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Climate Change Perception and Adaptation Options for Agriculture in Southern Khulna of Bangladesh

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Abstract Understanding perception and adaptation strategies at a community level is important for achieving sustainable adaptation options in a climate-vulnerable area. A study was conducted in two villages of Khulna district, Bangladesh, through Focus Group Discussions to capture the perceptions of the community on climate change and variability, and also to understand the current strategies to cope/adapt with the changing situation in the context of agriculture. Some future adaptation options were also presented to the community for their opinion in the light of their experiences. Findings revealed that the weather is unpredictable and variability has increased over time with no positive outlook or aspect associated with this change. Local people perceived changes in rainfall patterns, resulting in delayed rice planting, decreased yield and damaged sesame and mungbean crops due to water-logging. The extended summer periods with increasing average temperatures have resulted in decreased growth duration of crops, increased pest infestations, and decreased yields. The increased period during which river water is saline limits the scope of irrigation with river water. Communities are adapting to this changing situation by adopting high yielding salt tolerant rice varieties, introducing new crops like sesame and mungbean, and adopting rice-fish culture with tilapia, carp and prawn instead of brackish water shrimp.

Keywords: *community perception, climate change, adaptation options, agriculture*

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1. Introduction

Climate change and variability has emerged as a key concern for environmentally vulnerable countries [1]. Bangladesh is widely recognized as one of the most climate vulnerable countries in the world. It experiences frequent natural disasters, which cause loss of life, damage to infrastructure and economic assets, and adversely impact lives and livelihoods, especially of poor people living in remote or ecologically fragile parts of the country, such as river islands and cyclone-prone coastal belts [2]. The geographical location and geo-morphological conditions of Bangladesh have made the country one of the most vulnerable to climate change, particularly to sea level rise (SLR) [1,3]. The Intergovernmental Panel on Climate Change (IPCC) forecasts that global warming will result in sea level rises of between 0.18 and 0.79 metres by the last decade of the 21st century. This could increase coastal flooding and saline intrusion into aquifers and rivers across a wide belt in the south of the country, although most of the area is protected by polders [4]. The south western part, also known as the Ganges tidal plain, is comprised of the semi-active delta and is crisscrossed by numerous channels and creeks. This area is particularly vulnerable as its topography is very low and flat.

Climate change and variability (CC & V) is considered to be one of the most serious threats to sustainable development with adverse impact on environment, human health, food security, economic activities, natural resources and physical infrastructure [5,6]. The impacts of climate variability are manifested by floods, droughts, erratic rains and extreme events consequence on crop agriculture and food security in many parts of the world, particularly in developing countries [5,7,8,9,10]. Given the over-dependence on rain-fed agriculture by the majority of people living in rural areas, CC & V has been one of the major limiting factors in agriculture production, resulting in food insecurity and low-income generation [11]. The studies conducted by [12] revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production.

The adaptive capacity is influenced by factors such as knowledge about climate change, assets, access to appropriate technology, institutions, policies and perceptions inter alia [13,14]. Researchers counted that environmental perceptions are among the key elements influencing adoption of adaption strategies [15]. Perceptions are context and location specific due to

heterogeneity of factors that influence them such as cultrure, education, gender, age, resources, endowments, and institutional factors [16,17]. Increasing impacts of CC & V on agriculture have been associated with various adaptation and coping mechanisms [18]. These are based mainly on indigenous knowledge which embodies a wide variety of skills developed outside the formal education system [19]. Indigenous knowledge arises out of continuous experimentation, innovation and adaptation, blending many knowledge systems to solve local problems [19]. Such farmers' adaptive innovations, techniques, methods and processes, based on their own knowledge and skills to decrease or prevent devastating climate change impacts, are location specific and community specific. Climate change is a global phenomenon while adaptation is largely site-specific. A common disadvantage for local coping strategies is that they are often not shared widely, but rather handed down through oral history and local expertise [20]. As site-specific issues require site-specific knowledge, experience has shown that identified adaptation measures do not necessarily translate into cultural possibilities or alternatives–there are barriers to adaptation [5]. These innovations should be documented and disseminated so that other communities from distant locations can benefit from these adaptive initiations. Moreover, future adaptation options proposed by researchers need to be discussed with the farmers for their opinion before evaluation or validation. This may help in meeting the specific demands of community. Again, perception and experiences of both male and females and their participation in selecting future adaptation options are also important. Therefore, a study was conducted to understand and document the perception of the community on climate change and variability in respect to gender, and on their strategies to cope with or adapt to the changing situation in the context of agriculture. The study also sought to understand and document the farmers' responses on some adaptation options offered by researchers.

2. Methodology

2.1. Study Area

The study was conducted in two villages, namely, Katianangla and Laxmikhola under Bataiaghata and Dacope upazila in Khulna district of Bangladesh in 2011. The villages were selected purposively based on vulnerability to climate change. Between the selected villages, Laxmikhola was badly and Katianangla was partially affected by super cyclone Sidr and Aila. Katianangla is situated 14 km south of the the Khulna metropliton city and characterize by moderately saline area. It is protected with embankment and sluice gate of polder number 30. The village is connected with the city through roads and rivers and lesser vulnerable to strong wind and cyclone. On the other hand, Laxmikhola is 35 km from the city to the same direction which is under polder number 31 and highly saline area and more vulnerable to tropical cyclones and tidal surges. This village is dominated by single rice per year whereas the former village is largely characterize by two crops a year. Khulna district has a food deficit and is located in the south-west of the country, with a total land area of 3751.8 square kilometers. The maximum annual mean temperature of the district is 35.5°C and the minimum is 12.5°C. Mean annual rainfall is 1710 mm. This area is mainly characterized by tidal flooding of key agricultural areas in the wet season. The total population of the district is 2,559,910 of which 52% is male and 48% are female. The distribution of the farm families showed that on average more than 49% farmers are in the landless and marginal category. This number increases to about 79% including small farmers. Only 4% farmers are classified as 'large farmers'. The study area was selected to specifically represent communities affected by climate uncertainty, tropical cyclones and storm surges to different degrees. The communities were selected for the following reasons: firstly, they fall within the coastal saline area of Bangladesh where there are frequent shortages of food due to uncertainty of rainfall and lack of fresh irrigation water. Secondly, the area provides an opportunity to study impacts associated with climate change and vulnerability on crop and livestock; and thirdly they are already associated with existing climate change research projects and are familiar with the aims and philosophy of research.

2.2. Data Collection and Processing

Participatory tools and methods were used to capture the perceptions of the community on climate change, climate variability, and associated strategies to cope and adapt in the context of agriculture. Primary information was captured using focus group discussions (FGDs) with farmers, who were members of a local water users group. Each meeting was attended by about 30 participants, including one third females. All shared their views and experiences in an informal environment. General information was captured ensuring the participation of both male and female participants. The male and female participants were then divided into separate groups and data were captured using a checklist by the lead male researchers in the male group and female researchers for the female group.

During FGD, participatory tools were used for documenting local knowledge, technology and practices related to coping and adaptation strategies. Gender, age, social position and income of respondents were considered during the process. Captured data were validated through key informant interviews. Some probable simple adaptation options were presented by the researchers to the community for their opinion in the light of their knowledge and experiences. The proposed adaptations were selected based on the experiences of some farmers of south eastern part of Bangladesh, observing some innovative examples established by few innovative farmers which may be further improved. Some of the proposed options were common for both the villages and some were location specific. Among the proposed optins, relay cropping of cowpea and grass pea with transplanted Aman rice, some winter season crops like water melon and mask melon and okra have been adopted in the saline area of central south of Bangladesh. From the observation it was found that some farmers tried to grow winter season crop with the stored rain or fresh river water in the inner side of existing canal of rice-fish culture under gher were failed due to lacking of fer

irrigation at reproductive stage of crops. Therefore those option or with some modification were raised for their opinion for adoption. The participants analyzed the adaptation options in the light of their experiences and detailed discussions with the researchers group. The captured data were organized and presented according to desegregation of gender.

3. Results and Discussions

3.1. General Information

Composition of the farmers:

Ninety five percent of the inhabitants of the village Katianangla are locals and the rest are temporary migrants. Among the migrants, 2-3% are voluntary and rest of them had moved from extreme climatic hazard in their home areas. While in Laxmikhola, it was notable that this migration had not occurred as that was more climatically vulnerable area.

Farmers' category:

In both of the study villages, most of the participants were small to medium farmers. Only 5 to 10% belong to the large farmer category (Table 1). In Batiaghata, out of 10% of large farmers, 5% are landlords of whom 3% are absentee. The large and medium farmers are landowners. About 85% farmers belong to small and medium farmers. Among the small and landless farmers, 16 and 25% are owner cum tenant farmer and 5 and 10% tenant farmers were reported in Katianangla and Laxmikhola villages, respectively. A few farmers of both the villages have off-farm income.

Table 1. Farmers' category and their distribution in the study villages, 2011

Farmer's category	Katianangla, Batiaghata	Laxmikhola, Dacope
Large farmer (> 2 ha land)	10	5
Medium farmer (1-2 ha land)	50	25
Small (0.2-1.0 ha land)	35	60
Landless (homestead only)	5	10

3.2. Land Type and Their Uses

All the lands in the study area are inside the polder (embankment with sluice gate for drainage of tidal and rain water) number of 30 (Katianangla) and 31 (Laxmikhola). Farmers classified their land into three categories depending on inundation during wet season. The land types are highland, medium-highland and lowland and their corresponding inundation depths reported as 15-25 cm, 25-75 cm and more than 75 cm. Medium highland is the most dominant in the area followed by lowland (Table 2). The land types classified by the farmers differed from nationally fixed inundation depth. According to the Bangladesh Bureau of Statistics [21] all the lands of the study villages are under medium highland. The land which is normally inundated up to 90 cm depth during the rainy season for more than two weeks continuously is belong to medium highland [21]. The predominant land type of Batiaghata and Dacope are medium highland [22,23].

Table 2. Land type and their distribution at the study sites, 2011

Farmer's category	Katianangla, Batiaghata	Laxmikhola, Dacope
Highland	10	10
Medium highland	50	70
Low land	40	20

HL = 15-25 cm inundation, MHL = 25-75 cm inundation, LL = > 75 cm inundation

3.3. Crop Cultivation

The villagers of Katianangla considered their village as a medium saline area. They cultivate mostly two crops per year in a sequence. The most dominant cropping pattern is Sesame-Transplanted Aman (T. Aman) rice practiced in medium highland followed by Mungbean-T. Aman rice practiced in highland. On the other hand, single T. Aman rice only is practiced in Laxmikhola village due to salinity problems. The study villages are representative of the study upazilas in terms of major cropping sequences. T. Aman-Sesame and the single T. Aman are the major cropping sequences in Batiaghata whereas the later one is the most dominant in Dacope [24]. In the winter (rabi) season, land remains fallow due to lack of fresh irrigation water and higher soil salinity [23]. Lands remaining fallow after T. Aman rice are used for open grazing of cattle and goats. Farmers use the high yielding variety of rice in the high and medium-highland and local varieties in the lowland. The most dominant rice variety reported was BR23 with some recent adoption of BRRIdhan49 and BRRI dhan41. Local varieties of rice are cultivated on one fourth of the rice land. Farmers use the traditional varieties of sesame (T-6) and mungbean (Tilemug). DAE also reported BR23 and T-6 as the dominant T. Aman rice and sesame in the study upazilas (unpublished data).

3.4. Homestead

Each farm has on an average 80 m^2 area around the household. About 90% households have fruit trees and also cultivate vegetables in the different niches of homestead garden.

3.5. Fish Cultivation

About 60-80% farmers have pond of 100 to 200 m^2 size where mixed culture of fish with different carps species suitable for different depth of water in a pond is practiced. Again, 15% and 50% farmers have traditional rice-fish, in Laxmikhola and Katianangla, respectively. Poor people earn additional income from river fishing. The people of Laxmikhola have moved from brackish water aquaculture to fresh water aquaculture i.e. from shrimp to prawn and carp. About 30% of farmers are engaged both in crop production and fish culture.

3.6. Livestock

The majority of the farms have cattle and chickens. They fed their cattle with harvested straw in the wet season and by open grazing of the fields in the dry season.

3.7. Farmers' Perception on Climate Change

Perceptions on different events of climate change (with respect to gender) are presented in Table 3 and Table 4. From the results, farmers of the study villages are clearly aware of climatic variability. Farmers perceived that overall changes have occurred in rainfall patterns, temperatures, salinity of river water and frequency and intensity of cyclonic storms. Other researchers also found the household of rural Sahel aware of the same [25]. Fosu-Mensah et al. [26] also reported that 91% of interviewees perceived a long term change in temperature, most of them perceived an increase in temparature at Sekyedumase district in Ghana.

Table 3. Farmers' perception on climate change and their results, Kaqtianangla, Batiaghata

Climatic variability	Observations on changes		Results of climate change	
	Women	Men	Women	Men
Rainfall pattern and wet regime	Onset of monsoon delayed	Same as women	Delayed transplanting of Aman rice & decreased yield.	Forced to transplant late planted rice variety (photosensitive).
	Changes in rabi rainfall pattern	Same as women	Affect sesame harvest.	Drought causes yield reduction of sesame by 40%.
Temperature (hot and cold regime)	i) Extreme cold spell, fog increased during rabi season. ii) Dry periods are hotter.	i) Winter delayed. ii) Dry regime lengthened and summer temperature hotter.	i) Damage of flower of fruits like mango. ii) Declined crop performance (sesame, mungbean) yield.	Decreased sesame yield by 12% and mungbean failed due to poor emergence.
Salinity of river water (duration & salt period)	River water salinity lasts 2 months longer	River water salinity appears January now which was March 40 years back.	Availability of irrigation water for rabi crops decreased	Rabi crops affected and decreased yield.
Cyclone & storm	-	The peaks storm period has shifted later to the flowering stage of the T. Aman crop.	-	Delayed storm causes high sterility and lodging in T. Aman and thus affected yield.

Table 4. Farmers' perception on climate change and their results, Laxmikhola, Dacope

Climatic variability	Observations on changes		Results of climate change	
	Women	Men	Women	Men
Rainfall pattern and wet regime	Onset of monsoon delayed	i) Delayed onset of monsoon and unpredictability. ii) Reduced amount of rainfall both in wet and dry season.	Delayed transplanting of T. Aman rice, harvesting delayed and decreased yield.	Forced to transplant late planted rice variety, leading to reduced yields.
Temperature (hot and cold regime)	i) Increased fog during rabi season. ii) Dry periods are hotter.	i) Increased temperature throughout the year and hot period is longer. ii) Humidity less.	Reduced the clear sun shine hours which create problem for drying rice after harvest.	i) Insect infestation increased. ii) Growth period of crops is shortened and thus yield is decreased.
Salinity of river water (duration & salt period)	Increasing soil salinity through intrusion of river water with higher salinity by tidal surge.	River water salinity 2 months longer now. Previously it was up to May and now even up to July.	Intrusion of salt water reduced the grain yield of Aman rice and reduced the cropping intensity.	Drastic yield reduction in Aman rice. Rabi crops are not possible due to salt intrusion.
Cyclone & storm	Intensity and frequency increased.	Higher frequency and intensity of storms and cyclones. Tidal height is 30-120 cm higher now.	Losses of crop and livestock increased.	Delayed storm cause sterility in T. Aman rice due to lodging of rice.

Both men and women of the study villages perceived that rainfall patterns changed over the time both in wet and dry seasons. Onset of the monsoon has become delayed. The men of Laxmikhola reported that the total rainfall per annum has decreased. Other researchers reported that rainfall has become increasingly variable and has demonstrated an uneven distribution in the country [27]. The number of days without rain is increasing, although the total annual rainfall amount (mm) essentially remains the same. On the other hand, 81% of respondents reported a decrease in rainfall over the past 20 years in the Limpopo Basin of South Africa. Approximately 12% of farmers reported a change in the timing of rains and many of these respondents observed a delayed and shorter rainfall season [28]. Most of the farmers of Zambia felt that the rainy season started later and stopped earlier in the recent past as compared to a long time ago [29].

Men and women of Katianagla mentioned that dry periods had become lengthened and summer temperatures were hotter (Table 3 and Table 4). However, the men of Laxmiknola reported an increasing trend of temperature throughout the year. The perception of increasing summer temperatures is supported by the findings of [30].

River water salinity appears (reaches significantly high levels) in January instead of March. Thus the period of river water salinity has lengthened by two months over the last 15 years ago decreasing the availability of fresh irrigation water. The peak storm periods have shifted later compared to the past. Men and women responded in similar fashion which indicates the concern of women also for climate change.

Male respondents of Katinangla reported that stormy weather at the vegetative stage of T. Aman (September–October) was was positive as it reduced the insect population. But the peak storm period has shifted later to the flowering stage of the crop, causing sterility and is therefore negative. Again due to hotter temperature the insect infestations have become a greater problem. They also linked the variability of some components of the weather to others. For example, they mentioned that heavy

rain is linked to extreme cold and heat, cold winter (rabi) season results in less rain in pre-monsson (Kharif I) and monsoon (Kharif II) and heavy rain in Kharif I and Kharif II results in a warm rabi season. In addition, farmers of Laxmikhola added that there is no positive outlook or aspect about climate change rather all negative changes Detailed results of climate change and variability are described in Table 3 and Table 4.

3.8. Perception on Future Climatic Changes

Male farmers of Katianangla expected that the climatic variability may be further increased, with concurrent overall rainfall decreases. The river height is increasing due to siltation which if continued may increase the intrusion of salt water more to the crop land. The soil fertility is expected to further decrease. On the other hand, the male farmers of the high vulnerability area of Laxmikhola reported that the weather is unpredictable with probable increased temperatures. They expect that insect infestation in crops and rat damage may increase. New diseases and insect problems are coming and rice yield losses due to high-temperature sterility in the Boro (dry season) crops is expected to increase. River salinity may further increase due to reduced upstream flow resulting from decreased rainfall, however the main driver for reduced river flows may be due to increased irrigation pumping on the Ganges River in India, and hence be not directly related to CC. The female farmers did not feel they were able to predict future changes in climate. Under changing temperature and erratic rainfall patterns increasing incidences of disease and pests have been noticed in Nepal [31]. Bangladesh is predicted to experience an increase in average day temperatures of 1.0°C by 2030 and of 1.4°C by 2050 [5,32], which is expected to agravate the situation further. In relation to this, it is reported that the climatic variables, maximum and minimum temperatures are found to adversely affect both Boro and Aman rice yields [27].

Table 5. Desegregated experiences in changing crop cultivation and fish production to adapt in the changing climate, Katianangla and Laxmikhola villages, 2011

Village/Farmer category	Crop season	Experiences		
Katianangla				
Women		**> 5 years ago**	**Last 5 years**	**Present**
	Kharif II	Long duration local T. Aman	High yielding T. Aman variety, BR23	BR23 with declining yield, BRRI dhan49
	Rabi /Kharif I	Previously fallow then included jute, sesame	Dropped Jute, Included local mungbean	Continuing sesame and mungbean
Men		**40-50 years back**	**10 years back**	**Present**
	Kharif II	Long duration local T. Aman	BR23	BR23, BRRI dhan49
	Rabi/Kharif I	Previously fallow, then included sesame	Sesame, local mungbean (Tilemug)	Continuing sesame and mungbean
Laxmikhola				
Women		**Pre-shrimp (>25 years back)**	**Shrimp (3-25 years)**	**Post-shrimp (last 2 years)**
	Kharif II	Long duration local T. Aman	Local Aman with declining yield.	BR23 and local rice with improving yield.
	Rabi	Pulse, ridged gourd, water melon, musk melon	-	-
Men		**25-40 years ago**	**3-25 years ago**	**Present**
	Kharif II	Long duration local T. Aman	Integrated local Aman rice with low yield and shrimp.	i) Integrated T. Aman rice (BR23/local) with prawn, tilapia and carps
	Rabi	Fallow/pulses, water melon etc.	Shrimp only	Grazing cattle and trying salt tolerant crops.

3.9. Adaptation/Coping Mechanism: Farmer Experiences

Adaptation in agriculture is how perceptation of climate change is translated into the agricultural decision-making process [33]. Farmers have experienced that climate change and variability have directly affected the agriculture sector, especially crop, fish and livestock production. That situation led the people to adaptation strategies to mitigate the risk. Based on their experiences, knowledge and resources, they looked for adaptation strategies to cope with the changing climatic situation. It is also reported that these factors affect the choice of method for adaptation [34]. Adaptation options followed by the men and women in the study villages are detailed in Table 5. Female members of Laxmikhola village were able to mention adaptation scenarios in agriculture over a long period whereas it was for a shorter period in Katianagla village. The male participants of Katianangla village noted a 40% yield reduction of sesame over the past 40 years (Table 3). A notable yield reduction was also reported in mungbean. The changes in rainfall pattern and temperatures resulted in changes to emergence, germination and insect pests of crops. Besides the options mentioned above, the farmers have overcome the worsening situation by increasing river fishing, pulling rickshaws and vans, working as day labourers, taking loans from NGO/bank, small scale business with poultry and livestock, and engaging in handicrafts. Changes in temperatures and erratic rainfall patterns are affecting crop production in Nepal [35]. Among the farmers who did adapt, common responses included planting different crops, changing crop varities, changing planting dates, increasing irrigation, diversifying crops, changing the amount of land grazed or under cultivation, and supplementing livestock feed [28].

3.10. Future Adaptation Plan/Restriction and Concerns

The male participants of Katianangla village reported that the concept of pre-emptive adaptation is foreign to them. They don't plan so far ahead–they will wait till it

happens, and then they will adapt. They will look at regions further south which have already experienced the conditions and think about how they are farming. In contrast, the participants of southern part were interested for more tree plantations (quick-growing timber) as an adaptation option. The reason for the interest is that they hope the trees will modify the micro-climate and cause more rain. If they could stop the salinity increase, it would allow growing (on a small scale) of pumpkin and watermelon.

Women farmers reported that they can't sow sesame in early February due to high moisture in the soil particularly with the poor internal polder drainage system. They need new sesame cultivars tolerant to sudden stagnant water. Sesame gives better yield when sown in the medium highland, and poorest yield in the medium lowland. Women are more informed and passing their knowledge to their children (future generations) for adapting to changing situations. Both males and females are concerned for local control over drainage of tidal waters. Canals are blocked by bigger farmers for fish farming (reduction of drainage pathways). Polder maintenance is an issue, with some farmers expressing the concern that polders may collapse at any time.

3.11. Sources of Information on Climate Change and Seasonal Variability

The women's group responded that they are getting advice on seasonal variability and climate change from DAE (Directorate of Agricultural Extension) personnel at block and upazila level. They expressed a positive response to the DAE working in the villages commenting: "They give help to all farmers, not just the bigger landholders". They are aware that there is an Agricultural news and discussion in Bangladesh Television (BTV) at 7-8 am. This is one of the sources for that information. They also know that mobile phone service offering agricultural advice but they do not use this at present. They have received advice in training or trial site demonstrations by some projects. Men mentioned similar sources of information, but added others such as the WBD (Water Development Board), mass media (radio), NGOs, and relatives in other parts of the country.

Table 6. Responses of men and women against some proposed adaptation options, Katianangla, Batiaghata, Khulna

Proposed adaptation option	Response of women	Response of men
Replacing long duration T. Aman rice variety (BR23, 150 day) with short duration variety (125-130 day) for further intensification or reducing risk	i) Good for early harvest that may enable to avoid the risk of heavy rainfall for stormy weather during maturity of BR23 and may reduce the risk of damaging sesame for water logging with rain water. ii) Needs optimum rainfall to transplant short duration Aman rice by August 20.	Men responded as women but they emphasized on community approach for rat damage, proper drainage of rain or tidal water for easy harvest.
Relay cropping of cowpea and grass pea with T. Aman rice under single T. Aman cropping area	May be possible in medium highland.	The idea is good for medium highland but needs to be a community-based operation for protecting from open grazing.
Cultivation of direct dry seeded/dibbled or transplanted rice in Aus season	No response.	i) Can be tried in the medium highland after sesame or mungbean but needs short duration cultivars. iii) Aus rice depends on early Kharif 1 showers.
Deepening and broadening of inner side of existing canal of rice-fish culture under gher for storing more surface water for irrigation	No response.	i) May be 30-60 cm deeper is possible in existing canal of 120-150 cm width and about 60 cm deep. ii) If more, then need to increase the width of the canal but they expressed concern about taking up too much land.
Specially built ponds for irrigating the dry season crop	No response.	i) Ponds with an area of 80-100 m^2 at 180-210 cm depth may be possible to store fresh surface water for irrigating rabi crops but the farmers preference was for fish, not irrigation. .ii) Cost and area expansion is a concern to them.

Table 7. Responses of men and women against some proposed potential adaptation options, Laxmikhola, Dacope, Khulna

Proposed adaptation option	Response of women	Response of men
Crops and cropping sequence		
Relay cropping of cowpea and grass pea with T. Aman	No response.	The idea may be good for high land with medium salinity.
Cultivation of direct dry seeded/dibbled or transplanted rice in Aus season	No response.	i) In highland to medium highland may be possible but need short duration cultivars. ii) Aus crop depends on early Kharif 1 showers.
Deepening and broadening of inner side of existing canal of rice-fish culture under gher for storing more surface water for irrigation	No response.	i) Maybe broaden further 30 cm of existing canal of 120-150 cm width and about 90 cm deep. Water normally stored in the canal for 2 months may further extended one month by broadening of the existing canal. ii) They expressed concern about taking up too much land.
Specially built ponds in the crop field for irrigating rabi crops	Possible only for large farmer.	Ponds with an area of about 200 m^2 at 180-210 cm depth may be possible to store surface water for irrigation of rabi crops but needs initiative for demonstration.
Rabi cropping of watermelon, mask melon, okra and other vegetables	Only possible in the high land, plots with medium salinity.	i) Sesame and cowpea tried to grow with some assistance from projects but not successful due to salinity. ii) May be tried in medium soil salinity.

3.12. Response on Some Proposed Adaptation Options

Some probable adaptation options were proposed by the team of researchers to the farmers for their responses. Male farmers responded against all the options in both of the study villages. It was hard for the women to analyze their situation and provide their opinions of the proposed adaptation options. The desegregated captured responses are presented in Table 6 and Table 7.

4. Conclusions

Communities at a local level have been facing the adverse impacts of climate changes over the time and adapting with strategies as per their own traditional knowledge, skills and information. Considering the results discussed above, a few points are noted below for consideration.

- Men and women are mostly similar in how they perceive climate change and take part in local level adaptation process. Both groups should be considered for local level adaptation planning.
- The medium vulnerable area depends on the learning and adaptation processes of extreme vulnerable area (further south). Therefore, adaptation options need to be demonstrated in more climate vulnerable areas for wider dissemination.
- New crops, fish and agronomic practices suited for the changing climatic situation require investigation by researchers, followed by demonstration of the best options with community involvement to ensure the best possible community adoption.

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