

Seasonal Food Insecurity in the Drought-Prone Northwestern Region of Bangladesh: An Econometric Analysis

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Abstract

Agricultural crops of Bangladesh are especially sensitive to climatic variability such as temperature, rainfall, humidity, and natural disasters like floods, drought, salinity, and storm surges. The northwestern region of Bangladesh is particularly vulnerable to drought because of prevailing hydrologic and temperature conditions. In recent decades, the region has had a shortfall of crops production and hence seasonal food insecurity. This study carried out household interviews (n=314), followed by a structured questionnaire in the drought-prone northwestern region of Bangladesh to identify the determining demographic and socio-economic factors of seasonal food insecurity in the drought-prone northwestern region. This study used the Probit model for the analysis. Provision of micro credit, use of drought tolerant crops, and drought mitigating social safety net programs can help to improve food security in this region. The findings of this study provide a robust basis for policy makers, researchers, government, stakeholders, NGOs, and development partners for further research, project implementation, and development of specific policies in this field to lessen seasonal food insecurity conditions.

Keywords: Food insecurity, Drought, Northwestern region, Bangladesh

1. Introduction

Climate change due to global warming and its negative consequences on the environment and agro-ecosystem is a threat to the economy of Bangladesh. Agricultural crops are especially sensitive to climate variability such as temperature, rainfall, and humidity, as well as natural disasters like floods, drought, salinity, and storm surges (CEGIS, 2008). Bangladesh uses more than 70% of its land for agricultural purposes, often with multiple cropping seasons, while nearly all of the remainder is covered by forests, settlements, roads, and waterways (FAO STAT, 2009). Bangladesh is also one of the most densely populated countries in the world with over 940 people per square km. Its GDP per capita is about US\$ 848 (at current prices 2011-12) (Board of Investment, Bangladesh, 2013) and over 40% of the population of the country lives below the poverty line (Shahid & Behrawan, 2008). Population is increasing 1.8 million every year and is expected to increase to 185 million people by 2020 and 222 million by 2050 (Islam, 2013). The combination of high spatial and temporal climatic variability, extreme weather events, high population density, high incidence of poverty, social inequality, poor institutional capacity, and inadequate financial resources makes Bangladesh extremely vulnerable to natural disaster and food security (Ahmed, 2004). The northwestern region of Bangladesh has a large population living in extreme poverty. The intense drought and reduced crop production further exacerbate poverty by diminishing food security, especially during the summer season (March, April, and May). The drought-prone northwestern region has been experiencing recurrent below-average rainfall, high temperatures, high poverty, poor food consumption scores, weak economy and per capita GDP that are far below the national average (Zug, 2006a; Zug, 2006b; Bangladesh Planning Commission, 2012; UNDP, 2012). Populations living in the northwestern region had worse (lower) food consumption scores in comparison with other regions of Bangladesh (Bangladesh Planning Commission, 2012). Average annual rainfall, poverty headcount, and food insecurity data of different regions are depicted in Table 1.1.

Table 1.1. Average annual rainfall, percentage of poverty headcount, and food insecurity status for the years (2005-2010) of different regions of Bangladesh

National/Division	Average annual rainfall ^a	Poverty headcount (%) ^b	Food insecurity status (food consumption score) (%) ^c
Barisal	2126 mm	52.0	26.0
Chittagong	2918.5 mm	34.0	25.0
Dhaka	2148.8 mm	32.0	20.0
Khulna	1808.5 mm	45.7	25.0
Rajshahi (Study area)	1541.8 mm	51.2	31.0
Sylhet	4066.5 mm	33.8	24.0
National	2339.1 mm	40.0	25.0

Source: Weather base, 2013^a; UNDP, 2012^b; Bangladesh Planning Commission, 2012^c

Occurrences of drought are a major water deficiency related issue in the northwestern region of Bangladesh (Dey, et al., 2011). Drought not only leads to shortages of water and food but can also have a long-term environmental, socio-economic, and health impact on the population (Sheffield et al., 2009; World Health Organization, 2011).

According to the FAO Corporate Document Repository (2001), food security is defined as a situation in which “all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preference for an active and healthy life.” Food insecurity can be of limited duration and seasonally recurring (FAO Corporate Document Repository, 2001). This occurs when there is a cyclical pattern of inadequate availability and access to food and is associated with seasonal fluctuations in the climate, cropping patterns, work opportunities (labor demand) and disease (FAO 1996). The lack of food security and subsequent vulnerability is an outcome of, according to FAO (2008), a combination of four dimensions: availability, stability, access, and utilization of food (FAO, 2008). Thus, food insecurity (and consequent vulnerability) is an ex-ante (or forward-looking) risk or probability that a household will, if currently food secure, fall below the food security threshold, or if currently insecure, will remain so in the future (Chaudhuri et al., 2002).

Drought-prone areas are found in arid, semi-arid, and sub-humid regions of the country that experience less than average annual rainfall (Abbas et al., 2013). Drought causes the earth to parch and creates a hydrologic imbalance that results in water shortages, dried wells, depletion of groundwater and soil moisture, stream flow reduction, crop failure, losses of assets, scarcity of drinking water, and greater household food insecurity. During drought, food consumption falls, along with the household’s ability to meet food needs on a sustainable basis. Vegetables and many other beans are in short supply during the drought spell

time (FAO, 2007). There are is a high proportion of agricultural labor households because the major employment opportunity in drought prone regions is agricultural wage labor. There is very limited demand for labor from other sectors. So, alternative sources of employment are almost non-existent (FAO, 1991). In a society where agriculture is the primary economic activity, the impact of drought is observed in the form of decreased food production, as a consequence of decreases in cultivated land and crop yield and the second-order impacts are decreased employment and income (Paul, 1998). Such excessive dependence on agriculture makes the inhabitants of this region poorer and more vulnerable to drought. More than one-third of the households in the northwestern region face food shortage throughout the year and another one-third face temporary food shortages during the lean period (Shahabuddin & Ali, 2006). Concurrent with reduced food production, prices of food grains usually rise rapidly following a drought (Ghose, 1982; Watts, 1987). Decreased food production, abnormal increases in food grain prices and non-availability of jobs reduce the food entitlement of rural people, especially small farmers and landless laborers (Paul, 1998). The dynamic nature of food insecurity among households is a consequence of an array of risk factors such as seasonal unemployment, damaged crop production by extreme climatic events like drought, lack of alternative employment opportunities, and inability to manage these risks (Sen, 2010). Food insecure households have to cut back food consumption below subsistence levels that assures minimum caloric intake for health and survival (Stringer, 2000). The conceptual framework of the impacts of drought is depicted in Figure 1.1.

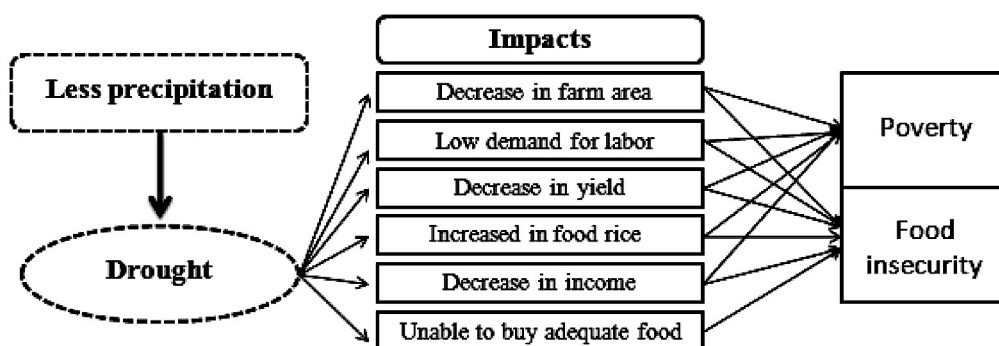


Figure 1.1. Conceptual framework of the impacts of drought
Source: Modified from policy study report of UNDP, 2009

In the summer season, most farmers in the northwestern region keep their land fallow because drought will diminish crop production to the extent that they cannot cover the total cost (TC) of production. As a consequence, they hired fewer agricultural labors. So, in the drought season, most of the poor, landless, and hired laborers face a general food insecurity problem due to lack of employment opportunity and other income generating activities. Without jobs and income they cannot afford food. Per capita food availability in the northwestern region declined from 458 g/day in 1990/1991 to 418 g/day in 1998/1999 while per capita fish intake decreased from 11.7 kg/year in 1972 to 7.5 kg/year in 1990 (Begum, 2002). Large numbers of people in the northwestern region live below the poverty line and face acute food insecurity. Drought diminishes dietary diversity and reduces overall food consumption, which could also lead to micronutrient deficiencies (IPCC, 2007). Household food insecurity leads to adverse health outcomes (Cook et al., 2004). In the drought season, the inhabitants of the northwestern region eat less nutritious food or substandard food because of the limited incomes. They became weaker and face other health problem which further reduces their productivity. Health related problems observed in the northwestern region are presented in Table 1.2.

Table 1.2. Health related problems in northwestern region of Bangladesh

Indicators	% of respondents	
	Severe drought-prone area of northwestern region	Slight drought-prone area of northwestern region
Malaria	12%	14%
Diarrhea	32%	6%
Typhoid	13%	11%
Fever	17%	14%
Dysentery	22%	19%
Pox	12%	9%
Consult with doctors	16%	27%

Source: Calculated by the authors based on their collected household cross-section data, 2010

There are large numbers of existing peer-reviewed studies focused on drought and food security in the world. Drought constrains rain-fed agricultural production, especially in arid and semi-arid lands (ASALs) of Kenya; which covers about 88% of the country. The result has been total crop failures and livestock deaths which led to severe food shortages in the country (Huho & Mugalavai, 2012). Prolonged drought is affecting the world's best food producing regions in the northern hemisphere threatening global grain reserves and world food security (Carter, 2013). Drought ranks as the single most common cause of severe food shortages, particularly in developing countries, and represents one of the most important natural triggers of malnutrition and famine. It affects the four dimensions of food security - availability, stability, access, and utilization (FAO, 2011). For Bangladesh, there are several studies about the drought issue. These studies focused on drought risk assessment in the western part of Bangladesh (Shahid & Behrawan, 2008), coping mechanisms practiced by drought victims in North Bengal, Bangladesh (Paul, 1998), integrated management of the coastal zone for food security (Bala & Hossain, 2009), groups vulnerable to food insecurity (Mallick & Rafi, 2009), Monga¹ and seasonal food insecurity in Bangladesh (Ahmed et al., 2012). However, very few studies focus on the socio-economic assessment of food insecurity in the drought-prone northeastern region of Bangladesh. The severity and category of drought in Bangladesh varies throughout the regions of Bangladesh and it is essential to review different policies for different drought levels or categories among the different regions. The northwestern region experiences more severe droughts compared to other regions of Bangladesh and therefore, this region may require different policies for ensuring food security. This study focuses on the demographic and socio-economic assessment of seasonal food insecurity resulting from severe droughts in the northwestern region of Bangladesh.

This study considers specific and relevant demographic and socio-economic factors in an econometric model to generate empirically supported explanations and assessment of food insecurity under severe drought conditions. The findings of this study provide a robust basis for policy makers, researchers, government, stakeholders, NGOs, and international organizations for further research, project implementations, and development of specific policies to lessen seasonal food insecurity in the northwestern region of Bangladesh. In addition, the findings of this study are also helpful for similar region or countries facing food insecurity under the severe drought condition.

The specific objective of this study is to identify the major determining factors of seasonal food insecurity in the drought-prone northwestern region of Bangladesh based on demographic and socio-economic characteristics and recommend an approach for the food insecure people.

The organization of the paper is as follows. Data and methodology sections briefly present an overview of seasonal food insecurity by Probit model. The results and discussions of the Probit model are presented in the following section, and the last section concludes the paper with major policy recommendations.

2. Study area

This study focused on the whole northwest region of Bangladesh (see Figure 2.1 for more details). The northwestern region has an area of 34,513 km², and is bounded by West Bengal of India in the north, Khulna and Dhaka divisions in the south, Asam and Meghalaya provinces of India and Dhaka division to the east and West Bengal of India to the west (Banglapedia, 2003). The northwestern region of Bangladesh is split into two divisions, namely, Rajshahi division and Rangpur division². Due to the lack of data, this study considered Rajshahi and Rangpur divisions jointly as Rajshahi division. Generally, it is the region lying west of Jamuna River and north of Padma River, and includes the Barind Tract³. The major portion of this region has severe drought conditions and the remaining portions have slight and moderate drought conditions. High levels of droughts are the common and recurrent phenomenon in the area because of lower rainfall and higher temperature (Paul, 1998; Rahman, 2011). This region is under threat in terms of food security because the four dimensions of food security (availability, stability, access, and utilization) are not working simultaneously. Agriculture is the principal source of employment engaging 40.99 % of the population as farmers and 22.9 % of the population as agricultural laborers. Almost 31 % of the people are landless poor who have greater vulnerability to drought and food insecurity (Banglapedia, 2003). This study also considers the less severe drought areas (sections which have higher rainfall and lower temperatures compare to severe drought areas) as the baseline or bench mark to compare with the severe drought-prone part.

3. Data and methodology

The primary sampling unit was the individual household. The sample size is 314 households. In this study, a household is defined as a group of people in a housing unit living together as a family and sharing the same kitchen. The head of the household is defined as the person making the major economic, social, and household decisions irrespective of age and gender.

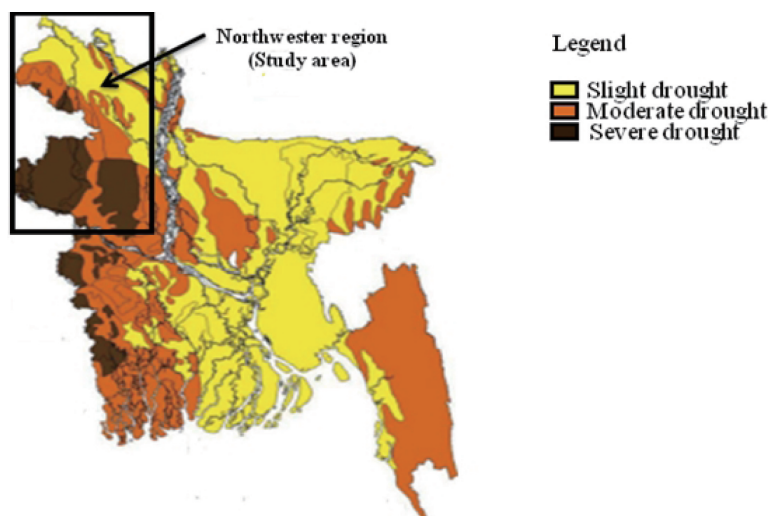


Figure 3.1. Study area (Northwestern region) of Bangladesh
Source: Prepared by the authors on the basis of Ahmed, A. U. 2006

Table 3.1. Sample household: some selected characteristics

Characteristics	Severe drought prone area of northwestern region		Slight drought prone area of northwestern region	
	Number	Percentage	Number	Percentage
Household head's individual characteristics				
Male headed household	103	65.61	97	61.78
Female headed household	54	34.39	60	38.22
Age group (25-60) years	87	55.41	82	52.23
Age group (>60) years	70	44.59	75	47.77
Household's characteristics				
Small farmer	71	45.22	79	50.32
Hired labor	47	29.94	51	32.48
Depends on SSP ⁴	39	24.84	27	17.20
3 members family	11	7.00	19	12.10
(4-7) members family	122	77.71	117	74.52
(>8) members family	24	15.29	21	13.38
Annual income (<20,000) Tk. ⁵	77	49.04	37	23.57
Annual income (20,000-40,000) Tk.	41	26.11	46	29.30
Annual income (41,000-60,000) Tk.	21	13.38	47	29.94
Annual income (61,000-80,000) Tk.	11	7.01	16	10.19
Annual income (>80,000) Tk.	7	4.46	11	7.00
Micro credit status				
Getting micro credit facilities	87	55.41	92	58.60
Not getting micro credit facilities	70	44.59	65	41.40
Educational attainment				
Illiterate	52	33.12	49	31.21
Primary education (1-5) classes	71	45.22	82	52.23
Secondary education (6-10) classes	31	19.75	17	10.83
More than secondary education	3	1.91	9	5.73
Price status				
Food security affected by high price in the drought season due to low agricultural production	127	80.89	52	33.12
Food security affected by other factors (Except high food price)	30	19.11	105	66.88
Food insecurity status				
Jointly getting/facing food availability, stability, access, and utilization in the drought season	49	31.21%	137	87.26%
Average cropping intensity ⁶	117%		181%	
Number of respondents	n=157		n=157	

Source: Calculated by the authors based on their collected household cross-section data, 2010

The household head represented his/her household members as the respondent for this survey. Personal interviews were conducted with household heads followed by a structured questionnaire to collect information regarding seasonal food insecurity during the drought season (March, April, and May) in 2010. Before conducting the survey, the severe and slight drought areas were selected in consultation with the Bangladesh meteorological officials and experts. Out of 314 respondents, 157 respondents were from severe drought areas of the northwestern region of Bangladesh and the remaining 157 respondents were from slight drought areas of the same region. Demographic and socio-economic characteristics of the study area are depicted in Table 3.1.

Household characteristics are nearly identical between the two groups except for annual income status and average cropping intensity.

A Probit or Normit model approach is used to identify different demographic and socio-economic factors of household food insecurity, and to check robustness of the estimated model. The Probit model is suitable for binary responses or decisions. It is also suitable for cumulative density function that emerges from the normal cumulative function (CDF)⁷ (Munizaga & Alvarez-Daziano 2001)..

Related continuous explanatory variables, including binary responses are considered for investigating and comparing the probability of a household’s food insecurity during the drought period. The model assesses the factors that influence the household’s food insecurity as follows:

$$SFI = \beta_0 + \beta_1 \sum HHC + \beta_2 \sum HC + \beta_3 \sum MC + \beta_4 \sum EA + \beta_5 \sum DTC + \beta_6 \sum SSNP + \beta_7 \sum P + \mu_i \dots\dots\dots (1)$$

where,

1. SFI represents seasonal food insecurity and is considered as the dependent variable,
2. HHC represents household head’s individual characteristics,
3. HC represents household’s characteristics,
4. MCD represents micro credit status (1=household got micro credit, 0=otherwise),
5. EA represents educational attainment (1=literate status of head of the household, 0=illiterate),
6. DTC represents use of drought tolerant crops (1=use drought tolerant crops, 0=otherwise),
7. SSNP represents social safety net program (1=household got social safety net support by the government, 0=otherwise),
8. P represents price of food items in drought residing area (1= high food price in drought season due to low production, 0=otherwise) and all of these are considered as the independent or explanatory variables.

Like the other explanatory variables, the dependent variable (seasonal food insecurity) holds the binary characteristics. The binary (one or zero response) variable is used to estimate the probability that a household is food insecure in the following way, where a household is food insecure = 1, and 0 = otherwise.

$$Pr(y = 1) = \theta(\beta'x) \dots\dots\dots (2)$$

where, Pr denotes the probability, and θ denotes the cumulative density function of the normal distribution, which gives the likelihood for both cases y=1 and y=0. $\beta'x$ is known as the Probit score of equation (2).

3.1 Description of variables that are used in the model

This study uses different of socio-economic variables in its model. These variables are described as follows:

Seasonal food insecurity: Seasonal food insecurity occurs when there is a temporary inability to meet food needs, usually associated with a specific shock or stress such as drought, floods, or civil unrest (World Food Programme, 2006). The northwestern region of Bangladesh faces food insecurity during the drought summer season (March, April, and May).

Household head’s individual characteristics: Household head’s individual characteristic consider the age and sex of the head of household. This study considered only the age of the head of household.

Household’s characteristics: Generally, household characteristics include sex, household size, occupation, housing facility, marital status, income status, durable goods in the household and so on. This study considered only household occupation, household size, and household income status as the household’s characteristics in the model.

Micro credit: Micro credit is an extension of extremely tiny loan given to the rural poor villagers to assist them to be identical human beings, so that they can operate small-scale business and can afford shelter, food, education as well as treatment to their families (Shukran & Rahman, 2011).

Educational attainment: household’s educational attainment. in most of the cases, the head of the household has either primary education [basic education at home] or illiterate [having no literacy].

Drought tolerant crops: Drought tolerant crops refer to the degree to which a crop is adapted to arid or drought conditions. The most drought tolerant crops are Maize, Cotton, and Wheat.

Social safety net programs: Social safety net programs are associated with protecting the poor. Social safety net programs are aimed at preventing people from falling below a certain poverty level and to help cope with adverse income

fluctuations (UNDP, 2012). Social safety net programs work towards sustainable food and livelihood security. Social safety net programs of Bangladesh include food for work (FFW), gratuitous relief (GR) and test relief (TR), vulnerable group development (VGD) Vulnerable group feeding (VGF), allowance for widows, honorarium for freedom fighters, old age allowance, and education stipends for female students.

Price: Price is a value that will purchase a finite quality, weight, or other measure of goods or services. This study considered the price of rice, vegetables, milk, egg, fish, meat, and other edible goods in the study area.

The above mentioned demographic and socio-economic variables are used in the Probit model to quantify their impacts on seasonal food insecurity in the study area. Table 3.1 describes the used variables in the Probit model with their expected sign.

Table 3.2. Description of variables with expected sign

Dependent/Independent Variable	Category	Description	Expected sign
Dependent variable			
Seasonal food insecurity			
sfis	Binary	1: Household is food insecure at drought period 0: Otherwise	
Independent variables			
Household head's individual characteristics			
Age of head of household			
mahh	Binary	1: (25-60 years) Age group 0: Otherwise	(-)
oahh	Binary	1: (>60 years) Age group 0: Otherwise	(+)
Household's individual characteristics			
cul	continuous	Cultivation of household own land and share crop land	(+/-)
nfm	continuous	No. of family members	(+/-)
tin	Continuous	Total income from farm and non-farm	(-)
Micro credit			
mcr	Binary	1: Household got micro credit 0: Otherwise	(-)
Educational attainment			
ilt	Binary	1: Illiterate 0: Otherwise	(+)
psc	Binary	1: Primary school 0: Otherwise	(+)
ssc	Binary	1: Secondary school 0: Otherwise	(-)
Drought tolerant crops			
dtc	Binary	1: Household use drought tolerant crops 0: Otherwise	(-)
Social safety net program provided by the government			
ssn	Binary	1: Household gets social safety net support 0: Otherwise	(-)
Price in drought season			
pri	binary	1: High food price in drought season due to low agricultural production 0: Otherwise	(+)

4. Results and discussion

As shown in table 4.1 below, most of the variables are significant with expected sign at the 1%, 5%, or 10% levels.

Table 4.1. Parameters estimate of seasonal food insecurity in the drought-prone north Bengal of Bangladesh

Independent Variables	Severe drought-prone area of northwestern region	Slight drought-prone area of northwestern region
	Coefficient	Coefficient
mahh	-1.175*** (0.002)	-0.771** (0.020)
oahh	0.541** (0.045)	0.229*** (0.000)
cul	-0.772 (0.473)	-0.319** (0.041)
nfm	0.370 (0.163)	0.304 (0.319)
tin	0.131 (0.430)	-0.110*** (0.000)
mcr	-2.139*** (0.000)	-1.740* (0.089)
ilt	0.831** (0.021)	0.301*** (0.000)
psc	1.441*** (0.000)	0.087* (0.007)
ssc	-0.517** (0.035)	-0.197*** (0.000)
dte	-0.562*** (0.000)	-0.054** (0.031)
ssn	-1.487*** (0.001)	-1.360*** (0.000)
pri	0.670*** (0.010)	0.192*** (0.004)
Constant	2.301*** (0.000)	1.230*** (0.003)
Pseudo R ²	0.471	0.516
n	157	157

Figures in parenthesis are P-value of respective regression coefficients. n=number of observations
 *** Significant at 1% probability level, **5% probability level, and *10% probability level.

According to the model, all of the variables are significant except cultivation, number of family members, and total income from farm and non-farm in the severe drought-prone area and only the number of family members in the slight drought-prone area of northwestern region. The general observation of the field survey identified that the number of family members, performance of cultivation and total income of the inhabitants of severe drought-prone area are inconsistent due to uncontrolled child birth and seasonal fluctuation like drought, precipitations, temperature, and seasonal unemployment. Like the severe drought-prone area, the number of family member of the slight drought-prone area is also inconsistent. Among all significant variables in the severe drought-prone region, middle age of household head, micro credit, primary school level education, drought tolerant crops, and social safety net programs are negatively correlated with the seasonal food insecurity which implies that increase in the above mentioned variables resulted in decrease food insecurity and vice-versa. In contrast, the variables, e.g., middle age of household head, cultivation, total income from farm and non-farm, micro credit, secondary school level education, drought tolerant crops, and social safety net programs are negatively correlated with the seasonal food insecurity in the slight drought area of the same region. The variables, e.g., age of household head, illiterate, primary level education, and high food price in the drought season due to low agricultural production are positively correlated with the food

insecurity in the severe drought-prone northwestern region which implies that these variables goes in the same direction as food insecurity. On the other hand, age of household head, illiteracy, and primary level education, and high food price in the drought season of the slight drought area of the same region is also positively correlated with the food insecurity. Aging people of head of household in both the severe and slight drought regions implies that household with older head, in general, are more food insecure than the household with younger head, as younger ones participate more in regular earnings activities. Beyond a certain age, aging heads of household are less able to participate in income generating activities. This outcome is supported by the Franco Modigliani's macroeconomics consumption theory "life-cycle hypothesis"⁸ from the early 1950s. The coefficients of the severe drought model ranges from -2.139 to 1.441 (except intercept/constant value) and the PseudoR² value indicates that 47% of the variation of the food insecurity is explained by the associated variables. Similarly, the coefficients of the slight drought model ranges from -1.740 to 0.304 (except intercept/constant value) and the PseudoR² value indicates that 51% of the variation of the food insecurity is explained by the associated variables. High constant values of severe drought-prone area suggest that food security is vulnerable to drought.

5. Conclusions and recommendations

Seasonal food insecurity because of drought in the northwestern region of Bangladesh is a recurrent phenomenon. Very little attention has been paid, so far, to the adaptation or mitigation and preparedness of seasonal food insecurity. This study identified demographic and socio-economic factors that are helpful lessening food insecurity conditions and protecting the poor livelihood in the drought-affected region. Drought, to the extent that it is weather related, is not controllable. As it is not possible to change the naturally occurring weather events, concerted action at a political and institutional level would help to build capacity, reduce peoples' vulnerability, improve food security, and reduce poverty under the severe drought conditions. Concerted action would require more finances to mobilize and implement the actions to remove food insecurity. Government, Non Government Organizations (NGOs), research institutions, and donor organizations can work as actors in favor of ensuring food security in Bangladesh. Micro credit, use of drought tolerant crops, increased educational facilities, and giving more financial and food support to the ageing, poor and illiterate people affected by the drought in the drought season can help to improve the seasonal food security in the severe drought-prone northwestern region of Bangladesh.

Endnotes

- ¹ Monga' is a Bangla word that has been derived from "Mehenga" meaning 'expensive' which indicates high food price, consequent poverty and hunger.
- ² Rangpur was declared as a division of Bangladesh and separated from Rajshahi division at 25 January, 2010.
- ³ Barind Tract (alternatively called varendra Tract in English and Varendra Bhumi in Bengali) is the largest Pleistocene era physiographic unit in Bangladesh and the Bengal Basin.
- ⁴ SSP stands for social safety net program
- ⁵ Tk. Stands for Taka (Bangladeshi currency)
- ⁶ Annual cropped area (sum of area under all crops in a year)/net land area * 100
- ⁷ If a variable x follows the normal distribution with mean μ and variance σ^2 , its probability density function (PDF) is $f(X) = \frac{1}{\sqrt{2\sigma^2\Pi}} e^{-(x-\mu)^2/2\sigma^2}$ and its cumulative density function (CDF) $f(X) = \int_{-\infty}^{x_0} \frac{1}{\sqrt{2\sigma^2\Pi}} e^{-(x-\mu)^2/2\sigma^2}$ where X_0 is some specified value of x .
- ⁸ The Life Cycle Hypothesis concludes that the average propensity to consume is greater in both young and aging individuals, since they are borrowing against future income (in the case of young individuals) or using savings (as wity aging or retired individuals). Middle aged people, on the other hand, have a greater propensity to save and a lowre propensity to consume, enhanced by a typically higher income.

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