Journal of Modern Science and Technology
Vol. 4. No. 1. September 2016 Issue. Pp. 63 – 74

Agricultural Adaptation Practices in Coastal Bangladesh: Response to Climate Change Impacts

Debanjali Saha[1*], Md. Shahriar Shafayet Hossain[2],
M. Shahjahan Mondal[3] and Rezaur Rahman[4]

Agriculture is one of the major livelihoods in the coastal Bangladesh and future changed climate is likely to affect the agricultural activities. Different adaptation measures have been taken in response to climate change in coastal Bangladesh. In this study, the agricultural adaptation practices were documented and analyzed according to different criteria to determine the present condition of coastal agriculture under the threat of climate change. Most of the adaptations are found to be practiced in the exterior coastal districts and are taken in response to chronic stresses such as salinity and regular flood and sudden shocks like cyclone and storm surge. Major forms of adaptations are improved crop variety, innovative cropping technique and infrastructural development. Though most of them are found to be sustainable in the long term, they are expected to face some barriers. Also, gender dimension is not addressed in many of these practices. Proper management and maintenance, coordination among implementing organizations, policy formulation and good governance are necessary for the success of future planned adaptations in the coastal region. This will ensure stability of the agricultural activities and development of the coastal inhabitants thus safeguarding the national food security.

Field of Research: Climate Change Adaptation in Agriculture

1. Introduction

The coastal area of Bangladesh is susceptible to frequent natural disasters which affect the lives and livelihoods of the coastal people up to a great extent. The exposure of the coastal districts to recurring stresses and sudden shocks of nature has been affecting one of the major livelihoods of the coastal community for a long period, which is crop agriculture. After every notable natural disaster, agricultural activities of the coastal area become static for a long duration, thus hampering the food security and socio-economic standard of the coastal community. Moreover, global climate change asserts a new depressing effect to the lives and agro economy of the whole world and Bangladesh is not out of its grip as well. According to IPCC 5th Assessment Report, global climate change is likely to further aggravate the flooding and salinity situations of South-Asian countries including Bangladesh. Under a high emission scenario, total sea level rise may reach up to 98 cm by 2100 (CDKN 2014). Erratic weather pattern and increased salinity intrusion will hamper

[1*] Lecturer, Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh; email: debanjalisaha@iwfm.buet.ac.bd
[2] Research Assistant, Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh; email: shahriar.buet08@gmail.com
[3] Professor, Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh; email: mshahjahanmondal@iwfm.buet.ac.bd
[4] Professor, Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh; email: rezaur@iwfm.buet.ac.bd

the agricultural activities as well as the lives of the coastal inhabitants who have an agro-based livelihood. Under these circumstances, adaptation is the only feasible choice to manage the climate change impacts for a country like Bangladesh having high population density and limited resources. Adaptation is a process of adjustment to actual or expected climate and its effects (IPCC 2014). Coastal agriculture sector has been experiencing various adaptations for quite a long time, since climate change has been evident in this country. The people have been autonomously taking steps to protect their agricultural activities from any natural or anthropogenic difficulties. Moreover, public awareness regarding climate change and necessary adaptation measures have immensely increased in recent times and the community understand and respond to such activities of the adaptation providers.

So far, a few studies have been conducted on the evaluation of some adaptation practices and potential adaptation options which can be suitable in the agriculture sector of the coastal region of Bangladesh. But none of them has focused on the documentation of practiced agricultural adaptations and their evaluation in the context of sustainability, gender sensitivity and barriers of these adaptations. This study has been performed to identify the adaptation measures taken by the coastal people from highest tiers of the government to the local level community to evaluate the present status of the coastal agriculture sector to cope with potential climate change. The first section of this paper provides with some introduction on the study while the second section discusses about the relevant literatures reviewed during this study with their findings. Then a brief overview of the study area is provided with a preceding methodology section. The next section covers the analyses of the documented adaptation practices which include discussion about the spatial distribution, types, providers and beneficiaries, issues responsible, sustainability and gender dimensions of the adaptation practices and lastly is followed by conclusion. This study delivers a generalized idea to the adaptation providers of both governmental and non-governmental sectors, policy makers and relevant personnel about the problems associated with implementation of planned adaptations, the obstruction from the beneficiary's side due to internal conflicts and lack of cooperation, inability of some measures to provide expected evidence of success, lack of institutional capacity, necessity of more effective measures, and gaps among policy and planning of the interventions. As a whole, this study explains the present scenario of the agriculture sector in combating climate change impacts which can significantly assist in improving the capacity and performance of the agricultural adaptations to protect livelihood stability and sustain food security of the coastal community of Bangladesh.

2. Literature Review

Different adaptation measures have been undertaken in the coastal areas of Bangladesh for decades in response to or in anticipation of the detrimental impacts of climate variability or climate change on agriculture. A number of studies have been conducted in this regard but most of them mentioned only about potential adaptation options related to crop agriculture. Cultivation of different stress tolerant, hybrid and short duration crop varieties, improvement in agricultural management, infrastructural development, disaster preparedness and rehabilitation, awareness building, etc., have been mentioned as potential adaptation options in coastal Bangladesh (Karim et al. 1998; Karim 2011). Some of these options have already

been practiced in local level in a small scale which can be expanded with proper knowledge dissemination, community participation and coordination between different governmental and non-governmental organizations. A number of policy, framework and legislation have also been developed regarding agricultural adaptations in the coastal region of Bangladesh. But very few systematic studies have been performed on the evidence of adaptation practices in this country and their performance in successfully adapting to climate change.

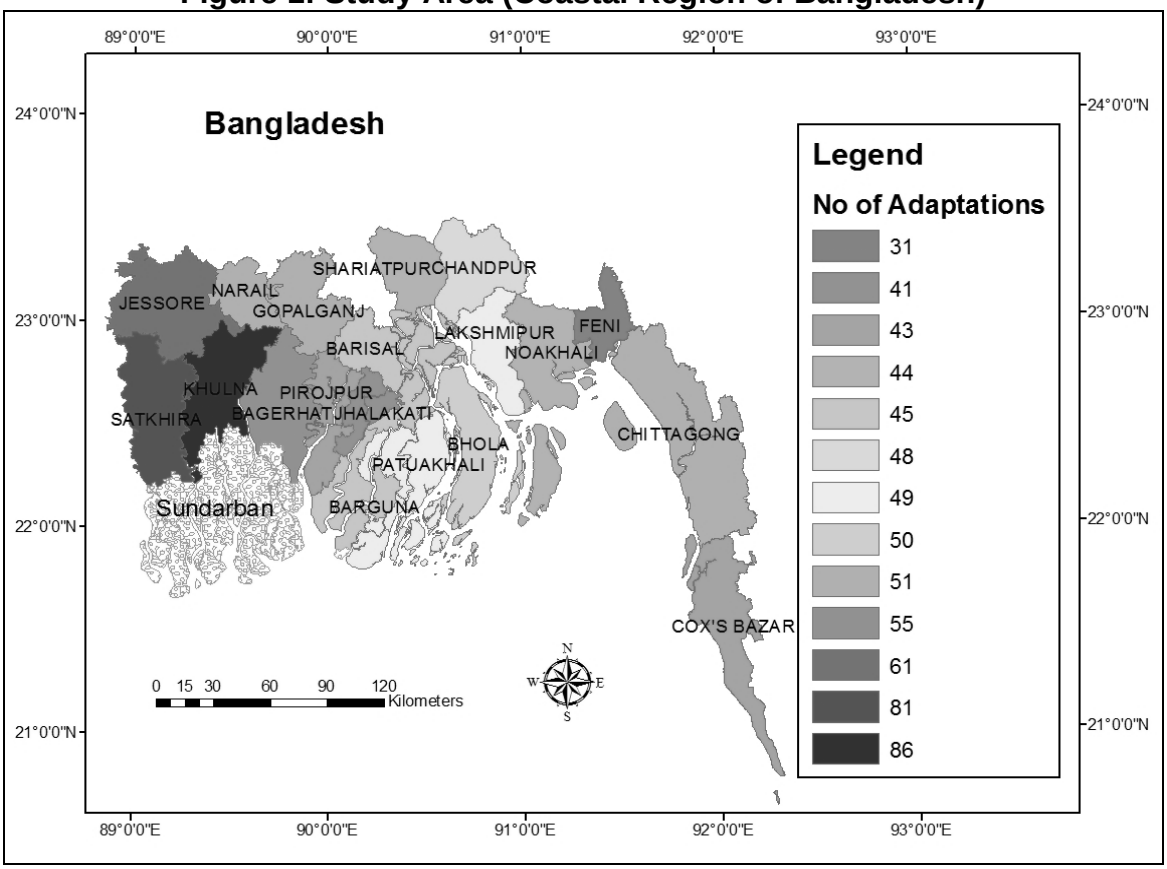
Some studies have evaluated the performance of embankments in favor of agricultural activities (Miah & Mohit 1996), while some have documented the suitability and capacity of stress tolerant crop cultivars such as BRRI dhan-47, 51, 52 55, Binadhan-8, 10, 11, Hysun-33 sunflower, jute and sugarcane varieties, etc. (Rahman 2011; Sutradhar et al. 2015). The acceptance of these practices in coastal districts of Bangladesh has proved their success. The analysis of agricultural adaptation practices in selected publications revealed that floating bed vegetable gardening has huge potentials to mitigate problems against flood. It is a very popular practice in south-western and south-central parts of Bangladesh, mostly in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokathi districts where land remain submerged most of the time in a year (Oxfam International 2009). Recently, Practical Action Bangladesh, under its Community based Adaptation to Climate Change Project has promoted dyke cropping, which has combined fish and vegetables cultivation in Shyamnagar and Kaliganj upazilas of Satkhira District. Also, coastal livelihood restoration and rehabilitation through training and capacity building activities, micro-credit facilities and crop insurance to poor farmers are some of the socio-economic adaptation practices taken in the coastal areas of Bangladesh for the betterment of agriculture sector in response to potential climate change. Such adaptation measures taken in this sector need proper evaluation and assessment to further escalate the scale of these practices and improve the condition of agriculture, thus providing livelihood stability to coastal communities. Some of the previous studies involved the evaluation of very few adaptation measures in the agriculture sector. But this study assessed most of the coastal agricultural adaptations and their responses to climate change impacts from different analytical contexts.

3. Study Area

Being a developing country, Bangladesh is manifested to a greater threat of climate change than many other countries of the world in spite of its position as a minor contributor to global greenhouse gas emissions. The agro economy of the whole country is at stake, but the coastal region of Bangladesh captures most of the focus. This region has always been full of vast resources and opportunities, as well as been vulnerable to frequent natural hazards due to several climatological and geographical characteristics. The coastal zone possesses a fragile ecosystem and the agriculture experiences the severity of natural disasters every now and then. Global warming induced future climate is likely to affect this region by increasing the frequency and intensity of the natural disasters and thus rendering the coastal community more vulnerable to climate change. These facts have made the people more concerned about taking adaptation strategies to protect their ways of living. The awareness raising activities and knowledge dissemination by both the government sector and non-governmental entities have also been more concentrated in the coastal zone rather than in other parts of the country. So, the

sustainability and performance of the agricultural adaptations in the coastal region are essential to be evaluated. Due to these reasons, the coastal region of Bangladesh has been selected for this study (Figure 1). This study sought to understand and analyze the existing adaptations in practice that were taken to protect the coastal agriculture sector from the negative impacts of climate change. For this study, adaptations in response to climate change were defined as: 'adjustments that reduce vulnerability to climate variability and change in response to, or in anticipation of, real or perceived stressors. These stressors may be exposure to sudden onset shocks, such as floods, and/or to slow onset stresses, such as changes in temperature and rainfall'.

Figure 1: Study Area (Coastal Region of Bangladesh)



4. Methodology

This study represents a synthesis on the agricultural adaptations in practice in the coastal Bangladesh, which is a part of a larger inventory of adaptation practices prepared under the project: "Deltas, vulnerability and Climate Change: Migration and Adaptation" (DECCMA), funded jointly by the Department for International Development, UK and International Development Research Center, Canada. According to a developed protocol (Tomkins et al. 2014), the evidence of currently observed and documented adaptations in the agriculture sector were collected from different published literatures. These evidences were collected by searching in a number of sources (Google, Google Scholar, etc.) and academic databases (ScienceDirect, Springer, Wiley, OARE, Academiaedu, etc.), national and international agencies and institutions, governmental organizations (GOs) and non-governmental organizations (NGOs), etc. Both Physical-Infrastructural-Technological

(PIT) and Socio-economic (SE) adaptations were added in the inventory separately and then the analyses on the adaptation measures were performed jointly. All the collected information were collated in a universal spreadsheet template having 43 different columns, namely, geographical location, provider/beneficiary, forms of adaptations, stresses and shocks, barriers to adaptations, gender relations, sustainability and resilience factors, etc. Information from each adaptation practice in coastal agriculture sector were added in these columns separately and based on these details the evaluation of the adaptation measures was performed.

5. Analyses of the Adaptation Practices

Different agricultural adaptations are observed to be practiced in the coastal region of Bangladesh ranging from hard engineering measures to soft socio-economic measures or technological innovations. About 60 such practices are observed of which 35 are found to be infrastructural-technological and 25 are socio-economic. The major adaptation practices have been innovation in crop technologies such as stress tolerant and short duration crop varieties, agricultural mechanization to ease up post-harvest activities, construction of polders and drainage infrastructures to protect agricultural lands from flooding and waterlogging, introduction of integrated farming practices and changes in cropping pattern. Besides, innovation in vegetable gardening, rainwater harvesting for irrigation, mixed cropping techniques like dyke cropping and relay cropping are among the emerging adaptation practices. Some research activities, training and knowledge dissemination and policy formulation have also been documented as agricultural adaptations.

5.1 Spatial Distribution of the Adaptation Practices

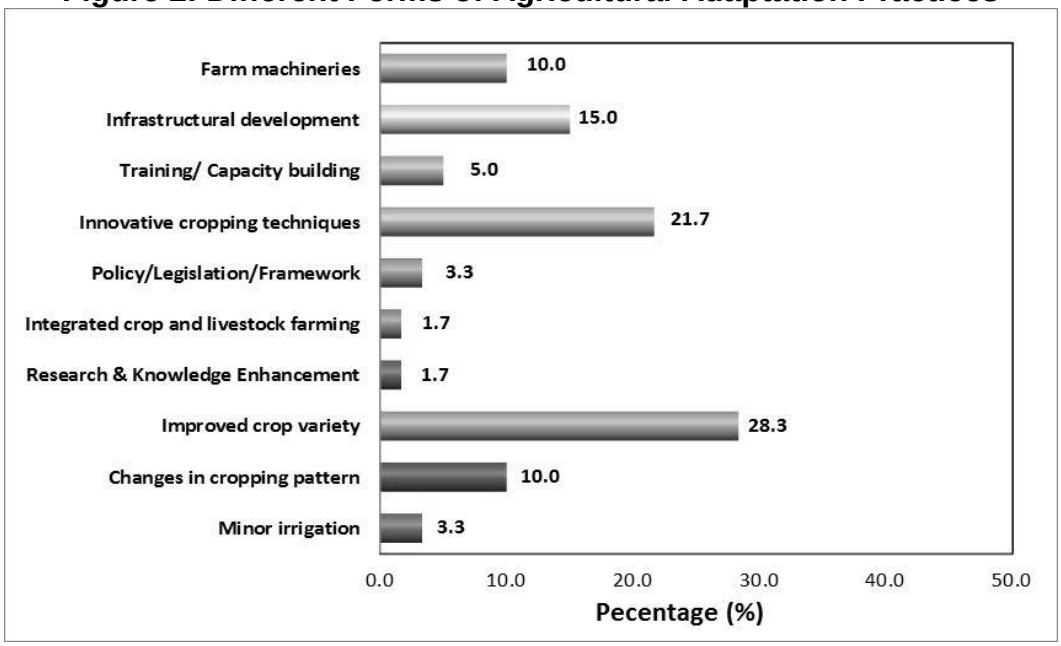
The 19 districts in the coastal region of Bangladesh witnessed diverse adaptation practices. The districts that are more exposed to the coast experienced more adaptations than the interior districts. Among those, Khulna, Satkhira, Bhola, Bagerhat, Pirojpur and Barguna have experienced more adaptations than the other districts. The highest number of adaptations was recorded for Khulna and Satkhira which was 9.8% each, of the total adaptations. Bhola, Bagerhat, Pirojpur, Barguna and Jessore experienced 6.7%, 6.5%, 6.2%, 6.2% and 6.0% adaptations respectively. The geographical location of a district and its exposure to different natural hazards are the major drivers of the variation of adaptation practices in the coastal districts. This is also the reason that both GOs and NGOs are more active in these areas about awareness raising and capacity building of the inhabitants.

5.2 Types of Adaptations

Different forms of agricultural adaptations take place in the coastal region of Bangladesh. Among these, improvement in crop varieties, innovative cropping techniques, infrastructural development, farm machineries, changes in cropping pattern, etc., are the major ones (Figure 2). About 28% adaptation practices are linked with improvement in crop varieties such as, salinity and submergence tolerant rice and non-rice varieties, short duration pulses and vegetables, cash crop cultivation like sunflower, watermelon and sesame, etc. (Unnayan Onneshan 2011; Titumir et al. 2012; Kibria et al. 2015). Innovative cropping techniques and changes in cropping pattern have a good share of practices, about 22% and 10%

respectively. Floating bed gardening, multiple cropping techniques like dyke and ridge cropping systems, hanging vegetable gardening, etc., are some emerging practices which are expected to support coastal agriculture in the future climate induced erratic weather pattern and lack of suitable irrigation water.

Figure 2: Different Forms of Agricultural Adaptation Practices



The adaptation measures taken in the agriculture sector are found to be aimed mostly to take action or implement change. About 92% of the adaptations are practiced with this aim. Some actions are also taken for capacity building of the coastal inhabitants or policy making. Also, most of the adaptations are found to be as deliberate adaptation measures as they have occurred as a result of real or perceived change in climatic condition. The coastal people have developed awareness about the damaging aspects of climate change through various training and capacity building activities for some time, and as a result both individual and government level adaptation measures have been taken to deal with the impacts of climate change in the agriculture sector. This is also the reason of the surge of adaptation practices during the last 10 years, as 45% of the agricultural adaptation practices coincide with the global climate change regime. This increased public awareness and government initiatives are expected to support this sector in future uncertainties of global climate scenarios and their unprecedented effects.

The adaptation measures in the agriculture sector have been occurred either in response to or in anticipation of the impacts of climate change. In spite of the responsiveness of the coastal people about future changed climate, only one fourth of the adaptation measures are taken with an anticipation of climate change in future. Such measures are: construction of climate resilient structure for flood protection and increase in agricultural production in anticipation of intense natural disasters in future (Oxfam International 2009; BCCT 2014j), floating bed vegetable gardening in flood prone areas to protect vegetables from increasing flood frequency and intensity (Alauddin & Rahman 2013), etc. But most of the adaptation measures (75%) are reactive in timing and occurs following the impact of climate change. This implies that, though increased awareness of the coastal community has made them

address climate change in their practices, but these have occurred mostly in reaction when the effects of this phenomenon have been visible in the coastal areas.

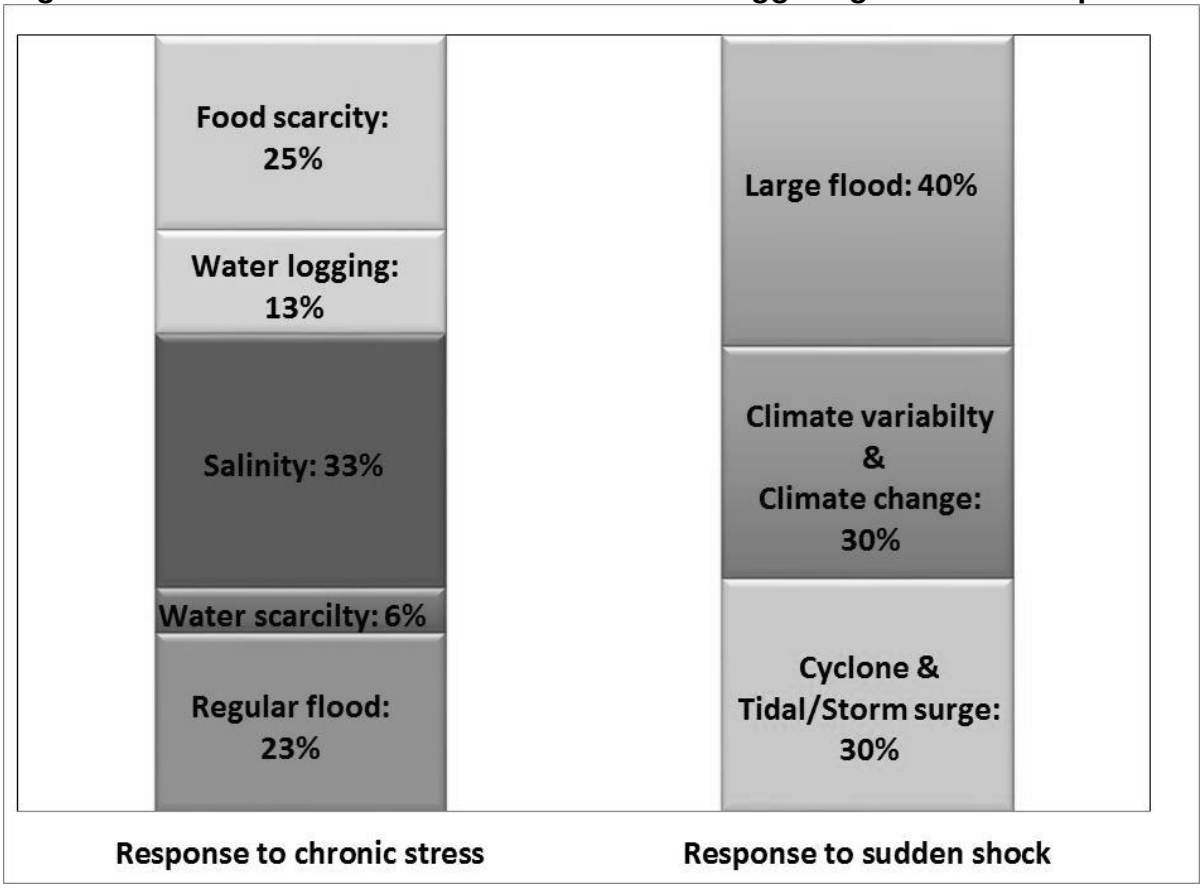
5.3 Providers and Beneficiaries of the Adaptation Practices

Different organizations and agencies provide adaptation measures to the coastal community depending on the activities of the organizations in the area. Sometimes individuals and communities provide and implement adaptation practices or strategies along with the GOs and NGOs. The government provides about 72% of the total agricultural adaptations in the coastal region, most of which are infrastructural and technological interventions. Bangladesh Water Development Board (BWDB), Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI) and Comprehensive Disaster Management Program (CDMP) are the principal government organizations providing such adaptations. Various NGOs such as Bangladesh Rural Advancement Committee (BRAC), Care Bangladesh, Oxfam International, Practical Action, etc., provide 21% of the adaptations while others (7%) are provided by private sectors. In most of the cases (92%), the local communities of the targeted area were reported to be the beneficiaries of the agricultural adaptations among which farmers, fishermen, disaster affected and vulnerable community were the majority.

5.4 Stresses and Shocks Responsible for the Adaptation Measures

The adaptation practices in the coastal agriculture have evolved in response to long term chronic stresses or any sudden shock, which have hampered the agricultural production of the country. About 72% of the adaptations were found to be taken in response to chronic stresses in the coastal Bangladesh. These include cultivation of salinity and submergence tolerant crop varieties in response to chronic salinity and waterlogging stresses, rainwater harvesting and alternate wetting and drying irrigation system to deal with irrigation water scarcity, introduction of farm machineries or changes in cropping pattern to facilitate crop cultivation and lessen food scarcity, etc. The large number of adaptation practices in response to stresses in agriculture sector indicates that, people of the coastal areas who have been affected by various chronic natural hazards and associated problems have somewhat learned to adapt with them with the help of governmental organizations or non-governmental agencies. The providers have been successful in making the adaptation measures available as well as enhancing the knowledge and capacity of the local people. On the other hand, only 28% of the agricultural adaptations have emerged in response to sudden shocks like cyclones or major floods, which indicates that, more emphasis needs to be given on making the coastal community and their agricultural practice resilient to the present and future climate induced disasters and shocks as climate variability or climate change is considered to be a serious shock to coastal agriculture. Figure 3 shows the distribution of adaptation practices in response to stresses and shocks.

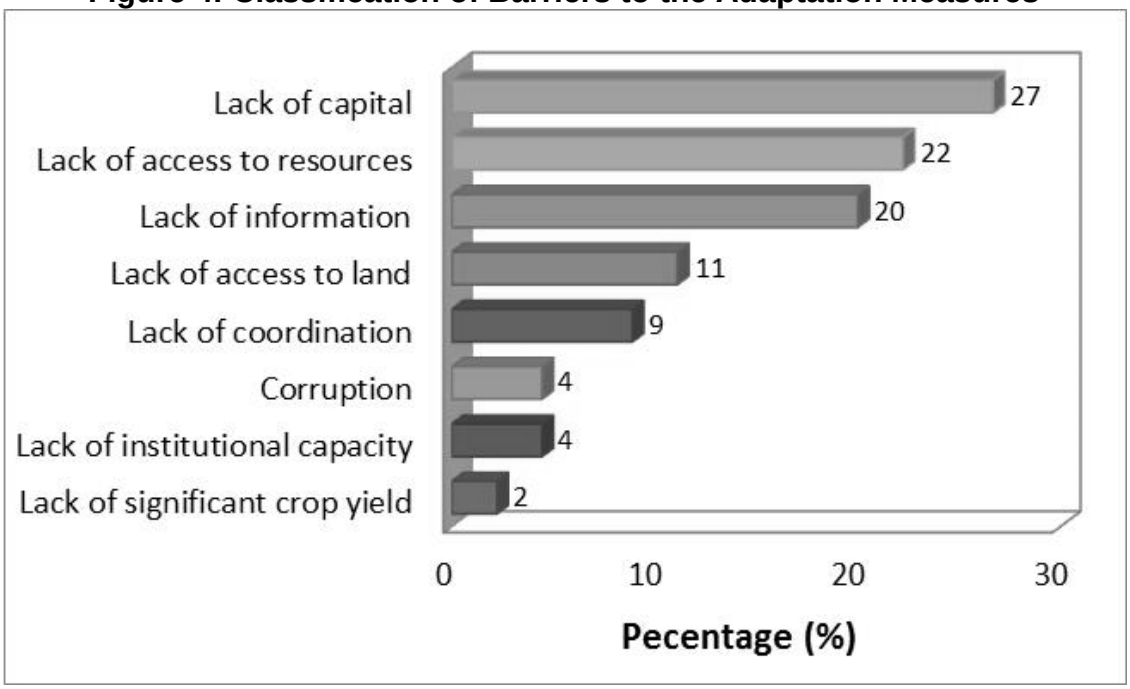
Figure 3: Distribution of Shocks and Stresses Triggering Different Adaptations



5.5 Sustainability Issues and Barriers to the Adaptation Measures

Long term sustainability is a major requirement for the success of any adaptation measure given the potential threat of climate change and its detrimental impacts. According to the major criteria of sustainability i.e., high public acceptance, cost effectiveness and high rate of return, suitability for the users, easy operation and maintenance, environmental friendliness, etc., about 70% of the agricultural practices have been identified as sustainable in the long run. But due to some barriers, the sustainability and effectiveness of these adaptations may be hampered. Almost half of the adaptations faced some barriers among which lack of capital, lack of access to resources and lack of proper information and knowledge were the major ones (Figure 4). Infrastructural measures such as construction of embankments and drainage structures require large capital investment which makes it difficult to implement such adaptations without proper incentives. Also lack of access to resources, such as necessary seeds for cultivating stress tolerant innovative crop varieties, is a limiting factor for taking such measures. Lack of knowledge and information of the responsible organizations or adaptation practitioners also threaten the successful enactment of the adaptations or their sustainable persistence.

Figure 4: Classification of Barriers to the Adaptation Measures



5.6 Gender Dimension of the Adaptation Practices

Though Bangladesh is one of the least contributing countries to the global climate change phenomenon, high vulnerability to climate change impacts is evident and adaptation is the only option to deal with this situation. But often the common practices and measures taken in the agriculture sector to adapt to the future climate greatly lack gender dimension. In spite of having gender sensitivity in national policy formulation (GED 2011; MoA 2013), only 28% of the agricultural adaptation measures are found to reflect gender issues. Cultivation of stress tolerant crop varieties involves women participation in post-harvesting activities which provides women empowerment up to an extent. Also, strengthening household capacity by training activities consider women welfare and facilitation. But regrettably, there are very less attempts to make the adaptive strategies and measures gender appropriate which is a prior requirement for proper management and improvement in coastal agriculture sector and associated socio-economic progress of the coastal community.

6. Discussion

The combination of frequent natural disasters, high population density, poor infrastructure and low resilience to economic shocks, makes Bangladesh especially vulnerable to climatic risks. To increase the resilience and adapt to climate change, implementation of necessary strategies and plans needs to be performed. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) have six pillars where agricultural adaptation strategies and options are included. To protect the poor and vulnerable community from the climate change impacts and to prepare them to deal with the future by increasing their knowledge and capacity, different adaptation options in the context of agricultural sector have been considered. Among them, a lot have already been practiced and implemented namely, infrastructural development for increasing agricultural activities and protection from crop damage,

development of stress resilient crop varieties to ensure food production and economic growth, research and knowledge enhancement activities to invent new agricultural technologies and machineries for livelihood improvement, capacity building and training of the disaster affected people to protect them from climate change impacts, etc. But the major barriers of the implementation of these strategies are poor operation and maintenance and governance issues. Infrastructural development activities like embankment, regulator or sluice gate construction often suffer from poor operation and maintenance and lack of coordination among the associated group of people. Also, conflict between different livelihood groups hampers the protection facilities of coastal polders and causes damages to the other sectors.

Though a large number of stress tolerant crop variety have been invented and many promising agricultural technologies have been introduced, but lack of appropriate management practices to improve cropping intensity and to boost up agricultural production, lack of quality seed and necessary technical knowledge of farmers, etc., are preventing these adaptation practices to scale up and flourish. Also, the productivity of these crop varieties has not been able to compete with the increasing problem of salinity and other hazards in the coastal areas. The innovative cropping practices like floating garden, integrated farming of crop and livestock, multiple cropping practices, etc., are effective adaptations which are being practiced in a small scale. Though these strategies seem sustainable in the context of future changed climate, lack of improved and planned system to optimize resources and maximize outputs from them has been the drawbacks of these practices. Steps are being taken to prepare the coastal people to deal with climate change by capacity building and training activities, but proper planning, management and execution require more efficient work force and knowledge intervention to make these efforts successful. Also, more anticipatory adaptation measures need to be implemented to deal with the climate change impacts. The policies, legislations and frameworks related to agricultural adaptations also require proper institutional support and coordination among the different levels of the organizations related to the implementation of these strategies. Availability of the required fund is a big issue for a developing country like Bangladesh which in many cases impedes the development activities. Also, there remain some discrepancies among the planning and policy in document and their practice in the field level which need to be resolved.

7. Conclusion

In the 21st century of global development and urbanization, the challenge that Bangladesh faces is to successfully implement and materialize the potential options and plans for climate change adaptations to provide sustainable development in the agriculture sector and to create a suitable environment for the economic and social development of the country in an integrated approach. The agricultural adaptations in the coastal Bangladesh have been analyzed and discussed in this study and it was found that, most of the adaptations were practiced in the exterior coastal districts and were taken in response to chronic stresses. In spite of their good future prospect towards long term sustainability, there are some barriers which are required to be eliminated. Also, gender dimension is absent in almost two third of the adaptation practices. So, proper management and maintenance, cooperation from different associated institutions and organizations, both governmental and non-

governmental, from the highest to lowest tiers of the society, and mostly the support of the community are very much essential for ensuring success of the adaptations. Also, elimination of the existing barriers to the adaptation practices and incorporation of gender dimension are necessary to create and maintain a climate change resilient and developed agro economy in the coastal region of Bangladesh. So far, no other previous study has described or evaluated the coastal agricultural adaptations in a way where the sustainability, success and barriers related to adaptations have been focused. The evaluation of the existing agricultural adaptation practices performed in this study will contribute a rather constructive type of knowledge to the academics as well as practitioners related to agriculture sector. This will provide the information of all the issues related to these measures to the adaptation providers and will help in eliminating the barriers and limitations to make this sector better equipped to deal with climate change impacts with more fruitful attempts in the near future. As this study is based on the secondary information about the adaptation measures, more efficient evaluation can be performed with primary level information collected from the field to better understand the advantages and difficulties of the agricultural adaptations and to make them more effective, sustainable and successful in the long run.

Acknowledgement

This work is carried out under the 'Deltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA)' project under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) program with financial support from the UK Government's Department for International Development (DFID) and the International Development Research Centre (IDRC), Canada. The views expressed in this work are those of the authors and do not necessarily represent those of DFID and IDRC or its Boards of Governors.

References

Alauddin, SM and Rahman, KF 2013, 'Vulnerability to Climate Change and Adaptation Practices in Bangladesh', *Journal of SUB*, vol. 4, no. 2, pp. 25-42.

BCCT 2014i, *Annual Report 2013-2014*, Project ID: 185, Mitigation and Low Carbon Development through Increase of Using Bio Gas Technology (in Bengali), Bangladesh Climate Change Trust, Ministry of Environment and Forrest.

CDKN 2014, *The IPCC's Fifth Assessment Report: What's in it for South Asia? Executive Summary*, Climate and Development Knowledge Network.

GED 2011, *6th five year plan FY 2011-FY 2015: Accelerating growth and reducing poverty*, General Economics Division, Planning Commission, Dhaka.

IPCC 2014, *Climate change 2014: Impacts, adaptation, and vulnerability, Working Group II contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press.

Karim, Z, Hussain, SG and Ahmed, AU 1998, 'Climate change vulnerability of crop agriculture', in: Huq S, Karim Z, Asaduzzaman M & Mahtab F (eds.), *Vulnerability and adaptation to climate change for Bangladesh*, Kluwer Academic Publishers, pp. 39-54.

Karim, Z 2011, *Assessment of investment and financial flows to adapt to the climate change effects in the agriculture sector*, Government of the People's Republic of Bangladesh, Dhaka.

Kibria, MG, Saha, D, Kabir, T, Naher, T, Maliha, S and Mondal, MS 2015, 'Achieving Food Security in Strom Surge-prone Coastal Polders of South-West Bangladesh', *SAWAS Journal*, Vol. 5, No. 1, pp. 26-42.

Miah, MM and Mohit, MM 1996, 'Factors Affecting the Performance of Flood Control, Drainage and Irrigation Projects in Bangladesh: A Case Study', *Journal of Civil Engineering*, The Institute of Engineers, Bangladesh, vol. 24, no. 4, pp. 147-154.

MoA 2013, *National agriculture policy 2013*, Ministry of Agriculture, Government of the People's Republic of Bangladesh, Dhaka.

Oxfam International 2009, *Climate change adaptation practices in thirty agro-ecological zones (AEZs) of Bangladesh*, Final Report, Jahangirnagar University, Dhaka.

Rahman, MM 2011, *Country report: Bangladesh, ADBI-APO Workshop on Climate Change and its Impact on Agriculture*, Ministry of Agriculture.

Sutradhar, LC, Bala, SK, Islam, AKMS, Hasan, MA, Paul, S, Rahman, MM, Pavel, MAA and Billah, M 2015, 'A Review of Good Adaptation Practices on Climate Change in Bangladesh', *Proceedings of 5th International Conference on Water & Flood Management (ICWFM-2015),* Institute of Water and Flood Management, BUET, Dhaka, Bangladesh, pp. 607-614.

Titumir, RAM and Basak, JK 2012, 'Effects of Climate Change on Crop Production and Climate Adaptive Techniques for Agriculture in Bangladesh', *Social Science Review*, vol. 29, no. 1, pp. 215-232.

Tompkins, EL, Suckall, N, Rahman, R and Siddiqui, T 2014, *Protocol on how to create inventories of observed adaptation to climate change*, Internal DECCMA working document.

Unnayan Onneshan 2011, *Implications of Climate Change on Crop Production in Bangladesh and Possible Adaptation Techniques*, Unnayan Onneshan - The Innovators.