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Farmers' Knowledge of Climate Change in Northern Bangladesh

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Abstract

The present study was undertaken to measure farmers' knowledge of climate change, to explore the relationships of the selected characteristics of the farmers with their knowledge of climate change and the contributing factors to farmers' knowledge of climate change and to identify the constraints faced along with their suggested solutions. A total of 98 farmers were selected as sample by multistage random sampling method from two Sadar upazilas of Thakurgaon and Rangpur districts. Data were collected by a structured interview schedule during 15 February to 30 March 2017. Eight questions on different aspects related to climate change were constructed to measure the knowledge of climate change. Scores were assigned for different responses of the selected questions as per difficulty. The highest proportion of the farmers (56.1 percent) had good knowledge, while 29.6 percent had excellent and 14.3 percent had fair knowledge of climate change. Out of eight independent variables, educational qualification, farm size, training exposure, farming experience and perceived effects of climate change showed significant positive relationships with knowledge of climate change. The regression analysis indicates that perceived effects of climate change by the farmers contributed highest in predicting their knowledge followed by farm size, training exposure, farming experience and educational qualification. 'Working at crop field has become difficult due to hotness' was the top ranked constraint faced by the farmers due to climate change. The majority of the farmers suggested that, afforestation and reforestation programs should be conducted and deforestation should be stopped to overcome the problems regarding climate change.

Keywords: *Farmers' knowledge, climate change, climate resilience, adaptation strategies.*

Introduction

Agriculture is the most vulnerable sector as its productivity totally depends on climatic factors like temperature, rainfall, light intensity, radiation and sunshine duration, which are predicted to be erratic. Incidences of floods, droughts, high temperature, flash floods etc. are predicted to be more frequent and intense in northern Bangladesh. The term 'global warming' is often used synonymously with the term 'climate change', but the two terms have distinct meanings. Global warming is the combined result of anthropogenic emissions of greenhouse gases and changes in solar irradiation, while climate change refers to change caused by global warming in weather (temperatures, precipitation, frequency of heat waves, etc.) and other climate system components, such as Arctic sea ice extent (Banglapedia, 2007). Climate is simply the weather that is dominant or normal in a particular region. It includes temperature, rainfall and wind patterns. Geography, global ocean currents, wind movement, vegetation, temperatures and other factors influence the climate of a specific area, which causes the local weather. That brings significant changes in agriculture, food security and economic growth (DFID, 2004). However, what is

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now certain is that changes in climate have already devastated the lives of poor people all over the world, particularly the agriculture dependent communities.

Climate change is one of the emerging issues of pro-poor growth, poverty and inequality. Poor people are generally the most vulnerable to the climate change as they live in disaster prone and remote areas where they have little capacity to adapt to the shocks. They are also more dependent on natural ecosystem services and products for their livelihoods (Thurlow *et al*., 2009). Any impact that climate change has on natural system therefore threatens employment and income generation (Skoufias *et al*., 2011). Agriculture is one of the most sensitive sectors to climate change (Cline, 2007), particularly changes in temperature, rainfall patterns, and increased likelihood of extreme events such as droughts and floods. According to David (2010) climate change in Bangladesh is an extremely crucial issue and it placed the country in first rank among the most vulnerable nations that will be affected by climate change in the coming decades. In Bangladesh, yield from rain-fed agriculture could be reduced to 50 percent by 2020 (IPCC, 2013) with increasing population and hunger, will have an extreme effect on food security (Sunny, 2011).

Specifically, the northern part of the country is facing extreme droughts. Most of the people in the northern area of the country are directly dependent on agriculture. Generally, the overall agricultural productivity in the region is very low mainly due to unavailability of irrigation facilities, inadequate rainfall in dry season and less water flow in the rivers. To overcome these adverse effects of climate change in agriculture sector, to improve the present condition and to develop the socio-economic condition of the farmers, their knowledge level need to be identified for taking appropriate resilience strategies. Despite being highly vulnerable, very little efforts have so far been made to understand the knowledge level of the farmers regarding climate change in Bangladesh. Ahmed (2000) made an attempt to analyze the adaptation potential of the country's crop agriculture, whereas Parveen (2004) examined food security aspect and implications of climate change. However, farmers' knowledge on climate change is not addressed specifically. Considering the present situation of climate change and its adverse effect on agriculture, knowledge level of the farmers for climate change are selected for this research. The findings of the study are expected to be of great value to the researchers, policy makers, extension service providers, students and particularly to the farmers. Considering these issues, the present study was undertaken with the overall objective to identify the farmers' knowledge of climate change in northern Bangladesh. To achieve this overall objective, the following specific objectives were considered: i) to measure the extent of knowledge of the farmers of climate change, ii) to explore the relationships and contributions of the selected characteristics of the farmers with their knowledge of climate change and iii) to identify the constraints faced by the farmers due to climate change and the possible solutions of these constraints.

Methodology

Locale, population and sampling design: Research design enables to answer research questions as objectively, accurately and economically as possible. It sets up a

framework for the test of relationship among variables and helps to keep the research in proper direction (Hasan *et al.*, 2018). Mixed-method combining both the qualitative and quantitative approaches was used in this research for more robust result than using a single approach. The study was conducted in two Sadar upazilas from two districts of Northern Bangladesh namely, Rangpur and Thakurgaon. These districts were selected purposively as the predominant livelihood activities of the peoples of these districts are agriculture and the sector is under substantial threat due to climate change. Multistage random sampling technique was used to select sample size from the population. At first stage, one union from each Sadar upazila i.e., Auliapur from Thakurgaon Sadar upazila and Tamphat from Rangpur Sadar upazila was selected randomly. A total of 976 farmers under these two unions constitute the population of the study. List of the farmers under these two unions were collected from respective upazila agricultural offices. From this list, 98 farmers (10 percent of the population) were selected randomly as the sample of the study.

Data collection: A structured interview schedule was prepared for data collection containing both open and closed form of questionnaires which were pre-tested with 10 farmers selected from the study area. Data were collected from 15 February to 30 March 2017.

Variables and their measurement: Farmers' knowledge of climate change was considered as the dependent variable of this study. For measuring knowledge of climate change, eight questions on different aspects related to climate change were used. Scores were assigned for responses of selected questions as per the difficulty level of the questions. For correct responses to all the questions, a respondent could get a total score of 21 while for wrong responses to all the questions a respondent could get zero. Thus, knowledge on climate change score of the farmers could range from 0 to 21, 0 indicating very poor knowledge and 21 indicating very high knowledge. Eight personal and socio-economic characteristics of the respondents namely: age, educational qualification, family size, farm size, annual income, farming experience, training exposure and perceived effects of climate change were selected to understand the factors relating to the knowledge of climate change. Standard and conventional procedures were maintained to measure these independent variables.

Measurement of constraints: In measuring the constraints of the farmers due to change of climate 15 constraints related to climate change issues were selected. Constraint Facing Index (CFI) was calculated and rank order of the constraints was done. The Constraint Facing Index was computed using the following formula:

$$CFI = (C_h \times 3)+(C_m \times 2)+(C_l \times 1)+(C_n \times 0)$$

Where,

CFI is Constraints Facing Index,

C_h is number of respondents having high constraint,

C_m is number of respondents having medium constraint,

C_l is number of respondents having low constraint, and

C_n is number of respondents having no constraint.

The Constraint Facing Index (CFI) of a constraint could range from 0 to 294. Attempts were also made to find out suggestions from the respondents to

overcome the identified constraints. Ranking of the suggestions based on number of frequencies of each suggestion was done through content analysis.

Data processing and analysis: The collected data were coded, compiled, tabulated and analyzed for interpretation. Different descriptive statistical measures such as frequency, number, percentage, mean, standard deviation and rank order was used for categorization and describing the variables. Karl Pearson's Product Moment correlation coefficient (r) (Pearson, 1895) was used for testing the relationships between the concerned variables. Nevertheless, the correlation analysis only indicates direction of relationship of variables with farmers' knowledge of climate change but cannot show their influences quantitatively so that multidimensional nature of knowledge can be explained. So, regression analysis (both enter and stepwise method) was run to explore the effect of explanatory variables on farmers' knowledge of climate change. Thus, the influential factors were identified that have effects on farmers' knowledge of climate change which helps to reveal highest coefficient of determination (R^2), that is, amount of change of dependent variable by the independent variables.

Results and Discussion

Farmers' knowledge of climate change

The categorical distribution of the knowledge of climate change of the farmers is presented in Table 1. The knowledge score of the farmers ranged from 3 to 20 with a mean of 12.17 and standard deviation of 4.17. The highest proportion (56.1 percent) of the farmers had good knowledge, while 29.6 percent and 14.3 percent had excellent and fair knowledge of climate change, respectively. The existence of good knowledge about the changes taking place in climate is probably due to the fact that, the prevalence of farmers getting education of secondary and higher secondary level is quite notable in the study area. Moreover, their perception regarding effect of climate change might made them curious about the pros and cons of climate change which in turns encouraged them to gain knowledge regarding it.

Table 1 Distribution of farmers according to their knowledge of climate change (n = 98)

Range		Categories	Respondents		Mean	SD
Possible	Observed		Number	Percent		
0-21	3-20	Fair knowledge (up to 7)	14	14.3	12.17	4.17
		Good knowledge (8 to 14)	55	56.1		
		Excellent knowledge (above 14)	29	29.6		
		Total	98	100.0		

Characteristics profile of the farmers

Eight selected characteristics of the farmers have been selected to describe the characteristics profile of the farmers. Categorical distribution of these characteristics is given in Table 2.

Table 2 Characteristics profile of the respondents (n = 98)

Characteristics (measurement unit)	Possible range (observed range)	Respondents			Mean	SD
		Category	No.	%		
Age (year)	Unknown (20 to 65)	Young (up to 35)	39	39.8	40.82	12.30
		Middle aged (36 to 50)	36	36.7		
		Old (above 50)	23	23.5		
Educational qualification (year of schooling)	Unknown (0.0 to 16.0)	Illiterate (0)	13	13.3	5.21	4.89
		Can sign name only (0.5)	26	26.5		
		Primary (1 to 5)	18	18.4		
		Secondary (6 to 10)	28	28.6		
		Above secondary (above 10)	13	13.3		
Family size (number)	Unknown (1 to 11)	Small family (up to 4)	34	34.7	5.12	1.63
		Medium family (5 to 6)	46	46.9		
		Large family (7 and above)	18	18.4		
Farm size (hectare)	Unknown (0.13 to 3.50)	Marginal (0.002 to 0.02 ha)	8	8.2	0.88	0.73
		Small (0.021 ha to 1.00 ha)	63	64.3		
		Medium (1.01 ha to 3.00 ha)	25	25.5		
		Large (above 3.00 ha)	2	2.0		
Annual income ('000' Taka)	Unknown (20.00 to 650.00)	Low income (up to 200)	79	80.6	132.52	103.91
		Medium income (201 to 400)	17	17.3		
		High income (above 400)	2	2.0		
Farming experience (year of farming)	Unknown (4 to 40)	One decade (<11)	26	26.5	21.03	11.23
		Two decade (11 to 20)	29	29.6		
		More than two decade (>20)	43	43.9		
Training exposure (days)	Unknown (0 to 90)	No training (0)	54	55.1	14.31	28.31
		Up to weeklong	22	22.4		
		Above weeklong but upto month	11	11.2		
		Above month	11	11.2		
Perceived effects of climate change (score)	0 to 27 (6 to 26)	Low (up to 9)	7	7.1	17.19	4.77
		Medium (10 to 18)	47	48.0		
		High (above 18)	44	44.9		

Majority (76.5 percent) of the farmers belonged to young to middle aged category compared to 23.5 percent under old aged category. The young to middle aged farmers are prone to adopt innovation, comparatively energetic and can take risk in

their decision. These farmers should consider for any sort of climate adaptation strategy. Education helps the farmers to broaden their thinking and expand their horizon of knowledge. Thus, education is one of the most important criterions in receiving knowledge of climate change. The findings of this study indicate that among the respondents about 13.3 percent were illiterate, 26.5 percent can sign only, 18.4 percent had education at primary level, 28.6 percent had education at secondary level and 13.3 percent of them had education above secondary level. The average family size of the respondents was 5.12 which is higher compared to the national average of 4.06 (HIES, 2016). Majority (81.6 percent) of the farmers had medium to small sized family while 18.4 percent had large sized family. It indicates that small families are increasing day by day. Farm size is one of the main indicators of holding farming status of the farmers. Majority (64.3 percent) of the farmers were small category. In Bangladesh, land fragmentation is a general process. Lands are divided into small pieces through generation to generation. For this reason, farm size of the farmers is being decreased day by day. Generally higher income gives an individual better status in the society. Overwhelming majority of the farmers (97.9 percent) was in the low to medium income category. Moreover, the mean farming experience of the farmers is 21.03 years with the standard deviation of 10.77 where 73.5 percent of the farmers possessed either two to one decade of farming experience. Training might have influence in acquiring information about changes taken place in farming activities in response to climate variability and changes. Majority (55.2) of the farmers had no training which calls for appropriate attention. The respondents who attend more training were concerned about the changes in farming due to the climate change. Perception regarding adverse effects of climate change helps a farmer to develop his/her adaptation strategies of the climate change resilience. Highest proportion (48.0 percent) of the farmers had medium perception about the effects of climate change.

Relationships between farmers' knowledge of climate change and their selected characteristics

Pearson's Product Moment Coefficient of Correlation (r) was computed in order to explore the relationships between the selected characteristics of the farmers and their knowledge of climate change and the results are presented in Table 3.

Table 3 Relationships between the dependent and independent variables

Dependent variable	Independent variable	Correlation coefficient (r)
Knowledge of climate change	Age	0.104
	Educational qualification	0.253*
	Family size	0.014
	Farm size	0.342**
	Annual income	0.141
	Farming experience	0.205*
	Training exposure	0.274**
	Perceived effects of climate change	0.387***

'*' indicating significant at 5% level of significance,

'**' indicating significant at 1% level of significance and

'***' indicating significant at 0.1% level of significance

Among the eight (8) selected characteristics five (5) namely, educational qualification, farm size, farming experience, training exposure and perceived effects of climate change of the farmers had significant positive relationships with their knowledge of climate change. Therefore, higher educational qualification, large farm size, high farming experience, high training exposure and more favorable perception of the farmers on effects of climate change help to gain more knowledge regarding climate change. This might be due to the fact that, high educational qualification and high training exposure helps to expand the horizon of outlook and insight of the farmers which aids them to become rational, conscious and get useful information to increase their knowledge of climate change. Moreover, large farm size and high farming experience helps farmers becoming more acquainted with the climate which in turns make them aware of the change in the climate ultimately broadening their level of knowledge. On the other hand, the more intensely farmers perceive the effects of climate change the more they become conscious about the change taking place in their surroundings. This helps them to become curious and gain more knowledge of climate change. However, age, family size, annual income had no significant relationship with farmers' knowledge of climate change at five percent level of significance.

Factors contributing to farmers' knowledge of climate change

In order to find out the relative contribution of independent variables to the farmers' knowledge of climate change, multiple regression analysis was computed. Out of eight variables five variables 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 permit a comparison of the unstandardized regression coefficient values. For this reason, a standardized regression coefficient values also computed to avoid the problems of different units of measurement.

Table 4 Contributing variables to explain the knowledge of climate change (n=98)

Variables entered	Unstandardized coefficient (B)	Standardized coefficient (Beta)	(% contribution)	t value	F value
Educational qualification	0.171	0.201		2.296*	
Farm size	1.184	0.208		2.386*	
Farming experience	0.097	0.261	34.4	3.035**	11.192***
Training exposure	0.041	0.276		3.265**	
Perceived effects of climate change	0.287	0.329		3.929***	

Constant = 2.674; R^2 = 0.378; Adjusted R^2 = 0.344; * = Significant at 5% level of significance;
** = Significant at 1% level of significance; *** = Significant at 0.1% level of significance.

The values of multiple determination coefficients (adjusted R^2) for all the five independent variables jointly explained 34.4% of variation in the knowledge of climate changes (Table 4). The observed t value for regression coefficient was significant in case of all the entered variables. For reaching an optimum model of prediction analysis of selected independent variables with the knowledge of climate change, these five significantly contributed variables to the knowledge of climate change were included in the stepwise multiple regression analysis (Table 5)
.

Table 5 Summary of stepwise multiple regression analysis showing contributing variables to knowledge of climate change (n=98)

Mo-del	Variable entered	Unstand-ardized coefficient (B)	Standar-dized coefficient (Beta)	Adjusted R^2	R^2 Change (% contri-bution)	t value	F value
1	Constant + Perceived effects of climate change	0.287	0.329	0.141	14.1	3.929***	16.875***
2	Constant + Perceived effects of climate change + Farm size	1.184	0.208	0.210	6.9	2.386**	13.926***
3	Constant + Perceived effects of climate change + Farm size + Training exposure	0.041	0.276	0.273	6.3	3.265**	13.155***
4	Constant + Perceived effects of climate change + Farm size + Training exposure + Farming experience	0.097	0.261	0.314	4.1	3.035**	12.117***
5	Constant + Perceived effects of climate change + Farm size + Training exposure + Farming experience + Educational qualification	0.171	0.201	0.344	3.0	2.296**	11.192***

** = Significant at 1% level of significance; *** = Significant at 0.1% level of significance.

According to multiple regressions analysis, among the five variables, perceived effects of climate change of the farmers contributed 14.1% in predicting their knowledge of climate change while farm size contributed only 6.9%. Whereas, training exposure, farming experience and educational

qualification contributed 6.3%, 4.1% and 3.0%, respectively.

Perception is a source of knowledge because it is a source of justified true beliefs about the world around us. The results revealed that perceived effects of climate change by the farmers increased their knowledge of climate change. This might be due to the fact that, perception might make them understand and become conscious about the consequences of the changes taking place in nature. As mentioned earlier training and educational qualification broaden the horizon of outlook of an individual through sharing experience and achieving skill which helps famers to improve the contents of cognitive domain (more knowledge) which explains the positive contribution of these variables towards the knowledge of climate change. Furthermore, farming is highly influenced by the components of climate. The farm size and farming experience are important contributing factor to farmers' knowledge of climate change which helps farmers getting accustomed with the climate to take time led adaptation strategies against the adverse effects of climate change which in turns enhance their knowledge.

Constraints faced by the Farmers due to Climate Change

The rank order of the constraints faced by the farmers due to climate change according to their Constraint Facing Indices (CFIs) is presented in Table 6.

Table 6 Distribution of the farmers according to their constraint facing indices

Constraints	Extent of constraints				CFI*	Rank order
	High	Medium	Low	No		
Lack of available irrigation and drinking water	5	25	35	33	100	15
Rising fuel demands to cope with water shortages	26	30	30	12	168	9
Lack of market access	31	25	24	8	167	10
Shortage of climate smart farm inputs	20	36	25	17	157	11
Lack of information	27	36	22	13	175	7
Poor soil fertility / soil degradation (erosion)	25	34	30	9	173	8
Unpredicted monsoon (weather)	36	44	10	8	206	5
Summer temperature increase	57	30	8	3	239	2
Insufficient rain to recharge aquifers	19	23	9	47	112	14
Poor crop production and livestock production (meat, milk, egg, etc.)	13	47	19	19	152	13
Outbreak of pests and diseases	42	45	9	2	225	3
Increase in household food insecurity	19	35	26	18	153	12
Working at crop field has become difficult due to hotness	58	34	5	1	247	1
Damage of ecology	45	26	15	12	202	6
Public health problems	46	36	10	6	220	4

*CFI= Constraint Facing Index

It is evident from Table 6 that, the top ranked constraint faced by the farmers due to climate change was found 'working at crop field has become difficult due to hotness'. This might be due to that straddling the Tropic of Cancer; Bangladesh has a tropical monsoon climate characterized by heavy seasonal rainfall, high temperatures, and high humidity. During summer crop fields becomes very hot due to direct sunlight ultimately intercultural operation in the crop field become very difficult. The second top ranked constraint faced by the farmers due to climate change was observed on 'summer temperature increase'. As the greenhouse gases like CO_2, methane, oxides of nitrogen and sulfur, fluoride etc. is increasing so the

amount of heat captured by earth's atmosphere is also increasing because these gases trap long wave radiations and causes increase in temperature. 'Outbreak of pests and diseases' was found as third ranked constraint faced by the farmers due to climate change. Pest and diseases are the foremost hindrance in cultivation of crops. The dynamics of crop disease and pest influx are changing rapidly due to changing climate. While there is clear evidence that climate change is altering the distribution of animal and plant pests and diseases, the full effects are difficult to predict. The least ranked constraint was 'lack of available irrigation and drinking water'.

Suggested solutions of the constraints

The suggestions offered by the farmers to overcome the climate change constraints are given in Table 7 with their citations and rank order.

Table 7 Suggestions offered by the farmers to overcome the climate change constraints

Suggestions	No. of citation	Rank order
Afforestation and reforestation programs should be conducted and deforestation should be stopped	61	1
Organizing more training program for the farmers as well as other stakeholders of farming in order to increase awareness about climate change problems	57	2
Policy makers and administrative officers involved in Ministry of Environment and Forest should come forward regarding policy development to keep climate change in safe limit	50	3
Increased use of renewable energy including energy from wind, solar, wave, bio-fuels, etc.	54	4
Height of brick kiln should be maintained at optimum level and these should be established in far away from crop field	49	5
Sustainable management and rational use of natural resources	44	6
Enhance 'political efforts' to address the existing governance challenges in the service delivery systems in Bangladesh	42	7
Uniformity of views among local and national stakeholders should be built for climate change policies and actions	39	8
Priority need to be given in organic and locally grown crops which are produced without hampering the environment	35	9

The findings of the research revealed that the top ranked suggestion given by the farmers was found on 'afforestation and reforestation programs should be conducted and deforestation should be stopped'. The reasons might be due to that forests are considered as lungs of environment which receive carbon dioxide (CO_2) and release oxygen (O_2) to make environmental balance. Tree plantation protects environment from degradation ultimately decrease climate change effects. Moreover, trees are the available sources which plays important role to improve the environmental and ecological balance. Farmers can also realize these phenomena and day by day they are getting awareness on this issue. 'Organizing more training program for the farmers as well as other stakeholders of farming in order to increase awareness about climate change problems' was found as second ranked suggestion opined by the farmers. The result might be due to that more the training program more awareness will be grown up among the farmers. Awareness will help them to cope with and adopt with climate change effects. The third ranked suggestion mentioned by the farmers

was 'policy makers and administrative officers involved in Ministry of Environment and Forest should come forward regarding policy development to keep climate change in safe limit'. Peoples might very aware about any laws and policies offered by government. So, if policy will be formulated to keep climate change in a safe limit the climate change effect will be lower. 'Priority need to be given in organic and locally grown crops which are produced without hampering the environment' was found as the last suggestions offered by the farmers to overcome the climate change constraints. The findings might be due to that organic and locally grown crops are grown without massive use of fertilizer and pesticides, ultimately keep environment safe and less hampered.

Conclusions

The majority of the farmers had possessed good knowledge on different climate change issues. These farmers need to be supported with their information demand for coping with the changed climatic situation. They also need to aware about different environmentally friendly cultivation practices and climate smart technologies. Different agricultural information sources need to support this kind of information for ensuring climate change resilience. High level of education and training exposure broaden the horizon of outlook of the farmers, thus different non-formal educational programs need to be launched to strengthen farmers' capacity to cope with the climate change issues who will in turn spill-over their knowledge to their neighbor farmers. The philosophy is 'let the farmer be the teacher of the other'. Again, different GOs and NGOs should undertake effective agricultural extension programs in order to increase the capacity of the farmers to cope with the changing climatic conditions. Group discussion, training programs, motivational campaigns could be highlighted in this regard. Similar studies may be conducted in other areas of the country to generalize the findings. Research should be undertaken particularly to identify the adaptation strategies used by the farmers in the changed climatic condition in other regions of the country and to explore the potentialities to overcome the constraints faced by the farmers.

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