14.74)	36.43 (36.37)	3.97*
Soybean oil	38.43 (15.25)	50.02 (19.09)	45.54 (23.10)	44.66 (19.84)	3.62*
Total meat	63.36 (39.30)	84.60 (51.83)	78.17 (36.79)	75.38 (43.71)	2.55
Fish	5.27 (14.84)	15.60 (26.36)	22.40 (34.60)	14.42 (27.25)	4.22*
Egg	16.93 (9.67)	23.67 (16.50)	22.15 (13.22)	20.92 (13.62)	2.77
Onion	36.73 (14.45)	45.07 (22.35)	47.09 (20.23)	42.96 (19.66)	3.24*
Garlic	7.60 (3.28)	11.45 (7.45)	13.86 (7.61)	10.97 (6.88)	9.63**
Chili	10.57 (6.91)	13.80 (8.63)	9.26 (5.46)	11.21 (7.32)	4.30*
Turmeric	2.73 (2.13)	4.08 (2.32)	4.93 (1.61)	3.91 (2.22)	11.76**
Ginger	3.80 (3.54)	4.40 (2.98)	7.05 (2.84)	5.08 (3.42)	12.20**
Other spices	1.16 (1.46)	2.63 (2.14)	4.30 (2.69)	2.69 (2.49)	21.22**
Milk	28.56 (38.99)	28.76 (52.06)	33.15 (38.35)	30.16 (43.28)	0.142
Sugar	19.44 (19.22)	21.20 (21.93)	23.64 (13.86)	21.42 (18.56)	0.512
Fruits	46.56 (37.91)	56.21 (86.08)	56.36 (38.34)	53.04 (58.33)	0.367
Total Foods items	1067.43 (300.51)	1169.50 (380.76)	1148.14 (305.12)	1128.35 (331.01)	1.06

Note: Figure in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Table 4. Daily per capita average calorie intake of different food items

Food consumption	District				
	Khagrachari	Rangamati	Bandarban	Total	F-value
Rice	1365.91 (395.43)	1506.38 (494.70)	1482.19 (439.11)	1451.49 (445.46)	1.14
Wheat	125.41 (119.01)	96.43 (115.51)	168.72 (124.06)	130.19 (122.26)	3.70*
Muri	74.45 (65.16)	33.62 (57.37)	32.58 (51.05)	46.88 (60.89)	6.74**
Potato	91.26 (48.16)	98.61 (53.78)	79.47 (41.48)	89.78 (48.32)	1.61
Brinjal	12.45 (7.52)	11.91 (7.35)	10.06 (4.17)	11.47 (6.56)	1.48
Leafy vegetables	34.71 (26.90)	30.19 (18.59)	32.72 (15.56)	32.54 (20.81)	0.47
Lentil	123.72 (62.21)	154.55 (186.29)	81.28 (48.48)	119.85 (119.67)	3.97*
Soybean	164.11 (65.14)	213.58 (81.55)	194.46 (98.65)	190.71 (84.72)	3.62**
Fish	5.59 (15.73)	16.54 (27.94)	23.74 (36.68)	15.29 (28.88)	4.22*
Meat	86.16 (53.45)	115.06 (70.49)	106.32 (50.04)	102.51 (59.44)	2.55
Egg	29.80 (17.03)	41.66 (29.04)	38.99 (23.26)	36.81 (23.98)	2.77
Onion	17.08	20.96	21.90	19.98	3.24*
	(6.72)	(10.39)	(9.40)	(9.14)	
Garlic	10.41 (4.50)	15.69 (10.21)	18.98 (10.42)	15.03 (9.43)	9.63**
Chili	25.05 (16.39)	32.70 (20.45)	21.95 (12.95)	26.67 (17.34)	4.30*
Ginger	3.49 (3.26)	4.04 (2.74)	6.49 (2.61)	4.67 (3.14)	12.20**
Other spices	1.48 (1.87)	3.37 (2.74)	5.50 (3.44)	3.45 (3.19)	21.22**
Milk	18.85 (25.74)	18.98 (34.36)	21.88 (25.31)	19.90 (28.56)	0.142
Sugar	72.51 (71.68)	79.06 (81.81)	88.18 (51.71)	79.92 (69.25)	0.512
Fruit	40.51 (32.98)	48.90 (74.89)	49.03 (33.36)	46.15 (50.75)	0.37
All Food items	2302.95 (566.36)	2542.23 (794.41)	2484.46 (678.33)	2443.21 (687.92)	1.32

Note: Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Table 5. Daily per capita average protein intake of different food items

Food consumption	District				
	Khagrachari	Rangamati	Bandarban	Total	F-value
Rice	21.01 (6.08)	23.17 (7.61)	22.80 (6.75)	22.33 (6.85)	1.14
Wheat	4.68 (4.44)	3.60 (4.31)	6.30 (4.63)	4.86 (4.56)	3.70*
Protato	1.98 (1.05)	2.14 (1.17)	1.73 (.90)	1.95 (1.05)	1.61
Vegetables	9.83 (7.62)	8.55 (5.27)	9.27 (4.41)	9.22 (5.90)	0.47
Lentil	7.52 (3.78)	9.39 (11.32)	4.94 (2.95)	7.28 (7.27)	3.97*
Soybean	9.61 (3.81)	12.50 (4.77)	11.38 (5.77)	11.17 (4.96)	3.62*
Fish	0.53 (1.48)	1.56 (2.64)	2.24 (3.46)	1.44 (2.72)	4.22*
Meat	12.67 (7.86)	16.92 (10.37)	15.63 (7.36)	15.07 (8.74)	2.55
Milk	0.57 (0.78)	0.57 (1.04)	0.66 (0.76)	0.60 (0.86)	0.14
Egg	2.03 (1.16)	2.84 (1.98)	2.66 (1.59)	2.51 (1.63)	2.77
Onion	0.44 (0.17)	0.54 (0.27)	0.56 (0.24)	0.51 (0.23)	3.24*
Garlic	0.40 (0.17)	0.60 (0.39)	0.73 (0.40)	0.58 (0.36)	9.63**
Ginger	0.20 (0.18)	0.23 (0.15)	0.37 (0.15)	0.27 (0.18)	12.20**
Chili	0.17 (0.11)	0.22 (0.13)	0.15 (0.09)	0.18 (0.12)	4.30*
Spices	0.03 (0.04)	0.08 (0.06)	0.13 (0.08)	0.08 (0.07)	21.22**
Fruits	0.42 (0.34)	0.50 (0.77)	0.50 (0.34)	0.48 (0.52)	0.37
All food items	72.11 (20.45)	83.45 (28.91)	80.08 (23.53)	78.55 (24.80)	2.25

Note: Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

Table 6. Frequency distribution of farm-specific revenue efficiency estimates from Cobb-Douglas stochastic revenue functions

Efficiency level (%)	Number of farm
1-10	6 (5)
11-20	10 (8.33)
21-30	3 (2.5)
31-40	12 (10.83)
41-50	11 (9.17)
51-60	16 (13.33)
61-70	17 (14.17)
71-80	26 (21.67)
81-90	18 (15)
91-100	1 (.83)
Mean Efficiency	56
Minimum Efficiency	1.15
Maximum Efficiency	91

Figures in the parentheses indicate percentages