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Effect of seasons on household food insecurity in Bangladesh

Mohammad J. Raihan[1] | Fahmida D. Farzana[1] | Sabiha Sultana[2] | Kuntal K. Saha[3] | Md Ahshanul Haque[1] | Ahmed S. Rahman[1] | Zeba Mahmud[4] | Robert E. Black[5] | Nuzhat Choudhury[1] | Tahmeed Ahmed[1]

[1]Nutrition and Clinical Services Division, International Centre for Diarrhoeal Disease Research, Bangladesh, Dhaka, Bangladesh

[2]Global Alliance for Improved Nutrition, Dhaka, Bangladesh

[3]Department of Nutrition for Health and Development, WHO, Geneva, Switzerland

[4]FHI 360, Dhaka, Bangladesh

[5]Department of International Health, Centre for Global Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland

Correspondence
Tahmeed Ahmed, Nutrition and Clinical Services Division, International Centre for Diarrhoeal Disease Research, Bangladesh, 68, Shaheed Tajuddin Ahmed Sharani, Mohakhali, Dhaka 1212, Bangladesh.
Email: tahmeed@icddrb.org

Abstract

Agriculture is the mainstay of livelihoods of the rural Bangladeshi population with the majority involved in the staple rice production which is subjected to seasonal variation. Rice production is invariably related to food insecurity which translates to the food shortage or *lean* periods. In order to have a comprehensive view on food insecurity in Bangladesh, it is necessary to assess the seasonality of food insecurity status and the factors associated with it. The objective of this paper is to compare the effect of two major rice harvest seasons and the *post-aus* rice harvest period on household food insecurity along with the contribution of relevant household characteristics. Data was collected during Bangladeshi *aman* harvest (November–January) and *boro* harvest (April–June) seasons and *post-aus* harvest (September–October) period. Information of 47,239 households from February 2011 to November 2013 was subjected to bivariate and multivariate analyses and statistical significance was declared when $p < 0.05$. Around 27%, 47%, and 26% of households were food insecure during *aman* harvest, *boro* harvest, and *post-aus* harvest period respectively. The *aman* harvest [adjusted OR (aOR): 0.54 [95% CI: 0.40–0.74; $p < 0.001$] and *post-aus* [aOR: 0.59 [95% CI: 0.44–0.80; $p < 0.001$] period had a lower odds of being food insecure when compared to *boro* harvest season except for the northern Rangpur region. Contrary to expectation, the prevalence of household food insecurity in the defined seasons is less during *post-aus* harvest period (the perceived *lean* period) and *aman* harvest season in comparison to the *boro* harvest season when food and work is more readily available in rural Bangladesh. There are several statistically significant household characteristics, namely household head being a farmer, educational status of household head, and household monthly income to have higher impact on food insecurity.

KEYWORDS

Bangladesh, food security, harvest, lean period, seasonality

1 | INTRODUCTION

The concept of food security was defined by the World Food Summit (WFS) (Food and Agriculture Organization of the United Nations (FAO), 13–17 November, 1996) as "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life." This led to the identification of its four dimensions—availability, access, utilization, and sustainability (Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD) & United Nations World Food Programme (WFP) (2014)). Food insecurity, on the other hand, is a situation when people lack secure access to sufficient amount of safe and nutritious food (Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD) & United Nations World Food Programme (WFP) (2014)). Food insecurity is related to poverty and hunger (United Nations (UN), 2014) and indeed is a major public health problem for low, middle income, and developed nations (Endale, Mengesha, Atinafu, & Adane, 2014). Asia is home to two-third of the world's undernourished population, with a significant proportion chronically lacking access to enough food. Bangladesh falls under the southern Asian region and undernourishment continues to take its largest toll in this region compared to the rest of the world except for Sub-Saharan Africa (Food and Agriculture Organization of the United Nations (FAO) et al., 2014).

Like many countries of the region, agriculture plays a critical role in the livelihoods of the Bangladeshi population. The agricultural sector is a significant contributor to the economy of Bangladesh with around 80% of the people, directly or indirectly, associated with it. Agriculture provides employment for around 48% of the work force and a major portion of the country's agricultural sector is engaged in producing rice, the staple food grain (Ahmed, Ahammed, & Tareque, 2012). Due to the twofold increase in country's population over the last several decades and the decrease in cultivateable land, the Government of Bangladesh (GoB) has taken a number of initiatives to increase crop production, especially rice (Ministry of Food: Government of People's Republic of Bangladesh, 2014b). Despite considerable progress in this sector along with economic development of the nation (Bangladesh Bureau of Statistics (BBS) and World Bank, 2010), a significant proportion of the population still remains food insecure (International Food Policy Research Institute (IFPRI), 2012, Niport, 2011). Dependency on a manual labor force and the use of traditional agricultural strategies affect crop production adversely and reduce food availability. This, in turn, intensifies food insecurity (Mondal, 2010).

Due to the seasonal variation in agricultural employment and limited employment opportunities elsewhere, millions of people in Bangladesh suffer from food insecurity throughout the year (Mozumder, Islam, Alam, & Rahman, 2009a). Rice production in Bangladesh has been found to vary according to season; traditionally, the largest harvest is *aman*, followed by *aus* (Marsh, 1998). The wet monsoon season *aman* rice is cultivated on around 53% of the total rice area (Hossain, Bose, & Mustafi, 2006). It is the most widespread rice cultivation and is applied in the coastal area as well as elsewhere (Shelley, Takahashi-Nosaka, Kano-Nakata, Haque, & Inukai, 2016). In contrast the pre-monsoon, short-duration, and drought-resistant *aus* rice is usually grown in the northern part of the country (Hossain et al., 2006; Shelley et al., 2016). However, during the past decades the dry season *boro* rice has been making an increasingly larger contribution to the total rice production of Bangladesh (Regmi, Oladipo, & Bergtold, 2016; Shelley et al., 2016). The high-yielding *boro* rice is contributing to around 60% of the total rice production in Bangladesh and is cultivated all over the country especially in the northern part while the *aus* rice is contributing the least (Akter & Jaim, 2002; Shahid, 2011). Rice in Bangladesh is grown during three seasons which overlap (Shelley et al., 2016) but there are two periods when no rice is harvested, causing hunger ("*monga*" *in local language*). These occur in February to March and September to October-November (Gill et al., 2003; Khandker, 2012; Zug, 2006) (Figure 1). The latter encompasses the *aus* harvest period and is severe and recognizable than the earlier one in terms of household food insecurity (Hossain, 2009; Hossain, Naher, & Shahabuddin, 2005; Hossain et al., 2006; Zug, 2006).

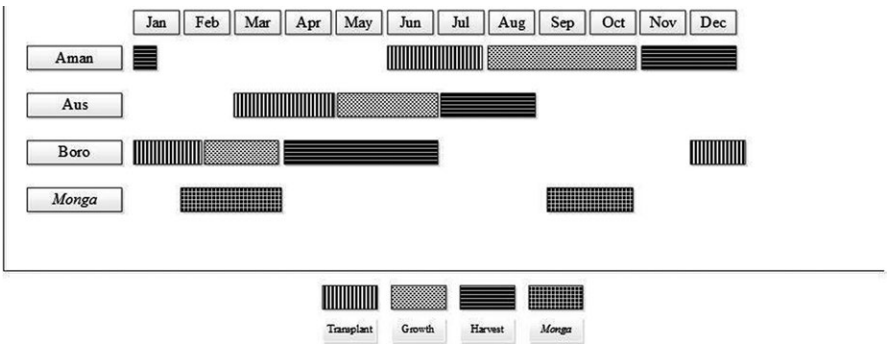

FIGURE 1 Seasonality of rice production (Hossain et al., 2006; Shelley et al., 2016; Zug, 2006)

Rice harvest periods bring employment and increased income while post-harvest periods offer few income generating opportunities. Decreased employment opportunities and decrease in subsequent income in the period before the harvest of *aman* rice that is, the *post-aus* harvest period were primarily noted to be responsible for the *lean* period phenomenon which has been found to be more pronounced in the northern part of Bangladesh (Shonchoy, 2011; Zug, 2006). Around 31% of the population residing in the northern part are ultra poor, living below the poverty line, and mostly depend on manual labor for income (Ministry of Disaster Management and Relief, B., 2012). Climatic shock such as crop failure due to flood especially in the northern and southern regions during the months before the *lean* period also contribute immensely to the vulnerability of households (Zug, 2006).

Seasonal effects on household food insecurity, caloric availability, employment, and income have been reported in several studies including some in Bangladesh (Food and Agriculture Organization of the United Nations (FAO), U. N. W. F. P. W. (1999), Garrett & Ruel, 1999; Gill et al., 2003; Hossain et al., 2005; Mascie-Taylor, Marks, Goto, & Islam, 2010; Mozumder, Islam, Alam, & Rahman, 2009b; Ruel et al., 1998; Zug, 2006). Nonetheless, no literature with nationwide representative data were identified to portray the effect of seasonality on household food insecurity in Bangladesh. Therefore, in order to have a comprehensive view on the seasonality of food insecurity in Bangladesh especially the household food insecurity status during the *lean* period, it is vital to assess the food insecurity status using nationally representative data during the harvest seasons and post-harvest period as per the rice calendar of Bangladesh.

The Food Security Nutritional Surveillance Project (FSNSP), has provided the opportunity to assess household food insecurity and the relevant contributing factors throughout the year (Hki, 2013). The FSNSP measures food insecurity using the experience-based scale—Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale, & Bilinsky, 2007) which supports the notion of food insecurity being characterized by lack of access due to poverty rather than shortage of supply (Diaz-Bonilla & Robinson, 2001).

It is noted that FSNSP's seasonal segregation failed to capture the *boro* harvest period which is accompanied by higher household income and consumption (Khandker, 2012). Therefore, in order to understand the food insecurity status of the households, the seasons need to be redefined to include *boro* harvest period.

The objective of this study is to compare the effect of the three redefined seasons, the *post-aus* harvest or lean period (September–October) and *aman* harvest (November–January) relative to the *boro* harvest (April–June) season on household food insecurity along with the contribution of relevant household characteristics to it. We aim to provide useful insight on the seasonal fluctuations in household food insecurity and the factors associated with it, which shall direct the policymakers to formulate relevant operational plans for the temporal production, import, and storage of food grains and its subsequent distribution through different government and private channels.

2 | MATERIALS AND METHODS

Food Security and Nutritional Surveillance Project (FSNSP), follows a repeated cross-sectional survey design. It collects data from the whole country every 4 months from households over three major seasons in Bangladesh as defined by FSNSP: the *post-aman* harvest period (January–April), the height of the monsoon (May–August), and the *post-aus* harvest season (September–December). Therefore, the FSNSP collects household data all through the year and seasonal variation of food insecurity and nutritional indicators were tracked by this process. From 2010 to 2015, FSNSP went through 16 rounds of data collection directed on six basic subthemes: food insecurity, nutrition of women and adolescent girls, maternal care and nutrition, child feeding, child health and hygiene, and nutritional status of children. The primary objective of FSNSP is to detect changes in household nutrition and food insecurity status by assessing the indicators of food insecurity and malnutrition. The conceptual framework of FSNSP (Helen Keller International and James P Grant School of Public Health, 2014) is provided below in Figure 2.

A three-stage sampling design was used to collect nationally representative data from households. For the first

FIGURE 2 Conceptual framework of FSNSP (State of food security and nutrition in Bangladesh: 2014). FSNSP, The Food Security Nutritional Surveillance Project

stage, the country was divided into 13 strata. Six strata corresponded to the six surveillance zones (coastal belt, eastern hills, haor region, padma chars, northern chars, and the northwest region) which are considered as the vulnerable areas pertaining to food insecurity, and remaining seven strata correspond to the seven administrative divisions (Dhaka, Chittagong, Rajshahi, Barisal, Khulna, Sylhet, and Rangpur) which includes all the *upazilas* not included in the surveillance zones. *Upazilas* are a subunit of districts and at present there are 490 *upazilas* in Bangladesh. The zones were selected targeting food insecure areas and to ensure nationally representative sample each round. From each agro-ecological zone, 12 *upazilas* were selected with replacement by rotation, while, 22 *upazilas* were selected with replacement but without rotation (stratified by division) from the rest of the country. The number of *upazila* in nonsurveillance zone varied from 1 to 8 depending on the number of *upazila* in the zone. From each surveillance zone, *upazilas* were selected by rotation into the sampling frame to minimize the random variation in estimates between rounds. The rotation followed a pattern in a way that 50% of the sampled *upazilas* were the same between any two consecutive rounds of data collection and 50% of the sampled *upazilas* were the same between the same seasons in two consecutive years.

In each selected *upazila* all villages/mohallas that were listed in the sampling frame as having fewer households than a given cut-off was combined with adjacent village/mohalla in order to create clusters of villages larger than this cut-off. The cut-off was 75 households in the Chittagong Hill Tracts and 150 households in the rest of the country. At the same time, all villages with a population over twice the given cut-off were split into clusters in the sampling frame. This enabled sampling weights to be much more uniform across areas. This equal sized cluster of households was named community. In the second stage, four communities were chosen at random and without replacement from all the communities in each selected *upazila*.

On third stage, every fifth household in the plain land and third household in the Chittagong Hill Tracts was selected for inclusion. The assigned community was approached to begin from the first eligible house from a randomly assigned approach road (north, south, east, or west) as determined by random number generator until 24 households were selected systematically and interviewed. A household were considered eligible for surveillance if there was at least one adult female aged 10–49 years or a child less than 5 years of age living in the household. All children less than 5 years of age in the household were weighed and measured, but only the caretaker of the youngest child in each household answered questions about child feeding and morbidity relevant to that child. All pregnant women in the household were interviewed. In every household, one nonpregnant woman or adolescent girl was randomly selected for measurement and asked about dietary consumption. The map of FSNSP surveillance area is illustrated in Figure 3.

While FSNSP has been consistent in providing nationally representative data, sampling methods have been redefined over time, most notably between the first and second rounds of data collection in 2010 and 2011 (first four rounds of data collection). The sampling strategy for the first few rounds is mentioned elsewhere (James P Grant School of Public Health (JPGSPH) and Helen Keller International (HKI), 2012).

2.1 | Sample size

The target sample size for each FSNSP round was 9,024 households for all the strata, calculated using the estimated prevalence of child wasting, underweight, and stunting; women's chronic energy deficiency; and household food insecurity along with considering food deficit and food consumption score. The sample size calculation used sample size formula for a single population proportion with 95% confidence interval and 5% precision. For this paper, data collected from February 2011 to November 2013 through FSNSP round four to twelve, was pooled together, which represents a total of 47,239 households.

2.2 | Data collection

All data were collected using a structured questionnaire in paper format and Personal Digital Assistants (PDAs)-supported proprietary survey software (Surveymaster v1 & v2). For each round, 36 two-member teams were employed for data collection.

2.3 | Variables of interest

The outcome variable was measured at the household level and dichotomized into food secure and food insecure households using HFIAS categorization. The HFIAS is a continuous measure of the degree of food insecurity (access component) in the household; data was recorded for the previous month (last 30 days) (Coates et al., 2007). The subjective scale contains nine questions that were asked to know anxiety and uncertainty of the participants about household food supply, insufficient quality of food (including variety and preferences of type of foods), and insufficient food intake. These questions[1] represent apparently universal domains of the household food insecurity experience of past 1 month and can be used to assign households along a gradient of severity, from food secure to severely food insecure. For the purpose of this manuscript, household food security status

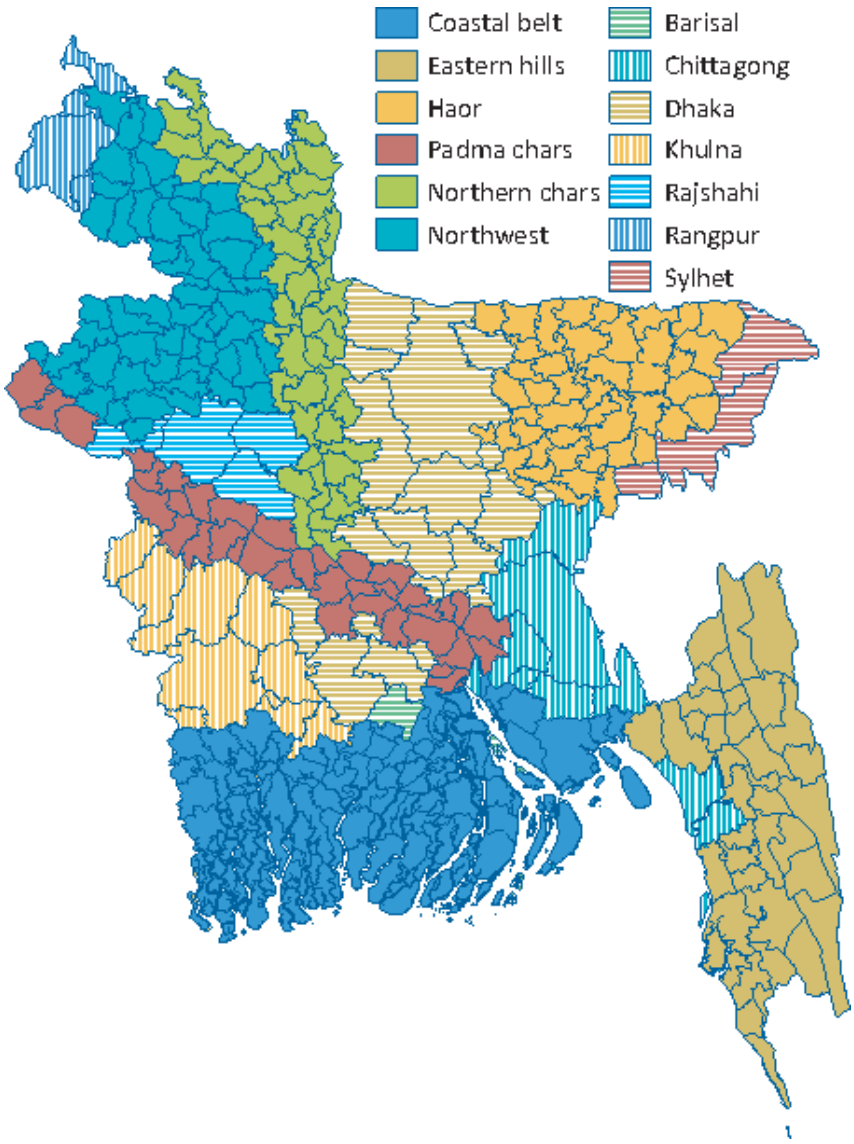

FIGURE 3 FSNSP surveillance area. FSNSP, The Food Security Nutritional Surveillance Project

has been dichotomized into households being food secure and food insecure. Any household categorized as either mildly, moderately, or severely food insecure according to the HFIAS criteria was defined as food insecure household.

Seasonality, our predictor variable, is segregated into *post-aus* period (September–October), *boro* harvest (April–June), and *aman* harvest (November–January) seasons. The *post-aus* or *pre-aman* harvest period represents the *lean/monga* period.

The other variables of interest which were subjected to bivariate analysis in order to understand their relationship with the outcome and also regressed in the multivariate model as potential predictors are: residential area dichotomized into rural and urban, sex of the household head, number of household member, educational status of the household head and households' women, index of household asset, household income, household women with income generating activities, occupation of the primary earner, presence of household member with age more than 50 years, recipient of remittance from abroad, beneficiary of safety net program, availability of homestead land, and agricultural land and presence of homestead garden. Homestead land is defined as the ownership of area/land which is used as a dwelling place for the household/family. However, availability of homestead garden was considered when any vegetable or fruit garden was present in the homestead land.

The index of household asset (asset index), a composite indicator of household wealth was calculated using principal component analysis following similar method used in the Bangladesh Demographic and Health Survey (BDHS) (Niport, 2011), using data on household electrical appliances, furniture, and types of vehicle owned, construction materials used for floor, roof and walls, types of kitchen fuel used, types of latrine, source of drinking water, and livestock owned.

2.4 | Data analysis

Univariate analysis was used to describe the household demographic and socioeconomic characteristics. We have also inspected the food insecurity status of different zones of Bangladesh stratified by our defined seasons. Simple logistic regression was carried out to understand the effect of seasons and other covariates on the household food insecurity. Multiple logistic regression was implemented in order to understand the independent effect of the seasons on the food insecurity status of households both overall and stratified by FSNSP zones. In addition, covariates of household demographic and socio-economic characteristics were regressed and also examined their independent effect on food insecurity. The *boro* harvest season was chosen as the reference in the multivariate analysis as it was hypothesized that the harvest period would offer the higher income and livelihood opportunities and hence household food insecurity is expected to be relatively low compared to the *aman* harvest season and the *post-aus* harvest or *lean* period. Statistical significance of any variable in the regression model was confirmed if p-value was less than 0.05. All analyses were conducted using the STATA svyset command for complex survey data in STATA v10 (Stata Corp, College Station, Texas, USA). The details of the *svyset* command are explained in the Stata manual (StataCorp, 2016). In order to make the result representative of the population, we have adjusted the weight of the sample by adjusting the strata (geographical region/zone and administrative divisions), primary sampling unit (*upazila*) and secondary sampling unit (villages). The strata were adjusted due to the stratified sampling, and the fact that the variance of the outcome variable-HFIAS is not homogenous across the strata. Several posthoc tests following the multiple logistic regression analysis were performed to identify any multicollinearity between variables used, and to assess the overall predictive accuracy and predictive capacity of the multiple logistic regression model.

2.5 | Ethical consideration and consent procedure

This study was approved by the Research Review Committee and Ethical Review Committee, the two obligatory components of the institutional review board of International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b). Verbal informed consent was taken from study participants.

3 | RESULTS

As for the descriptive results, a total of 47,239 households were available for the study of which 90.51% were from rural areas. The average number of household members was 4.88 (95% CI: 4.87–4.90) and 70.1% of households had at least one member above the age of 50. Overall, 56.5% households were food insecure. However, when stratified, 26.7% households were food insecure during *aman* harvest, 46.8% during *boro* harvest, and 26.6% during *post-aus* harvest period. Additionally, 89.2% households had a male household head, 42.2% household head had no formal education, and around 12.2% households did not have any women with formal education. Moreover, 19% households had income below Tk 3,000 (1 USD = ~78 Tk.) per month, but importantly, median income (Tk. 83,000) of female headed households which had foreign migrant earner were higher than that of the median income (Tk. 6,000) of female-headed households which did not have any foreign migrant earner. Day laboring was the most prominent profession of the households' main earner at 38.2% and 53% households did not have any women involved in income-generation activities. Furthermore, 16.1% of households received remittance from abroad and 33.6% households were beneficiaries of at least one safety net program. Our result also indictated, 32.6% households had no homestead land, 61.2% had no agricultural land, and 37.8% households had no homestead garden.

Inspecting the food insecurity status of the FSNSP zones stratified by seasons, our results show that food insecurity is highest in Barisal, situated in the southern part of the country during *aman* harvest (71.8% [95% CI: 62.09–79.95]) and *boro* harvest (71.2% [95% CI: 65.68–76.12]) season but was rather low during the *post-aus* harvest (30.9% [95% CI]: 24.75–37.79) period. Food insecurity in the Northern region—Rangpur, which is highly vulnerable to *lean* period, is lowest during *aman* harvest (53.13% [95% CI: 47.34–58.82]) but highest among all strata during *post-aus* harvest (85.42% [76.87–91.17]) season. Among the FSNSP vulnerable zones, the coastal belt has the highest proportion of food insecure households during all three seasons. All results are tabulated in Table 1.

Our bivariate analysis implied that there is no significant difference between the different seasons in terms of food insecurity; however, when all other variables were regressed in the multivariate model, both *aman* harvest and *post-aus* harvest periods appeared highly significant; the odds of being food insecure was 0.54 (95% CI: 0.40–0.74; $p < 0.001$) times less during *aman* harvest and 0.59 (95% CI: 0.44–0.80; $p < 0.001$) times less during the *post-aus* harvest when compared to the *boro* harvest season. In terms of the other regressors, residence in rural areas significantly predicted the occurrence of food insecurity (OR: 2.37 [95% CI: 1.98–2.84]; $p < 0.001$); however, when adjusted for other variables, residential area was not statistically significant. In addition, our results suggested that independently the odds of households to become food insecure increased by 1.15 (95% CI: 1.09–1.21; $p < 0.001$) times with the addition of each household member. Presence of any household member with age more than 50 years and sex of the household head

TABLE 1 Food insecurity status across regions and seasons

Zone	Food insecure *n* (%)					
	Aman harvest	95% CI	*Boro* harvest	95% CI	*Post-aus* harvest	95% CI
Coastal Belt	1137 (62.17)	59.92–64.36	1457 (63.99)	61.99–65.94	881 (70.99)	68.40–73.45
Eastern Hills	743 (55.49)	52.81–58.13	1996 (67.94)	66.23–69.60	1219 (66.72)	64.53–68.85
Haor Basin	792 (57.18)	54.56–59.77	1892 (66.55)	64.79–68.26	1198 (63.86)	61.66–66.00
Padma chars (Lower active floodplain)	747 (55.01)	52.35–57.64	1262 (52.69)	50.69–54.69	778 (44.15)	41.85–46.48
Northern chars (Upper active floodplain)	1086 (62.85)	60.54–65.10	1295 (56.92)	54.88–58.95	1143 (62.77)	60.52–64.96
Northwest floodplain	1114 (48.18)	46.15–50.22	1551 (52.12)	50.32–53.91	678 (49.93)	47.27–52.58
Chittagong	259 (53.96)	49.48–58.37	519 (51.95)	48.85–55.04	250 (40.06)	36.29–43.96
Dhaka	468 (37.14)	34.52–39.85	931 (40.71)	38.71–42.74	405 (42.72)	39.61–45.90
Khulna	197 (41.04)	36.72–45.50	351 (59.49)	55.48–63.38	303 (57.39)	53.12–61.54
Rajshahi	182 (62.76)	57.05–68.13	204 (53.13)	48.12–58.07	39 (27.46)	20.76–35.37
Rangpur	153 (53.13)	47.34–58.82	623 (64.90)	61.82–67.85	82 (85.42)	76.87–91.17
Sylhet	165 (57.29)	51.51–62.88	209 (54.43)	49.42–59.35	57 (59.38)	49.30–68.72
Barisal	69 (71.88)	62.09–79.95	205 (71.18)	65.68–76.12	59 (30.89)	24.75–37.79

were not significant in the bivariate analysis, but when other variables were held constant, households with no member aged above 50 years were 1.45 (95% CI: 1.07–1.97; $p < 0.05$) times more and households with female head appeared to be 1.57 (95% CI: 1.26–1.96; $p < 0.001$) times more likely to be food insecure.

Additionally, we found that if the household head had no formal education (adjusted OR [aOR]: 2.82, 95% CI: 2.20–3.60; $p < 0.001$) or did not complete SSC (Secondary School Certificate) exam (aOR: 2.15, 95% CI: 1.75–2.64; $p < 0.001$) or if the household did not have any women with formal education (aOR: 1.30, 95% CI: 1.02–1.64; $p < 0.05$), significantly predicted household food insecurity. Asset index as continuous predictor also significantly (aOR: 0.80, 95% CI: 0.73–0.86; $p < 0.001$) predicted household food insecurity. However, the odds were 10.2 (95% CI: 6.57–15.9; $p < 0.001$) if income per month was below 3000 Tk, 10.6 (95% CI: 6.46–17.20; $p < 0.001$) if between 3,000–5,999 Tk, 4.63 (95% CI: 3.28–6.54; $p < 0.001$) if between 6,000–9,999 Tk and 2.22 (95% CI: 1.66–2.97; $p < 0.001$) times more if between 10,000–20,000 Tk when compared to household income of more than 20,000 Tk. Furthermore, the result indicated that if adjusted for other variables, the odds of a household to be food insecure was 2.09 (95% CI: 1.33–3.29; $p < 0.05$) times more if the occupation of the primary earner was day laboring compared to someone who lives abroad. Women's income-generating activity status was found not to be significantly associated with household food insecurity. However, the adjusted odds of households being food insecure was 1.75 (95% CI: 1.26–2.43; $p < 0.05$) times more if remittance from abroad was received and 1.31 (95% CI: 1.13–1.51; $p < 0.001$) times more if being beneficiary of a safety net program. Adjusted odds of being food insecure was 1.74 (95% CI: 1.54–1.96; $p < 0.001$) times more if they did not have any agricultural land; however, possession of homestead land or homestead garden were not significant predictors of household food insecurity independently. All bivariate and multivariate results are shown in Table 2.

The posthoc diagnostic tests performed showed the mean Variance inflation factor (VIF) was 1.28, indicating minimum multicollinearity (Alin, 2010; Paul, 2006) between variables used in the multiple logistic regression model. Other parameters suggest that the sensitivity was 72.5%, specificity was 74.5%, and the overall predictive accuracy was 73.6%. Finally, the ROC curve indicated that the predictive capacity of the estimated model was 81.2%.

Additionally, covariate adjusted multiple logistic regression model stratified by FSNSP zones showed that the odds of households being food insecure was significantly lower ($p < 0.05$, aOR < 1.00) in Coastal Belt, Eastern Hills, Haor Basin, Padma chars, Northern chars, Northwest floodplain, Dhaka, Khulna, Rajshahi, Rangpur and Sylhet during *aman* harvest and in Haor Basin, Padma chars, Northwest floodplain, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet, and Barisal during *post-aus* period relative to *boro* harvest season. The results are shown in Table 3.

4 | DISCUSSION

This study tried to highlight the fluctuation in household food insecurity status during the major harvest seasons

TABLE 2 Bivariate and multivariate statistics

Predictors	*n*	Unadjusted OR[a] (95% CI)	*p*-value	Adjusted OR[b] (95% CI)	*p*-value
Season					
Boro harvest	47,183				
Aman harvest		0.89 (0.69–1.15)	0.375	0.54 (0.40–0.74)	0.000
Post-aus harvest		0.80 (0.55–1.15)	0.222	0.59 (0.44–0.80)	0.001
Residential area	47,183				
Urban					
Rural		2.37 (1.98–2.84)	0.000	0.87 (0.56–1.34)	0.522
Sex of household head	47,183				
Male					
Female		1.04 (0.93–1.16)	0.532	1.57 (1.26–1.96)	0.000
Homestead gardening					
Yes					
No		0.84 (0.68–1.04)	0.118	0.90 (0.73–1.10)	0.294
Beneficiary of safety net program	43,560				
No					
Yes		2.33 (2.03–2.69)	0.000	1.31 (1.13–1.51)	0.000
Occupation of primary earner	31,174				
Foreign employment					
Farmer		2.09 (1.54–2.83)	0.000	1.06 (0.65–1.72)	0.819
Day laborer		6.15 (4.75–7.96)	0.000	2.09 (1.33–3.29)	0.001
Businessman		1.32 (0.99–1.76)	0.060	1.12 (0.78–1.61)	0.536
Professional		1.35 (0.98–1.87)	0.067	1.29 (0.88–1.89)	0.197
No Income		0.63 (0.11–3.72)	0.605	0.20 (0.03–1.37)	0.101
Others		1.17 (0.37–3.69)	0.785	1.38 (0.65–2.94)	0.403
Education status of household head	47,092				
SSC complete or above					
No formal education		8.55 (7.16–10.2)	0.000	2.82 (2.20–3.60)	0.000
Did not complete SSC		4.13 (3.53–4.84)	0.000	2.15 (1.75–2.64)	0.000
Household Income/month (Tk)	31,174				
20,000+					
0–2,999		10.4 (8.15–13.3)	0.000	10.2 (6.57–15.9)	0.000
3,000–5,999		14.1 (10.5–18.9)	0.000	10.6 (6.46–17.2)	0.000
6,000–9,999		5.66 (4.45–7.20)	0.000	4.63 (3.28–6.54)	0.000
10,000–20,000		2.22 (1.72–2.86)	0.000	2.22 (1.66–2.97)	0.000
Remittance from abroad	47,183				
No					
Yes		0.66 (0.59–0.73)	0.000	1.75 (1.26–2.43)	0.001
Household women education status	47,183				
At least one educated women					

(Continues)

TABLE 2 (Continued)

Predictors	*n*	Unadjusted OR[a] (95% CI)	*p*-value	Adjusted OR[b] (95% CI)	*p*-value
No women educated		2.27 (1.85–2.78)	0.000	1.30 (1.02–1.64)	0.032
Household women occupation status	47,183				
At least one women with IGA					
No IGA		0.79 (0.70–0.90)	0.000	0.99 (0.89–1.11)	0.898
Any household member above 50 years old	47,183				
Yes					
No		1.18 (0.92–1.51)	0.202	1.45 (1.07–1.97)	0.017
Asset index[c]	47,183	0.51 (0.48–0.54)	0.000	0.80 (0.73–0.86)	0.000
Homestead land	47,183				
Some homestead land					
No homestead land		1.34 (1.12–1.59)	0.001	0.95 (0.82–1.11)	0.517
Agricultural land	47,183				
Some agricultural land					
No agricultural land		1.90 (1.56–2.31)	0.000	1.74 (1.54–1.96)	0.000
Household size	47,183	0.99 (0.96–1.02)	0.515	1.15 (1.09–1.21)	0.000

Notes. SSC: Secondary School Certificate; IGA: Income Generating Activity.
[a]Odds ratio. [b]$n = 31{,}116$. [c]Asset index and Household size were continuous variables.

of rice and the *post-aus* harvest or the *lean* period in Bangladesh. Regional variation was observed in terms of household food insecurity status, which was found to be highest in the southern region during *aman* harvest and in the northern region during *boro* harvest season. Our covariate adjusted analyses showed that, overall the odds of households being food insecure was significantly less during *aman* harvest and *post-aus/lean* period in comparison to *boro* harvest season, despite higher proportion and odds of households being food insecure in the northern Rangpur region during *post-aus* period. Our finding refutes the traditional belief that the *lean* period in Bangladesh from September to the border of November, corresponding to the *post-aus* period translates to higher household food insecurity status except for the Rangpur region.

In order to have a comprehensive overview of the food insecurity situation in Bangladesh, it is imperative to understand the seasonal dynamics of rice production in the country, the staple cereal grain of the population. Household food insecurity in the agro-based economy of Bangladesh is fundamentally determined by rice production and its price (Faridi & Naimul Wadood, 2010; Hossain, 2009; Hossain et al., 2006). The increase in the production of rice in recent decades has been cited as the major contributor to the increased food availability *per capita*, stability in grain price, and an overall reduction in poverty (Hossain, 2009). However, production of rice in Bangladesh, similar to all other countries (Gadgil & Kumar, 2006), suffers seasonal variation due to the difference in harvest period (Hossain et al., 2005; Pitt & Khandker, 2002; Zug, 2006). The non-harvest periods pertain to loss of household food production along with agricultural employment which constitutes the subsistence of 75% of the country's population (Alam, Hoque, Siraj, & Muhammad Faizal, 2009; Hossain et al., 2005; Zug, 2006).

Scrutinizing the significance of our multivariate result, it is needed to be contextualized that the high-yielding variety of *boro* rice, transplanted during December–January/February and harvested in April–June (Hossain et al., 2006; Shahid, 2011; Shelley et al., 2016), has gained immense popularity in Bangladesh during past decades. From the total cultivation area of 0.5 million hectares and contribution of less than 10% to the cumulative rice production in the 1970s (Hossain, 2009; Hossain et al., 2005), the *boro* rice is now cultivated in around 4.80 million hectares and equates to around two-third of total rice production (Ministry of Food: Government of People's Republic of Bangladesh, 2014a), making *boro* rice the largest harvest among all cereal grains in Bangladesh (Shahid, 2011). Thus, the *boro* and *aus* harvest (Hossain et al., 2006) seasons now provide employment and food during April–August, which may substantially boost the overall food security scenario and mitigate the adverse effects of the perceived *lean* period extending from September to October. Added to that is the current propensity toward diversification of crops by forsaking the traditional practice of rice

TABLE 3 Independent relationship of seasons and food insecurity stratified by FSNSP zones

Zone	*n*	Season	Adjusted OR (95% CI); *p*-value
		Boro harvest	Reference
Coastal Belt	3,347	*Aman* harvest	0.60 (0.49, 0.73); 0.000
		Post-aus	1.17 (0.94, 1.46); 0.161
Eastern Hills	4,104	*Aman* harvest	0.47 (0.39, 0.57); 0.000
		Post-aus	0.84 (0.70, 1.01); 0.068
Haor Basin	3,835	*Aman* harvest	0.60 (0.49, 0.74); 0.000
		Post-aus	0.73 (0.61, 0.88); 0.001
Padma chars (Lower active floodplain)	3,685	*Aman* harvest	0.70 (0.56, 0.88); 0.002
		Post-aus	0.54 (0.45, 0.64); 0.000
Northern chars (Upper active floodplain)	3,816	*Aman* harvest	1.25 (1.03, 1.52); 0.027
		Post-aus	1.06 (0.88, 1.29); 0.525
Northwest floodplain	4,186	*Aman* harvest	0.72 (0.61, 0.85); 0.000
		Post-aus	0.60 (0.49, 0.73); 0.000
Chittagong	1,435	*Aman* harvest	0.74 (0.53, 1.05); 0.089
		Post-aus	0.86 (0.63, 1.16); 0.313
Dhaka	3,256	*Aman* harvest	0.60 (0.48, 0.75); 0.000
		Post-aus	0.68 (0.54, 0.86); 0.001
Khulna	1,101	*Aman* harvest	0.37 (0.26, 0.52); 0.000
		Post-aus	0.40 (0.26, 0.62); 0.000
Rajshahi	624	*Aman* harvest	0.30 (0.16, 0.56); 0.000
		Post-aus	0.19 (0.11, 0.33); 0.000
Rangpur	1,152	*Aman* harvest	0.61 (0.45, 0.86); 0.004
		Post-aus	6.33 (3.32, 12.1); 0.000
Sylhet	768	*Aman* harvest	1.53 (1.02, 2.28); 0.035
		Post-aus	1.51 (0.86, 2.65); 0.014
Barisal	575	*Aman* harvest	0.87 (0.50, 1.55); 0.660
		Post-aus	0.15 (0.09, 0.25); 0.000

Note. [a]Adjusted for: Residential area, Sex of household head, Homestead gardening, Beneficiary of safety net program, Occupation of primary earner, Education status of household head, Household income/month (Tk), Remittance from abroad, Household women education status, Household women occupation status, Any household member above 50 years of age, Asset index, Homestead land, Agricultural land, Household size.

monoculture, as evident from the transplantation of winter *rabi* crop during October (Mostofa, Karim, & Miah, 2010; Rahman, 2009). The upward trend observed in the cultivation of winter *rabi* vegetables (Mostofa et al., 2010), other cereal grains including maize (Ali, Waddington, Hudson, Timsina, & Dixon, 2008), wheat and mungbean (Rawson & Stauffacher, 2011) together with noncereal crops such as potatoes and onions (Rahman, 2009) in the fallow during the period bordering October generates employment and food for the households. Moreover, targeted microcredit and government relief programs (Hossain et al., 2005; Pitt & Khandker, 2002), the ever-expanding fisheries sector (Guhathakurta, 2008; Roos, Wahab, Hossain, & Thilsted, 2007), and different household food and nonfood coping strategies (Shonchoy, 2011; Zug, 2006) also contribute significantly toward the alleviation of seasonal food insecurity scourges.

Our finding of households being less prone to food insecurity during *post-aus* and *aman* harvest period relative to the *boro harvest* period when food and employment are more readily available should be of great importance to the policymakers and the relevant stakeholders. The phenomenon needs to be explored in greater detail to have a more profound understanding of the seasonality of household food insecurity in Bangladesh.

On the covariates of our multivariate model, our finding suggests that despite the dissimilarity in challenges that constraints access to food in rural and urban settings which

affect the urban poor mostly (Ruel, Garrett, Hawkes, & Cohen, 2010), there is no significant difference in household food insecurity status between rural and urban strata. On the significant association between household food insecurity and household head being female supports similar findings in Africa (Arene & Anyaeji, 2010; Endale et al., 2014) and in neighboring Nepal (Gill et al., 2003). In explaining the greater affinity of female-headed households toward food insecurity, the discrimination in resource availability (Quisumbing, Brown, Feldstein, Haddad, & Peña, 1995) needs to be highlighted. Females also tend to have lesser pay and less diversified income-generating activities (Endale et al., 2014; Maxwell et al., 2000; Ramachandran, 2007) and are more likely to have shorter available paid working hours (Babatunde, Omotesho, Olorunsanya, & Owotoki, 2008) due to more time devoted toward household chores and child rearing (Mallick & Rafi, 2010). However, our result does indicate that female headed households with main household earner being a foreign migrant have much higher income than female-headed households whose main earner is not a foreign migrant. Additionally, around half of the female household heads of our sample were not in a conjugal relationship, indicating the lesser chance of availability of a male earner in the household. Indeed, it needs to be mentioned that the government and the NGOs in Bangladesh are working relentlessly in reducing gender disparity and empowering women (Hoque & Itohara, 2009; Mair & Marti, 2009) which are reflected in doubling of women's workplace participation rate since the mid'90s (The World Bank, 2008).

In concordance with our study, consensus among many literatures established household size (Babatunde et al., 2008; Endale et al., 2014; Feleke, Kilmer, & Gladwin, 2005), education status of the household head (Arene & Anyaeji, 2010; Babatunde, Omotesho, & Sholotan, 2007; Babatunde et al., 2008; Benson, 2007; Endale et al., 2014) and the household women (Chinnakali et al., 2014; Olumakaiye & Ajayi, 2006; Quisumbing et al., 1995; Ramachandran, 2007; Regassa & Stoecker, 2012), index of household assets or wealth (Faridi & Naimul Wadood, 2010; Feleke et al., 2005; Regassa & Stoecker, 2012), and household income (Chinnakali et al., 2014; Endale et al., 2014; Thorne-Lyman et al., 2010) as significant predictors of household food insecurity. However, in contrary to findings of the positive impact of women's income on calorie intake or food security status of the households (Garcia, 1991; Laraia, Siega-Riz, Gundersen, & Dole, 2006; Ramachandran, 2007), our result shows that income-generating activity of the resident women is not independently associated with household food insecurity.

As for the occupation of primary earner, our results dictate day laboring is significantly associated with household food insecurity. Day laboring is a "daily wager" job with no option of getting paid if the person could not attend work. In rural Bangladesh, day laboring primarily involves working in the agricultural sector and the post-harvest periods provide them with little opportunity to be fully employed (Gill et al., 2003; Zug, 2006).

The negative relationship of the presence of elderly members and household food insecurity found in our analysis has disputed a previous Bangladeshi study (Faridi & Naimul Wadood, 2010). Elderly members are often associated with decreased income potential (Faridi & Naimul Wadood, 2010) and significant morbidity (Muga & Onyango-Ouma, 2009) which are likely to add a considerable burden to the intra-household income and food distribution. Nonetheless, elderly household members play the vital role of stabilizing the family, controlling household economy (Muga & Onyango-Ouma, 2009), and passing agricultural knowledge to the younger members (Marsh, 1998), all contributing toward averting food insecurity.

Additionally, in the context of remittance in Bangladesh, the social phenomenon of abroad migration of household members as a coping mechanism against food insecurity (Shonchoy, 2011) is important to highlight. Previous studies (Khandker, 2012; Mohapatra, Joseph, & Ratha, 2009) have demonstrated a positive association between food security and remittances. Migration of family members usually occurs when the households are low on income and food insecure (Mohapatra et al., 2009; Shonchoy, 2011; Zug, 2006). Thus, our result of the negative association of food security and receiving remittances from abroad indicates that the households may not be receiving enough remittances to mitigate their food insecurity. Money that is spent for foreign migration may not be fully compensated by the remittances they send back home (Rahman, 2000), causing the households to become vulnerable to food security. A similar phenomenon in terms of eligibility should be considered for safety net programs. Despite many studies, which found safety net programs to lessen food insecurity (Barrett, 2010; Del Ninno, Dorosh, & Subbarao, 2007; Mozumder et al., 2009b; Sabates-Wheeler & Devereux, 2010; Zug, 2006), it can be presumed that households enrolled under any safety net program need to satisfy the threshold level of food insecurity to become eligible beneficiaries, justifying our finding of the significant association of food insecurity and households' subscription to safety net program(s).

On the possession of land, a scarce resource in Bangladesh due to its high density of population (Hossain et al., 2005), is a notable determinant of household food security status as the land provides a reliable source of income and food for the households in the agro-based country (Faridi & Naimul Wadood, 2010; Garrett & Ruel, 1999). Our finding of the nonsignificant contribution of homestead land ownership to household food insecurity refutes the general understanding and is open to further exploration. However, the

significant relationship between possession of agricultural land is in concordance with the findings of a similar study (Feleke et al., 2005; Regassa & Stoecker, 2012). Moreover, our finding also portrays similar nonsignificant relationship between homestead gardening and household food security status, which may oppose two previous studies in Bangladesh (Bushamuka et al., 2005) but indicates the unreliability of homestead food production as a steady source of income (Marsh, 1998).

Finally, it is to be noted that the occurrence of *lean* period has been recognized as an important phenomenon in the country's poverty reduction strategy paper (Zug, 2006). The GoB in its effort to alleviate the ramifications of the *lean* period has been conducting frequent relief programs and introduced social safety net programs targeting the affected households (Ministry of Disaster Management and Relief, B., 2012, Zug, 2006). Microcredit, as mentioned before, has also been made available to the rural poor people and marginal farmers mostly by nongovernment organizations with the intention to not only overcome financial hardship but also to empower and to connect them to institutional service network. In recent years, the crop sector is expected to grow larger because of the expansion of microcredit program for rural households (Alamgir, 2010). Nonetheless, as our findings indicate, the northern region of Rangpur is still suffering from the drastic effect of food insecurity during the *lean* period and therefore, it could be recommended that the GoB and other relevant stakeholders take immediate measures to screen for beneficiaries and expand social safety net program activities and microcredit distribution in the region.

5 | STRENGTHS AND LIMITATIONS

The pooled cross-sectional nature of the data and redefining the seasons as per the rice calendar of Bangladesh offered versatility and robustness to the subsequent statistical analyses. However, our multivariate analysis did not adjust the effect of the shocks such as flooding or price hike. Moreover, due to the cross-sectional nature of our data, we failed to show the proportion of people at risk of becoming food insecure in consecutive seasons. The substantial amount of food aid which Bangladesh (Gill et al., 2003) has been receiving has also been ignored.

6 | CONCLUSIONS

The finding of this study illustrates the difference in household food insecurity status in the context of the major rice harvest seasons and the *post-aus* harvest or *lean* period. Our results confirm that the household food insecurity status, on contrary to traditional belief, is lesser during the post-aus or lean period in comparison to the boro harvest season, when food insecurity appears to be bower across Bangladesh with the exception of the Rangpur region, where GoB and other stakeholders need to provide more context-specific inputs. The result of this study also confirms the significant contribution of several household characteristics towards household food insecurity. Further study is recommended using nationwide data to provide more insights on the food insecurity status of the households especially during the *post-aus* period using additional but relevant variables such as climatic shocks and price hikes which the FSNSP has failed to capture.

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CONFLICT OF INTEREST

Disclaimer: KKS is a member of the World Health Organization. The author alone is responsible for the views expressed in this publication and they do not necessarily represent the decisions, policy or views of the World Health Organization.

ENDNOTE

[1]Worry about food/unable to eat preferred foods/eat just a few kinds of foods/eat foods they really do not want eat/eat a smaller meal/eat fewer meals in a day/no food of any kind in the household/go to sleep hungry/go a whole day and night without eating.

ORCID

Tahmeed Ahmed http://orcid.org/0000-0002-4607-7439

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