Case study

A CASE STUDY ON EVALUATION OF SOCIO-ECONOMIC CONSEQUENCE OF CLIMATE CHANGE IN A PROJECT AREA IN BANGLADESH

UN ESTUDIO DE CASO SOBRE LA EVALUACIÓN DE LAS CONSECUENCIAS SOCIOECONÓMICAS DEL CAMBIO CLIMÁTICO EN UN ÁREA DE PROYECTO EN BANGLADESH

Abstract

There have been tremendous impacts of climate change on a rural areas in their socioeconomic in terms of environmental events. Even though the agriculture sector has been adversely affected and decreased productivity due to climate change. Moreover, rural development and conservation policies have been influenced by climate change likewise natural disasters, migration, poverty, diseases, and food security. Thus, adopt the impact of climate change, stakeholders and experts suggest and develop various practices and solutions. Additionally, they develop integrated problem-solving action and adaptation strategies for the long term which can be directly related to the climate problems. This study concentrates on the perspectives, experiences, and estimates of farmers and experts about climate change in rural areas. This research offers five viewpoints such as observable impact, hazard, the result of mitigation activities, methodologies, and predicted implications. According to the AEZ classification, the 36 districts and 87 Upazila from project areas were selected on the basis of the largest surface areas where tuber crops were cultivated, strong, and leading position in crop production. Moreover, according to the AEZ classification, 17 zones were selected where tuber crops were cultivated in the following 36 districts (AEZ). The study highlights the three main points: demographic information of the participants, overall information about climate change, and the planning for climate change to investigate the socioeconomic condition of the project area affected by climate change impact. Integrated planning, patterns for crop production, river management for water resources, and so on the need to develop the socioeconomic condition of the project area.

Comment [U1]: In the abstract you should include the most important results.

Key words: Climate Change, Socio-economic status, Action plan, Bangladesh

1. Introduction

It is unpredictable in recent human history that the climate is change and will continue into century at a rate which is highly uncertain the risks related to the climate change (Adger ~~WN,~~ 2003). Particularly for those areas of societies that are dependent on resources that are sensitive to changes in temperature, drought, societal sensitivity to the hazards connected with climate change may make already difficult social and economic issues much more difficult(Barua et al., 2017, 2020). Risks are evident in agriculture, fisheries, and

Comment [U2]: Remove

many other sectors that support rural communities' livelihoods in emerging nations (IPP, 2014).By increasing the country's vulnerability to climate change, climate change is predicted to make Bangladesh more vulnerable to natural disasters (Khan, et al.,2015). Thus, it is important to evaluation the socio-economic scenarios of the climate change impact for the long term and available options to response. Integrated viewpoints on mitigation, adaptation and resilience climate change remains vital for combat the problems in socio-economic status (Kriegler E.,et. Al., 2012). Moreover, food security, food shortage, and demand increase for food are arisen in affected areas of the impact of the climate change in agriculture sector and rural life (Dubbeling ~~M~~., 2011). The modern and progressive practice and solution in order to adaptation to the adverse impact of the climate change can mitigation (Klein ~~RJ,~~, et al., 2017). Moreover, policy and the implementation process implemented by comprehensive adaptation planning frameworks, policy engagement or forming as well as changing in institutional arrangement (Elijah ~~VT~~, Odiyo, 2019).For the combat the solution for the climate change impact, farmers tend to focus on short term process, while experts want long term sustainable policies.Adaptation techniques may be closely tied to the climate challenge if short-term remedies are included into long-term problem-solving tactics. This study concentrates on the perspectives, experiences, and estimates of farmers and experts about climate change in a rural setting.

Comment [U3]: Remove

1.1. Aim of the Study and Problems Questions

On the basis of environmentalview of the problems statements are, climate change has detrimental impact on soil, water resources and so on. Also, it poses a danger to socioeconomic issues like sickness, migration, and poverty. Education and technology, perception and experiences are all linked to these socioeconomic situations. The socioeconomic and environmental impacts of the climate change both progressively worsen. The goal of the investigation is to determine participants' perception on the effects of the climate change on local farming and rural areas in Project areas based on the personal experiences. Moreover, aims to look different farmers' and expert views and experiences of climate hazards, the result of mitigation activities, strategies, and predicted repercussions are. The purpose of this investigation is to minimized the gap by presenting the

perspectives, experiences, and predictions of the expert and farmers about the outcomes of the climate change. This research offers five viewpoints such as observable impact, hazard, the result of mitigation activities, methodologies, and predicted implications in the diverse rural area of farmers and experts on the basis of the weather conditions. In Bangladesh, farmers are intimately tied to the farming industries, and the change in weather seems to have an impact on crops dependent on the agriculture sector. Consequently, socioeconomic issues in the rural area might be brought on by climate change. However, institutional cooperation is also a topic of interest when it comes to agricultural policies. There are three theoriesunderline the investigation. The research initial premise state that the agricultural industries face socioeconomic risks, environmental risks based on climate change, and hazards. The second one is that as a result of forthcoming socioeconomic situations, farmers would experience unfavorable effects of the climate change. The social network and collaboration with all stakeholders are reinforced the mitigation of the negative impact of the climate change in rural area. According to the third point of the study, although professionals place more emphasis on planned adaptation on large scale than farmers' do on autonomous adaptation on small scale. Also planning discipline works on it. On the basis of the research the following problem questions are within the purview of the study; (i) What is the micro and macro socioeconomic hazards resulting from the climate change in the project areas? (ii). What are the effects do social networks and cooperation have on all stakeholders? (iii). What functions do plan at the micro and macro level serve?

2. Methodology of the Study

The intention of the study is to ascertain the climate change impact, finding the hazards may poses in the project areas, the mitigation outcome as well as techniques and perception and experience of the farmers' and agriculture experts. According to the AEZ classification(Appendix B), the 36 districts and 87 Upazila from project areas (Appendix A)were selected on the basis of the largest surface areas where tuber crops were cultivated, strong and leading position as crop production. Moreover, according to the AEZ classification, 17 zones were selected where tubers crops cultivated in following 36 districts (AEZ). However, the areas are also confronted of threads from drought, soil leaching, flood, and water scarcity due to climate change. Thus, the research works needed big data and empirical evidence. Data were collected by two steps: primary data was collected as

Comment [U4]: Final sentence of the introduction

Comment [U5]: You should clarify what the acronym means

structure questionnaires and misstructure questionnaires and secondary data was gathered from institutional and e-sources reports of both local and internationally. Additionally, information from official website of FAO and United Nation (UN) as international sources and locally from DAE, Bangladesh Ministry of Environment, Forest and Climate Change, Bangladesh Meteorological Department in Ministry of Defense of the Government of Bangladesh, Soil Research Development Institute, Ministry of Agriculture, Bangladesh Bureau of Statistics. Tables, graphs, statical data and mapping were represented for the resulting data as documentation.

The variable of the research regarding the climate change were examined by extreme or unexpected weather conditions. Also, secondary data was utilized in order to analyze the climate change situation. All represented 36 districts including 800 villages linked with 17 AEZs by using ArcMap-10software. The questionnaires were carried out according to the determining the study areas. There were eight variable such as land categorized by AEZs, whether farming, good agricultural practices, livelihood of production, the amount of wetland, average of the own land for cultivation, cooperative and organic agricultural practices. 800 villages in 36 districts in project areas were reviewed and ranked 4 and above.

Table 1: Variable according to the criteria

Rural areas	Criteria	Subjects
Variable 1	50%	land categorized by AEZs
Variable 2	2 points	wetland
Variable 3	2 points	average of the own land
Variable 4	75%	cooperative
Variable 5	16-20%	good agricultural practices
Variable 6	50%	Organizational advice
Variable 7	25-50%	Certified organic agriculture
Variable 8	3 points	Livelihood crop production

Observing the selected areas map and according to the 8 criteria the districts were categorized in 8 based on geographical similarity and zone site and size. The case study evaluation participants' perceptions and experiences about the adaptation strategies which was heterogenous or not source of primary data. Consequently, there were five group were

determined. The semi-structured questionnaires were arranged from November, 2021 to April, 2022. Simultaneously, climate experts' perception and experiences, structural questionnaires were conducted for the farmers. The questionnaires consisted three parts as community information, general information about climate change linked with agriculture and the relationship between climate change and organizational planning. The case study was evaluated using the data from random sample 160 farmers and 40 experts.First step, 160 structured questionnaires evaluated by filling the information from farmers from the 36 districts (Appendix A).After that, semi-structured questions were collected the information from the 40 experts (Appendix C-D). The experts included from public organization, Research Institute, local government and village leaders in terms of agricultural practices. All questionnaires carried out face-to-face interviews from five groups of geographical areas in project area. Table 2 shown the number of participants from 5 groups of area:

Table 2. Selection of Participant (Farmers and Experts)

AEZ Group	Districts (36)	No of Farmers	No of Experts	Total
Zone 1, 3, 4, 7,8	17 Upazila	32	8	40
Zone 9, 15, 16, 17	15 Upazila	28	7	35
Zone 19, 22, 23	19 Upazila	34	8	42
Zone 25, 26	17 Upazila	36	10	46
Zone 27, 28,29	19 Upazila	30	7	37

3-point Likert type scale were included in questionnaires and open-ended questions were designed for data collection. These data were recorded on SPSS (Statistical Package for Social Science) software package (IBM SPSS Statistics 24.0) and '*analyze/descriptive statistics* 'were used to describe the data. All the findings were visualized via Microsoft Excel Worksheet 2010.

3. Data analysis

According to the AEZ (Appendix B) most of the project area are medium to high level of fertility. However, most of Barisal, Jhalkati, Pirojpur, Patuakhali, Bagerhat, Barhuna, Khulnaand Satkhira, Sunamganj, Habiganj, Kishoreganj and Brahmanbaria have high level of fertility due to the high organic matters. Though, paddy is the common crops in most of the AEZ area (Haider H, et. Al., 2022) with jute, pulse, wheat, vegetable, tuber crops are not grown everywhere. About 54 million tons of rice produce in 2019 which was

ranked as 4th largest producer country (IRRI, 2019). The project areas (Appendix A)have different kinds of climate diversity and geographical perspectives. Few districts are in hilly area, few are near to the sea level, few are plain land and near the river basin. But southwest districts in Bangladesh are expected and more prone to climate change effects Flood, drought, cyclone are common in Bangladesh which can cause extensive damage of the agriculture and insecure for food security, health hazard, socioeconomic loss and so on (Mirza.,et. Al., 2011).About 42 Upazillas' in 8 coastal districts were affected by pre-monsoon type cyclone Mahasen where 14,828 house were damage (Disaster Report 2013-Bangladesh, 2014). The tropical cyclone of Ayla occurred in During May 22, 2009 in southwest monsoonareas of Bangladesh and lost economically 89.46 billion taka (US$1 billion) (Ali Asif Shawson (May 20, 2020). On the other hands, extreme stormcyclone sidr in 2007 whichcausing large scale evacuation (Peter Foster (November 18, 2007).Progressive development of the climate change impact damage the agriculture mainly which is result of 16% agriculture GDP (Jasna, 2014). Thus, it is solely necessary adaptive strategies apply in irrigation system, crop diversity and harvest time change due to the adverse impact of the climate change.

This study is based onfarmers' and experts' responses to the impacts of climate change.Thedatasetcontains 160 farmers' and 40 experts' observations in thirty-six districts in project areas by using SPSS software package (IBM SPSS Statistics 24.0) which were findings werevisualized via Microsoft Excel Worksheet 2016. The following Fig 1.2 shown the survey consisted three main point: demographic information of the participants, overall information about climate change, and the planning for climate change.

Framework of Questionnaires

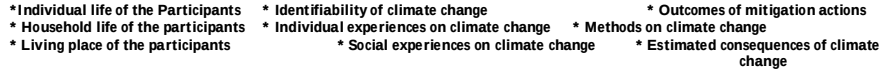

Figure .1.1. The Framework of questionnaires.

3.1 *Participants information about Demographic*

It can be stated that about more than half of participants were male, while about more than quarter were female participants for both farmers and experts. According to the result of the data 70% and 80% were male and 30% and 20% female for farmers and experts respectively attending the research.

Figure. 1.2. The rate of the gender of the attendant participants.

Comment [U6]: Delete figure, repeat text information

The base role of the participants in this research was educational background of the participants. The finding displayed that there were majority farmers completed their primary school. About 72% primary, 1% farmers were doing Masters. On the other hand, more than half of the experts (70%) were Bachelor's, 25% high school and 1% were primary educated experts. This result stated that the education level was different between farmers and experts. Consequently, more farmers used to traditional methods, especially for adaptation strategies. But educated person can understand the climate change problems and to help to increase the crop production.

Figure.1.3. Educational Background of the farmers and experts

Comment [U7]: Delete figure, repeat text information

There were five categories household size where 75% of the farmers shown 3-4household size. Additionally, while 21% of them had a household size 5-6 persons and 1-2 person had in 7% of farmers household. The household size categorized as medium, large or small. In the figure of 1.4.b represented that farm size ranged from <50 to 200> acr. Although 12.6 % of them had more than 200 acr farm areas. The size ofthe farms as small, medium or large. However, the farm size differs for each village due to thegeographical reason.

Figure. 1.4**.** The number of people in household (a) and the size of farm areas(b) for the farmers.

Comment [U8]: Delete figure, repeat text information

According to the result (Figure 1.5) demonstrated that largest proportion, 90% farmer willing to stay their present residence and the largest number of experts also willingness to continue to living their present place. However, the production of the crops hampered in that place, but they still love to live their village. As a result, it can be said that farmers did not migrant. Thus, theresults are crucial in order to sustain mitigation and adaptation of climate change.Moreover, while the participants, who wanted to migrate to urban areas, underlinedeconomic concerns due to lack of monetary acquisitions, the experts highlightedinsufficient social activities. The results are directly related to socio-spatial planningbased on social and economic balance.

Figure. 1.5. The willingness to continue living in their place of residence of the participants.

Comment [U9]: Delete figure, repeat text information

According the figure of 1.6.a. it stated that the rate of ownership (58%) was higher than the rate of tenancy (16%) which was define by the proximity between residential and agricultural lands in case of farmers and as figure 1.6.b. theproximity between residential and agricultural lands wasdefined by farmers' perceptions in Figure 1.6.a. While 45% of the farmers statedclose proximity, 28% of them perceived it as middle proximity in Figure 1.6b. Thefindings supported some rural planning studies in terms of several perspectives suchas transportation, sustainability of agricultural areas, and food security on macroeconomic conditions. According to the results, even thoughapproximately 58% of thefarmers had close and middle proximity from their residential areas to agriculturalareas, it was remarkable that the rate of vehicle use is high in/ outside of villages. On theother hand, the ownership is a significant determinant of adaptation and mitigationactions due to the sense of belonging. There is an inverse proportion betweenbelonging and migration. Thus, the results should be considered as a remarkableadvantage at macro economy in terms of food security and agricultural sustainability.

Figure 1.6.The ownership status (a) and the proximity between residential and agricultural lands (b)for farmers.

Comment [U10]: Delete figure, repeat text information

3.2. General Information about Climate Change of the Participants

In this section consisted that the general information of participant's perception of climate change, observation, methods and risks. These results were connected with the adaptation of alleged climate change which was calculated by statistical methods. The participants observations were investigated where they mentioned that climate change is extreme. The research also evaluation the participants understanding about the environment, social, economic and political context as long or short duration.

It is important to understand the perceptions of the participants about the climate change as a fundamental to adapt to climate adverse impacts. It is observed from the finding of the research that, perceptions were highly influenced by the communication systems. According to the figure 2.1, the 43% farmers focus on global warming, where 22% on unexpected change in weather, 20% depletion. On the other hands the experts expressed that 53% global warming, 32% and 28% emphasized on greenhouse and CO_2 emission. The result specified that the participant rely on traditional past process and information. The scholar think that temperature and rainfall pattern affected the growth and production of the crops more than the mention events in result.

Figure.2.1. General perception of the climate change by the participants

Comment [U11]: Delete figure, repeat text information

Regarding the importance of farmers' and experts' perceptions, the components of the climate change were categorized into five groups: the existing reasons of climate

change, the future impacts of climate change, climate change adaptation process, action plans and intervention tools or methods and nothing. According to the graph (Figure.2.2) farmers expressed that “nothing” (50%) where (60%) experts thought that ‘the existing reason of climate change. So, it can be said that most participant do not know about adaptation, action plan and intervention methods of the climate change.

Thus, it is stated that the information was inadequate in order to take action on climate change. Therefore, there were inconsistency between participant’s perception and the process of the climate change. So, it suggested that education, planning is essential in order to combat the negative consequences of the climate change.

Figure.2.2.The key component of the climate change process by farmers(a) and experts(b).

Sufficient water in time and knowledge about the climate change is important in agricultural sector. According to the figure 2.3. the farmers shown 42% medium level and 55% was high level of climate change while, experts expressed that (55%) more than half experts in medium and 41% was high level. As farmers emphasized as high and medium of climate change means that severity drought and water depletion were utmost imperative problem in project area. Summarized the point that public support, awareness and collaboration with all stakeholders combat the problems in project area.

Figure.2.3. The level of climate change for a. Farmers; b. Experts

Comment [U12]: Delete figure, repeat text information

The results proceeded (Figure.2.4.) with an analysis of participants' observations about climate change. The observations of farmers on climate change were in line with the climatic variables. About 32% farmers said that unexpected change in weather, majority (61%) said that increased the annual temperature. Contrary, 43% experts observed season shift, 40% of the experts emphasized on increased the annual temperature. It is evidenced that temperatures increase in the globe, however, the seasonal shift and unexpected change weatherwere defined under 'other' option, and there was adifferentiation between farmers'and experts' views was linked with environmental, socioeconomic perspectives likewise drought, water depletion, and decrease the crops production. Consequently, both participants shown their individual and social experiences to reduce the impact of the climate change.

Figure.2.4. The observed of the climate change of farmers and experts

It is established by scientists by their research that human impacts on climate change conditions have been vital in recent age. As observed in the figure .2.5. 65% of the farmers said to high level of human impacts, while, 93% of the experts referred to high level of human impact on climate change. It is obvious that human mostly linked with climate change related events.

Figure.2.5. The level of human impact for a. farmers, b. Experts.

Comment [U13]: Delete figure, repeat text information

As observed in figure 2.6 the farmers and experts emphasized that human has impact on climate change which were differed from each other as per the open questionnaires. Though more than quarter (21.5%) the farmers were marked on uses of water, 25.1% experts emphasized on unawareness and inadequate reforestation-destroying nature, accordingly. Unnecessary usage of water stated the vital problem in environmental and

socio-ecology. Moreover, 9.8% for farmers and 7.2% of the experts mentioned the urbanization-population growth. Similarly, the data represented that, 8.4% farmers said that extreme electricity used and machineries while 18% of the expert expressed same statistics. The human impacts had the most negativeinfluence on adaptation and mitigation decisions against climate change. All theseimpacts might bring about adverse environmental and socio-economic consequencessuch as drought, decreased income, decreased crop yields; thus, an integrated planningfocuses on all of these variables.

Figure.2.6. The level of human impact on climate change for a. farmers; b. Experts.

Comment [U14]: Delete figure, repeat text information

Concern level of participant and the climate change has intimate connection demonstrated in the findings 3.2.7. Although, 55% of farmers said that they were concerned it highly but it was too late for everything, 32% was concerned but said it needed to developed. Similarly, 50% of expert concerned but said it can be developed and 20% of experts said that “I am concern, but next generation could be improved it”. It is clearly stated that farmers were concerned about the future generation since going to face the economic suffering. Contrary, experts suggested for new methods and solution to combat the negative concern of the climate change. According to the statistics, increasein awareness and education may be more affective in order to deal with their concerns.

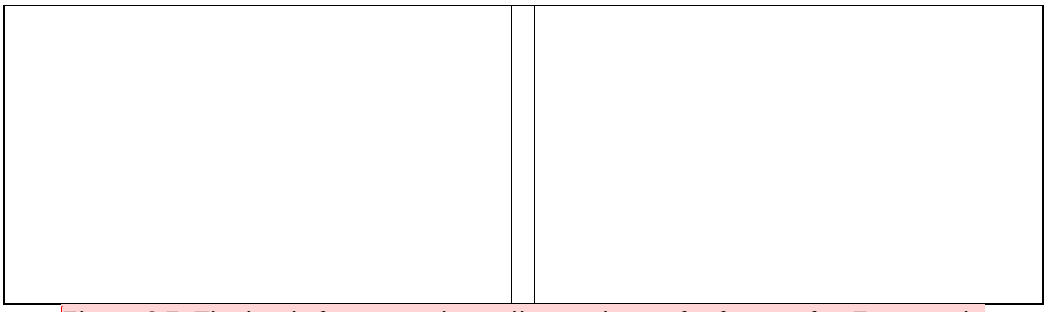

Figure.2.7. The level of concern about climate change for future of a. Farmers; b. Experts

Comment [U15]: Delete figure, repeat text information

As observed the figure 2.7., 54%, 50% and 47% were for annual reports and informative programs, increasing cooperation among institutions, and developing the modern irrigation systems shown respectively mentioned by farmers. They also expressed that 12% reforestation, 9% education, 7% product pattern systems were mentioned by farmers. According to the report, the policy support is compulsory in order to reduce the adverse effects of the climate change.

Figure. 2.8. The social efforts that can reduce the impact of climate change for farmers.

Comment [U16]: Delete figure, repeat text information

A loss in crop diversity, a fall in crop yields, product pattern alterations, economic harm, and drought were among the significant outcomes (Figure 2.9). According to the comments, almost 37% of the experts claimed that agricultural yield had decreased. In addition, 30% of the experts predicted that project's area agricultural fields will suffer increased economic damage. Another forecast made by 8% of the experts is drought. There was general agreement that as unfavorable effects of climate change on

agricultural areas rise, economic circumstances will suffer as a result of climate change and these issues might be seen as relating to food security.

Figure.2.9. The estimated result of climate change on agriculture for experts

Comment [U17]: Delete figure, repeat text information

In addition to this, over half of the experts (66%) said that raising awareness and promoting education are essential steps in reducing the negative effects of climate change on agricultural areas. In addition to this, over half of the experts (66%) said that raising awareness and promoting education are necessary aspects in reducing the negative effects of climate change on agricultural areas. The specialists next concentrated on afforestation (17.9%), administrative interactions (3%), irrigation, and excessive water-using plants (13%), in that order. Given these reactions, environmental initiatives are essential for lowering climate change-related incidents. This study demonstrated the effectiveness of expert-recommended progressive strategies for raising participants' awareness. In addition, 13% of respondents underlined the value of contemporary irrigation systems, while 5% of respondents cited the significance of administrative interactions.

Figure. 2.10. The methods applied to increase awareness for the experts

Comment [U18]: Delete figure, repeat text information

The strategies recommended by the experts produced statistically favorable results for socio-spatial planning. For instance, families might use less subterranean water if they were more aware of climate change-related occurrences. Additionally, these techniques might aid in reducing and adapting to the consequences of climate change on agricultural land, which would reinforce the favorable effects on food security. An integrated strategy might strengthen both awareness and education.

The results of the study's participant perspectives revealed that 50% of farmers and experts thought project area's resilience level was insufficient to deal with the detrimental effects of climate change (Figure 2.11). The majority of participants indicated in their replies that the negative effects of climate change will worsen in the future. Awareness among participants might be raised by a variety of communication techniques to assist deal with these negative effects. According to the findings, of the farmers, 72.2%, 37.5%, and 19.4% learnt about climate change through media (TV/radio), social media/the internet, and neighbors/family.

Figure. 2.11. The level of resilience to climate change for farmers and experts.

The findings (Figure. 2.12) showed that farmers (88.9%) and experts (75%) had a strong belief in the financial threats posed by climate change. According to the comments, farmers were more concerned than specialists. Weather has a direct impact on crop quality and yields, therefore these changes in agriculture might have an impact on farmers' incomes. The majority of interviewees were worried about their fundamental living situations.

Figure. 2.12. The economic risks of climate change for farmers and experts.

The findings (Figure 2.13) showed what would happen to study area
's food production and marketing if mitigation and adaptation measures were not taken on agricultural areas. While 29.2% of farmers emphasized the serious effects of climate change, 42.9% of the experts claimed that project area had a comparable degree. According to the comments, the unavoidable effects of climate change may have an impact on food production and marketing. The participants, however, did not focus on a

single response. The effects of climate change on food production and marketing were thus not well understood in study area.

Figure. 2.13. The impact of climate change on food production and marketing for the farmers and experts.

3.3. The relation between Climate Change and Planning

The questionnaire developed on evaluations of mitigation actions ensure to the agriculture sector where it represented by low, medium and high (Figure 3.1). According to the figure 3.1. farmers emphasized 45% urban sprawl, 45% migration and 22% food dependency, whereas experts 53$29% and 45% respective events. Not only experts but also farmers emphasized that actions were not only connected with impact of climate change. Contrary, they were alleged that were affected by environmental, social, economic and political conditions affected the actions.Moreover, farmers mentioned that 45% reduce poverty, 63% reduce drought, and 69% reduce efficiency product which reflected the environmental and socio-economic condition of the project area. Analyzing the finding, it can be said that, farmers emphasized socio-economic acquisition with migration actions while experts stressed on adaptation process research actions of the climate change terms of the environment background.

Figure. 3.1. The outcome of the mitigation actions for Farmers and experts.

Adaptation of climate change were categorized by tree resulted from the farmers' practices the techniques in agriculture field in various districts to adjust to climate change according to the AEZ. The finding shown that farmers mentioned land consolidation 44.5%, 41% organic farming, 43.1% improved machineries and public transport system which were lower impact. Likewise, 35% Improved machineries and public transport system and 22% land consolidationranked low by the experts. Good Agriculture Practices (60%) as high impact level shown by the farmers whereas, experts focus on highly (74%)Good Agriculture Practices, (60%)Organic farming, 60% decrease waste generation and (60%) having information for planning. These findings showed a significant correlation between farmers' practices and socioeconomic factors like education, as well as a link between environmental and policy factors and agricultural practices. As a result, there exist connections between the recommendations made by the participants, and the development process for adaptation planning should systematize these techniques.

Figure. 3.2. The methods of the climate change for farmers and experts.

4. Conclusion

The purpose of the study is to investigate how climate change would affect the project areas, as well as the risks may present, the outcome of the mitigation activities and anticipated effects in contrast to farmers" and experts' perspectives and experiences. In concern of the demographic aspect, the result shown that male participants of both framers' and experts were common. In this research, most of the farmers had primary level education while experts had bachelor's level. It can be said that lack of proper information can affect adaptation and mitigation action in the study areas. Also, it is assured that due to the poor education level hampered to gather knowledge and awareness about the climate change affects, mitigation and adaptation strategies. Moreover, the house hold size was 3-4 people for about half of the farmers in the research areas where there was no balance tern of their land size, however, most of the farmers had own property. As per family tradition of the farming, most of the farmers want to continue living in their place as well experts also want to live here. Similarly, there were a strong linkage between farmers to continue living their place and sense of belonging. That point has arisen a positive influence for planning organization or institute to make a long terms project in order to agricultural sustainability. Thus, it would be a significant term in order to strengthen adaptation and mitigation actions.

Comment [U19]: Result paragraph, not conclusion

According to the farmers and experts "global warming" was the leading concept of the climate change. Most of the expert had knowledge about existing reasons of the climate change, while the majority farmers had no idea about the climate change cause, its impact

in their crops. Certainly, it is true that both participants had no actual knowledge about adaptation, mitigation process and action plan. In this circumstance, bring result in serious hindrances for adaptation and mitigation process.But they observed the changes happened in their areas like temperature increase, duration long for raining, seasonal shifting which is noteworthy issue to increase their activities regarding the climate change impact.

Comment [U20]: Result paragraph, not conclusion

It is stated that, the expert impressions were higher than the farmers' overviews about the human impacts on climate change. Farmers' experiences stressed the usage of water, inadequatereforestation and destroying nature; furthermore, experts' experiences highlightedinadequate reforestation and destroying nature, unawareness, and the extreme usageof electricity and vehicles. So, it is obvious to said that the concept or viewpoints about the climate change were differed between farmers and experts. Analyzed the data, it is observed that, about 30% of farmers had significant knowledge about the climate change, while, 70% of the experts had It meant that farmers were more pessimistic about the climate change and less concern due to the proper information.To minimized the negative impact of climate change, it is recommended that educational program, training, workshops, strong administrative and integrated planning are the fundamental issues to cope the issues.Main risk issues in agriculture were water depletion and desertification mentioned by both farmers and experts for the research areas. Thus, it is certainly important to determine of protected areas and an integrated planning system and policy strategies need strengthening. Both participants underline the common philosophies such as pattern of planning and organizational collaboration to deal with climate change impact which is related to political issues and environmental issues. They also improved numerous applications related to the climate change. The study resulted those farmers experienced mostly focus on irrigation system change, involvement of expert to demonstrate technologies and experts' suggestion was also change of the pattern of planning, institutional involvement, irrigation system change, good agriculture practices, irrigation system development.So, this finding concluded that both participants had synchronization. This circumstance provides positive benefits to mitigation and adaptation to climate change.On the other hands the strong institutional and among all stakeholders' farmers and expert network improve in the study areas by public support and awareness. In other words, increased strong networks among stakeholders are facilitated by public backing. Farmers emphasized annual reports and educational programs, as well as institutional collaboration, in accordance with social standards, whereas specialists emphasized an

improvement in educational and awareness initiatives, as well as administrative cooperation. So, in order to combat climate change, both farmers and scientists emphasize two key ideas: administration cooperation and education and awareness efforts. These ideas have implications for socioeconomic and political issues from a planning perspective. Majority expressed that they were poor in resilient to climate change. Despite the fact that they both find out that climate change posed an economic danger, however, there were no agreement for crop production and supply chain or marketing. Farmers mentioned that it is crucial to having market places, other social and cultural amenities in their area. As a result, for the sustainable agriculture needs to protect the climate change risk which is the most viable issue for the sector. Farmers use agriculture machineries in their field which may cause pollution and they have no idea the linkage of the machineries uses to the climate change.

Seasonal shift, rapid weather change, the alteration of product patterns, product pattern planning, and crop diversification are a few of the key problems with climate change. Farmers and experts rely on public institutions and organizations as the top administrative priority when discussing institutional collaborations to lessen the effects of climate change. Additionally, farmers emphasized the value of universities, experts stating that co-organization for all stakeholders. Thus, the significance of public backing was once again emphasized. Farmers highlighted socioeconomic and environmental challenges when questioned about mitigation and adaptation measures. The majority of farmers place little emphasis on disaster risk reduction. Because of this, it might be assumed that farmers tend to see the effects of their activities firsthand. programs and administrative cooperation, it might be said.

In the issue between climate change and planning, they have suggested that the mitigation improved by improve the planning, decisionmakers views, production will also increase. Therefore, despite the fact that the climate change mitigation dealings assist rural economies and they also account the urbanization in various aspect of climate change. Farmers admitted that they need extensive knowledge of the crops cultivation during the adverse impact of climate change, whereas specialist emphasized to effective agriculture operation and agriculture good practice (GAP) at high level. Other side there were less noticeable effects of different agriculture methods on climate change and adaptation strategies where agriculture methods should be improved in light of regional dynamics.

Moreover, farmers strongly emphasized on production pattern planning in consideration of the projection consequences of climate change, while the experts draw attention on potential water resources in near future. Both of farmers and experts stressed on to improve the fertile level of the agriculture land in present which may offered to development in near future. In case of mitigation approaches, farmers and experts given similar statement that, there are various factors that intimately related to the urbanization and that effects of climate change on urban extension were negligible. Plans for river basin management, on the other hand, are crucial for safeguarding water supplies. Along with these plans, the estimations and determination of farmers' socioeconomic conditions may present a chance for integrated planning.It is recommendation for further research that include more research area in Bangladesh. Also giving more emphasize on planning, environmental cropping pattern by examine in details. Last but not least, planning related policy regarding the climate change will be developed by analyzing the farmers', all stakeholders interlink with experts and administration.

References

1. Hasanuzzaman, M., Agroecological Zones. https://hasanuzzaman.weebly.com/uploads/9/3/4/0/934025/agroecological_zones_aez.pdf. Assessed on 07.08.2022.
2. Agro-Ecological Zones_AEZs Maps. bamis.gov.bd was first indexed by Google in April 2019. https://www.bamis.gov.bd/en/page/aezs-maps/.
3. Bangladesh Bureau of Statistics. (2018). Statistical Pocket Book 2018. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
4. Barua, P., Rahman, S.H. and Molla, M.H. "Sustainable adaptation for resolving climate displacement issues of south eastern Islands in Bangladesh", International Journal of Climate Change Strategies and Management. 2017: Vol. 15 No. 2, pp. 60-80.,2020.
5. MoA. (2019). Annual report 2018-2019. Ministry of Agriculture (MoA), Government of the People's Republic of Bangladesh, October 2019, Dhaka, Bangladesh.
6. Rahaman, M.S., Haque, S., Sarkar, M.A.R., Rahman, M.C., Reza, M.S., Islam, M.A., Siddique, M.A.B. (2021). A cost efficiency analysis of boro rice production in Dinajpur district of Bangladesh. Fundamental and Applied Agriculture, 6(1), 67-77. Doi: https://doi.org/10.5455/faa.137178.
7. Haider H, Ritu TI, Al Zubaer MA, Alam M, Islam MH, Rahman A. Journal of Bangladesh Agricultural University. J Bangladesh Agril Univ. 2022;20(2):211-6.
8. IPCC (Intergovernmental Panel on Climate Change). *Impacts, adaptation, and vulnerability.* Fifth Assessment Report. 2014: Cambridge, UK: Cambridge University
   Press.
9. IRRI. 2019. Country brochure, International Rice Research Institute, Philippines. http://books.irri.org/Bangladesh_IRRI_brochure.pdf. (Accessed: 15 April 2022).
10. Shelley IJ, Takahashi-Nosaka M, Kano-Nakata M, Haque MS, Inukai Y. Rice cultivation in Bangladesh: present scenario, problems, and prospects. Journal of International Cooperation for Agricultural Development. 2016;14:20-9.
11. Mirza M. Climate change, flooding in South Asia and implications. Regional environmental change. 2011 Mar;11(1):95-107.
12. Disaster Report 2013-Bangladesh, https://reliefweb.int/report/bangladesh/disaster-report-201331 Oct 2014 (Accessed on 1 July 2022).
13. Khan MT, Khalily MB, Scheyvens H. Loss and damage, caused by cyclones Sidr, Aila and Mahasen: Coping strategies, adaptation and the role of microfinance. Institute for Global Environmental Strategies.; 2015 Dec.

14. Jasna VK, Som S, Burman RR, Padaria RN, Sharma JP. Socio economic impact of climate resilient technologies. International Journal of Agriculture and Food Science Technology. 2014;5(3):185-90.
15. Adger WN, Huq S, Brown K, Conway D, Hulme M. Adaptation to climate change in the developing world. Progress in development studies. 2003 Jul;3(3):179-95.
16. Kriegler E, O'Neill BC, Hallegatte S, Kram T, Lempert RJ, Moss RH, Wilbanks T. The need for and use of socio-economic scenarios for climate change analysis: a new approach based on shared socio-economic pathways. Global Environmental Change. 2012 Oct 1;22(4):807-22.
17. Dubbeling M, Zeeuw HD. Urban agriculture and climate change adaptation: ensuring food security through adaptation. InResilient cities 2011 (pp. 441-449). Springer, Dordrecht.
18. Klein RJ, Adams KM, Dzebo A, Davis M, Siebert CK. Advancing climate adaptation practices and solutions: emerging research priorities. Stockholm Environment Institute.; 2017 May 22.
19. Elijah VT, Odiyo JO. Perception of environmental spillovers across scale in climate change adaptation planning: The case of small-scale farmers' irrigation strategies, Kenya. Climate. 2019 Dec 26;8(1):3. https://hasanuzzaman.weebly.com/uploads/9/3/4/0/934025/agroecological_zones_aez.pdf.
20. Peter Foster (November 18, 2007). "Bangladesh cyclone death toll hits 15,000". The Telegraph. Retrieved May 5, 2019.
21. Ali Asif Shawson (May 20, 2020). "Cyclone Amphan: Bangladesh may face losses worth Tk12,744cr". *Dhaka Tribune*. Archived from the original on May 27, 2020. Retrieved May 20, 2020.

APPENDIXS

Appendix A. Research area (Project area):

Name of the region	Name of the district	Name of the Upazila	Name of the region	Name of the district	Name of the Upazila
Dhaka	**1. Manikganj**	Singair	Dinajpur	**21.Dinajpur**	Birganj
	2. Munshiganj	Srinagar			Parbatipur
	3.Narsingdi	Belabo			Butler
	4.Kishoreganj	Hossainpur		**22.Thakurgaon**	Pirganj
		Pakundiya			Ranisangkail
		Culiarchar		**23.Panchagarh**	Debiganj
Faridpur	**5.Faridpur**	Charabhadrasana			Dumar
	6.Madaripur	Sadar	Mymensingh	24.**Mymensingh**	Sadar
		Kalkini			Gafargaon
Jessore	**7.Jessore**	Sadar			Gauripur
		Monirampur			Trishal
		Chougachha			Phulbaria
		Abhaynagar			Ishwarganj
	8.Narail	Sadar		**25.Netrokona**	Purbadhala
		Lohagarh		**26.Jamalpur**	Madarganj
	9.Magura	Sadar			Islampur
		Sreepur	Rajshahi	**27.Rajshahi**	Bagha
	10.Jhenaidah	Sadar			Mohanpur
		Kaliganj		**28.Natore**	Lalpur
		Shailkupa			Baraigram
	11.Chuadanga	Sadar		**29.Chapainawabganj**	Shibganj
		Alamdanga		**30.Naogaon**	Mahadevpur
	12.Meherpur	Sadar			Raninagar
		Mujibnagar			Manda
Rangpur		Sweet pond			Badalgachi
	13.Rangpur	Pirganj	Bogra	**31.Joypurhat**	Sadar
		Pirgachha			Panchbibi
		Gangachara		**32.Pabna**	Aestragram
	14.Gaibandha	Fulbaria			Chatmohar
		Saghata			Ishwardi
		Gobindganj		**33.Sirajganj**	Shahjadpur
	15.Kurigram	Ulipur			Kazipur
		Phulbari			Ullapara

	16.Lalmonirhat	Hatibandha		**34.Bogra**	Shajahanpur
		Aditmari			Sherpur
	17.Feni	Sonagazi			Sonatala
Rangpur	**18.Nilphamari**	Syedpur			Sariakandi
		Dimla	Comilla	**35.Comilla**	Titus
		Domar			Baruda
Sylhet	**19.Habiganj**	Nabiganj			Chandina
		Baniachang		**36.B , Baria**	Nabinagar
		Madhabpur			Banjarampur
Chittagong	**20.Chittagong**	Boalkhali			
		Patiya			

Appendix: B. AEZ (Agroecological Zone) in Bangladesh where Potato cultivation						
Name of the AEZs	**Location**	**Extent**	**Land type**	**Organic matter content**	**Fertility level**	**Suitable crops**
1. Old Himalayan Piedmont Plain	Most of Panchagarh and Thakurgaon districts and north-western parts of Dinajpur districts	4008 km^2	*High:* 58% *Medium high*: 34% *Others*: 8%	Low	Low to medium	**Kharif:** B. Aus, T. Aman, Jute, Summer vegetables, Summer pulse, Sesame **Rabi:** Pulses, Potato, Vegetables, Wheat, Mustard
3. Tista Meander Floodplain	Most of greater Rangpur, eastern part of Panchagarh and Dinajpur; northern Bogra and part of Jaipurhat, Noagaon and Rajshahi districts.	9468 km^2	*High*: 35% *Medium high*: 51% *Others*: 14%	Medium	Medium	**Kharif:** B. Aus, T. Aus, Jute, T. Aman, GM, Kaon **Rabi:** Wheat, Sugarcane, Potato, Mustard, Blackgram, Tobacco
4. Karatoya-Bangali Floodplain	Eastern half of Bogra district and most of Sirajganj district.	2572 km^2	*High*: 23% *Medium high*: 44% *Medium low*: 14% *Others*: 19%	Medium to high	Medium	**Kharif:** Jute, B. Aus, T. Aman, Kaon, GM **Rabi:** Wheat, Vegetables, Pulses, Mustard, Potato, Boro
7. Active Brahmaputra - Jamuna Floodplain	Eastern part of Kurigram, Gaibandha, Bogra, Sirajganj and Pabna districts. Minor areas also occur in Dhaka, Munshiganj, Narayanganj and Chandpur districts.	3190 km^2	*Medium high*: 37% *Medium low*: 20% *Others*: 43%	Low	Low to medium	**Kharif:** Jute, B. Aus, B. Aman, T. Aman, Kaon **Rabi:** Wheat, Mustard, Sweet Potato, Groundnut, Cheena.
8. Young Brahmaputra and Jamuna Floodplain	Western parts of Sherpur, Jamalpur and Tangail districts, parts of Manikganj, Dhaka, Munshiganj and Gazipur districts and a belt of adjoing and old Brahmaputra channel through Mymensingh, Kishoreganj and Narsingdi districts.	5924 km^2	*High*: 18% *Medium high*: 42% *Medium low*: 19% *Others*: 9%	Low to medium	Low	**Kharif:** B. Aus, T. Aman, T. Aus, Jute, Green manures, Fox tail millet **Rabi:** Wheat, Potato, Tobacco,Mustard, Boro
9. Old Brahmaputra Floodplain	Large areas in Sherpur, Jamalpur, Tangail, Mymensingh, Netrokona, Kishoreganj, Narsingdi and Narayanganj districts. Small areas in the east of Dhaka and Gazipur districts.	7230 km^2	*High*: 28% *Medium high*: 35% *Medium low*: 18% *Others*: 17%	Low to Medium	Low	**Kharif:** B. Aus, T. Aman, T. Aus, Jute, Green manures **Rabi:** Mustard, Wheat, Pulses, Onion, Potato, Grasspea

15. Arial Beel	Munshiganj and Dhaka district.	144 km^2	*Medium high*: 13% *Low*: 73% *Others*: 14%	Medium	Medium to high	**Kharif:** Aus rice, Jute **Rabi:** Pulses, Mustard, Potato, Boro rice
16. Middle Meghna River Floodplain	Parts of Kishoreganj, Brahmanbaria, Comilla, Chandpur, Narsingdi and Narayanganj	1555 km^2	*Medium high*:8% *Medium low*:29% *Low*: 25% *Very low*: 11% *Others*:27%	Low	Medium	**Kharif:** B. Aus+B.Aman, Jute **Rabi:** Boro rice, potato, wheat, mustard
17. Lower Meghna River Floodplain	Chandpur, Lakshimpur and Noakhali.	909 km^2	*High*: 14 *Medium high*: 28 *Medium low*: 31 *Others*: 27	Medium	Medium to high	**Kharif:** T. aman, jute **Rabi:** Boro rice, Potato, Wheat, Mustard, Groundnut, Lentil, Chickpea, Soybean, Chilli
19. Old Meghna Estuarine Floodplain	Kishoreganj, Habiganj, Brahmanbaria, Comilla, Chadpur, Feni, Noakhali, Laksmipur, Narsingdi, Narayanganj, Dhaka, Shariatpur, Madaripur, Gopalganj and Barisal.	7740 km^2	*Medium high*: 24% *Medium low*: 33% *Low*: 21% *Others*: 27%	Medium	Medium	**Kharif:** B. Aus+B. Aman, T. Aman, Jute **Rabi:** Boro rice, Wheat, Potato, Mustard, Grasspea, Chickpea, Winter vegetables
22. Northern and Eastern Piedmont Plains	Sherpur, Netrokona, Sunamganj, Sylhet, Moulivibazar, Habiganj, Brahmanbaria and Comilla	4038 km^2	*High*: 33% *Medium high*: 31% *Medium low*: 16% *Others*: 80%	Medium	Low to medium	**Kharif:** T. Aus, T. Aman, Jute **Rabi:** Boro rice, Wheat, Mustard, Potato, Grasspea, Black gram
23. Chittagong Costal Plains	Feni, Chittagong and Cox's Bazar	3720 km^2	*High*: 17% *Medium high*: 43% *Medium low*: 13% *Others*: 27%	Low	Medium	**Kharif:** T. Aus, T. Aman, Taro **Rabi:** Boro rice, Potato, Mustard, Tomato, Cowpea, Brinjal, Radish, Country bean, Yard long bean
25. Level Barind Tract	Dinajpur, Gaibandha, Joypurhat, Bogra, Naogaon, Sirajganj and Natore	5049 km^2	*High*: 30% *Medium high*: 55% *Others*: 15%	Low	Low	**Kharif:** T. Aman, Sugarcane, Maize **Rabi:** Sugarcane + Potato, Maize, Mustard, Wheat, Tomato, Onion, Cabbage
26. High Barind Tract	Rajshahi, Nawabganj and Naogaon	1600 km	*High*: 93% *Others*: 7%	Low	Low	**Kharif:** T. Aus, T. Aman, Sugarcane, Maize **Rabi:** Boro rice, Wheat, Sugarcane + Cabbage/Cauliflower, Maize, Mustard, Potato, Chickpea, Black gram, Lentil, Ladies Finger.

27. North Eastern Barind Tract	Dinajpur, Rangpur, Gaibandha, Joypurhat and Bogra	1079 km^2	*High*: 36% *Medium high*: 56% *Others*: 8%	Low	Low	**Kharif:** T. Aus, T. Aman, Sugarcane, Jute, Sesame **Rabi:** Boro rice, Wheat, Sugarcane + Potato, Maize, Mustard, Blackgram, Cabbage,Cauliflower

29. Northern and Eastern Hills	Khagrachhari, Chittagong Hill Tracts, Bandarban, Chittagong, Cox's Bazar, Habiganj and Moulivibazar	18172 km^2	*High*: 92% *Others*: 8%	Low	Low	**Kharif:** B. Aus, T. Aman, Jhum cultivation **Rabi:** Boro rice, Potato, Sweet potato, Cucumber, Sweet gourd, Snake gourd, Bitter gourd, Ridge gourd, Brinjal, Country bean, Coriander
30. Akhaura Terrace	Brahmanbaria district and minor areas in Habiganj district	113 km^2	*High*: 11% *Medium high*: 10% *Medium low*: 15% *Others*: 64%	Low	Low	**Kharif:** T. Aus, T. Aman, Jute, Sugarcane + Turmeric **Rabi:** Boro Rice, Wheat, Mustard, Potato

T. — Transplanting; B. — Broadcasting