Food security status and its determinants: A comparative study between farm households under government and non-government agricultural extension services in Bangladesh

Susmita Sarmin [a,*], Md. Faruq Hasan [a], Md. Abu Sayed Mondol [a],
Md. Zulfikar Rahman [b], Md. Rezaul Karim [a,c]

[a]*Department of Agricultural Extension, Hajee Mohammad Danesh Science and Technology University, Bangladesh*
[b]*Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh*
[c]*International Agricultural Policy and Environmental Governance, University of Kassel, Germany*

Abstract

The ability to obtain food security is essential to human existence. Secure food access can have a variety of positive effects, such as economic expansion, the creation of jobs, and the eradication of poverty. This study assessed the food security status of farm households and its determinants in the Dinajpur district of Bangladesh. Efforts were also made to assess and compare the socio-economic demographics and item-wise calorie intake among households receiving government and non-government agricultural extension services. One hundred twenty-five (125) farm households receiving government or non-government extension services were selected using a multi-stage random sampling procedure. The percentages, means, and standard deviations were employed to summarise the data gathered during the interviews. The inferential statistical investigation involved using the independent sample t-test, correlation analysis, and multiple regression analysis. The findings revealed that 68.8 % of the families in the study area were food secure, while food insecurity was more prevalent for those receiving non-government extension services. In addition, significant differences existed between the selected characteristics of the two groups of farmers in terms of age, household head's education, average family education, household size, farm size, farming experience, annual household income, annual household expenditure, knowledge on food and nutrition, and extension sources contact. There were also large discrepancies between the food item-wise calorie consumption between the two groups of farmers. The major determinants of household food security were dependency ratio, household size, training exposure, annual household income, knowledge on food and nutrition, and extension sources contact. It is recommended that both government and non-government agricultural extension organisations work together in an effective, transparent, and unbiased manner to reduce food insecurity.

Keywords: Dietary security, nutrition, calories, NGO, SDGs.

1 Introduction

The idea of food security is multifaceted, giving useful insights into the nature and scope of a population's food situation as it relates to a wide variety of issues that vary in relevance across geographic and social borders (FAO, 2019). It's a sophisticated, sustainable development issue relating to health, economic growth, the environment, and commerce (Fairbairn & Dunlop, 1997). In Bangladesh, there are wide variances in terms of food security. This might be due to a number of underlying causes, some of which include natural catastrophe risk, agricultural land distribution and quality, educational possibilities, health care availability, economic prospects, and nutritional and caring behaviours (Fahim *et al.*, 2021).

Above-average floods, rising food prices, banking sector governance concerns, an inflow of Rohingya refugees from Myanmar, etc., have all been significant drags on Bangladesh's economy since 2016 (UNHRC, 2015; World

* Corresponding author: susmitahstu@gmail.com

Bank, 2018). Despite tremendous progress in areas such as economic growth, human development, and vulnerability reduction, Bangladesh still confronts significant obstacles, with roughly 22 million people still living in poverty (World Bank, 2018). In 2021, 4.0 % of the working population earned less than $1.90 purchasing power parity (PPP) per day, while in 2019, 20.5 % of the population was poor (Asian Development Bank, 2022). Not only the poverty situation and income generation but the present hunger status is also alarming. According to the Global Hunger Index 2021 (GHI), Bangladesh ranked 76th out of 116 countries with a score of 19.1 and a moderate hunger level (GHI, 2021).

By adopting the 2030 Agenda for Sustainable Development (SDGs) in 2015, the international community reaffirmed its determination to eradicate world hunger (United Nations, 2017). There has been a lot of progress towards these Millennium Development Goals. However, Bangladesh still has a "high" incidence of hunger and malnutrition, which might be a roadblock to meeting the Sustainable Development Goals (SDGs) (BRAC James P Grant School of Public Health and National Nutrition Services, 2019). Several significant factors keep people trapped in the vicious circle of poverty. Specifically, the human security of grassroot people (especially farmers) in Bangladesh and their food rights are often compromised due to political, financial, and environmental factors (Szabo *et al.*, 2022). The government of Bangladesh is trying to assist the farmers through its Local Government Institutions. Different non-government organisations are also trying to offer interventions to assist this community. However, in many cases, these social safety net programmes hardly succeed. In addition, most farmers remain out of reach of these programmes (World Bank, 2022).

In addition, food security is crucial in farming communities under government and non-government organisation extension services because it directly influences the well-being and livelihoods of these communities. Ensuring food security enhances economic development, poverty alleviation, and nutrition (FAO, 2013). It improves agricultural productivity and builds resilience to climate change (Wheeler & von Braun, 2013), empowering communities with the knowledge and skills needed for sustainable farming practices and reducing the risk of conflicts related to food scarcity.

Needless to mention, government and non-government organisations have a great role in providing essential extension services to farmers to achieve optimum food security. Extension services serve as a link between scientists who research to find solutions to issues in agricultural practice and farmers. Only when they are effectively shared with farmers, innovative technology and excellent techniques lead to

better yields and enhanced food security (Singh, 2002). Delivering agricultural extension services has been guided by four central tenets: greater distribution of knowledge regarding farmers' skill development, use of better farm technology, general farm management practices, and simple access to input and product markets. These initiatives have similar goals: to boost output while simultaneously reducing poverty and bolstering food security (GSS, 2010). But, it is uncanny that the relationship between government and non-government organisations, throughout most of the history of Bangladesh, has been oppositional and competitive, particularly concerning their role in managing development at the grassroots (Islam, 2012).

Emphasising the issues mentioned above and keeping the shortcomings in mind, the food security and nutritional status of different farm households are in question, and effective and need-based interventions by different government and non-government services could be a light in the darkness to mitigate the crisis that prevails in Bangladesh. With this in mind, this study was undertaken considering the following specific objectives:

- To determine and compare the socio-economic demographics of the farmers receiving government or non-government agricultural extension services;

- To assess and compare the food security status of farm households under government and non-government agricultural extension services;

- To ascertain and compare per capita per day calorie intake of different food groups;

- To identify the determinants of household food security and measure their contribution.

2 Materials and methods

The ex-post-facto cross-sectional research design was followed for the study. The details of the methodology are provided in the following sub-sections.

2.1 Description and history of the area

This research was conducted in the Biral upazila (i.e., administrative unit) of Dinajpur district in northern Bangladesh. It is situated in 25.6335° North latitude and 88.5505° East longitude with a total area of 352.16 km². The total population of the upazila is estimated at 231,476 (Banglapedia, n.d.). Biral upazila in Dinajpur district had been selected for this study due to its notable vulnerability to food insecurity, characterised by factors such as poverty,

limited resource access, and susceptibility to adverse climatic conditions. According to BBS (2016), Biral is one of the most poverty-ridden upazilas in the Dinajpur district, and the poverty and vulnerability situation is noted as "very high" according to the report of poverty and vulnerability maps of Bangladesh 2016. Additionally, the availability of comprehensive data, strong local partnerships, and a need to address food security challenges in this region have made it a suitable choice for targeted interventions and research efforts. This selection aligns with addressing food security issues and improving the local population's well-being in Biral upazila. Thus, this upazila was selected for data collection. Among the twelve unions (lowest administration level) of Biral upazila, two, Mongolpur and Ranipukur, were randomly selected for data collection.

2.2 Sampling

Upon discussing with the local farmers and extension personnel, i.e., Upazila Agriculture Officer (UAO), and Agricultural Extension Officer (AEO) in the upazila agriculture office, it has been observed that, among different government and non-government agricultural extension service providers, Department of Agricultural Extension (DAE) was the major government sector contributor working with Common Interest Groups (CIGs) of the farmers in the study area. On the other hand, World Vision Bangladesh was the major non-government sector contributor to agriculture in the study area. Thus, the beneficiary farmers of the CIG (as government sector; GO) and World Vision Bangladesh (as non-government sector; NGO) were considered as the population of the study.

Together, these two unions represent 1,250 households. For this study, we employed a purposive as well as multistage random selection technique to pick a sample of 125 households using Cochran's (1977) sample size calculating formula. In the case of union-wise and group-wise sample selction, 10 % of the population of each union and the group was considered. In addition, a reserve list containing 10 % of the sample (12 households) was made to use in case the original sampled farmers were unavailable for interview. The detailed distribution of the population and sample are shown in Table 1.

2.3 Data collection

Considering the study's objectives, a structured interview schedule was designed with closed-ended questions to acquire the necessary data. The schedule has scales where they are needed. The questionnaire focused on assembling data on different socio-economic demographics and profile characteristics of the GO and NGO farmers, including age,
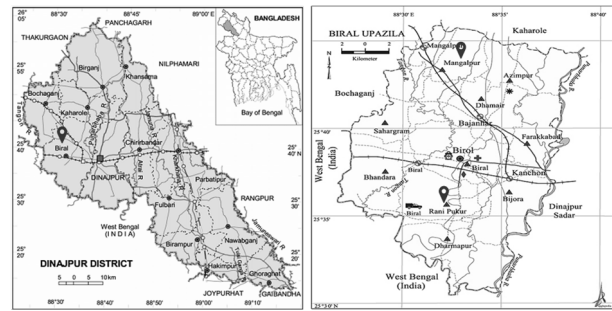
Fig. 1: *Maps showing the sampled locations in Biral upazila of Dinajpur district (Source: Banglapedia (n.d.))*

dependency ratio, household head's education, average family education, household size, farm size, farming experience, training exposure, credit received, annual household income, annual household expenditure, aspiration, knowledge on food and nutrition and extension sources contact. The seven-day recall period was considered to avoid biases that may occur because of shorter reference periods (24 hours). Farmers were asked to indicate the foods consumed from different food categories as FAO (2016) recommended. The food categories were tubers, cereals, fish, milk, meat, eggs, oils and fats, fruits, legumes, vegetables, sugars, and beverages. Twenty sample households were used to test the Bengali version of the interview schedule and straighten out any flaws before the main data collection began. Face-to-face interviews with respondents were conducted between September 15 and October 20, 2019, to collect the necessary data.

2.4 Measurement of the household food security

In this research, household food security was the dependent variable. The consumption method was used to evaluate food security. Measures of consumption more closely reflect the utility that individuals successfully extract from income, and for the poor, the vast majority of their income is spent on food. This makes consumption a superior indicator of household food security over income (FAO, 2001).

The Dietary Intake Assessment (DIA) method was used in this study to assess household food security. It is often conducted in various ways, mainly through recollection methods (24-hour, 7-day, and 30-day), dietary frequency surveys, and food records (individually or by an observer). A number of research projects assessing food security have used these methods (Jensen & Miller, 2010). Here, the 7-day recall technique was applied. The actual caloric intake of the household was determined using the household calorie acquisition technique. First, dietary energy (kilocalories) was derived by matching particular items with a food

Table 1: *Distribution of the population and sample.*

Union	Type of farmer	Population	Sample farmers	Reserve list
Mongolpur	Common Interest Group farmers (10 groups)	300	30	3
	World Vision Bangladesh beneficiary farmers	342	34	3
Ranipukur	Common Interest Group farmers (10 groups)	300	30	3
	World Vision Bangladesh beneficiary farmers	308	31	3
	Total	1250	125	12

composition table (Shaheen *et al.*, 2013) based on what each family reported buying or eating during the previous week. The total number of calories was calculated by dividing the amount purchased or consumed by the number of household members.

Household size was normalised to the adult equivalent to account for age and gender disparities in residential settings. Because people of different ages and sexes have different dietary needs, the World Health Organization (WHO) created the adult equivalency formula (Kumar & Mahadevan, 2011). The result was converted to calories per person per day by dividing by the total number of days in the recall period (7 days). Finally, the daily average calorie consumption, which was compared to an estimate of the minimum daily calorie need of 2122 kcal, was estimated using the following formula (HIES, 2016):

$$\text{Calories per person per day} =$$
$$\frac{\text{Total quantity of calories consumed per household per week}}{\text{Adult equivalent household size} \times \text{recall period in days}}$$

Both Mahzabin (2014), who alalysed the food situation of farmers in the plains, and Shahiduzzaman (2014), who looked at the plight of landless people in the Char region, used a similar technique.

2.5 Measurement of independent variables

Fourteen variables were evaluated to describe the profile characteristics of the sample farmers. The measuring techniques and probable scales for these properties are shown in Table 2.

2.6 Data analysis and processing

SPSS (Statistical Package for Social Science) version 25 was used to analyse the data. For the difference of means "Independent Sample t-test" was computed regarding all the variables to measure the difference between the farmers of government and non-government agricultural extension services. Moreover, the Product Moment correlation coefficient (r) of Karl Pearson (Pearson & Anderson, 1895) was employed to examine the correlations between the variables in question. Multiple regression analysis (both enter and stepwise methods) was run to determine the influence of explanatory variables on farmers' household food security.

3 Results

3.1 Socio-economic demographics of the farmers

The socio-economic characteristics of the study population have been depicted in Table 3. The majority of respondents (47.2 %) were between the ages of 18 and 35, with a mean age of 40 years. The young to middle-aged farmers are prone to adopt innovation, are comparatively energetic and can take risks in their decisions. They are eager to learn more and gain knowledge. These farmers could be seen as potential recipients of knowledge regarding food and nutrition. The majority (40 %) of the respondents had a low dependency ratio. It is said that the lower the dependency ratio, the higher the chances of being empowered and knowledgeable. Furthermore, education helps the farmers to broaden their thinking and expand their horizons of knowledge. Thus, education could be one of the most important criteria for self-sufficiency and receiving a spectrum of practical knowledge. The majority of respondents had finished primary and secondary school, giving them an average of four years of schooling. This might have been reflected in the majority (49.6 %) of the farmers having good knowledge on food and nutrition. Nevertheless, one-fourth of the respondents could sign their name only, while only 9.6 % had completed higher secondary levels. Surprisingly, 7.2 % of the respondents were completely illiterate. Though the education score

Table 2: *Measurements of different independent variables.*

Variables	Scoring method	Scale/Score
Age household head	Number of years	-
Dependency ratio	The number of dependent members (aged <15 and >65) divided by the number of independent members (aged 15 to 65) and multiplied by 100	-
Household head's education	Years of schooling	1 for each year of completion[†], 0.5 for can sign name only, 0 for cannot read and write
Average family education	Years of schooling. Average of the total educational scores of the household members	1 for each year of completion[†], 0.5 for can sign name only, 0 for cannot read and write
Household size	Number of members in the family	-
Farm size	Hectare	-
Farming experience	Number of years	-
Training exposure	Number of days	-
Credit received	Thousand BDT[*]	-
Annual household income	Thousand BDT[*]	-
Annual household expenditure	Thousand BDT[*]	-
Aspiration	A total of eight statements (4 positives and 4 negatives) were used to measure the aspiration of a respondent regarding food security. The Likert-type scale (Likert, 1932) was used for scoring	strongly agree = 5, agree = 4, no opinion = 3, disagree = 2, strongly disagree = 1
Knowledge on food and nutrition	Eighteen questions of different weights regarding food and nutrition were generated following Bloom's Taxonomy (Bloom, 1956)	-
Extension sources contact	The score was computed based on a respondent's extent of contact with 15 selected extension sources	frequently = 3, occasionally = 2, rarely = 1, not at all = 0

[*]Thousand BDT equals approximately $ 9.04; [†]If a respondent completed 5 years of education, his/her score was 5.

of the household head was quite notable, the average family education of most households (73.6 %) in the study area was inferior.

With an average of four family members, an overwhelming number of the households were small-sized and had marginal-sized farms. The average farm size of the households was only 0.59 ha. and most families (62.4 %) reported yearly incomes exceeding US$ 2200, with an average of BDT 223,533 (US$ 2359). However, the majority (79.2 %) of the households had low expenditure, with an average of BDT 153,315 (US$ 1618). In addition, due to high interest rates and strict terms and conditions, an overwhelming majority (95.2 %) of the respondents had received low credit from credit-providing organisations.

Just over half (53.6 %) of the respondents had completed more than weekly to monthly training sessions. The training courses were offered to farmers who were active members of various NGOs. They were educated in areas such as social development, vegetable cultivation, leadership, and various income-generating activities (including butchering, tailoring, and raising cows and goats for milk and meat). It is also noted that extension sources are very effective for receiving information and knowledge about new and modern technologies. The majority (68 %) of the farmers had medium contact with different extension sources, i.e., Upazila Agriculture Officer (UAO), Agricultural Extension Officer (AEO), model farmers, input dealers, posters, and leaflets. Moreover, the highest proportion (56.0 %) of the farmers had medium expectations of achieving food security.

3.2 Difference in socio-economic demographics of the beneficiary farmers

Depiction from Table 3 also suggests that significant differences existed between the selected characteristics of the two groups of farmers. Significant differences were found in ten characteristics, namely, age, household head's education,

Table 3: *Distribution of the farmers according to their socio-economic characteristics.*

Categories	Percentage			Mean (SD)			Difference GO − NGO	t-value
	GO	NGO	Overall	GO	NGO	Overall		
Age (years)								
Young (up to 35)	21.7	70.8	47.2	47.50	33.72	40.34	13.78	7.469**
Middle aged (36-50)	41.7	24.6	32.8	(11.72)	(8.80)	(12.37		
Old (above 51)	36.7	4.6	20.0					
Dependency ratio								
No dependency (0)	15.0	6.2	10.4					
Low (1-50)	35.0	36.9	36.0	67.94	86.13	77.40	−18.19	−1.861^{NS}
Medium (51-100)	35.0	33.8	34.4	(55.47)	(53.81)	(55.15)		
High (>100)	15.0	23.1	19.2					
Household head's education (in years)								
Can't read and write (0)	10.0	3.1	6.4					
Can sign only (0.5)	21.7	40.0	31.2	5.93	3.77	4.80	2.16	2.825*
Primary level (1 to 5)	18.3	35.4	27.2	(4.89)	(3.59)	(4.38)		
Secondary level (6 to 10)	33.3	15.4	24.0					
Above secondary level (above 10)	16.7	6.2	11.2					
Average family education (in years)								
Fairly educated (<6)	38.3	90.8	65.6	6.12	3.07	4.53	3.05	7.174**
Highly educated (6-10)	50.0	9.2	28.8	(3.097)	(1.41)	(2.82)		
Very highly educated (>10)	11.7	-	5.6					
Household size (number)								
Small (up to 4)	51.7	60.0	56.0	5.03	4.35	4.68	0.68	2.273*
Medium (5-6)	31.7	33.8	32.8	(2.12)	(1.096)	(1.697)		
Large (above 6)	16.7	6.2	11.2					
Farm size (in ha)								
Landless (<0.021)	-	3.1	1.6					
Marginal (0.021-0.200)	18.3	81.5	51.2	1.12	0.0997	0.59	1.02	4.347**
Small (0.201-1.000)	50.0	15.4	32.0	(1.89)	(0.10)	(1.41)		
Medium (1.001-3.000)	20.0	-	9.6					
Large (>3.000)	11.7	-	5.6					
Farming experience (in years)								
Low (<11)	21.7	92.3	58.4					
Medium (11-20)	41.7	4.6	22.4	22.38	4.51	13.09	17.88	10.214**
High (21-30)	11.7	3.1	7.2	(12.86)	(5.59)	(13.24)		
Very high (>30)	25.0	-	12.0					
Training exposure (number of days)								
No training (0)	40.0	1.5	20.0					
Weeklong (1-7)	3.3	38.5	21.6	11.95	12.95	12.47	−1.00	−0.529^{NS}
Above weeklong to monthly (8-30)	51.7	60.0	56.0	(12.12)	(8.95)	(10.56)		
Above monthly (>30)	5.0	-	2.4					
Credit received (BDT)								
Low (up to 100)	90.0	100.0	95.2	45.43	28.46	36.61	16.97	1.422^{NS}
High (>100)	10.0	-	4.8	(93.79)	(20.64)	(66.92)		
Annual household income (BDT)								
Low (up to 100.000)	11.7	32.3	22.4	354.88	137.45	241.81	1.02	3.964**
Medium (100.001-300.000)	58.3	66.2	62.4	(434.52)	(79.90)	(324.08)		
High (>300.000)	30.0	1.5	15.2					
Annual household expenditure (BDT)								
Low (<227)	56.7	100.0	79.2	233.09	79.66	153.31	217.43	3.964**
Medium (227-451)	33.3	-	16.0	(146.46)	(391.35)	(130.08)		
High (>451)	10.0	-	4.8					
Aspiration (Score)								
Low (<20)	3.3	6.2	4.8	27.10	27.72	27.42	−0.62	−0.941^{NS}
Medium (20-29)	63.3	49.2	56.0	(3.63)	(3.76)	(3.697)		
High (>29)	33.3	44.6	39.2					
Knowledge on food and nutrition (score)								
Fair (<18)	-	4.6	2.4	35.08	31.83	33.39	3.25	2.390*
Good (18-33)	41.7	44.6	43.2	(7.24)	(7.93)	(7.75)		
Excellent (>33)	58.3	50.8	54.4					
Extension sources contact (score)								
Low (<16)	11.7	29.2	20.8	25.50	19.12	22.18	6.38	5.314**
Medium (16-30)	65.0	70.8	68.0	(8.15)	(5.01)	(7.40)		
High (>30)	23.3	-	11.2					

GO = governmental organisation, NGO = non-governmental organisation, SD = standard deviation, *$p < 0.05$, **$p < 0.01$,
NS= not significant.

average family education, household size, farm size, farming experience, annual household income, annual household expenditure, knowledge on food and nutrition and extension sources contact between the two groups of farmers as indicated by the t-test. The GO farmers are in a better position than their counterparts in all these cases.

3.3 Household food security status of the farmers

Daily calories consumed per person were used to measure the farmers' household food security. The households had a daily calorie consumption ranging from 1452 kcal to 3650 kcal per individual. The estimated overall mean household calorie consumption was higher than the national mean of 2210.4 kcal (HIES, 2016). Results of Table 4 show that considering GO and NGO farmers separately, the mean is higher for the GO farmers ($p < 0.05$).

Table 4: *Daily calories consumed by the beneficiary farmers.*

	Calorie intake per person (kcal per day)			
Categories	Mean	SD	Difference	t-value
GO	2477.67	528.42		
NGO	2280.88	384.45	196.79	2.394*
Overall	2375.34	467.85		

GO = governmental organisation, NGO = non-governmental organisation. * $p < 0.05$.

The average calorie intake is insufficient to depict the actual food security/insecurity situation in the study area. Farmers are classified into three categories depending on their food security status (Table 5): severely food insecure (calorie intake less than 1805 kcal/day/person), food insecure (calorie intake 1805-2121 kcal/day/person), and food secure (calorie intake greater than 2121 kcal/day/person).

Table 5: *Categorisation of beneficiary farmers according to the food security status of their household.*

	in percentage		
Food security status	Overall	GO	NGO
Severely food insecure (<1805*)	9.6	8.3	10.8
Food insecure (1805-2121*)	21.6	18.3	24.6
Food secure (>2121*)	68.8	73.3	64.6

*kcal per day per person. GO = governmental organisation, NGO = non-governmental organisation.

Results of Table 5 reveal that the majority of the overall farm households (both GO and NGO) were food secure. In comparison, about one-third were food insecure to a varying

extent (insecured to severely food insecured). In contrast with GO farmers, the food insecurity situation is graver for their counterparts.

3.4 Intake of calories by food items

Per capita per day calorie intake is required to ensure the optimum nutritional needs of the body. A comparative scenario of calorie intake by the beneficiaries is presented in Table 6, along with the national level of calorie intake as well as the recommended desired intake (HIES, 2016).

It is observed from the findings that the major supply of calories came from the consumption of cereal sources. The second important calorie supply came from potatoes and pulses, followed by vegetables. In addition, the major protein source in the diet was fish and pulses. Apart from a few food items, a common trend in calorie intake was observed between the national level and the study area.

3.5 Determinants of household food security status

Three steps were followed to determine the influence of the selected characteristics of the farmers on their household food security: first, the correlation analysis; second, the multiple linear regression; and finally, the stepwise multiple regression. The steps are given in the following subsections:

3.5.1 Relationships between the variables through correlation analysis

The correlation analysis (Annex I) shows that twelve out of fourteen variables are significantly related to the farmers' household food security status. Among the twelve significant independent variables, ten, namely, age, household head's education, average family education, farm size, farming experience, training exposure, annual household income, annual household expenditure, knowledge on food and nutrition, and extension sources contact had a significant positive relationship. In contrast, dependency ratio and household size have a negative relationship with household food security status.

3.5.2 Result of multiple regression analysis

Correlation analysis only depicts the direction of the relationship of variables but cannot show their influences (Sarmin & Hasan, 2019). So, multiple regression analysis (both enter and stepwise methods) was run to determine the influence of explanatory variables on farmers' household food security. Out of fourteen independent variables, twelve were included in regression analysis due to their significant values in correlation analysis. The different independent variables had their own units of measurement that did not

Table 6: *Per capita per day calorie intake by food items (in kcal).*

Food items	Current intake				Recomm. intake*
	National*	Overall	GO	NGO	
Cereals	1421.7	1244.50	1340.48	1146.04	1337
Potato	62.9	128.89	68.39	71.77	59
Vegetables	91.3	58.14	59.70	57.33	77
Pulses	54.5	92.84	94.10	92.54	136
Milk/milk products	33.7	38.47	49.86	28.55	51
Edible oils	240.8	278.23	290.69	267.59	193
Meat, poultry, eggs	52.1	63.65	56.24	57.41	57
Fish	82.2	72.05	83.66	62.04	76
Fruits	25.0	18.88	19.08	18.88	42
Sugar	27.5	38.32	42.29	34.89	30
Spices \ condiments	74.2	79.08	77.87	71.45	154.32

*National level of calorie intake and recommended intake suggested by Household Income & Expenditure Survey (HIES, 2016).

permit a comparison of the unstandardised regression coefficient values (B). For this reason, standardised regression coefficient values (β) were also computed to avoid the problems of different units of measurement, and the results are presented in Annex II.

The overview of the model used for multiple linear regression depicts that the multiple correlation coefficient (Multiple R) between all the predictor variables and household food security is 0.851. Moreover, the coefficient of determination (R^2) indicates that all the independent variables explain 72.4 % of the variance in household food security. The adjusted R^2, calculated by only including the significant independent variables, reveals that 68.9 % of the dependent variable's variation is attributable to these independent variables. This means that the current analysis does not account for the remaining 31.1 % of the overall variation in household food security. The F-test result of 20.648 is significant at p <0.01, indicating that the multiple regression model significantly influences the dependent variable in this investigation. Hence, this model is a perfect fit to predict the significant contributions of independent variables.

The observed t-value for the regression coefficient was significant for six variables (Annex II): dependency ratio, household size, training exposure, annual household income, knowledge on food and nutrition and extension sources contact. To reach an optimum model of prediction, these six significant variables were included in the stepwise multiple regression analysis (Table 7).

Results from stepwise multiple regression analysis (Table 7) showed that farmers' extension sources contact had the highest contribution (42.1 %) in predicting their household food security. In comparison, the dependency ratio had the second highest contribution (14.5 %) in prediction. Training exposure, annual household income, knowledge on food and nutrition and household size contributed 8.7 %, 2.3 %, 2 % and 1.9 % in prediction, respectively.

4 Discussion

4.1 Differences in demographic characteristics of the farmers and their consecutive household food security

Governmental organisations (GOs) are government-established and funded entities with larger budgets and authority to address societal needs through public services and policy implementation. Their extension services typically encompass agricultural support, education, and public welfare initiatives. In contrast, the non-governmental organisations (NGOs) operate independently, relying on donations and grants to address specific social issues, often focusing on grassroots community development, humanitarian aid, and advocacy (Rahman & Tasnim, 2023). While GOs benefit from government resources and authority, NGOs bring flexibility and innovation to societal challenges. The classification of a farmer as a "GO farmer" or "NGO farmer" is determined by the nature of support received, decided by the organisations providing assistance. This distinction aids in understanding funding sources, services offered, and organisational structures guiding agricultural initiatives, with some farmers interacting with both GOs and NGOs through collaborative efforts in addressing agricultural development and food security.

Socio-demographic characteristics like household head's education, average family education, annual household income, knowledge on food and nutrition, extension sources

Table 7: *Summary of stepwise multiple regression analysis showing contributing variables to household food security status (n=125).*

Model	Independent variables (X)	B	β	Adjusted R^2	R^2 change	t-value	F value
Constant		1989.64				15.455***	
Constant + X1	Extension sources contact (X1)	9.232	0.241	0.416	42.1	3.694*	89.342*
Constant + X1 + X2	Dependency ratio (X2)	-2.325	-0.279	0.559	14.5	-4.979*	79.608*
Constant + X1 + X2 + X3	Training exposure (X3)	10.241	0.245	0.644	8.7	4.226*	75.823*
Constant + X1 + X2 + X3 + X4	Household size (X4)	-28.963	-0.187	0.661	1.9	-3.262	61.347*
Constant + X1 + X2 + X3 + X4 + X5	Annual household income (X5)	0.000	0.201	0.681	2.3	3.359*	54.025*
Constant + X1 + X2 + X3+ X4 + X5 + X6	Knowledge on food and nutrition (X6)	8.277	0.153	0.699	2.0	2.846	49.057*

* $p < 0.1$

contact have significant impact on determining household food security. In the study area, the farmers under GO extension services were better positioned in all of the above-mentioned demographics than their counterparts. This might be due to more substantial and sustained support they received from government sector. Financial assistance, technical training, and access to resources on a larger scale might have enabled farmers to invest in better agricultural practices, infrastructure, and technology which ultimately uplifted their status. In contrast with government's more extensive reach and long-term policies and reforms, NGO farmers had to rely on more localised, project-based assistance, which could have been less consistent and comprehensive, limiting their access to resources and opportunities for socio-economic advancement (Findley *et al.*, 2011), thus the result.

In consistent with the demographic status of the farmers, food insecurity is a burning reality, particularly for the small and marginal farmers in the study area and it is much more severe in the case of farmers under NGO agricultural extension services. This is probably due to two factors: the lower socio-economic condition of the NGO-participating farm households and several limitations of the NGO sector. Generally resource-poor farm households seek demand-driven, efficient services from extension organisations in most developing countries (Prasad, 2016). However, in Bangladesh, government extension services are selective as well as they lack inclusiveness in selecting beneficiaries compared to non-government organisations (Islam & Sharmin, 2011). Although, the non-government extension service-providing organisations are the more client-responsive and competent service provider that raises the voice of the resource-poor farmers in problems definition (Uddin & Qijie, 2013), yet with limited resources and reliance on donations, it often makes it challenging for them to comprehensively address widespread issues linked with food insecurity. In addition, NGOs face logistic constraints, lack direct access to government funding, and operate in regions with unstable political or economic conditions. In contrast, governmental organisations typically have larger budgets, infrastructure, and policy frameworks to implement more extensive and sustainable food security programmes. This might be the reason for the higher prevalence of food-insecure households under non-governmental organisations (NGOs). Thus, for bringing household food security, the NGO and GO collaboration for selecting beneficiaries and operationalising the extension programmes must be built up for efficient extension services for all farmers.

4.2 Intake of calories by food items

Food security aims to ensure that everyone has access to nutritious food in sufficient quantities to support their health (Dev *et al.*, 2014). Findings depict that the beneficiaries

lack calorie supply from many of the important food items in their diet compared to the recommended desired calorie level. Rice is the main staple food in Bangladesh, covering a major portion of the calories from cereal sources (Morshed, 2023). Although food grain production has increased dramatically, there are still nutritional issues in Bangladesh. Inadequate food intake and chronic malnutrition are still major issues for the poor in this country, neither of which have been addressed by the lack of national food security (Dev *et al.*, 2014). Furthermore, a greater quantity of food might not always be sufficient to meet the nutritional requirements. Diets comprising a higher amount of carbohydrates and lacking other sources, i.e., protein, lipids, vitamins, and minerals, or vice-versa don't ensure proper bodily utilisation of food (Trakselis & Stein, 2019). Thus, awareness regarding a balanced diet and endeavours to ensure all food groups' availability, access, and utilisation is essential.

4.3 Determinants of household food security status

Regarding the determinants of household food security status, extension sources contact and training exposure together predict about 50.8 % of the household food security status. These two predictors are responsible for capacity building and activation of skills to utilise different factors associated with food security. Inadequate or unapplied skills cause food insecurity. Land preparation, planting, and harvesting skills help lessen transitory food insecurity (Njura *et al.*, 2020). Previous studies show that extension services provided in the field are the single most important component in reducing food insecurity (Bodnar & de Steenhuijsen-Piters, 2011; Mogues *et al.*, 2012 and Ton *et al.*, 2013). Moreover, training in the efficient use of high-yield seeds and the free distribution of such seeds were also found to have a favourable influence on food security in Uganda (Pan *et al.*, 2015), so as farmers' field schools in Tanzania (Larsen & Lilleør, 2014). However, when food security was not improved, it was often due to extension services' failure to properly engage communities, government institutions, educational institutions, and the corporate sector (Babu *et al.*, 2016, Jaim & Akter, 2016).

Additionally, a high dependency ratio, characterised by more dependents than breadwinners, emerges as the second most important negative factor influencing household food security. When there are more mouths to feed, family food supplies might become tight owing to outstripping production. The majority of the dependents in rural homes are children, making the high dependence ratio a significant burden. There is a higher chance that a family may be food insecure if some of its members cannot work and contribute to the household's income. These relatives provide nothing to the

home but expenses (Sisha, 2020). They force their dietary needs on the working member(s). These results lend credence to the idea that community-based education reduces birth rates, and hence, the dependence ratio is worthwhile (Samim *et al.*, 2021). It was also found that the average annual family income played a significant role in determining a family's level of food security in the households. This may be the case since it is often assumed that a household's food security will improve if its marginal production and contribution to the family income both rise (Samim *et al.*, 2021; Sani & Kemaw, 2019). Similar studies have found that household income influences food security and purchasing power (Akukwe 2020; Etea *et al.*, 2019; Bizikova *et al.*, 2020). Moreover, knowledge on food and nutrition is also important in achieving the utilisation dimension of food security by ensuring a balanced and nutritious diet. According to Weerasekara *et al.* (2020), in the absence of nutritional knowledge, which influences household preference, attitude, and food consumption behaviour, families are more likely to prioritise the convenience of cooking a specific dish in their decision-making process. Factors such as degree of education, attitude toward nutrition, the impression of food quality, location, and socio-economic status have been connected to this knowledge gap.

5   Conclusion

Despite Bangladesh's efforts to achieve Sustainable Development Goal 2 and address food insecurity, over one-third of households in the study area remain food insecure. Government sector farmers are significantly better than their NGO sector counterparts, highlighting vulnerabilities among the latter. Persistent challenges include reach of efficient support for all beneficiaries irrespective of their association with different extension service providers and deviations from desired calorie intake and inadequate nutrition. Key influencing factors, such as extension sources contact, dependency ratio, training exposure, household size, annual income, and knowledge on food and nutrition, were identified and strengthening these factors can contribute to achieving food security. Addressing vulnerability requires collaborative policies from both government and NGO sectors, with targeted capacity-building programmes, especially for NGO farmers in sustainable agriculture, financial literacy, and business skills. In the broader context, NGOs play a crucial role in the economic growth of developing nations, and addressing various social needs. Effective cooperation between government and NGOs is now imperative to accelerate development efforts, considering changing environments and the need for resource optimisation. Col-

laborative efforts can harness comparative advantages for the benefit of both parties, ensuring the most efficient use of limited resources in development initiatives and reaching wider population. Social Safety Net (SSN) programmes should engage the population transparently, and off-farm income-generating activities, extension and training support, and nutrition campaigns should empower vulnerable groups. Recognising that neither sector alone can reach the entire vulnerable population, a collaborative, effective, transparent, and indiscriminate approach is essential to eradicate food insecurity.

Conflict of interest

The authors declare that they have no conflict of interest.

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