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Agricultural Challenges and Adaptation for Changing Climate: A Study on Early Flash Flood-prone Areas in Bangladesh

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Abstract Bangladesh's environment and climate have changed a lot and Bangladesh has converted as the most exposed country. This vulnerability is exposed in adverse way in Bangladesh due to magnitude of changing climate. It can be said that for national food security, respective agricultural household should adapt to climate change. A large portion of inhabitants of Bangladesh are dependent on agriculture for their needs, living, income and maintenance, and most importantly economic growth also depends on agriculture. To adapt to climate vulnerability, farmers may face many challenges. In this regard, the first motto was to perceive the level of challenges faced in agriculture such as unpredictable weather, excess cost of inputs, restricted access to agricultural markets, etc. during production. For fulfilling this specific objective, adoption of resilience indices to agriculture were developed. Those adoption resilience indices were making hurdles for farmer's livelihood and adjustment due to climate change. The adoption resilience indices were calculated through the principal confrontation matrix, and it was found that "unpredictable weather" ranked as number one followed by the high cost of farm inputs. Another objective of this exploration was to explore how those adaptation resilience indices affect farmers' enthusiasm for their adaptation. To fulfil this objective, the ordered logit model had been used using 378 boro cultivator's data which were collected from selected 'haor' (lowland) in Sylhet. The results show that the two variables namely "Changed in crop varieties" and "Changed crop to livestock" had a positive impact on the farmers' adapting strategies for changing climate. That means, those farmers were easily motivated to change their crop varieties and preferred rearing livestock during flood.

Keywords Perception, Adaptation Planning, Unpredictable Weather, Farmers' Enthusiasm, Flash Flood

1. Introduction

Global occurrence due to climate change brings an adverse circumstance to the development of agriculture. It hampers economic activities along with insecurity of food in developing countries [1, 2]. Changing climate also makes hamper to economic value and capital along with drastic changes to ecosystems [1, 3-6].

Agricultural areas are highly affected due to induced water in hostile environment, resulting in severe deteriorations in efficiency, which increases food insecurity. Wang et al. [7] showed rising significant extreme weather events create hardliners for agricultural production. Adaptation is an inevitable effort to adjust with adverse climate in the highly sensitive areas of agricultural dependent economies [8, 9]. To accelerate

agricultural production along with to seek international co-operation, IPCC [10] showed that adaptation effort is needed all over the world. Persson and Dzebo [11] had given recognition adaptation as a 'global challenge'. It is also clearly defined in the Paris Agreement. There are studies that already proved that adaptation has brought fruitful results for farmers during short and long run [12, 13].

Adaptation means forestalling from the hostile reaction of climate. On the other hand, adaptation means going to initiative different steps to head off financial losses. Profitable adaptation depends not only on governments (GoB) initiative but also on the active and prolonged engagement of stakeholders. Integration adaptation pathways into local development strategies and plans depend not only on sharing knowledge, but also on sectoral coordination with the stakeholders can enhance adaptation.

The system should include other relevant stakeholders at national level, regional level, multilateral and international organizations, public and private sectors for sharing effective management of knowledge [14]. Different types of geographical location and socio-economic situation can lead different adaptive actions on priority basis of local context [15].

In some situation, adaptation planning process is incompetent to address the issue of flooding. Roy et al. [16] showed that in case of flooding, there is a shortage of adaptation techniques. The occurrences of early flash flood have become almost natural in every year and hamper economic growth. In Bangladesh, rural women are adapting with flood or salinity through their locally known different strategies (crop diversification, tree plantation, etc.) along with their financial and other challenges in their daily life. The challenges are almost common such as volatile meteorological conditions, excessive price of farmstead inputs, restricted access to agri-extension, etc.

Ferdushi et al. [17] showed that the percentage of adaptation is higher for rural women than men. Zhai et al. [18] showed the negative consequences due to climate could have been reduced through farmer's changing farming systems. In this way, farmers can maintain their lifestyle with utmost flexibility through surviving better option with current volatile meteorological conditions. Wolf et al. [19] showed climate change is getting worsen day by day, so environmentalists predict that it is a worthless necessity of familiarization to transformed geographical and ecological scales to feed the rapidly increasing population in developing country.

The study concentrates on determining the factors those significantly affect rice farm cultivator's decision of adaptability in flood-prone areas in Bangladesh. Those factors are categorized as follows:

i. Impact of socioeconomic status on adopting new strategy.
ii. Adaptation resilience indices.
iii. Impact of climate-induced variables on adopting a better technique.

2. Materials

2.1. Methodology

The present study uses a cluster sampling in which the census areas were considered as a cluster consisting of 100-120 farmers. The objectives of this work have been done by using collected primary data from four purposefully clusters. Same structure has been used for collecting sample from three villages randomly from four diverse regions selected purposively. The following recognized sample determination formula has been used for the households:

$$n = z^2\left[p(1-p)/d^2\right] * D_{eff}$$

where p represents proportion, Z represents normal variate of 95% confidence interval, and D_{eff} represents effects of sampling. The obtained sampling was estimated based on 50% indicator (ratio of households adapted to the new technology), using 0.13 precision and effect of design was 1.85, in total of 420 household's data were collected. Later, this questionnaire was subsequently employed to collect essential data since Nov 2017 from 378 boro cultivators. Many farmers were migrated in urban areas for flooding on that time. In this regard, we became able to collect data from only 378 farmers. Some features of data had been used by the research work of Ferdushi et al. [17].

2.2. Association Measure

χ^2 statistics are commonly perceived to evaluate independence test. By calculating cross tabulation, it can be proved the relationship exists between outcome and exposure variables.

The statistics of χ^2 is as follows:

$$\chi^2 = \sum_i^n \frac{(O-E)f}{E \times f}$$

where, O represents the observed frequency of the respective variables; E represents the expected frequency of the respective variables.

2.3. Principal Confrontation Matrix

The confrontation matrix is one kind of performance measurement analysis. Here, the terms strengths and weaknesses mean opportunities. On the other hand, threats aimed at developing a better strategy. In our analysis, there were altogether four strong and weak points (from 0 to 3). Considering at the various internal options (strengths, weaknesses and others), the highest score of 3 for the best option was set up, later a score of 2, 1 and 0 has been chosen for the next best option consecutively. The corresponding point is multiplied by different items and summing up altogether for the confrontation matrix.

PCI= (NP*0+LP*1+MP*2+HP*3)

Here,

PCI means principal confrontation matrix.

NP means no problem; LP means low problem.

MP means moderately problem; HP means highly problem.

2.4. Ordered Logit Model

In this study, the ordered logistic model is considered about farmer's approach about adaptation for changing climate. Influencing aspects of farmer are represented by three categories, named:

i) Optimism to adaptation, ii) negativity to adaptation, and iii) unlikely to adaptation.

Hilbe [20] used ordinal logit model when a dependent variable is categorized into more than two categories and the value of each category has a sequential order considering the respective value was bigger than previous one. This perception is used in this study. The steps of logit model are as follows:

1. Observed ordinal variable J is a function of Y^* that means unmeasured latent variable.
2. The ordered logit model considers a continuous unmeasured latent variable Y^*. The values of O depend on Y^*. The ordered logit model is also named as an ordered logistic regression model.

The following example has given assuming, Y = 3,

$$Y_i = 1 \; if \; Y_i^* \; is \leq j_1$$

$$Y_i = 2 \; if \quad j_1 \leq Y_i^* \leq j_2$$

$$Y_i = 3 \; if \; Y_i^* \; is \geq j_2$$

3. The continuous latent variable Y_i^* is equivalent to

$$Y_i^* = \sum_{j=1}^{n} \beta_j X_{ji} + e_i = O_i + e_i$$

Where, the ordered logit model estimates:

$$O_i = \sum_{j=1}^{n} \beta_j X_{ji} = E\left(Y_i^*\right)$$

In case of Y=3

$$P\left(Y_i = 1\right) = \frac{1}{1+\exp\left(O_i - j_1\right)}$$

$$P\left(Y_i = 2\right) = \frac{1}{1+\exp\left(O_i - j_2\right)} - \frac{1}{1+\exp\left(O_i - j_1\right)}$$

$$P\left(Y_i = 3\right) = 1 - \frac{1}{1+\exp\left(Z_i - j_2\right)}; \; where \quad j = 1,2,3,...,n.$$

Independent variables are categorized into three types: i) socioeconomic statuses, ii) adaptation resilience indices, iii) impact of climate induced variables. The ordered logit model was estimated based on the factors influencing for having adaptation of farmers towards adverse climate fluctuation. The ordered logit model had been estimated using the STATA 16.0 version.

3. Results

3.1. Principal Confrontation Matrix

The confrontation matrix is a weighted index. The items for measuring the degree of challenges were arranged through the principal confrontation matrix (Table 1). Unpredictable weather was ranked as 1 which means this item was the most challenging for adaptation. The excess cost of inputs was ranked as 2. There were 294 respondents who reported their opinion as it was highly challenging for adaptation. 230 respondents agreed with the statement "restricted to field agro-officer" was a barrier to adaptation. 134 respondents marked "restricted to agro-markets" was a great challenge for adaptation. "Restricted to timely weather information" was considered as the number 5 challenge among 7 items, and "restricted to agro-subsidies" was ranked as 6 by the respondents. Limited farm size was also a barrier for the respondent but they identified it as 7 number challenge for adaptation.

3.2. Results of Cross Tabulation

3.2.1. Chi-square Test of Socio-economic Statuses

Association test of socio-economic status is given in Table 2.

3.2.2. Chi-square Test of adaptation Resilience Indices

Chi-square test of adaptation resilience indices is in Table 3.

Table 1. Challenges to adaptation

Adaptation resilience indices	Degree of challenges					
	No problem (NP)	Low problem (LP)	Moderately problem (MP)	Highly problem (HP)	[a]PCI	Rank
Unpredictable weather	3	2	61	312	1060	1
Execs cost of inputs	0	4	80	294	1046	2
Restricted to field agro-officer	1	9	138	230	975	3
Restricted to agro-markets	79	51	114	134	681	4
Restricted to timely weather information	3	9	140	226	967	5
Restricted to agro-subsidies	80	51	136	111	656	6
Limited farm size	201	80	62	35	309	7

[a]PCI= (NP*0+LP*1+MP*2+HP*3). Source: Field survey and authors' calculation.

Table 2. Association test in between adaptation and socio-economic status

Socio-economic status	Category	Optimism, (percentage)	Negative, (Percentage)	Undecided, (Percentage)	Total, (Percentage)	*P-value*
Gender	Female	170 (45.0)	80 (21.2)	99 (26.2)	349 (92.3)	0.048
	Male	21 (5.6)	4 (1.1)	4 (1.1)	29 (7.7)	
Age	<30	32 (8.5)	8 (2.1)	13 (3.4)	53 (14.0)	0.013
	31-45	97 (25.7)	36 (9.5)	48 (12.7)	181 (47.9)	
	46-60	52 (13.8)	23 (6.1)	29 (7.7)	104 (27.5)	
	60^{+}	10 (2.6)	17 (4.5)	13 (3.4)	40 (10.6)	
Education	Illiterate	139 (36.8)	65 (17.2)	61 (16.1)	265 (70.1)	0.013
	Know how to write	25 (6.6)	7 (1.9)	8 (2.1)	40 (10.6)	
	Primary	12 (3.2)	8 (2.1)	22 (5.8)	42 (11.1)	
	Secondary	12 (3.2)	4 (1.1)	10 (2.6)	26 (6.9)	
	Higher secondary	2 (0.5)	0 (0.0)	1 (0.3)	3 (0.8)	
	Graduate	1 (0.3)	0 (0.0)	1 (0.3)	2 (0.5)	
Income (yearly)	<50000	31 (8.2)	16 (4.2)	5 (1.3)	52 (13.8)	0.003
	50000-150000	80 (21.2)	30 (7.9)	34 (9.0)	144 (38.1)	
	150000^{+}	80 (21.2)	38 (10.1)	64 (16.9)	182 (48.1)	
Off farm income	Yes	121 (32.0)	49 (13.0)	32(8.5)	202 (53.4)	0.000
	No	70 (18.5)	35 (9.3)	71 (18.8)	176 (46.6)	
Training	Yes	6 (1.6)	2 (0.5)	11 (2.9)	19 (5.0)	0.000
	No	283 (74.9)	11 (2.9)	65 (17.2)	359 (95.0)	
Livestock	Yes	115 (30.4)	2 (0.5)	23 (6.1)	140 (37.0)	0.080
	No	174 (46.0)	11(2.9)	53 (14.0)	238 (63.0)	
Land ownership	Yes	210 (55.6)	8 (2.1)	35 (9.3)	253 (66.9)	0.000
	No	79 (20.9)	5 (1.3)	41 (10.8)	125 (33.1)	
Total		191 (50.5)	84 (22.2)	103 (27.2)	378 (100)	

Gender, age, education, income (yearly), income during off farm, training, and land ownership were associated with adaptation. But the variable livestock were not statistically significant.

Table 3. Association test of adaptation resilience indices

Adaptation resilience indices	Degree of severity	Optimism, N (%)	Negative, N (%)	Undecided, N (%)	Total, N (%)	*P-value*
Lack access of subsides	No challenging	51 (13.5)	13 (3.4)	16 (4.2)	80(21.2)	0.001
	Low challenging	30 (7.9)	12 (3.2)	9 (2.4)	51(13.5)	
	Moderately challenging	68 (18.0)	36 (9.5)	32 (8.5)	136(36.0)	
	Highly challenging	42 (11.1)	23 (6.1)	46 (12.2)	111(29.4)	
Restricted access to agro-market	No challenging	51 (13.5)	13 (3.4)	15 (4.0)	79 (20.9)	0.002
	Low challenging	31 (8.2)	11 (2.9)	9 (2.4)	51 (13.5)	
	Moderately challenging	59 (15.6)	28 (7.4)	27 (7.1)	114 (30.2)	
	Highly challenging	50 (13.2)	32(8.5)	52 (13.8)	134 (35.4)	
Restricted access to field-agro officer	No challenging	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)	0.045
	Low challenging	4 (1.1)	5 (1.3)	0 (0.0)	9 (2.4)	
	Moderately challenging	64 (16.9)	30 (7.9)	44 (11.6)	138 (36.5)	
	Highly challenging	123 (32.5)	48 (12.7)	59 (15.6)	230 (60.8)	
Unpredictable weather	No challenging	41 (10.8)	12 (3.2)	15 (4.0)	68 (18.0)	0.010
	Low challenging	34 (9.0)	12 (3.2)	9 (2.4)	55 (14.6)	
	Moderately challenging	62 (16.4)	29 (7.7)	27 (7.1)	118 (31.2)	
	Highly challenging	54 (14.3)	31(8.2)	52 (13.8)	137 (36.2)	
Change crop variety	Insufficient capital	20 (5.3)	4 (1.1)	11 (2.9)	35 (9.3)	0.000
	Insufficient statistics	98 (25.9)	36 (9.5)	43 (11.4)	177 (46.8)	
	Labor scarcity	6 (1.6)	3 (0.8)	17 (4.5)	26 (6.9)	
	Insufficient cultivable land	67 (17.7)	41 (10.8)	32 (8.5)	140 (37.0)	
Crop to livestock	Insufficient capital	166 (43.9)	67 (17.7)	98 (25.9)	331 (87.6)	0.023
	Insufficient statistics	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)	
	Insufficient cultivable land	24 (6.3)	17 (4.5)	5 (1.3)	46 (12.2)	
Reduce livestock	Insufficient capital	114 (30.2)	47 (12.4)	31 (8.2)	192 (50.8)	0.000
	Insufficient statistics	2 (0.5)	0 (0.0)	0 (0.0)	2 (0.5)	
	Insufficient cultivable land	75 (19.8)	37 (9.8)	72 (19.0)	184 (48.7)	
Total		191 (50.5)	84 (22.2)	103 (27.2)	378 (100)	

The results show that the variables namely, lack access of subsidies, limited access to agri-market, limited access to agri-extension, unpredictable weather, change crop variety, crop to livestock, and reduce livestock were statistically significant. Reduced livestock is highly statistically significant. Lack of access subsidies and limited access to agri-market were also highly statistically significant. 331 farmers had given their opinions that they had chosen crop to livestock strategy for insufficient capital. On the other hand, 133 farmers who had a positivity towards adaptation mentioned that lack of money was a big problem for adaptation.

3.2.3. Chi-square Test of Climate Induced Variables

Estimation of chi-square test among with cultivator's decision and some factors of climate has been set in Table 4.

From the analysis, it has been found that 50.3% of people had experienced flood damage in the last five years, 38.4% farmers agreed that production of rice was hampered due to changing climate and 31.7% of people mentioned that precipitation was increased.

Table 4. Association test of adaptation and environmental factors variables

Environmental Factors	Decision	Optimism, (Percentage)	Negative, (Percentage)	Undecided, (Percentage)	Total, (Percentage)	*p-value*
Experienced flood damage (last 5 years)	Disagree	1 (0.3)	0 (0.00)	0 (0.00)	1 (0.3)	0.612
	Agree	190 (50.3)	84 (22.2)	103 (27.2)	377 (99.7)	
Rice production affected by climate change	Disagree	46 (12.2)	32 (8.5)	24 (6.3)	102 (27.0)	0.034
	Agree	145 (38.4)	52 (13.8)	79 (20.9)	276 (73.0)	
Increase precipitation	Disagree	12 (3.2)	6 (1.6)	7 (1.9)	25 (6.6)	0.000
	Moderate	59 (15.6)	35 (9.3)	60 (15.9)	154 (40.7)	
	Agree	120 (31.7)	43 (11.4)	36 (9.5)	199 (52.6)	
Total		191 (50.5)	84 (22.2)	103 (27.2)	378 (100)	

3.3. Results of Ordered Logit Model

3.3.1. Logit Analysis of Socio-economic Statuses

Logit's results are given in Table 5. The analysis shows that socio-economic statuses directly impacted on enthusiasm for adaptation. Farmer's positivity to adaptation was influenced by income, off-farm earnings, and change in rural market structure.

Table 5. Logit analysis of impact of socio-economic statuses on likely for adaptation

Socio-economic	Coefficient	S.E.	z	P > z
Gender	1.084	0.785	1.38	0.167
Age	0.003	0.010	0.36	0.719
Education	0.113	0.132	0.85	0.399
Income (yearly)	1.000	0.000	2.02	0.040
Off farm income	1.280	0.291	4.41	0.714
Training	1.750	0.938	1.87	-0.087
Livestock	-0.750	0.299	-1.98	-1.160
Land ownership	1.290	0.300	4.30	1.290
/cut^1	-2.116	6.142		
/cut^2	0.280	8.557		
Likelihood ratio	85.5			

Furthermore, it was found that age was a positive but insignificant impact on the enthusiasm for adaptation due to changing climate. The results also show that gender, education, and landowner verities have undesirable impact on the enthusiasm for adaptation to adjust with changing climate but those variables were not significant. The variable income is significant at 5% level of significance that means *p*-value is less than 0.05. So if income escalates one unit, it is expected 1.00 unit escalate in the log odds, too.

Off-farm earnings are very significant, while gender, age, education, and the landowner are not significant. The overall goodness of fit was good. The likelihood ratio value is 85.5 for the model along with 78.6% prediction value suggesting that the model fits very well using sampling data.

3.3.2. Logit Analysis of Adaptation Resilience Indices

Ordered logit analysis of adaptation resilience indices on enthusiasm for adaptation can be seen in Table 6. The enthusiasm for adaptation is influenced by the restricted to agro-markets, restricted to agro-markets and reduced livestock. Furthermore, it was found that lack of access subsides, change crop variety and crop to livestock had a significant association proceeding their alternate plan due to changing environment. Unpredictable weather and crop to livestock had a negative impact on having alternate adaptation but those variables were not significant.

Table 6. Logit analysis of adaptation resilience indices on farmers' enthusiasm to adaptation

Adaptation resilience indices	Coefficient	Std.	z	P > z
Lack access to subsides	0.124	0.188	0.66	0.510
Restricted to field agro-officer	0.742	0.379	1.96	0.050
Restricted to agro-markets	0.444	0.205	2.17	0.030
Restricted to timely weather information	-0.578	0.37	-1.62	0.106
Change crop variety	0.039	0.095	0.41	0.684
Crop to livestock	-0.092	0.106	-0.87	0.387
Reduce livestock	0.228	0.093	2.46	0.014
/cut^1	2.912	0.949		
/cut^2	3.945	0.960		
Likelihood ratio	55.23			

Table 7. Logit model on influence of environmental factors on adaptation

Influence of environmental factors	Coefficient	Std.	z	P > z
Increased precipitation	-0.320	0.069	-4.66	0.000
Experienced flood damage (last 5 years)	-13.451	623.948	-0.02	0.983
Rice production loss due climate change	-0.073	0.028	-0.38	0.704
/cut[1]	-14.725	623.948		
/cut[2]	-13.712	623.948		
Likelihood ratio	-33.15			

Most of the variables show the expected hypothesized signs. These results show that the restricted to the agro-markets is significant at 5% level of significance (p=0.05). Restricted to field agro-officer is associated with adaptation and p-value is 0.05.

From the results, it can be said that for a one-unit increase in restricted to agro-markets, restricted to field agro-officer and reduced livestock respectively, it has been expecting 0.742, 0.444 and 0.228-unit increase respectively in the log odds. The variables namely lack access subsides, restricted to timely weather information, change crop variety and crop to livestock are not significant. The overall goodness of fit can be explained by ($p<0.000$) and is good.

Threshold parameters cut[1] (2.912) and /cut[2] (3.945) describe that outcomes were ordered. This model had a 38.6% correct prediction value. The likelihood ratio value was 55.23 implying that the model has more chance to fit smoothly to adaptation resilience indices.

3.3.3. Logit Analysis of Climate Induced Variables

The results of environmental factors induced logit model describe the determinants of enthusiasm for adaptation are prevailing in Table 7. The consequences of the study represent “increase precipitation” was significantly and negatively related to enthusiasm to adaptation. That means, one-unit increase of the variable “increase precipitation” decreases -0.320 unit in the log odds given all of the other variables are held constant in the model.

Furthermore, it was found that another two variables “experienced flood damage” and “rice production loss” had a negative association with the enthusiasm to cope up with changing climate. But those variables were not significant.

The likelihood ratio value was 33.15 value implying that the model has more chance to improve the influences of environmental factors on adaptation.

4. Discussion

The reality is that the farmer’s livelihoods are galloped due to rain-fed agriculture focusing on changing climate and urgent adaptation in present situation. The survey report of Harvey et al. [9] shows that 95% farmers had changed their strategy according to their local climate. Ayanlade et al. [21] showed 67% of farmers had witnessed undergoing climate changes in southwestern Nigeria. They also showed that there is a lack of rural farmers’ awareness about climate change. Along with these adverse climate scenarios, farmers are facing some other problems as well. The principal confrontation matrix describes that the variables “restricted to field agro-officer”, “restricted to timely weather information” and “restricted to agro-subsidies” are highly problems in adapting new strategy for farm cultivator. In total 1342 farmers, all those variables are identified as highly problems for local farmers. For evolving adaptation strategy by smallholder farmers, it has an imperative requirement to gather knowledge about the factors those can influence farmers' enthusiasm towards adaptation to hostile environment [17, 22, 23]. Farmers’ policy was influenced by their income level, off-farm earnings, and change in rural market structure. Below et al. [24] established an action-grounded guide associated with alternate farmer’s policy to get rid from hard time. According to their research, they found that the small amount of financial dealing with infrastructure and education makes adaptation best.

The results showed that farmers benefited from agricultural field services. Lei et al. [25] showed that most farmers took adaptive approaches including changing their cultivating and harvesting dates, altering crop varieties, and refining irrigation groundwork. This result is similar with this study result. It appears that change crop variety and crop to livestock had an encouraging effect on farmers.

Rahut et al. [26] showed a major part of farmers adopted based on climate risk. There was agronomic support from the Chinese central government that helped to mitigate their adverse exposure [25]. Lack of access subsides is significantly and positively related to the enthusiasm of adaptation although farmers are not getting enough support from our GoB. In those cases, they used to adapt by crop to livestock and sometimes they reduce their livestock. Wood et al. [27] showed that poorer farmers in developed counties are more likely to adapt. Several studies showed that access to information had enabled farmers to become knowledgeable about the influences of adverse circumstances of climate [28, 29]. They also showed how farmers could have adjusted and overcome their situations with access to additional facilities. Restricted access to agri-extension is very significant in our study that means farmers can access agri-extension limitedly, but this

variable helped them to adopt. [30] showed their research in highland areas of Ethiopia that 80% of farmers experienced different types of effects of adverse climate consequences. Ferdushi et al. and Zamasiya et al. [17, 31] showed gender discrepancy has different influences on farmers' enthusiasm towards adjustment to changing climate. Zhai et al. [18] showed a large part of the respondents self-confessed about the major influence of climate change and 70.3% believe changing climate had an exposed risk to their livelihood in China during 2013–2014. [32] showed agricultural involvement can strengthen capacity building along with institutional involvement. The farmers of this investigation had also shown concern about the unpredictable weather and high cost of farm inputs along with institutional involvement. [33] showed that distributing information related to climate can motivate farmers to adjust with climate. [34] showed that farmers involved in an off-farm income activity means extra income which helps farmers to take a positive decision of having alternate adaptation strategy. [30] identified that institutional barriers along with financial obstacle should be addressed to attain desired level of mitigation in south Asia.

The farmers of this study informed that financial and restricted access to agro-extension made hurdle to adapt to best strategies. That means there is a knowledge gap between farmers and agro-extension service. [35] showed transnational adaptation initiatives to achieve key success to mitigate. The previous study has proved that farmers' perceptions and willingness towards threat and susceptibility are a major concern. If the farmers in Bangladesh can achieve transnational help about adaptation initiatives, they could have mitigated in a proper way and resolved their financial problem.

5. Conclusions

In Bangladesh, natural calamity is common in each year. From this background, farmers always face challenges in different ways. This natural calamity has a diverse impact on agriculture as well as farmer. They work hard but at the end they could not achieve their ultimate goal. They can only mitigate the situation in a sense. Agricultural farmers in Bangladesh have conveyed their utmost concern on changeable meteorological conditions, excess cost of farm inputs, field agricultural services, agricultural markets, weather information on time, restricted access to agricultural subsidies and their limited farm size. The results of principal confrontation matrix indicate that those areas were highly challenging for adaptation of the households due to hostile weather, excess cost of farm inputs, and restricted access to agricultural extension officer. The results indicated that most of the female and middle-aged farmers have positivity to adaptation. Most of the farmers were illiterate and didn’t get any training who have positivity to adaptation. Farmers who have their own land have positivity to adaptation. The results also indicated that farmers with lack access subsides with moderate problem have decided positivity to adaptation. Most of the farmers were facing highly problems to adapt due to hostile weather. Farmers felt that along with climate change, other issues related to farm are making a serious problem and affecting the Bangladesh agricultural sector.

In this regard, to overcome these above-mentioned issues, farmers could have mitigated the situation working with the government and the NGOs for adapting new strategies. To adapt a proper adaptation for reducing climate change vulnerability, farmers need subsidies, training and market facility, etc. Indigenous farmers have combined their traditional experience with indigenous knowledge to achieve a direct pathway of adaptation. The strategies of investment planning that have been adopted for infrastructure development, financial and social capital growth, knowledge sharing can enable farmers to become able to gather more information of the influences of hostile climate.

Overall findings can be explained as there is a necessity to develop constructive and fruitful training in village to village for farmers. The official representatives should have taken a new initiative to inaugurate new adaptation technique to bring up successful outcome in adverse climatic conditions. High officials can provide weather forecasting through technological advancement or by short mobile message. They can reduce farm inputs and can provide agricultural aids which can help to alternate their plan. It can also make sure that they can have easy access to the door of agricultural markets for selling their goods.

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