Effects of Farmers Knowledge and Climate Change on Yields of Crop in the Saline Prone Area of Bangladesh

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ABSTRACT

Southern part of Bangladesh is one of the most affected areas confronting the effects of climate change especially in agricultural sector. The study was planned to examine effect of climate change on agriculture in the saline prone areas, and estimate the level of contribution of the selected characteristics of the farmers to the effect of climate change on agriculture. For this reason, data were collected from 88 farmers under study group and 30 farmers under control group from 16 March, 2017 to 15 April, 2017. Descriptive statistics, multiple regression, t-test were used for data analysis. There was a negative effect of climate change on agriculture comparing the study and control group changed score from 2015 to 2017. In case of study group, 61.4 percent of the farmers had medium effect, 17.0 percent had low effect and 21.6 percent of the farmers had high effect of climate change on agriculture. It was also found that out of eleven factors, seven namely age, level of education, annual family income, farming experience, training exposure, agricultural knowledge and knowledge on climate change had significant contribution to the effect of climate change on agriculture in the saline prone areas. It **is** concluded that climate change may play a significant role in decreasing the yield of cereal crops, yield of vegetables, yield of pulses and increasing number of adopted new varieties of agricultural crops by the farmers. It **is** recommended that the Bangladesh government and NGOs should take initiative for reducing effect of climate change on agriculture for a sustainable agricultural development.

Key words: Saline prone areas, climate change, agriculture, Bangladesh

1. INTRODUCTION

Climate change refers to the variation in the earth's global climate or in regional climates over time. It is the change of climate which attributed directly or indirectly to human activity that alters the composition of the global atmosphere [1]. Climate change is a phenomenon due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization and industrialization [2] resulting into variations in solar energy, temperature and precipitation. Climate change is an emerging environmental challenge to date is a natural process and has been considered through increased variability and uncertainty of precipitation. Greenhouse gases (GHGs) mainly CO_2, N_2O and CH_4 majorly emitted from the energy sector are the major contributing agents of climate change. Emission of Carbon Dioxide (CO_2) is the major element which forms more than 80% of the total GHG. GHGs have created a greenhouse effect which subsequently altered precipitation patterns and global temperatures. Several basic indicators in our surroundings, such as steady rise in temperatures, increasing concentration of greenhouse gases in the atmosphere, and growing weather or climatic uncertainties, show the aggregate effects of these changes. Intergovernmental Panel on Climate Change (IPCC) [3] reported that the global mean surface air temperature has increased in Bangladesh. Bangladesh is a densely populated (around 158.9 million

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people lives in its 1, 47,570 square kilometer of land; [4]) and agro-based (47.5% of the total manpower is involved in agriculture) developing country. Here, agriculture contributes 18.82% of the gross domestic product (GDP) of the country in the year of 2014-2015 [5]. The livelihood of the Bangladeshi depends on mostly agriculture for which reason Bangladesh is identified as a highly vulnerable country to Climate Change [6]. The agriculture in Bangladesh is vulnerable for two reasons. First, the existing system of food production is highly climate sensitive because of its low level of capital investment and adoption of modern technological options. Second, agriculture is the main source of livelihoods for a majority of the population i.e. 48% population depends on agriculture [7]. This will put greater number of people at risk when agriculture is affected due to climatic variability and uncertainty [8]. Effect of climate change on agriculture are very vague that climate change **may have** increased productivity in some region while it to be decreased in another region [9]. During the wet monsoon, the severity of salt injury is reduced due to dilution of the salt in the root zone of the standing crop. The dominant crops grown in the saline areas are local transplanted Aman rice with poor yields. Salinity problem received little attention in the past but due to increased demand for growing more food to feed the booming population for the country, it has become imperative to explore the potentials of these lands for crop production. Although, climate change has an enormous effect on agriculture in the saline area of Bangladesh, little research has been conducted regarding the effect of climate change on agriculture in the saline prone areas particularly in Bangladesh. Hence, in view of the foregoing discussion, the research regarding this topic entitled 'Effect of Climate Change on Agriculture in the Saline Prone Areas of Bangladesh' was taken into consideration and the present study was carried out to:

i. assess the extent of effect of climate change on agriculture;
ii. describe some selected characteristics of the farmers;
iii. explore the contribution of the farmers' selected characteristics to the effect of climate change on agriculture.

2. MATERIAL AND METHODS

2.1 Study Area

The study was conducted in the Assasuni Upazila of Satkhira district. The area of Assasuni Upazila (Satkhira district) is 402.36 sq km, located in between 22°21' and 22°40' north latitudes and in between 89°03' and 89°17' east longitudes. It is bounded by Satkhira sadar and Tala Upazilas on the north, Shyamnagar Upazila on the south, Paikgachha and Koyra Upazilas on the east and Kaliganj and Debhata Upazilas on the west. Assasuni Upazila has several unions in which Protapnagar union was selected randomly as the study area.

2.2 Population and Sampling

Updated lists of all the farmers of the selected villages of Assasuni Upazila were prepared with the help of Sub-assistant Agricultural Officer (SAAO) and local leader. A purposive sampling procedure was used to select the study group. The total number of farmers in Protapnagar union **is** 1001 which constituted the population of the study. The distribution of population, sample and location is shown in Table 1. There are several methods for determining the sample size; here, the researcher used Yamane's [10] formula for study group:

$$n = \frac{z^2 P(1-P) N}{z^2 P(1-P) + N\,(e)^2}$$

Where, n = sample size; N, population size = 1001; e, the level of precision = 10%; z = the value of the standard normal variable given the chosen confidence level (e.g., z = 1.96 with a confidence level of 95 %) and P, the proportion or degree of variability = 50%;

According to the formula, the sample size (n) **was 88**. A reserve list of **9 farmers** (ten percent of the sample size) was also prepared so that the farmers of this list could be used for interview if the farmers included in the original sample were not available at the time of conducting the interview.

Table 1. Distribution of the farmers according to population and reserve list

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Selected Upazila	Selected Union	Selected Villages	Population	Sample Size	Reserve List
Assasuni	Protapnagar	Protapnagar	156	14	1
		Kallayanpur	178	16	2
		Nakna	145	12	1
		Kurikahunia	187	16	2
		Khajra	164	15	1
		Kola	171	15	2
Total			1001	88	9

2.3 Control Group Selection

The respondents' size of the control group was 30 farmers which was calculated as one-third of the sampled population. Sampling was done as 88 respondents who involved in farming activities from the study area and 30 respondents as controls far away from the study area from the farmers. To ensure similar socio-economic conditions for both the control and test groups, a two-way stratified random sampling technique was used [11], in which education and farm size were considered as two individual strata [12]. Education was categorized into three groups: group 1 (denoted E_1), respondents are illiterate or can sign only; group 2 (denoted E_2), respondents have primary education, and group 3 (denoted E_3), respondents have secondary or higher education. Farm size was also categorized into three groups: group 1 (denoted F_1), small farm group (farm size up to 0.5 hectors); group 2 (denoted F_2), medium-farm group (farm size 0.51 to 1.0 hector), and group 3 (denoted F_3), large farm group (farm size above 1.0 hector). The two-way stratified random table is given as Table 2.

Table 2. Two-way stratified random sampling of respondents based on their Level of education and farm size

Category	% of respondents	Study Group	Control Group (one-third of the study group)
$E_1 \times F_1$	4.5	4	1
$E_1 \times F_2$	20.5	18	6
$E_1 \times F_3$	3.4	3	1
$E_2 \times F_1$	17.1	15	5
$E_2 \times F_2$	29.5	26	9
$E_2 \times F_3$	2.3	2	1
$E_3 \times F_1$	13.6	12	4
$E_3 \times F_2$	5.7	5	2
$E_3 \times F_3$	3.4	3	1
Total	100	88	30

With the help of the two-way stratified random sampling procedure, homogeneous/ similar categories of control and testing group respondents were selected, and then the proportionate random sampling technique was used to select either study or control group respondents from each village/group.

2.4 Data Collection Methods and Tools

Individual interviews were used in the survey and was face-to-face [13] situation by the researcher. A semi-structured interview schedules were prepared with open and closed questions to reach the objectives of the study. The survey tools were initially constructed based on an extensive literature reviews and pre-tested. Then, the schedule was pre-tested with 15 randomly selected farmers in the study area. Thus, necessary additions, deletions, modifications and adjustments were made in the schedule on the basis of experiences gained from pre-test. The questionnaire was also checked for validity by educational experts at Sher-e-Bangla Agricultural University (SAU). Finally, based on

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background information, an expert appraisal and the pre-test, the interview schedule was finalized. The final data collection was started from 16 March and completed in 15 April, 2017.

2.5 Selection and Measurement of Variables

A research work usually contains at least two important variables viz. independent and dependent variables. In this study 11 farmer's selected characteristics were independent variables and they are: age, level of education, family size, effective farm size, annual family income, experience in farming, training exposure, extension media contact, organizational participation, agricultural knowledge and knowledge on climate change. The dependent variable of this study was the 'effect of climate change on agriculture in the saline prone areas of Bangladesh'. The methods and procedures in measuring the variables of this study are presented below:

2.5.1 Measurement of Independent Variables

Age of the farmers was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the respondents. Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution. Family size of a farmer was determined by the total number of members in his/her family including him/her, children and other dependents. Effective farm size of a farmer referred to the total area of land on which his/her family carried out the farming operation. The term annual income refers to the annual gross income of farmer and the members of his family from different sources. It was expressed in taka. In measuring this variable, total earning in taka of an individual farmer was converted into score. Farming experience of a farmer was determined by the total number of year involved in farming activities. A score of one (1) was assigned for each year farming activities. Training exposure of a farmer was determined by the total number of agricultural training received regarding farming activities. A score of one (1) was assigned for each type of training attended. Extension media contact of a farmer was measured by computing extension media contact score on the basis of their nature of contact with eight extension media. Organizational participation of a respondent was computed on the basis of his/her participation in different organizations. Agricultural knowledge of a farmer was measured by asking him/her 12 questions related to different components of agricultural production. It was measured assigning weight 2 for each question. Climate change knowledge of a farmer was measured by asking him/her 10 questions related to different components of climate change. It was measured assigning weight 3 for each question.

2.5.2 Measurement of Dependent Variable

Effect of climate change on agriculture was the dependent variable of the study. To reveal this effect of climate change on agriculture, the researcher considered four (04) components: change in the yield of cereal crops, change in the yield of vegetables, change in the yield of pulse crops and change in the adopted new varieties. All the major components were measured with the help of identified subcomponents. Each subcomponent was measured against the identified items, collected through the process of review of relevant literature, focused discussion with the officials, experts and experienced farmers. Effect of Climate Change (ECC) on agriculture was calculated by using the formula:

$$ECC = CYCC + CYV + CYPC + CANV$$

Where,
ECC = Effect of Climate Change on agriculture, CYCC= Change in the yield of cereal crops, CYV= Change in the yield of vegetables, CYPC= Change in the yield of pulse crops and CANV= Change in the adopted new varieties
In each case, the effect was measured in difference-in-difference method. In this study, the difference between 2015 and 2017 was measured both for study and control group respondents. Finally, the study group was compared with the control group based on difference between 2015 and 2017 data record [14].

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2.6 Processing and Analysis of Data

Both descriptive and analytical methods were employed in order to analyze the data. Descriptive techniques have been used to illustrate current situations, describe different variables separately and construct tables and graphs presented in results. These included: frequency distribution, percentage, range, mean, median and standard deviation. In most cases the opinions of respondents were grouped in broader categories. Statistical test like multiple regression analysis was run to determine the contribution of the selected characteristics of the farmers to their effect of climate change on agriculture in the saline prone areas of Bangladesh. The model used for this analysis can be explained as follows:

$Y_i = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + e$ (i=1, 2, 3, 4)
Where,
$Y_{i=1}$ is the change in yield of cereal crops, $Y_{i=2}$ is the change in yield of vegetables, $Y_{i=3}$ is the change in yield of pulse crops, $Y_{i=4}$ is the change in adopted new varieties
Of the independent variables, x_1 is the age of farmer, x_2 is level of education, x_3 is family size, x_4 is effective farm size, x_5 is annual family income, x_6 is farming experience, x_7 is training exposure, x_8 is extension media contact, x_9 is organizational participation, x_{10} is agricultural knowledge and x_{11} is knowledge on climate change. On the other hand, b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, b_{10} and b_{11} are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance, and a is constant value of the regression equation.

3. RESULTS AND DISCUSSION

3.1 Characteristics of the Farmers

There were various characteristics of the farmers that might have consequence to fight against climate change. But in this study, eleven characteristics of them were selected as independent variables that might greatly influence the effect of climate change on agriculture are presented below:

3.1.1 Age

Considering the recorded age farmers were classified into three categories namely 'young', 'middle' and 'old' aged following MoYS [15]. The distributions of the farmers in accordance of their age are presented in Table 3. Middle-aged farmers comprised the highest proportion (45.5 percent) followed by old aged category (38.6 percent) and the lowest proportion were made by the young aged category (15.9 percent). The middle and old aged farmers were generally more involved in farm activities than the young aged farmers. The researcher thinks that the results might be due to the inherited traits at the study area.

Table 3. Distribution of the farmers according to their age

Category	Basis of categorization (years)	Observed range (years)	Farmers		Mean	SD
			Number	Percent		
Young aged	≤ 35	27-65	14	15.9	45.61	9.38
Middle aged	36-50		40	45.5		
Old aged	> 50		34	38.6		
Total			88	100.0		

3.1.2 Level of Education

Based on the educational scores, the farmers were classified into five categories. The distribution of farmers according to their level of education is presented in Table 4. Farmers under primary education category constitute the highest proportion (46.6 percent) followed by secondary education (35.2 percent). On the other hand, the lowest 1.1 percent in above secondary education category followed by can't read

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and sign category (4.5 percent) and 12.5 percent farmers were above can sign only category. The researcher thinks that the results might have due to the lack of torchbearer's effect at the study area.

Table 4. Distribution of the farmers according to their level of education

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Can't read and sign	0	0-12	4	4.5	4.83	3.25
Can sign only	0.5		11	12.5		
Primary education	1-5		41	46.6		
Secondary education	6-10		31	35.2		
Above secondary	>10		1	1.1		
Total			88	100.0		

3.1.3 Family Size

According to family size, the farmers were classified into three categories (Mean ± Standard Deviation) viz. 'small', 'medium' and 'large' family. The distribution of the farmers according to their family size is presented in Table 5. Large family constitute the highest proportion (71.6 percent) followed by the medium size family (20.5 percent). Only 8.0 percent farmers had small family size. The findings indicated that average family size of the study area was smaller than the national average which is 4.85 . The trend of nuclear family has been rising in the study area and subsequently the family member becoming smaller than the extended family.

Table 5. Distribution of the farmers according to their family size

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Small family	≤ 3 (Mean-1SD)	3-7	7	8.0	4.65	1.22
Medium family	4-6 (Mean ± SD)		18	20.5		
Large family	> 6 (Mean+1SD)		63	71.6		
Total			88	100.0		

3.1.4 Effective Farm Size

Based on their farm size, the farmers were classified into five categories following the categorization according to DAE [17]. The distribution of the farmers according to their farm size is presented in Table 6. The medium farm holder constitutes the highest proportion (51.1 percent) followed by small farm holder (36.4 percent). The findings of the study reveal that most of the farmers were marginal to small sized farm holder. The average farm size of the farmers of the study area (1.39 ha) was higher than that of national average (0.60 ha) of Bangladesh. The researcher thinks that due to the enhancing the economic status of the farmers, farmers is likely to be motivated to buy land.

Table 6. Distribution of the farmers according to their farm size

Category	Basis of categorization (ha)	Observed range (ha)	Farmers		Mean	SD
			Number	Percent		
Landless	≤ 0.02	0.12-5.35	0	0	1.39	1.10
Marginal	0.021-0.20		3	3.4		

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Small	0.21-1.00	32	36.4
Medium	1.01-3.0	45	51.1
Large	>3	8	9.1
	Total	88	100.0

3.1.5 Annual Family Income

On the basis of annual family income, the farmers were classified into three categories (national standard) namely 'low', 'medium' and 'high' annual family income. The distribution of the farmers according to their annual family income is presented in Table 7. Data reveal that the farmers having medium annual income constituted the highest proportion (38.6 percent), while the lowest proportion was high income (25.0 percent) and low annual family income constituted by 36.4 percent farmers. Overwhelming majority (75 percent) farmers have low to medium level annual family income. The researcher thinks that the results might have due to the climate changing effects on their farming production at the study area.

Table 7. Distribution of the farmers according to their annual family income

Category	Basis of categorization ('000' Tk.)	Observed range ('000' Tk.)	Farmers		Mean	SD
			Number	Percent		
Low income	≤ 120	60-540	32	36.4	197.75	127.30
Medium income	121-250		34	38.6		
High income	> 250		22	25.0		
Total			88	100.00		

3.1.6 Farming Experience

Considering farming experience scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely 'little, 'medium' and 'high' experience in cultivation. The distribution of the farmers according to their farming experience is presented in Table 8. The majority (64.8 percent) of the farmers fell under medium farming experience category, whereas only 19.3 percent in little farming experience category followed by 15.9 percent in high farming experience category. Around 84.1 percent of the farmers in the study area had low to medium farming experience.

Table 8. Distribution of the farmers according to their farming experience

Category	Basis of categorization (year)	Observed range (year)	Farmers		Mean	SD
			Number	Percent		
Little experience	≤ 12 (Mean-1SD)	7-36	17	19.3	19.82	7.03
Medium experience	13-27 (Mean ±SD)		57	64.8		
High experience	> 27 (Mean+1SD)		14	15.9		
Total			88	100.0		

3.1.7 Training Exposure

Based on the training exposure score, the farmers were classified into four categories namely 'no training', 'low', 'medium' and 'high' training exposure. The distribution of the farmers according to their training exposure is presented in Table 9. Highest proportion (78.4 percent) of the farmers had medium training exposure compared to 14.8 percent in high training exposure and 6.8 percent in low training exposure category, respectively. Trained farmers show favorable behavior towards positive attitude in

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cultivation. The researcher thinks that the results might have due to the materialization of training program by different organizations at the study area.

Table 9. Distribution of the farmers according to their training exposure

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Low training	≤2 (Mean-1SD)	0-15	6	6.8	5.94	3.16
Medium training	3-9 (Mean ± SD)		69	78.4		
High training	> 9 (Mean+1SD)		13	14.8		
	Total		88	100.0		

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3.1.8 Extension Media Contact

The farmers were classified into three categories on the basis of their exposure to farm information through communication exposure scores and distribution of the three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' extension media contact. Table reveals that majority of the farmers (79.5 %) had medium extension media contact. Finding also reveals that 11.4 percent of the farmers had low extension media contact which demands for strengthening and improving the communication strategy.

Table 10. Distribution of farmers according to their extension media contact

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Low contact	≤ 21 (Mean -1SD)	20-28	10	11.4	23.97	1.94
Medium contact	22-26 (Mean ± SD)		70	79.5		
High contact	> 26 (Mean +1SD)		8	9.1		
	Total		88	100.0		

3.1.9 Organizational Participation

On the basis of organizational participation score, the farmers were classified into four categories namely 'no', 'low', 'medium' and 'high' organizational participation. The distribution of the farmers as per their organizational participation is presented in Table 11. Data reveals that the highest proportion (50.0 percent) of the farmers had medium organizational participation, while 30.7 percent farmers had low organizational participation, 13.6 percent farmers had low organizational participation and the lowest 5.7 percent farmers had high organizational participation. The researcher thinks that the results might be logical because the farmers of the study area were busier in income generating activities. Hence, the high organizational participation in the study area was low.

Table 11. Distribution of the farmers according to their organizational participation

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Numbe r	Percent		

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No participation	0	0-7	12	13.6	1.89	1.38
Low participation	1 (Mean-1SD)		27	30.7		
Medium participation	2-4 (Mean ± SD)		44	50.0		
High participation	> 4 (Mean+1SD)		5	5.7		
Total			88	100.0		

3.1.10 Agricultural Knowledge

Agricultural knowledge scores of the farmers ranged from 13 to 21 against possible score of 0 to 24. Based on the agricultural knowledge scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely poor, moderate and sound agricultural knowledge. Table reveals that overwhelming majority (73.9 %) of the farmers had moderate agricultural knowledge, 20.5 percent had poor knowledge and the lowest 5.7 percent had sound agricultural knowledge.

Table 12. Distribution of the farmers according to their agricultural knowledge

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Poor knowledge	≤ 16 (Mean-1SD)	13-21	18	20.5	17.95	1.70
Moderate knowledge	17-20 (Mean ± SD)		65	73.9		
Sound knowledge	> 20 (Mean+1SD)		5	5.7		
Total			88	100.0		

3.1.11 Knowledge on Climate Change

Knowledge on climate change scores of the farmers ranged from 14 to 21 against possible score of 0 to 30. Based on the knowledge on climate change scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely poor, moderate and sound knowledge on climate change. Majority (75.0 %) of the farmers had moderate knowledge on climate change. The researcher thinks that the results might be due to having primary level of education among the farmers.

Table 13. Distribution of the farmers according to their knowledge on climate change

Category	Basis of categorization (score)	Observed range (score)	farmers		Mean	SD
			Number	Percent		
Poor knowledge	≤ 16 (Mean-1SD)	14-21	14	15.9	18.57	1.67
Moderate knowledge	17-20 (Mean ±SD)		66	75.0		
Sound knowledge	> 20 (Mean+1SD)		8	9.1		
Total			88	100.0		

3.2 Effects of Climate Change on Agriculture in the Saline Prone Areas

In order to measure the effect of climate change on agriculture, the agricultural production of the farmers of study group was compared with the control group. Negative significant production of the farmers of the

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study group was observed which might be attributed to effect of climate change on agriculture. Effect of climate change on agriculture was measured in four dimensions (Table 14). In this study, the difference between 2015 and 2017 was measured both for study and control group respondents. Finally, the study group was compared with the control group based on difference between 2015 and 2017 data record. The changed result for the study is presented below.

3.2.1 Effect of Climate Change on Study Group vs Control Group

Study group farmers were considered them who cultivated field crops where they faced the climatic hazards and control group farmers were considered them who cultivated field crops where they did not face the climatic hazards. Study group changed mean score of agricultural production was found -4.62 while the control group gained only -3.89 (shown in Table 14).

Table 14. Distribution of study group and control group respondents' level of agricultural production based on their changed value

Sl. No.	Agriculture Indicators	Study Group (changed mean value differences)	Control Group (changed mean value differences)	t-test
1.	Yield of cereal crops	-2.23	-1.86	-12.03**
2.	Yield of vegetables	-0.56	-0.50	-6.18 **
3.	Yield of pulse crops	-0.73	-0.73	-9.80 **
4.	Adopted new varieties	-1.10	-0.80	-9.01**
	Total	-4.62	-3.89	-15.73 **

** t-value at 1% significant level

Effect of climate change on agriculture = Mean score of study group agricultural production - Mean score of control group agricultural production = -4.62 - (-3.89) = -0.73
The score of effect of climate change on agriculture found -0.73. So, there was a negative effect of climate change on agriculture.

3.2.2 Effect of Climate Change on Agriculture in the Saline Prone Areas

On the basis of effect of climate change observed range on agriculture in the saline prone areas, the respondents were categorized into three categories namely negative, no and positive effect as shown in table 15. Table shows that 65.9 percent of the farmers had negative effect, 0 percent had no effect and 34.1 percent had positive effect of climate change on agriculture. Thus, an overwhelming majority (65.9 percent) of the farmers had negative effect of climate change on agriculture.

Table 15. Distribution of the respondents according to effect of climate change on agriculture

Category	Basis of categorization (score)	Observed range (score)	Farmers		Mean	SD
			Number	Percent		
Negative effect	-12 to -1	12 to -12	58	65.9	-1.55	- 4.43
No effect	0		0	0		
Positive effect	1 to 12		30	34.1		
	Total		88	100.0		

3.3 Factors Related to the Effect of Climate Change on Agriculture

In order to assess the factors contributing to the effect of climate change on agriculture, multiple regression analysis was conducted.

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3.3.1 Factors Related to the Change in the Yield of Cereal Crops

Table 16 **shows** that there **is** a significant contribution of respondents' age, level of education, training exposure, agricultural knowledge, knowledge on climate change while coefficients of other selected variables don't have any significant contribution on change in yield of cereal crops as well as effects of climate change on agriculture in the saline prone areas of Bangladesh. The value R^2 0.422 means that independent variables accounts for 42% of the variation in change in yield of cereal crops as well as effect of climate change on agriculture. The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have negative b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of change in yield of cereal crops as vice-versa. Therefore, the b-value of training exposure **is** negative value (-0.228). So, it can be stated that as training exposure increase by one unit, change in yield of cereal crops decrease by 0.228 units. This interpretation is true only if the effects of all other predictors are held constant. However, each predictor may explain some of the variance in respondents' change in yield of cereal crops conditions simply by chance. In summary, the models suggest that the NGOs and DAE should consider farmers' age, level of education, training exposure, agricultural knowledge and knowledge on climate change while offering and implementing any sustainable agricultural development program.

Table 16. Multiple regression coefficients of contributing factors related to change in the yield of cereal crops

Dependent variable	Independent variables	B	*P*	R^2	Adj. R^2	F	*P*
Change in yield of cereal crops	Age	-.005	.030*	0.422	0.410	11.974	0.003**
	Level of education	-.168	.002**				
	Family size	.169	.513				
	Effective farm size	.381	.240				
	Annual family income	-.003	.356				
	Farming experience	.038	.542				
	Training exposure	-.228	.000**				
	Extension media contact	.332	.068				
	Organizational participation	-.060	.712				
	Agricultural knowledge	-.180	.037*				
	Knowledge on climate change	-.136	.004**				

** significant at *P* = 0.01; * significant at *P* = 0.05

3.3.2 Factors Related to the Change in the Yield of Vegetables

Table 17 **shows** that there **is** a significant contribution of respondents' level of education, farming experience, training exposure and knowledge on climate change while coefficients of other selected variables don't have any significant contribution on change in yield of vegetables as well as effect of climate change on agriculture in the saline prone areas of Bangladesh. The value R^2 0.390 means that independent variables accounts for 39% of the variation in change in yield of vegetables. The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have negative b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of change in yield of vegetables as vice-versa. Therefore, the b-value of knowledge on climate change **is** negative value (-0.279). So, it can be stated that as knowledge on climate change increase by one unit,

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change in yield of vegetables decrease by 0.279 units. This interpretation **is** true only if the effects of all other predictors are held constant. However, each predictor may explain some of the variance in respondents' change in yield of vegetables conditions simply by chance. In summary, the models suggest that the NGOs and DAE should consider farmers' level of education, farming experience, training exposure and knowledge on climate change for offering program to increase the vegetable production.

Table 17. Multiple regression coefficients of contributing factors related to change in the yield of vegetables

Dependent variable	Independent variables	B	*P*	R^2	Adj. R^2	F	*P*
Change in yield of vegetables	Age	.004	.872	0.390	0.372	18.684	0.009**
	Level of education	-.058	.001**				
	Family size	.016	.890				
	Effective farm size	-.061	.674				
	Annual family income	-.001	.506				
	Farming experience	-1.48	.018*				
	Training exposure	-.060	.000**				
	Extension media contact	.088	.278				
	Organizational participation	.052	.481				
	Agricultural knowledge	.057	.502				
	Knowledge on climate change	-.279	.025*				

** significant at P = 0.01; * significant at P = 0.05

3.3.3 Factors Related to the Change in the Yield of Pulse Crops

Table 18 **shows** that there **is** a significant contribution of respondents' level of education, annual family income, training exposure, agricultural knowledge and knowledge on climate change while coefficients of other selected variables don't have any significant contribution on change in yield of pulse crops as well as effect of climate change on agriculture in the saline prone areas of Bangladesh. The value R^2 0.586 means that independent variables accounts for 58% of the variation in effect of climate change on agriculture. The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have negative b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of change in yield of pulse crops as vice-versa. Therefore, the b-value of agricultural knowledge **is** negative value (-0.273). So, it can be stated that as agricultural knowledge increase by one unit, change in yield of pulse crops decrease by 0.273 units. This interpretation **is** true only if the effects of all other predictors are held constant. However, each predictor may explain some of the variance in respondents' climate change in yield of pulse crops simply by chance. In summary, the models suggest that the NGOs and DAE should consider farmers' level of education, annual family income, training exposure, agricultural knowledge and knowledge on climate change for offering program to increase the pulse crop production.

Table 18. Multiple regression coefficients of contributing factors related to change in the yield of pulse crops

Dependent variable	Independent variables	B	*P*	R^2	Adj. R^2	F	*P*
Change in yield	Age	.014	.542	0.586	0.568	21.574	0.000**

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of pulse crops	Level of education	-.022	.000**
	Family size	.071	.536
	Effective farm size	.108	.448
	Annual family income	-.251	.043*
	Farming experience	.000	.990
	Training exposure	-.104	.002**
	Extension media contact	.115	.151
	Organizational participation	.018	.806
	Agricultural knowledge	-.273	.037*
	Knowledge on climate change	-.312	.007**

** significant at *P* = 0.01; * significant at *P* = 0.05

3.3.4 Factors Related to the Change in the Adopted New Varieties

Table 19 **shows** that there **is** a significant contribution of respondents' level of education, farming experience, training exposure and knowledge on climate change while coefficients of other selected variables don't have any contribution on change in adopted new varieties as well as effect of climate change on agriculture in the saline prone areas of Bangladesh. The value R^2 0.493 means that independent variables accounts for 49% of the variation in effect of climate change on agriculture. The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have negative b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of change in adopted new varieties as vice-versa. However, each predictor may explain some of the variance in respondents' effect of climate change on agriculture conditions simply by chance. In summary, the models suggest that the NGOs and DAE should consider farmers' level of education, farming experience, training exposure and knowledge on climate change for offering program to adopt new varieties.

Table 19. Multiple regression coefficients of contributing factors related to change in the adopted new varieties

Dependent variable	Independent variables	B	*P*	R^2	Adj. R^2	F	*P*
Change in adopted new varieties	Age	.008	.794	0.493	0.478	7.713	0.000**
	Level of education	-.381	.000**				
	Family size	.039	.800				
	Effective farm size	.155	.426				
	Annual family income	-.001	.409				
	Farming experience	-.611	.006**				
	Training exposure	-.082	.033*				
	Extension media contact	.176	.106				
	Organizational participation	-.003	.972				
	Agricultural knowledge	.004	.975				
	Knowledge on climate change	-.413	.001**				

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** significant at P = 0.01; * significant at P = 0.05

4. CONCLUSION

From the results it could be concluded that the composite effect of climate change on agriculture needs to be minimized. It **is**, therefore, recommended that an effective step should be taken by the Department of Agricultural Extension (DAE) and Non-Government Organizations (NGOs) for strengthening the farmers' qualities in favor of mitigating effect of climate change on agriculture in the saline prone areas. The old and medium aged farmers faced more effect of climate change on their agriculture. So, the extension workers should work with them for minimizing the effect of climate change on agriculture. Conclusion could be drawn that the farmers could be more ameliorated in all aspects of socio-economic of life if government takes more educational projects (like night school, adult education and so on) to make them more educated. It **is** concluded that high annual family income, farming experience and training exposure encouraged the farmers to mitigate effect of climate change on agriculture. Therefore, it **is** recommended that the extension workers should work with experienced farmers and; motivate them to enhance the annual income and to participate in training program which would help to reduce effect of climate change on agriculture. Conclusion could be drawn that agricultural knowledge and knowledge on climate change of the farmers had influenced to reduce the effect of climate change on agriculture. Hence, it **is** recommended that actions should be taken for increasing the agricultural knowledge and the knowledge on climate change of the farmers by the concerned authorities through the non-formal educational program.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

This work accomplished in cooperation between all authors. Author MWAS designed and supervised the study, and edited the script. Author MEH wrote the protocol and the first draft of the manuscript, and managed analysis of the study. Author MSUM supervised the work and performed statistical analysis. Author SMN and AFMMH managed the literature searches and carried out all the field work. All authors read and approved the final manuscript.

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