



A Participatory Approach: Climate Change Perceptions and Adaptation Strategies of Small-holder Farmers in Bangladesh

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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Case Study

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ABSTRACT

One of the global challenges to sustainability in this age of climate change is how to sustain the growing population by providing services to increase food production from farmland. The purpose of this study was to investigate farmers' perceptions of agriculture adaptation strategies, acceptance of tuber crops as adoption in adverse climatic conditions and the constraints on them in relation to climate change. Finding from the study research will bring advantages for small-holder farmers with the community-based approach (PRA method) which may develop action plan, perception about the climate change in the case of 150 Upazila in 60 districts of Bangladesh. It is also demonstrated the farmers insights of climate change and agriculture adaptation tactics and their limitations on them in relation to climate change. Most of the participants didn't read or perceive {literacy rate in project area was 68.4% (MSVSB 2019, BBS)} such as climate change, global climate change, temperature change etc. as an issue or development and adaptation problem and expected given the restricted knowledge base community members had concerning climate change. About average percentage of the participant was thirty-three of men and twenty of women in a group from 150 Upazila in 60 districts who were concern about the board range of challenges that were summarized into six broad unranked categories. Key finding exposed that from PRA analysis, few of the farmers do understand climate to be dynamical issues, however, mostly participants did cultivation with different varieties with their seasonal patterns (i.e., longer and warmer dry seasons and shorter and a lot of intense rainy seasons) and ready to cultivate tuber crops in adverse climatically condition. It is evaluated and ranked the different ways to

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observed the cultivation of tuber crops which can contribute to climate change adaptation (scale ranging based on climate change adaptation and from very low to high potential). Mitigation and adaptation strategies and constraints, cropping systems incorporating risks and adaptations possibility assessment is a simultaneous study effort as climate change-resilient farming and cropping systems that undergo continuous changes with the changing environment, farming culture, and technological innovations. This study stated that farmer perception of global climate change was surveyed and compared to the actual acquaintance to observe that they might not much influence adaptation. Research outcome would be contributing to our inclusive understanding of climate change and adaptation among vulnerable in project area.

Keywords: Climate change; adaptation; perceptions.

1. INTRODUCTION

1.1 Agricultural Alteration

One of the global challenges to sustainability in this age of climate change is how to sustain the growing population by providing services to increase food production from farmland. The uneven climate of Bangladesh is becoming more impulsive in recent ages, precipitation, adverse weather and sea level rise are observed which will be exaggerated by continuing the issues. Bangladesh is becoming most vulnerable to climate change due to low-lying topography and geographical location. "Tremendous climatic hazards, often in the appearance of floods, droughts, coastal and riverbank erosion, salinity intrusion, cyclonic storm surges, and water logging that make the community people more vulnerable in Bangladesh" [1]. In 21st century, the question is raised how the people can adapt in adverse climatic condition. It is necessary to continue agriculture production and for that it will be necessary not only to conserve soil and water resources but also focused on the climate change knowledge like adaptation, perceptions, action plan as well as to feed the growing world population.

Mainly drought and flood are the climatic disaster in Bangladesh which is a major obstacle to the production of main crop paddy. Lack of irrigation and floods are hampering paddy production. In that context, climatic adaptation is very necessary, and dietary changes are required. In this case, the tuber crop especially the yam (Kachu) crop can be an alternative crop regards these disasters. The tuber is a drought and flood-tolerant crop that is highly productive and nutritious. In addition, potatoes, sweet potatoes, and tree potatoes increase the nutritional value of the soil as well as have many nutrients. If this can be introduced as an alternative to rice, the national food will be discouraged by rice

production. This paper will be concentration on potential production of tuber crops as adaptation strategy tool, farmers perception about global climate change, action plan by modifying their cropping pattern, water management and a good approach to adapting to a changing climate.

1.2 Cropping Pattern is a Big Challenge in Bangladesh

Farmers can be protected from economic recession from environmental challenges and market instability by the practice of climate change-resilient agriculture and cropping patterns practices (Rao et al. 2015; Dos Bell et al. 2020). However, for increase sustainable food production, it is crucial to intensification and diversification of cropping systems in agriculture (Tilman et al. 2011) [2]. Also, it is equally important for food security and sustainable nutritional balance for smallholders' farmers who particularly face the challenges especially socioeconomic difficulties [3-5].

Scholars observed that food production and intensification are mostly affected by availability of fresh water, salinity, waterlogged condition, soil erosion and so on [6]. However, there are various reasons for climate change-resilient system and cropping system differs such as climatic features [7], soil properties [8], land topography [9], and water availability [10] from region to region. One of the crops, tuber crops act as key role to contribute in agriculture sector such as high production, conservation of surface and groundwater quality, reduced erosion potential, and improved soil quality and health across the tropics. In Bangladesh, there are a lot of research gaps, and there is a need for additional research about the potential production of tuber crops for soil, and human health, as well as a need for an open-access data information system for research on tuber crops in the tropics. While tuber crops show a lot

of promise, tuber crops are less susceptible to pests and thus pesticides and chemical fertilizers are not used in them. Tuber crops can contribute to climate change adaptation has been evaluated and ranked the different ways on a scale ranging from very low potential to contribute to climate change adaptation to very high potential.

There are different sizes of farms, ownership, and farming system due to the agro-ecological conditions and several distinct land type of Bangladesh. Mostly, more than one enterpriser has a large farm (>3 hectares) and few are mixed farming situations, integrated farming system (agriculture, poultry and livestock), and possibly other enterprises are present within the agriculture farming system. There are many cropping patterns practiced in Bangladesh due to land type, soil texture, flooding regimes, rainfall (amount and distribution), and the resource base of the farmers. Commonly, cropping most of them are dominate patterns are as follows [11].

1.3 Research Gap and Research Questions

To eliminate the climatic adverse effect, many potential agricultural adaptation alternatives have been suggested likewise potential adaptation measures and adopted in practice. It is assumed few adaptation strategies for climate change impact analysis, although the adaptation process itself remains unclear. It is urgently need to understand what kind of adaptation is possible, and feasible (tuber crops) during adverse weather conditions; Who will be responsible for implementation; And what is needed to facilitate or encourage their development or acceptance. The purpose of this study was to investigate farmers' perceptions of agriculture adaptation strategies and the constraints on them in relation to climate change. Through out the research study, it will be finding the answer of the following question in project area: (1) Do farmers perceive the climate to be changing, and if so, how? (2) Are farmers taking adaptive actions in response to the perceived changes (mainly Tuber Crops cultivation as adaptation process)? (3) How

farmers involvement to enhance their resilience?

1.4 Mitigation and Adaptation Strategies and Constraints

Crop management is an ongoing research effort where risk and adaptation effectiveness assessments are included. Crop management is an ongoing research effort where risk and adaptation effectiveness assessments are included. Also, due to the changing environment, farming culture, and technological innovations, then the climate change-resilient farming and cropping systems undergo continuous changed [12]. In this climatic adverse condition, farmers want to increase their profitability by practicing adaptation, mitigation, and vulnerability using stress-tolerant varieties, shifting cropping systems, adjustment of agronomic practices, and irrigation [13]. However, many time adaptation, sustainable farming systems and mitigation practices not sustain due to the traditional agriculture practices, main agriculture crop (paddy) cultivation, and habitual behavior in Bangladesh [14]. Generally, they migrant their job or farming system, try to achieve high-income profitable farming businesses, while there are limited household financial resources, farming skills, and access to credit [15].

1.5 Research Aims

The purpose of this study was to investigate farmers' perceptions about global climate change, agriculture adaptation strategies in climatic adverse condition, acceptance of tuber crops as adoption in adverse climatic conditions and the limitation in project area in relation to climate change.

Specifically, the study sought to:

- i. To define clearly the ranges of possible small-scale project areas farmers perceive the climate change impact;

Table 1. Irrigation aystem with cropping pattern

| | Rabi | Kharif-1 | Kharif-11 |
|---------------------|---|--------------------------|--------------------|
| Rainfed condition | Wheat/potato/pulses/oilseeds/sugarcane | Boro (local) Aus/jute | Fallow |
| Irrigated condition | Wheat/Boro/potato/ tobacco/ winter vegetables | Fallow/T. Aus | T. Aman/ fallow |

- ii. To explore adaptive actions in response of the farmers and community members to the changes they perceive within the study sites;
- iii. Determine climate change adaptive actions, acceptance of the tuber crops and resource needs in study location.

It is expected that at the end of the study, the public and policymakers will be well informed and their knowledge improved about the effect of climate change on root crop production. Management or adaptation options for these crops will be identified.

2. METHODOLOGY

2.1 Selection of Study Location and Data Collection

The study was phased out into various activities and different approaches used to achieve the objectives. To understand of climatic impact to expect and the methods of analysis likely to be most effective on agriculture production. It was done by searching literatures and case study. Here Participatory Rural Appraisal (PRA) method has been applied in Tuber Crops Development Project areas. PRA is a qualitative data collection method. Upazila Agriculture Officers assisted in the round-the-clock research method in the project area. The study analyzed and define scop that topographical regions and rural populations most likely to be vulnerable. While the origins and details of PRA are discussed here, it is worth noting that specific methods followed a similar format to those of Coppock et al. [16]. This study mainly analyzed the following events: a. Production; alternate crops, production techniques, nature and extent of resources use, and cost of production information. Also emphasized and evaluated; b. Consumption; the role of the crop in overall food consumption; percent consumed domestically versus exported, price fluctuation. C. Policy issues are relevant to Agriculture and in particular root and tuber crop production.

In this case study, define the final output or the indirect effects of climate change with interactions between the impact of climate change on root and tuber crop yields and factors were examined. Different steps involved in the PRA like socioeconomic scenario analysis, participatory assessment, and qualitative assessment based on existing experience and expertise. Finally, potential adaptation measures

were identified and examined. This research was conducted at the Upazila level in 150 Upazilas in 60 Districts of Bangladesh.

2.2 Planning Problems and Solutions

In Bangladesh, the agriculture sector facing extreme climate change impact, social and economic complexity. Also, small-holder farmers are facing their socio status stressors and try to make them individual. Their knowledge level was differed person to person and have different perception about the farming system, climate change impact, adaptation and mitigation process. Thus, the research employed took on a participatory-based approach and utilized PRA methods to collect data and implement community action plans at the local level from the bottom-up. In national level in Bangladesh top-down model has been followed and also in case of climate change adaptation programs implemented. In PRA, there were limited tools/activities used by this research include; Social-status map: It represented the key agricultural resources; surrounding observation: it was covered vegetation coverage, soil types, land use coverage patterns, cropping strategies, and opportunities for other agricultural practices or related activities; agriculture farms layout: this allow team members to better understand what the average household in a community is like; discussions with community: further investigation about climate change impact; stakeholder involvement assessment; : This allows communities to identify specific partners in development; farmers living status mapping: it identifies essential resources which need in community a daily basis; seasonal agriculture cropping calendars: This is used to determine when certain agricultural activities, such as crop planting, occur, as well as times of vulnerability, stress, and food scarcity. It is also used to recognise when social and cultural activities take place.

2.3 Data Validation

As data validation, a workshop has been arranged with progressive farmers, extension service providers (Upazila Agriculture Officer, Additional Agriculture Officer, Sub-Assistant Agriculture Officers, Deputy Director) researchers (Bangladesh Agriculture Research Institute, Tuber Centre) and input dealers (import-export stakeholders, business man). In this workshop data from PRA assessment were presented in the workshop, and finalized the

research report with necessary modification and tuning.

3. RESULTS

3.1 PRA Plenary: A Project Introduction and Initial Challenge Listing

Participatory approach conducted by a group discussion in the community as a challenge and encouraged researchers to acquire an initial feel for community challenges and, more importantly, to initiate a dialogue between community members, researchers, and other stakeholders to begin developing pathways to solutions. In this approach fifty-three community members participated in the group from each region (13 regions) discussion for each region where thirty-three percent of them were men and twenty percent of them were women who concern with a broad range of challenges. The whole challenges were condensed into six broad unranked categories, as follows:

- **Agriculture:** Participants cited low agricultural production as a key challenge due to the prevalence of pests, crop diseases, livestock diseases, and also climate change impact. The migration and shortening of seasonal rain patterns, create challenges when planning for farming activities and the acquisition of inputs fertilizer, pesticides, tractors, labor, land, money, and so on to solve these problems.
- **Infrastructure:** Poor roads were a problem that was frequently brought up but didn't seem to be taken seriously. Poverty: All participants agreed that widespread poverty was a major challenge throughout the community, with a lack of natural and institutional resources cited as the primary causes.
- **Water resources:** A shortage of safe and easily accessible drinking water because of having no functional protected water sources (i.e., protected springs, boreholes,

or shallow wells). Alternatively, mostly on open unprotected sources, leading to a high prevalence of waterborne diseases. A need for improved crop irrigation was also expressed to cope with shifting rain patterns.

- **Health:** Health was raised repeatedly by elderly female participants, citing a need for better and more affordable health services. Additionally, waterborne illnesses like typhoid were commonly reported.
- **Gender inequality:** One older female participant raised the subject of gender-based violence, but no one else pursued it. This was probably due to the open environment of the conversations, which meant that delicate subjects were largely avoided. Overall, it was said that the presence of the participants was effectively high and meeting was successful. There was a genuine feeling of engagement and interest in the PRA process.

3.2 PRA Plenary: Final Ranking of Priority Problems and Analysis

Farmers and women members attended the final PRA approach where, using a pairwise ranking matrix in problems ranking index (Table 2) and participants completed a final ranking of their challenges. In this study resulted that the most important challenge was water resources were overwhelmingly ranked. It was expected that challenges related to agriculture or finance to be ranked more important. Furthermore, health challenges were ranked as the second-highest priority. Lack of access to adequate health services, however, is probably considered as an all-encompassing community concern that should be a basic requirement, similar to problems with water resources. Therefore, increasing community well-being could significantly enhance agricultural output and standard of living. As was to be expected, financial difficulties were scored rather highly, coming in at third on the priority list.

Table 2. Final challenge rankings for project areas from highest (1) to lowest (7) rank challenge

| | |
|---|--|
| 1 | Water Resources: Contaminated water sources leading to a high rate of water borne illnesses and |
| 2 | Health: High prevalence of illnesses making work difficult. Lack of knowledge and care. |
| 3 | Finance: High rate of poverty. No money for agriculture inputs/investments. |
| 4 | Agriculture: Changing climate. Traditional practices, lack of knowledge. |
| 5 | Government not much support. NGOs offer some help but unsustainable. |
| 6 | Infrastructure: Poor roads. Supply chain not much developed. |

Agriculture-related difficulties came in fourth. Given that Upazillas in the project region are a subsistence farming population grappling with the effects of climate change, this lower ranking was unexpected. Therefore, it may be assumed that despite the fact that there are agricultural issues, community members believed their farming systems were capable of sustaining them for the time being. Furthermore, creating routes for improving agricultural productivity or adaptability might be challenging and might not be currently possible for project regions.

4. DISCUSSION

Results disclosed that global climate change impacts were being perceived in project areas. Generally, impacts were delineated as fluctuations in seasonal patterns. Wet seasons were shorter, with less consistent rain and a lot of severe storms, whereas dry seasons were according to be turning longer with a lot of extremely high temperatures that were according to during this analysis. This translated to a decline in total agricultural productivity as a result of farmers being unable to accurately predict once downfall events would occur, thus disrupting ancient farming patterns. Specific descriptions varied; however, this was the unremarkably accepted perception notwithstanding the age, sex, or status of the participants. Most of the participants farmers didn't read or perceive {climate change, global climate change, temperature change} as a world issue or development and adaptation problem and expected given the restricted knowledge base community members had concerning climate change. These finding suggest that if it is not possible prerequisite to farmers for the successful adaptation and understanding the climate change as its local context, otherwise it will not work in the project area.

From the study, it has been established that many of farmers responding with the taking action plan and altering their behaviors to the changes they perceived. They have been changed their farming system as the adaptation strategies likewise many of them participants were making adjustments in the timing of certain farming activities like land preparation and planting in correspondence to shifting seasonal patterns. That changed farming system were very similar to the seasonal calendar activity of the PRAs, which clearly compared the timing of farming activities before and after the onset of the perceived changes. In the project areas,

farmers cultivated tuber crops (Yam, Kochu) in water logged condition and any fields where tuber crops beginning to expand farming activities into wetlands and other uncultivated areas that were well endowed with moisture and nutrients as well as human nutrition.

The research showed the uncertainty to determine adaptive action at that time as because there was no consensus on how to define "successful adaptation" [17]. "In some cases, the definition of successful adaptation can have competing interpretations in both research and practice" [18] (Sherman et al., 2016). As the IPCC, adaptation is "the process of adjustment to actual or expected climate and its effects. However, in human systems, adaptation seeks to moderate or avoid harm and exploit beneficial opportunities" [19]. Under this definition, it is obvious that the project area is adapting because they are adjusting their farming systems (altering the timing of farming practices in response to actual changes in the climate (shifting seasonal patterns/cultivation tuber crops) to moderate effects and avoid harm. Moreover, communities exploit beneficial opportunities, like land expansion (Yam or Kochu cultivation in water logged condition) to further mitigate harm.

Additionally, more specific to recognized adaptation by Adger, Arnell, and Tompkins [20] statement that that 'successful adaptation must "balance effectiveness, efficiency, and equity through decision-making structures that promote learning and are perceived to be legitimate." Tompkins et al. [21] discuss anticipatory adaptation planning, which ensures "that the vulnerable are prepared, risk information is distributed, risk management plans developed, and public goods are managed to account for climatic changes." The IPCC [19] uses the term 'adaptation management' to describe the "process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change" and "involves adjusting approaches in response to observations of their effect and changes in the system." Research recommended that, farmers need efficient adaption strategies that will be effective and legitimate over the time.

The scholar, Tompkins et al. [21], stated that "anticipatory adaptation planning is a more formal and proactive form which was not substantially occurring at either study-site. Lack of budget, information and adequate knowledge, there was no developed plan, risk information,

supply and plan management and so on". Thus, given the analysis informed that it was urged to upgrade the status of the adaptation taking policy in study area. In addition, those who need to be upgrading the quality of their adaptations to be more proactive and anticipatory in order to enhance their resilience. The matrix ranking results showed that in order to improve climate change resilience, a wider range of opportunities and challenges needed to be addressed. While health and financial issues appeared to be almost equally important to participants, it was believed that agriculture was identified as the biggest challenge and opportunity. From analyses data demonstrated that action plan has many feasible pathways for the community to improve their resilience to climate change. The matrix ranking activity represented community-based challenges and opportunities could be most effectively pursued where water resources management seemed to be most obvious challenge but also the greatest opportunity for development. Others ranking elements were not more demanding and could not lead to the greatest cumulative gain for the community as water resources could. So it is recommended that the action plan develop on enhancing water resources as the most feasible and effective way to enhance project area's resilience to climate change.

5. CONCLUSION

The case study was conducted in Tuber Crops Development Project areas to find the character of global climate change adaptation and perception of small-scale farmers resulted from the utilization of a community-based approach (PRA methods). From the assessment of the PRA approach, result showed that small-scale farmers in analysis space do understand the climate to be dynamical, primarily within the variety of variations within the temporal order of seasonal patterns (i.e., longer and warmer dry seasons and shorter and a lot of intense rainy seasons) and ready to cultivate tuber crops in adverse climatical condition. It is also markedly observed that, farmers do not perceive the mechanism of global climate change such as local-level events: deforestation, drought, flood, waterlogged, soil erosion and environmental degradation. The farmers were adapting primarily by creating changes within the temporal order of farming activities like the cultivation of the tuber crops, seasonal change, crops pattern change, whether or not this adaptation may well be deemed 'successful depends on one's

interpretation of the literature. Regardless, the analysis results conjointly indicated that interventions may well be utilized to enhance the resilience of participants. The result also stated that the perception of the farmers and understanding the climate change and adaptation among the vulnerable community of the project areas. The community farmers' actual climatic knowledge data were compared with the scientific knowledge and finding that the determine how they may or may not influence adaptation. Thus, it suggested that the scientific knowledge was not a prerequisite for adaptation as scientific phenomenon was not understood. In PRA approach, qualified and successful adaptation were discussed for potential improvement in the community. This recommendation that, the participant able to cope up the adaptation efforts on their own, and also need to enhance with the appropriate, more proactive, reasonable and effective adaptive approaches through outside intervention aimed. Furthermore, there is a need to identify prerequisites adaptation and apply to achieve for the community. In this study analyzed the resource management where the water has the most priority among the community rather the agriculture sector. The result suggested that, water resource need more emphasis to management and research.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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