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ADAPTIVE AGRICULTURAL STRATEGIES AGAINST CLIMATE CHANGES IN COASTAL VULNERABLE DACOPE UPAZILA OF BANGLADESH

S. A. R. Chowdhury[1] and J. Talukder[2]
[1]SRDI, Dhaka; [2]Horticulture Centre, DAE, Shulakia, Kishoreganj

ABSTRACT

The survey was conducted in 2018 at Polder 32 in Dacope Upazial of the coastal Khulna district of Bangladesh. Polder 32 is constituted of two unions, including Kamarkhola and Sutarkhali. One hundred fifty (150) farmers in Polder 32 were selected as the sampling of this study. In this study, an interview method was used. A pre-tested structured interview schedule was carefully prepared covering the research objectives in mind to gather relevant data. Excellent cooperation has been obtained from respondents and others in the study area. Researchers have also collected documents from various organizations, such as the Upazila Agriculture Department, for this purpose. In this study, five characteristics of respondents were selected as independent variables, including age, educational background, annual income, communication exposure, and farmers' knowledge on climate change. On the other hand, the study includes a dependent variable, the extent of agricultural adaptation of its impacts on climate change. This variable was measured based on various aspects of adaptation. The adaptation score was calculated based on respondents' adaptation for 20 aspects. The study revealed that the educational level of farmers in the study area was in secondary level and most of the respondents were of middle aged. Consequently, most of the respondents had medium level of knowledge on climate change. The study also revealed that most of the respondents were within medium level of income having the average value of 48.46 thousand tk. per annual. This study explored that “Right controlling of sluice gate by beneficiaries” and “cultivation of salt-tolerant crops” ranked in the 1st and 2nd positions, respectively. On the other hand "support from NGOs" received the lowest score (131), thus ranking last in the ranking for agricultural adaptation to climate change.
Key words: Adaptation, climate changes, agriculture.

Introduction

Climate change and variability are already affecting the lives and livelihoods of people living in coastal, arid and semi-arid regions of Bangladesh. Floods, tropical cyclones, storms and droughts are becoming more common and will become even more severe in the coming decades. These changes threaten the significant achievements of Bangladesh, which is ensured from the last two decades in raising income, reducing poverty and achieving self-sufficiency in rice production (BCCFR, 2013). Warm climates generally accelerate plant growth and development, but extremely cool or hot climates can also affect productivity. In the past few decades, early flowering and maturity of various crops have been recorded, often associated with higher temperatures (Craufurd and Wheeler, 2009). Elevated maximum temperatures (such as climate and weather) can cause severe yield loss and unsuccessful reproduction in many crops (Lobell *et al*., 2011). However, the human population is vulnerable to the consequences of climate change, mainly because of the socio-economic and political background in which they live. Therefore, vulnerability climate change is particularly differentiated by geography, income levels, types of livelihoods, and governance (O'Brien *et al*., 2007).

Coastal ecosystems, especially in the southwest, are strongly associated with salinity. Salinity in Bangladesh affected 8.33 million hectares of land in 1973 and reached 102 million hectares in 2000. In 2009, it increased to 105.6 million hectares. Over the past 35 years, salinity has increased to 26% in the country (SRDI, 2010). Another study shows that the salinity has extended 8330 square kilometers in 1973 to 10560 square kilometers in 2009 (SRDI, 2010). However, it has been observed that not all coastal agricultural land is used for crop production, mainly due to soil salinity. Increased salinity limits the growth

of upright crops, affects overall crop production, and makes the soil unsuitable for many potential crops. Soil salinity is considered an important limitation for grain production in coastal areas of the country (Huq, 1999). The effects of salinity are considered to be one of the most serious threats to the environment and can adversely affect food security, agriculture, fisheries, human health, biodiversity, water, and other natural resources. The coastal areas of Bangladesh provide a hostile environment for normal crop production throughout the year. The organic matter content of coastal soils is very low (1.0-1.5%). In salty soils, nutrient deficiencies or N and P are common. Micronutrients such as Cu and Zn are both widespread. As a result, reduced food crop production in coastal areas has a significant impact on Bangladesh's national economy (Haque, 2006). This threat is being increased by a reduction in upstream freshwater tides and groundwater runoff (Palash, 2015). SRDI conducted a comparative study of salt-affected areas between 1973 and 2009 and found that about 2.222 billion hectares (26.7%) or new land has been affected by varying levels of salinity over the past 40 years. It has been shown to seriously hinder biodiversity (SRDI, 2010). Bangladesh did not play a significant role, but the impact of climate change on migration has been increasingly threatened (Islam *et al*., 2019). The migration phenomenon has been an important part of human history since the civilization began in search of improved food, shelter and living conditions. However, whether forced or not, human movement is the most important consequence of today's climate change and decades to come (Steiner, 2008). Deteriorating environments and climate change can lead to massive migration, where the world is currently not equipped to adequately prevent or cope with this. Furthermore, even when migration is a coping mechanism and survival strategy, increased migration itself may contribute to further deterioration and vulnerability (Morton *et al*. 2008). The Intergovernmental Panel on Climate Change (IPCC) has identified human movement as the biggest impact of climate change.

All of those catastrophic disasters will result in loss of their profession, crop cultivation, afforestation, fish cultivation, and other normal activities that weaken their lives and force them to lead very much, a miserable life that has an immense impact on people's lives and livelihoods. In addition, these disasters wash away residential areas and other infrastructure, displacing coastal populations internally and forcing them to move elsewhere. Every year, serious natural disasters such as floods, cyclones and riverbank erosion are losing valuable GDP. According to the World Bank (WB) report, losses associated with environmental degradation are estimated to be more than 4.3% of Bangladesh's GDP, which has reduced the capacity of government poverty alleviation programs (UNDP, 2012). Poor people living in marginalized lands who are well acquainted with nature-dependent livelihoods face barriers and constraints to their well-being in a changing climate. The study mainly focused on understanding the impacts of climate change and agricultural adaptation on the southern coastal areas of Bangladesh. Agricultural activities in these areas are heavily hindered by various types of climate hazards from climate change. Therefore, in this area, farmers' awareness of climate change and the adaptation of agriculture to climate change are very necessary. Therefore, in this situation, it is necessary to know farmers' awareness of climate change and the extent of agricultural adaptation to be ensured the secured agricultural production at Coastal Dacope upazila of Bangladesh.

Materials and Methods

The survey was conducted in 2018 at Polder 32 in Dacope Upazial of the coastal Khulna district of Bangladesh. Polder is mainly identified by embankment/dike, where the total length of the polder dike is 49.50 km and the design water level is 4.27 m (PWD). There are 16 drains and 35 inlets flowing through a 45.00 km cannel in the polder. The total gross area is 8,097 ha and the net cultivable area is 6,500 ha. Embankments and water control structures, as well as drains, are subject to performance limitations due to the low cress height of the dikes, damage due to structures in the drains and silt deposition. Polder 32 is constituted of two unions, including Kamarkhola and Sutarkhali. One hundred fifty (150) farmers in Polder 32 were selected as the sampling of this study. To conduct research, all research methods have their own policy of collecting data. Data needs to be consciously identified, carefully selected, and methodically collected, and accuracy and precision are clearly important qualities in research measurements. In this study, an interview method was used. A pre-tested structured interview schedule was carefully prepared

covering the research objectives in mind to gather relevant data. The questions and statements contained in the schedule were simple, direct and understandable by respondents. The schedule included both private and public questions. Researchers first established a relationship with the respondents and articulated the purpose of the study using local languages wherever possible. As a result, respondents answered the questions appropriately without hesitation. Whenever respondents found it difficult to understand, the question was clarified. Excellent cooperation has been obtained from respondents and others in the study area. Researchers have also collected documents from various organizations, such as the Upazila Agriculture Department, for this purpose. In this study, five characteristics of respondents were selected as independent variables, including age, educational background, annual income, communication exposure, and farmers' knowledge on climate change. On the other hand, the study includes a dependent variable, the extent of agricultural adaptation of its impacts on climate change. This variable was measured based on various aspects of adaptation. The adaptation score was calculated based on respondents' adaptation for 20 aspects.

Data collection and processing: Data was collected by interviewing selected sample farmers. The researchers themselves collected the data for this study. To facilitate aggregation, the data collected was properly coded and transferred from the interview schedule to the master sheet. Whenever necessary, qualitative data was converted to quantitative format with appropriate scoring. Aggregations and crosstabs were based on classifications developed by the researchers.

Data analysis procedure: The analysis was performed using statistical processing by the SPSS (Statistical Package for Social Sciences) computer package. The variables were described using descriptive analysis such as numbers, proportions, ranges, means, standard deviations, and ranks. Pearson's product moment correlation-efficient (r) was calculated to investigate the relationship between respondents' selected characteristics and agricultural adaptation to climate change. Five percent (0.05) level of probability was used for rejecting a null hypothesis.

Results and Discussion

Demographic and Socioeconomic Profile of the Respondents: Bangladesh, in particular the southwestern coastal area, is suffered each year with the drastic effects of natural hazards such as storms, floods, cyclones, erosions, salinity etc. These dangers affect not only human lives but also their livelihood and socio-economic Services. That is why it is not possible to combat these drastic events in climate change with great force. Here, adaptation to climate change is an important tool to reduce the vulnerability of poor coastal residents in our country. Adaptation to climate change refers to both the adaptation process and the condition of adaptation. In the social sciences, adaptation refers to combat by individuals and the collective behavior of socio-economic systems. That is why it is essential to realize the link between adaptive capacities of climate affected people from climate sensitive area along with their socio-economic profile. Actually, the socio-economic status reflects the actual state of the study area, and also reflects the adaptability of the climate-related household to climate change (Naher, 2012), which was minutely investigated under the present study covering the maximum elements of socioeconomic profile for surveyed respondents. The age of the respondents in this study was divided into three groups (Table 1). The classification was made based on the objectives and agreeable of the research, so that the respondents could provide the relevant information at least ten years ago. Data in Table 1 showed that the average age of the respondents was 43.41. Most of the respondents were in middle aged (54.67%), old in 2nd highest and young in the lowest position. However the middle aged respondents are crucial for obtaining ample data; as they passed the more time in that locality and gathered enough experiences have bear expansive experiences about the situations of their community. In the study area the educational status of the respondents were classified in to five categories ranging from illiterate to above secondary level. The study revealed that most of the respondents were in secondary level (46%). Whereas 2nd highest in above secondary level (Table 1), which ensured the more qualitative data in our study, as the educated community are more capable to be shared the actual data about their localities. Income is another important demographic factor on which human behavior depends mostly. Here the present study expressed the extent

of income of the respondents, where it was observed that most of the respondents were within medium level of income with the average value of 48.46 thousand tk. per annual (Table 1). This level of income is favorable for adaptive agricultural strategies in the Coastal Dacope upazila of Bangladesh. On the basis of their organizational participation score, the respondents were divided into three categories as low (1- 8), medium (9-14) and high (>14) were presented in Table 1. Data furnished in Table 1 indicated that 52.00 percent had medium communication exposure. A similar finding was obtained by Mandal (2011). That means, the farmers were moderately localized, i.e. they had medium outside contact to their social system. The study also indicated that above half of the respondents 58.67 percent of the farmers had medium knowledge on climate change compared with 13.33 percent having low knowledge and 28 percent had high knowledge on climate change. Similar results were obtained by Yeasmin (2013). Knowledge is derived from education and previous experience. The educational level of farmers in the study area was in secondary level and most of the respondents were of middle aged. Consequently, most of the respondents had medium level of knowledge on climate change.

Table 1. Salient features of the selected characteristics of the respondents

Characteristics with scoring system	Range		Category	Respondents		Mean	SD
	Possible	Observed		No.	Percent		
Age (yrs.)	-	24-65	Young (up to 30) Middle aged (31 – 50) Old (>50)	30 82 38	20 54.67 25.33	43.41	7.29
Education (level of schooling)	0-18	0-16	Illiterate (0) Can sign only Primary (I-V) Secondary (VI-X) Higher Secondary (>X)	4 7 14 69 56	2.67 4.67 9.33 46.00 37.33	8.46	4.56
Annual family income (000' BDT)	-	40-300	Low (up to 50) Medium (50.10-75) High (76-125) Very high (>125)	40 70 29 11	26.67 46.67 19.33 7.33	48.64	11.53
Communication exposure (Scale score)	0-25	4-24	Low (1-8) Medium (9-14) High (>14)	40 78 32	26.67 52.00 21.33	11.34	4.10
Knowledge on climate change (Scale score)	0-45	11-40	Low (1-14) Medium (15-30) High (31-45)	20 88 42	13.33 58.67 28.00	25.10	5.89

Source: Field Survey, 2018.

Agricultural adaptation of climate change: Agricultural adaptation of the climate change was measured by computing an adaptation score, which could range from 0 to 60. Based on their possible adaptation scores, the farmers were classified into three categories: Low adaptation, medium adaptation and high adaptation. However the observed scores ranged from 11 to 51 with an average of 41.63 and a standard deviation of 5.82.

Table 2. Overall categories of farmer based on their agricultural adaptation

Range		Category	Respondents		Mean	SD
Possible	Observed		No.	Percent		
0-60	11-51	Low (<24) Medium (25-45) High (>46)	26 90 34	17.33 60.00 22.67	41.63	5.82

Source: Field Survey, 2018.

This study explored the adaptation level of climate change to agriculture. In this regard, the degrees of consent to each statement perceived by the farmers were minutely assessed. The adaptation score for each statement was calculated using the adaptation index (AI) and arranged in rank order according to the range of adaptation levels shown in Table 3. The adaptation index (AI) ranges from 0 to 450, where 0 indicates no perception and 450 indicates the maximum adaptation of a single statement on agricultural adaptation with climate change. Table 3 also showed that "right controlling of sluice gate by beneficiaries" and "cultivation of salt-tolerant crops" ranked in the 1st and 2nd positions, respectively. On the other hand "support from NGOs" received the lowest score (131), thus ranking last in the ranking for agricultural adaptation to climate change.

Table 3 Statement-wise score of agricultural adaptation of the climate change in Dacope Upazila of Khulna district

Sl.	Adaptive agricultural techniques	AI scoring	Ranking
1	Adoption of new crops	276	8th
2	Preservation of fresh water in khals within the polder	289	7th
3	Practices of modern agricultural techniques	210	15th
4	Controlling of river bank erosion	267	11th
5	Adjusting the sowing and planting time of crops	332	3rd
6	Orientation of new crops especially water melon	326	4th
7	Cultivation of saline tolerant varieties of crops	439	2nd
8	Right controlling of sluice gate by beneficiaries	448	1st
9	Use mulching for retain moisture	293	6th
10	Practices of integrated nutrient management	272	9th
11	Increase application of organic matter	174	18th
12	IPM for crop cultivation	180	17th
13	Pond system in each crop field	270	10th
14	Re-sectioning of embankment	229	14th
15	Excavation of khals in dry season	265	12th
16	Water organization for proper water management	201	16th
17	Services from DAE/Agricultural department	264	13th
18	Service of BWDB	170	19th
19	Government support in agricultural inputs	304	5th
20	Support from NGOs	131	20th

Source: Field Survey, 2018.

Correlation studies: In this regard, the null hypothesis was "there is no significant relationship between selected characteristics of the respondents and their overall adaptation against climate change impact."Coefficients of correlations were computed to find out the relationships between the selected characteristics of the respondents and their overall adoption against climate change impact and presented in Table 4. All the independent variables are found significantly related with the dependent variable. These ensure the core adaptation criteria for the study area.

Table 4. Correlation between dependent variable (agricultural adaptation of climate change) and independent variables

Dependent variable	Independent variable	Correlation Co-efficient (r) at 148 df (N=150)
Agricultural adaptation of climate change	Age	0.499**
	Education	0.595**
	Annual income	0.587**
	Communication exposure	0.583**
	Extension media contact	0.596**
	Knowledge on climate change	0.581**

**=Significant at 0.01 level

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