**Farmers’ Perceptions toward Climate Change with Emphasis on Cropping Systems in the Haor Areas of Kishoreganj District, Bangladesh**

**Abstract**

A survey was conducted in three Haor areas, viz. Austagram, Itna, and Mithamoin under the Kishoreganj district of Bangladesh to assess farmers’ perceptions of climate change and its impacts on cropping systems. In these regions, Boro rice is traditionally the dominant crop, accounting for 18% of the total rice production and 27% of the Boro rice cultivated nationwide. Despite the agricultural significance of these areas, a considerable portion of the kanda and medium high land remains fallow. The primary objective of this research was to explore farmers' understanding of climate change and their adaptive responses concerning cropping systems in the selected Haor regions. A total of 150 farmers were randomly selected and interviewed face-to-face using a structured questionnaire to ensure representative and reliable data collection**.** The results showed that the farmers’ understanding of climate change was much lower than expected; a maximum of 42.7% of farmers pointed out that climate change means frequent flooding, and about half portion (50%) of the farmers opined that temperature, early flooding, thunderstorms, and lightning have increased over time. They strongly agreed that Boro rice is affected more frequently by natural hazards than in previous times, and its cultivation is also affected by a lack of seed, irrigation, and high production costs. A notable proportion of the farmers (56.7%) have adopted adaptation strategies that are less climate-smart and nutrition-sensitive. Only 53.3% of farmers cultivated oilseeds, pulses, and vegetables other than Boro rice. A lack of technological knowledge is the main obstacle to practicing climate-resilient, modern cultivation practices. However, they are agreeable to cultivating nutrition-sensitive and high-value crops if they have technical support.

**Keywords:** Boro rice, Climate change, Climate-smart, Climate-resilient, Cropping system, Haor areas, High-value crops.

**1. Introduction**

The geographic location, climate, and topography of Bangladesh make it highly vulnerable to sudden-onset disasters such as floods, river erosion, cyclones, droughts, tornadoes, cold waves, earthquakes, drainage congestion, waterlogging, arsenic contamination, salinity intrusion, and the broader impacts of global climate change. Agriculture plays a vital role in the national economy, employing more than 40.60% of the workforce and contributing about 14.23% to the national GDP [1,2].

The Haor region in northeastern Bangladesh is particularly susceptible to climate-related threats. This landscape is characterized by large bowl-shaped depressions that form seasonal wetlands between the natural embankments of alluvial fan-river networks. These wetlands experience a substantial influx of water and sediment from upstream India during the monsoon season [3]. The Haor basin spans 20,022 square kilometers and includes parts of seven districts: Sylhet, Sunamganj, Habiganj, Moulvibazar, Kishoreganj, Brahmanbaria, and Netrokona [4]. Among them, Kishoreganj is a hotspot for flash floods, a condition highlighted by the Bangladesh Delta Plan 2100 as a major development challenge [5,6,7]. The region includes 373 Haors covering approximately 859,000 hectares—around 43% of the total Haor area. In 2018–19, about 246 acres of cropland in Kishoreganj were damaged due to floods and excessive rainfall, leading to a yield loss of 50.23 kg per acre and a total production loss of 235 metric tons [1,2,8,9,10].

Globally, climate change is already manifesting in various forms—rising temperatures, sea level rise, heavy rainfall, high humidity, and frequent floods—which damage property and disrupt agriculture, forestry, infrastructure, and public health. Bangladesh, as a developing country, is not exempt from these effects [11,12,13]. Natural hazards such as droughts, floods, riverbank erosion, waterlogging, and cyclonic storm surges regularly impact vulnerable regions, including chars, Haors, and coastal zones [14]. These hazards significantly reduce crop yields and damage property. In the Haor region, many households engaged in monocrop farming and fishing are frequently affected [15,16]. Due to limited livelihood options, many poor and extremely poor residents experience severe food insecurity that persists throughout the year [14,17].

Boro rice cultivation and its associated activities constitute the primary source of income for most Haor dwellers. However, this source of income remains highly vulnerable due to natural hazards and the geographic fragility of the region [15,18]. Unpredictable events, such as pre-monsoon flash floods, have caused significant damage—resulting in a loss of approximately 0.92 metric tons of Boro rice and turning vast areas of the Haor region in Kishoreganj into submerged wetlands. Such climatic disruptions make agricultural output increasingly risky and uncertain, underscoring the urgent need for alternative livelihood options in the region [7,19].

The total area of the Haor in Kishoreganj is approximately 12,506.7 hectares [1]. It is highly significant for both Boro rice cultivation and inland freshwater fish production. About 86% of the total cropped area in the Haor is suitable for Boro rice cultivation. Additionally, the region offers a substantial fishery resource, covering around 110,856 hectares [20,21].

The region is dominated by single-crop farming, especially Boro rice. The prevailing cropping patterns in Kishoreganj are: Boro–Fallow–Fallow (80%), Fallow–Fallow–T. Aman (3%), Boro–Fallow–T. Aman (8%), and Fallow–Aus–T. Aman (6%) [9,10]. However, farmers are increasingly experimenting with short-duration crops such as oilseeds, vegetables, and tuber crops. To improve cultivation efficiency, they are also adopting agricultural machinery, including power tillers, tractors, combine harvesters, weeders, and seeders [22,23,24].

Climate change continues to influence both crop production and livelihood sustainability. Therefore, this study aims to (i) assess farmers’ understanding of climate change and its impacts on cropping systems, (ii) explore existing cropping patterns in the Haor region, (iii) identify major climatic hazards and agricultural vulnerabilities, (iv) examine the status of agricultural machinery use among farmers, and (v) investigate current and future adaptation strategies employed by Haor farmers in response to a changing climate.

**2. Materials and Methods**

**2.1 Survey site**

The study was conducted in three major Haor areas—Austagram, Itna, and Mithamoin—located in the Kishoreganj district of Bangladesh (Figure 1). These regions are particularly significant for Haor-based research due to their extensive wetland ecosystems and vulnerability to climatic hazards. The main river systems influencing these areas include the Meghna River, which originates from the confluence of the Surma and Kushiyara rivers, along with other important rivers such as the Baulai and Kalni. Notable water bodies within these Haor areas include Haular Haor, Maora Beel, Chapra Beel, Kaira Beel, Ugli Beel, Sonabandha Beel, Ghora Beel, and Agalpa Beel. During the monsoon season, water covers over 600,000 hectares of these wetlands [1,2].

The selected study area comprises four upazilas and twelve unions distributed across the three Haors [1,2,6,7]. Geographically, the survey sites are situated between 24°26′ N latitude and 90°47′ E longitude. These regions are highly exposed to climate-induced hazards such as seasonal and flash floods, thunderstorms, droughts, hailstorms, and lightning events. These recurring climatic stresses significantly disrupt agricultural activities and livelihoods. Considering their ecological significance and vulnerability, these three Haor regions were purposively selected as the study areas for this research.



Mithamonin

Austagram

Itna

Figure 1: Location of the study area (Kishoreganj District of Bangladesh)

**2.2 Sampling, questionnaire and data collection**

The sample size for this study was determined based on the total population under investigation. A total of 250 respondents were selected using a random sampling technique to ensure representativeness. A team of skilled professionals designed a structured questionnaire to assess the impact of climate change on the cropping system in three selected *Haor* areas of the Kishoreganj district, Bangladesh. Data collection was conducted through face-to-face interviews to ensure accurate and comprehensive responses. The survey included a diverse group of stakeholders, such as local and model farmers, Sub-Assistant Agriculture Officers (SAAO), Agriculture Extension Officers (AEO), Additional Agriculture Officers (AAO), Upazila Agriculture Officers (UAO), scientists from the National Agricultural Research System (NARS), and NGO personnel working in the respective *Haor* areas. From each of the three selected *Haor* areas, nine villages were randomly chosen to ensure a broad geographic and demographic representation. To supplement and validate the findings from structured interviews, 15 focus group discussions (FGDs) were conducted with 12 to 15 farmers in each group, across 10 different villages of the study area, particularly focusing on Dingaputa Haor. These FGDs aimed to explore the SWOT (Strengths, Weaknesses, Opportunities, and Threats) of *Haor* agriculture under the influence of climate change and to triangulate information gathered through the questionnaires. The sample size was finalized based on data saturation, where no new significant insights were emerging with the addition of more respondents. It is important to note that the quantitative data presented and analyzed in the Results section (n=150) is based exclusively on interviews with farmers; insights from other stakeholder groups were used only to supplement and contextualize these findings through FGDs and expert consultations. This approach ensured the reliability and adequacy of the collected data to meet the objectives of the study.

**3. Results**

**3.1 Socio-demographic characteristics of the farmers**

The study surveyed a total of 150 farmers across three Haor areas—Austagram, Itna, and Mithamoin—of Kishoreganj District in Bangladesh. The socio-demographic characteristics of the respondents are presented in Table 1. The results show that the average age of the respondents was 33.90 years. A significant proportion (33.30%) of the respondents were within the 41–50 age group, followed by 31.30% in the 21–30 years category and 22.70% in the 31–40 years group. A significant proportion (33.30%) of the respondents were within the age group of 31–45 years, followed by 31.30% in the 21–30 years category, and 22.70% in the 41–50 years group. Only 12.70% of the respondents were aged 20 years or below, indicating that the majority of the farming population falls within a productive age group. Regarding gender distribution, the majority of respondents were male (71.30%), while females accounted for 27.30%, with a negligible portion identifying as other categories. In terms of education level (Figure 2), 49.30% of the farmers had received secondary-level education, 46.00% had primary-level education, and only 4.70% had completed higher secondary education (HSC) or above. This indicates a moderately educated farming community with limited higher education exposure. The primary occupation of the respondents was farming, with 79.30% identifying it as their main livelihood (Figure 3). Other occupations included fisheries (7.30%), poultry rearing (6.70%), and labor work (6.70%), suggesting a predominantly agrarian community with some occupational diversity. Regarding family structure, most respondents had 4 to 6 children, while 25.30% had 1 to 3 children, and 20.70% had 7 to 9 children. In terms of labor force, 67.30% of households had 2 to 4 active members, whereas 32.70% had only one active member. These findings reflect a relatively high family size with moderate labor availability within households.

**Table 1: Socio-demographic characteristics of respondents (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of farmers’** | **Category** | **Respondents (No.)** | **Respondents (%)** | **Rank order** | **Mean** |
| Age (20-50) | <20 years | 19 | 12.70 | 4 | 33.90 |
| 21-30 | 47 | 31.30 | 2 |
| 31-40 | 34 | 22.70 | 3 |
| 41-50 | 50 | 33.30 | 1 |
| >50 | -- | -- |  |
| Gender  | Male  | 107 | 71.30 | 1 | 1.74 |
| Female | 41 | 27.30 | 2 |
| Others  | 2 | 1.30 | 3 |
| Family members  | 1-3 | 38 | 25.30 | 2 | 1.95 |
| 4-6 | 81 | 54.00 | 1 |
| 7-9 | 31 | 20.70 | 3 |
| >9 | --- | --- | - |
| Active family members  | 1 | 49.0 | 32.70 | 2 | 1.83 |
| 2-4 | 101.0 | 67.30 | 1 |
| >4 | --- | --- | - |

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**3.2 Agricultural information of respondents in the survey**

The results indicate that most surveyed farmers were medium-scale producers (56%), owning 1.01–3.0 hectares of land, while a smaller proportion (23.3%) were large-scale farmers. Land ownership was predominant, with 75% of respondents owning their land, suggesting a strong base for stable agricultural investment. The average farming experience was 15.58 years, with the majority having 10–20 years of experience, reflecting a mature farming community. In terms of topography, most farmers cultivated medium-low to medium-high land, which are typically prone to seasonal flooding in Haor areas. While 42.7% reported fertile land, only 11.3% rated their land as highly fertile, suggesting room for soil productivity improvement. Around 33.3% experienced submergence from June to October, the peak monsoon period, indicating significant climate vulnerability. Lastly, over half (55.3%) reported no alluvial soil coverage, which could impact fertility and crop yield, though among those with alluvium, 33.3% rated it as high—highlighting spatial variability in soil quality.

**Table 2. Agricultural information of respondents in the survey (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category**  | **Respondents (No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| Farmer types  | Landless (<0.002 ha)  | - | - | - | 2.63 |
| Marginal (0.02-0.20 ha) | - | - | - |
| Small (0.21-1.0 ha) | 31 | 20.70 | 3 |
| Medium (1.01-3.0 ha) | 84 | 56.0 | 1 |
| Large (>3.0 ha) | 35 | 23.30 | 2 |
| Land ownership  | Owner | 113 | 75.3 | 1 | 1.41 |
| Leasing  | 20 | 13.3 | 2 |
| Sharecropper/profit-sharing | 10 | 6.7 | 3 |
| Integrated  | 7 | 4.7 | 4 |
| Others | -- | --- | - |
| Farming experience | <10 years | 20 | 13.3 | 2 | 15.58 |
| 10-20 years | 130 | 86.7 | 1 |
| 21-30 years | -- | - | - |
| >30 years | -- | -- | - |
| Types of cultivated land  | High (above the normal level of flood)  | 23 | 15.3 | 3 | 2.79 |
| Medium high (Up to 0.10-0.90m of flooded) | 37 | 24.7 | 2 |
| Medium low (Up to 0.91-1.80m of flooded) | 55 | 36.7 | 1 |
| Low (Up to 1.81-3.0m of flooded) | 18 | 12.0 | 4 |
| Very low (>3.0m of flooded) | 17 | 11.3 | 5 |
| Land fertility  | High fertility | 17 | 11.3 | 3 | 2.69 |
| Fertility | 64 | 42.7 | 1 |
| Medium fertility | 35 | 23.3 | 2 |
| Low fertility | 17 | 11.3 | 3 |
| Very low fertility | 17 | 11.3 | 3 |
| Submerging period | May to December | 30 | 20 | 3 | 2.47 |
| June to October | 50 | 33.3 | 1 |
| June to November | 40 | 26.7 | 2 |
| July to September | 30 | 20 | 3 |
| Is land covered by alluvium soil? | Yes | 67 | 44.7 | 2 | 1.55 |
| No  | 83 | 55.3 | 1 |
| Status of land covered by alluvium soil  | Very high | 30 | 20 | 3 | 2.47 |
| High | 50 | 33.3 | 1 |
| Low  | 40 | 26.7 | 2 |
| Very low | 30 | 20 | 3 |
| Don’t know | -- | -- | - |

**3.3 Farmers’ perceptions about climate change in the Haor area and its impact on crop production**

All respondents in the survey area perceived climate change primarily as frequent flooding. When asked about their understanding of climate change, 42.7% identified frequent flooding as the most prominent indicator. Other perceptions included excessive fog in winter (8.7%), frequent storms (8.0%), excessive heat (8.0%), excessive cold (7.3%), heavy precipitation (6.7%), less precipitation (6.7%), irregularity in seasons (6.0%), and irregular weather patterns (6.0%) (Table 3 and Figure 4). Regarding long-term changes, 50% of the respondents stated that the temperature had increased over the past 10 years, whereas 17.3% believed that it had decreased. In terms of rainfall patterns, 41.3% of farmers opined that rainfall had increased during the last decade, while 40% disagreed. The mean perception score for rainfall changes was 1.87. Additionally, 9.3% of the participants believed that there had been no change, and another 9.3% stated that they had no knowledge regarding changes in rainfall. A majority of the respondents (60%) reported that early flooding had occurred more frequently in the last 10 years, whereas 20% disagreed with this statement. The average perception score on this matter was 1.70. Meanwhile, 10% of farmers indicated no change, and 10% reported a lack of knowledge regarding this issue. When asked about the trend of thunderstorms, 62% of the farmers believed that the frequency of thunderstorms had increased in the past decade. In contrast, 20% stated that thunderstorms had not increased, while 10% noted no change, and another 10% admitted they had no idea about any change (Table 3).

**Table 3. Farmers’ perceptions about climate change in the survey area and its impact on crop production (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category**  | **Respondents (No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| Changing trend of temperature in the last 10 years | Temperature increased  | 75 | 50 | 1 | 1.99 |
| Temperature decreased | 26 | 17.3 | 2 |
| No change | 25 | 16.7 | 3 |
| Don’t know | 24 | 16 | 4 |
| Changing trend of rainfall patterns in the last 10 years | Rainfall increased  | 62 | 41.3 | 1 | 1.87 |
| Rainfall decreased | 60 | 40 | 2 |
| No change | 14 | 9.3 | 3 |
| Don’t know | 14 | 9.3 | 3 |
| Changing trend of flood in the last 10 years | Early flood  | 90 | 60 | 1 | 1.70 |
| Late flood | 30 | 20 | 2 |
| No change | 15 | 10 | 3 |
| Don’t know | 15 | 10 | 3 |
| Changing trend of thunderstorms in the last 10 years | Thunderstorms increased  | 93 | 62 | 1 | 1.65 |
| Thunderstorms decreased | 30 | 20 | 2 |
| No change | 14 | 9.3 | 3 |
| Don’t know | 13 | 8.7 | 4 |

**3.4 Major natural hazards identified by farmers in the survey area (n=150)**

Most farmers in the three surveyed Haor areas were able to identify key natural hazards, as presented in Table 4. Among them, 64% reported flash floods as the primary natural hazard. Other hazards identified by the respondents included drought (6%), storm (6%), hailstorm (5.3%), lightning (4.7%), cold and heat waves (4.7%), and pest attacks (4.7%) (Figure 5). Regarding the trend of natural hazards, 78% of the farmers indicated that such events had become more frequent over the last 10 years, while 11.3% disagreed with this observation. Another 10% of respondents stated they had no knowledge on this matter. To understand the perceived effects of natural hazards on boro rice cultivation, a significant portion of farmers strongly agreed with their impact. Specifically, 42.7% agreed that natural hazards negatively affected rice production, with a mean agreement score of 1.52. When asked about the specific impact of these hazards on the boro season, 70.7% of the farmers stated that early and extreme flooding had the most detrimental effect, with an average impact score of 1.39. Other reported hazards affecting the boro season included drought (23.3%), storm and hailstorm (3.3%), “chita dhan” (immature rice grains) (1.3%), and pest attacks (1.3%). In terms of early planting of boro rice as a strategy to protect against natural hazards, 52.7% of farmers believed that advanced cultivation could be effective. However, 42.0% disagreed, and the remainder were unsure or lacked knowledge about this approach. During the survey, some farmers explained that chita dhan often occurred due to delayed drainage of water and other hazards during the boro season. Specifically, 14.7% cited delayed water recession, 10% reported pest attacks, 4.7% mentioned miscellaneous reasons, and 2% admitted that they did not know the reasons. To identify problems in boro rice cultivation that were not caused by natural hazards, the survey revealed several key constraints faced by the farmers (Table 4). These included:

* High production costs (28.7%)
* Lack of irrigation facilities (28.0%)
* Unfair market prices for crops (16.7%)
* Scarcity of quality seeds (12.7%)
* High irrigation costs (6.7%)
* Shortage of labor and high wages (4.0%)
* Difficult and delayed harvesting (1.3%)
* Other issues (2.0%)

These findings are visually represented in Figure 6 and emphasize that high production costs and irrigation-related problems were the most significant challenges faced by farmers in the Haor region.

**Table 4. Major natural hazards of respondents in the survey area (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category**  | **Respondents (No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| In the last 10 years, natural hazards have become more common, is it correct? | Yes | 117 | 78 | 1 | 1.33 |
| No | 17 | 11.3 | 2 |
| Don’t know | 16 | 10.7 | 3 |
| Do you think, Boro crops cultivated in Haor areas are getting affected more by natural hazards than previous?  | Completely agree | 79 | 52.7 | 1 | 1.52 |
| Agree  | 64 | 42.7 | 2 |
| No opinion  | 7 | 4.7 | 3 |
| No agree  | --- | --- | - |
| Not at all  | --- | --- | - |
| What types of hazards are affected in Boro season crop by natural hazards? | Early & extreme flood  | 106 | 70.7 | 1 | 1.39 |
| Drought  | 35 | 23.3 | 2 |
| Storm and Hailstorm  | 5 | 3.3 | 3 |
| Chita dhan | 2 | 1.3 | 4 |
| Pest attack | 2 | 1.3 | 4 |
| Others  | --- | --- | --- |
| Don’t know | --- | --- | --- |
| Do you cultivate more Boro rice in advance to protect natural hazards?  | Yes | 79 | 52.7 | 1 | 1.53 |
| No | 63 | 42.0 | 2 |
| Don’t know | 8 | 5.3 | 3 |
| What are the reasons for not cultivating more Boro rice in advance?  | Delay in moving water | 22 | 14.7 | 2 | 2.11 |
| Chita dhan  | 103 | 68.7 | 1 |
| Pest attack | 15 | 10 | 3 |
| Others  | 7 | 4.7 | 4 |
| Don’t know | 3 | 2.0 | 5 |

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**3.5 Future adaptation of technologies for a changing climate**

The results show that a majority of farmers (56.7%) had not yet adopted climate change adaptation techniques, with lack of technological knowledge and property cited as the primary barriers (Table 5). Despite this, there is strong potential for future adaptation, as 91.3% expressed willingness to cultivate hybrid crops, particularly oilseeds, potatoes, and maize, provided they receive technical support. Short-duration rice variety BRRI dhan28 was overwhelmingly favored (92.7%) for its resilience, indicating farmers’ preference for practical, hazard-mitigating strategies. While 53.3% cultivated Rabi crops beyond Boro rice, diversification remains modest, constrained by capital and soil quality. Encouragingly, 66.7% of farmers were open to adopting hybrid crops with technical guidance, and 91% showed readiness to adopt zero tillage practices if supported, revealing a strong willingness to embrace climate-resilient technologies.

**Table 5. Future adaptation of technologies by Haor farmers for a changing climate (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category**  | **Respondents** **(No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| Adaptation techniques are used for a changing climate  | Yes | 65 | 43.3 | 2 | 1.59 |
| No | 85 | 56.7 | 1 |
| If no, what is the reason?  | Lack of technological knowledge | 64 | 42.7 | 1 | 1.91 |
| Lack of property | 57 | 38 | 2 |
| I’m not aware of climate change | 7 | 4.7 | 4 |
| Lack of interest | 22 | 14.7 | 3 |
| I don’t know what to do | - | - |  |
| What types of variety do you cultivate?  | BRRI dhan28 | 139 | 92.7 | 1 | 1.10 |
| BRRI dhan29 | 7 | 4.7 | 2 |
| BRRI dhan58 | 4 | 2.7 | 3 |
| BRRI dhan64 | - | - | - |
| BRRI dhan74 | - | - | - |
| BRRI dhan84 | - | - | - |
| BRRI dhan88 | - | - | - |
| BRRI dhan89 | - | - | - |
| Others | - | - | - |
| What types of variety do you cultivate to protect the natural hazards?  | Short duration varieties  | 131 | 87.3 | 1 | 1.13 |
| Long duration varieties  | 19 | 12.7 | 2 |
| Don’t know | - | - |  |
| How much is the production cost per hectare?  | 10000-20000 | 17 | 11.3 | 3 | 29013.33 |
| 21000-30000 | 107 | 71.3 | 1 |
| 31000-40000 | 22 | 14.7 | 2 |
| 41000-50000 | 3 | 2 | 4 |
| 51000-60000 | - | - |  |
| 61000-70000 | 1 | 0.70 |  |
| Cultivation of crops other than *boro* rice in the rabi season | Yes | 80 | 53.3 | 1 | 1.47 |
| No | 70 | 46.7 | 2 |
| Cultivated rabi crops other than *boro* rice, who responded “Yes” | Wheat | 18 | 12 | 3 | 3.01 |
| Potato | 39 | 26 | 2 |
| Maize  | 61 | 40.7 | 1 |
| Vegetables  | 7 | 4.7 | 5 |
| Pulses | 7 | 4.7 | 5 |
| Oilseeds | 16 | 10.7 | 4 |
| Spices | 2 | 1.3 | 6 |
| Others | - | - | - |
| Mentioned problems that responded “No” | Low land | 44 | 29.3 | 2 | 2.75 |
| Very low-fertility soil | 24 | 16 | 3 |
| Lack of technological knowledge | 22 | 14.7 | 4 |
| Lack of capital  | 47 | 31.3 | 1 |
| Lack of interest | 12 | 8 | 5 |
| I don’t know what to do | 1 | 0.7 | 6 |
| Cultivation of a hybrid crop other than *boro* rice in the *rabi* season  | Yes | 137 | 91.30 | 1 | 1.09 |
| No | 13 | 8.7 | 2 |
| If you show interest in cultivating, what are they?  | Potato | 47 | 31.3 | 2 | 2.63 |
| Maize | 23 | 15.3 | 3 |
| Vegetables  | 21 | 14 | 4 |
| Oilseeds | 57 | 38 | 1 |
| Spices  | 2 | 1.3 | 5 |
| Others  | - | - | - |
| Is your land suitable for the production of a hybrid crop in the rabi season?  | Off course  | 41 | 27.3 | 2 | 1.89 |
| Yes | 93 | 62 | 1 |
| No opinion  | 9 | 6 | 3 |
| No | 6 | 4 | 4 |
| Not at all | 1 | 0.70 | 5 |
| If I gain technical knowledge for crop production, I will cultivate a hybrid crop. Mentioned opinion.  | Completely agree | 50 | 33.3 | 2 | 1.67 |
| Agree  | 100 | 66.7 | 1 |
| No opinion  | - | - | - |
| No agree  | - | - | - |
| Have any idea about zero tillage crops? | Yes  | 82 | 54.7 | 1 | 1.45 |
| No | 68 | 45.3 | 2 |
| If you have an idea about zero tillage crops, how can you get? | Cultivate the crop himself  | 74 | 49.3 | 1 | 1.61 |
| Get experience from others | 61 | 40.7 | 2 |
| Get information from the News media or a book | 15 | 10.0 | 3 |
| By training or hearing | - | - | - |
| Crop will produce if I have technical knowledge about zero tillage | Completely agree | 61 | 40.7 | 2 | 1.71 |
| Agree  | 76 | 50.7 | 1 |
| No opinion  | 9 | 6 | 3 |
| No agree  | 3 | 2 | 4 |
| Not at all | 1 | 0.70 | 5 |

**3.6 Improvement of the farmers’ attitude influenced by GO and NGO organizations (n=150)**

Various governmental (GO) and non-governmental (NGO) organizations played a role in shaping and improving farmers’ attitudes in the Haor areas by providing advice and services. As presented in Table 6, the majority of farmers (90.7%) reported receiving advice from the Department of Agricultural Extension (DAE). However, a small number of respondents expressed disagreement or stated that they did not benefit from such support. Regarding access to agricultural loans or credit facilities, 48.7% of the farmers reported that it was difficult for general farmers to obtain loans. Additionally, some respondents emphasized that the process was not just difficult but very difficult, indicating significant barriers to credit access in the region.

**Table 6. Improve the farmers’ attitudes influenced by GO and NGO organizations (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category** | **Respondents (No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| Are you getting agricultural advice and services from the Department of Agricultural Extension?  | Yes | 136 | 90.7 | 1 | 1.09 |
| No | 14 | 9.3 | 2 |
| What do you think about agricultural loans/credits? | It is very easy to get | 13 | 8.7 | 4 | 3.01 |
| Easy | 20 | 13.3 | 3 |
| Difficult  | 73 | 48.7 | 1 |
| Very difficult | 41 | 27.3 | 2 |
| I don’t know | 3 | 2 | 5 |
| Are you satisfied with the services of Govt. or private organizations? | Very satisfy  | 68 | 45.3 | 1 | 1.72 |
| Satisfy  | 68 | 45.3 | 1 |
| Fairly satisfy  | 7 | 4.7 | 2 |
| Unsatisfied | 2 | 1.3 | 4 |
| Very unsatisfied  | 5 | 3.3 | 3 |

**3.7 Farmers’ perceptions about machinery for crop production (n=150)**

Agricultural machinery was widely recognized by farmers as a means to ease the labor and time requirements of crop production and processing. In the survey, 43.3% of the respondents understood agricultural mechanization to mean the use of machinery such as tractors in farming operations. A higher proportion (68%) specifically identified tractors as the primary machinery used in the Haor agricultural sector (Table 7). Additionally, 29.3% of the farmers considered power tillers to be significant implements for crop production in this region. A smaller group (32%) believed that the use of quality fertilizers also fell under the scope of mechanization, while only 10.7% associated it with the application of insecticides. Despite this variation in interpretation, the majority of farmers (90%) agreed that mechanization brought clear benefits to agriculture. For instance, 70% of the respondents reported using tractors for land preparation. When asked about weed control, 32.7% of farmers mentioned the use of weeders in crop production. However, a notable proportion (47.3%) incorrectly stated that tractors were used for weed control. Regarding seed sowing, 72.7% of the farmers reported using seeders, with an average agreement score of 1.37. Furthermore, 60% of the respondents stated that combined harvesters were used for harvesting paddy in the Haor area. Consequently, a majority (72.7%) viewed the combined harvester as an essential implement for crop production. In the context of mustard cultivation, 61.3% of farmers believed that oil-extracting machines were essential for effective mustard production. Among them, 29.3% considered tractors to be useful implements for growing mustard crops.

**Table 7. Farmers’ perceptions about machinery input for crop production in the Haor area (n=150)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of respondents**  | **Category** | **Respondents (No.)** | **Respondents (%)** | **Rank order**  | **Mean** |
| What do you mean by agricultural mechanization?  | Use of good seeds | 21 | 14 | 3 | 2.83 |
| Use of quality fertilizer | 48 | 32 | 2 |
| Use of insecticides | 16 | 10.7 | 4 |
| Use of machinery in agriculture  | 65 | 43.3 | 1 |
| Don’t know | - | - | - |
| What implements are used to do agricultural work in Haor region? | Tractors | 102 | 68 | 1 | 1.35 |
| Power tiler  | 44 | 29.3 | 2 |
| Combined harvester | 3 | 2 | 3 |
| Don’t know | 1 | 0.7 | 4 |
| Do you think agricultural mechanization has benefited?  | Yes | 135 | 90 | 1 | 1.10 |
| No | 15 | 10 | 2 |
| What implements are used to cultivate land?  | Tractors | 105 | 70 | 1 | 1.35 |
| Harvester | 38 | 25.3 | 2 |
| Thrasher  | 7 | 4.7 | 3 |
| Don’t know  | - | - | - |
| What implements are used to protect the weed? | Tractors | 71 | 47.30 | 1 | 2.26 |
| Harvester | 18 | 12 | 3 |
| Thrasher  | 12 | 8 | 4 |
| Weeder  | 49 | 32.7 | 2 |
| Don’t know | - | - | - |
| What implements are used to sow the seed?  | Seeder | 109 | 72.7 | 1 | 1.37 |
| Harvester | 34 | 22.7 | 2 |
| Thrasher  | - | - |  |
| Weeder  | 7 | 4.7 | 3 |
| Don’t know | - | - | - |
| What implements are used to harvest the paddy? | Tractor | 48 | 32 | 2 | 1.79 |
| Combined harvester | 90 | 60 | 1 |
| Thrasher  | 7 | 4.7 | 3 |
| Ripper | 5 | 3.3 | 4 |
| Don’t know | - | - | - |
| What implements are essential in the Haor region? | Tractor | 24 | 16 | 2 | 1.97 |
| Combined harvester | 109 | 72.7 | 1 |
| Thrasher  | 15 | 10 | 3 |
| Weeder | 2 | 1.3 | 4 |
| What implements are essential to cultivate in mustard crops? | Tractor | 44 | 29.3 | 2 | 3.59 |
| Combined harvester | 11 | 7.3 | 3 |
| Thrasher  | - | - | - |
| Weeder | 3 | 2 | 4 |
| Oil harvesting machine  | 92 | 61.3 | 1 |

**4. Discussion**

The Haor region is recognized as a highly productive area for crop cultivation, significantly contributing to the national economy. As highlighted by Bokhtiar et al. [25] and the World Bank [26], the country's development efforts can’t be foreseeable without the sustainable growth of Haor agriculture. In accordance with this view, the present study assessed demographic, socioeconomic, and agricultural data, alongside farmers’ perceptions of climate trends, natural hazards, and their adaptation practices.

The findings revealed that the average age of the respondents was 33.90 years, with 33.30% belonging to the 31–45 age group. The majority were male (71.30%) with secondary-level education (49.30%), and farming remained the dominant occupation (79.30%). These observations are in line with the results of Ali et al. [6], Aziz et al. [7], and Baishakhy et al. [19], who reported similar socioeconomic characteristics of farmers in the region. A large proportion of farmers were either illiterate or had dropped out after primary education, limiting their access to advanced agricultural knowledge.

According to the survey, most households had 4 to 6 children (54%) and 2 to 4 active working members (67.30%), while 32.70% had only one earning member. These findings corroborate with earlier reports by GoB [2] and BHWD [3]. Additionally, 56% of the respondents were classified as medium farmers, owning between 1.01–3.0 hectares of land. About 75% of the farmers owned their land, which aligned with the findings of Kazal et al. [18] and Kamruzzaman et al. [11]. As reported by Karim et al. [13], the soils in Haor are known to be highly fertile, offering significant potential for agricultural productivity.

Kabir et al. [27] noted that understanding farmers’ perspectives was essential to addressing climate-induced challenges in Haor areas. This study supported that view, as farmers’ perceptions revealed that 42.7% identified climate change as increased frequency of flooding. Approximately 50% believed that temperature, early flooding, thunderstorms, and lightning events had intensified over time, consistent with the findings of Chakraborty et al. [8]. Farmers strongly perceived that Boro rice cultivation was more frequently affected by natural hazards than before, aligning with Dey et al. [9]. Flash floods were identified as the most prominent hazard by 64% of respondents, supporting earlier reports by Gaydon et al. [28]. These hazards often led to complete crop loss in the region, as reported by Kabir et al. [27]. Kamruzzaman et al. [29] also described how Boro rice often became *chita* (immature) due to these extreme events.

In addition to climatic hazards, other constraints such as seed shortages, irrigation problems, and high production costs were commonly reported by farmers, which corroborate with the studies of Karim et al. [13], Rahaman et al. [20], and Rakib et al. [21]. Adaptation strategies were adopted by 56.7% of farmers; however, these were found to be less climate-smart and nutrition-sensitive, as suggested by Ferdushi et al. [10]. Only 53.3% of the farmers diversified their cropping systems by cultivating oilseeds, pulses, or vegetables besides Boro rice, supporting the observations of Hasan et al. [23] and Kamruzzaman et al. [12].

The results reveal that although some farmers are cultivating crops such as maize, potato, and oilseeds during the Rabi season, monocropping of Boro rice remains the dominant practice. This overreliance on a single crop increases vulnerability to climatic hazards and limits soil fertility and income diversity, as also noted by Ferdushi et al. [10] and Nath et al. [16]. Encouraging crop diversification is therefore essential to enhance both resilience and nutritional outcomes.

The lack of technological knowledge emerged as a major barrier to practicing climate-resilient and modern farming techniques. This finding was consistent with Hansen et al. [22], who identified poor technical know-how as a limiting factor in climate adaptation. As a result, both vegetable cultivation and consumption remained low among Haor farmers, leading to nutritional deficiencies such as vitamin A and C deficiencies. However, the farmers showed willingness to adopt nutrition-sensitive and high-value crops if technical support were available, as suggested by Hoq et al. [24] and Jakariya et al. [4]. The current study confirmed that the primary strengths of Haor agriculture were fertile soil and surplus rice production, while monocropping and malnutrition were notable weaknesses, aligning with Nath et al. [16].

Regarding access to information, 90.7% of farmers reported receiving advice from the Department of Agricultural Extension, though a few respondents expressed dissatisfaction—an observation also reported by Khan et al. [15]. In terms of agricultural mechanization, 43.3% of the farmers considered tractors as essential machinery for the sector, aligning with the findings of Suvra [17] and Uddin et al. [14]. Moreover, 60% of the respondents indicated the use of combined harvesters for paddy harvesting, and 72.7% agreed that such implements were indispensable for modern crop production. These results are in line with the study of Nath et al. [16], while Karim et al. [13] further emphasized that mechanization significantly facilitated agricultural tasks and improved farmers’ livelihoods.

**5. Conclusion**

This study aimed to explore farmers’ perceptions of climate change impacts on cropping systems in the Haor region. The findings revealed that farmers’ understanding of climate change remained relatively limited; only 42.7% associated climate change with the increased frequency of flooding, while approximately 50% believed that temperature, early flooding, thunderstorms, and lightning had intensified over time. Farmers strongly agreed that Boro rice cultivation is now more frequently affected by natural hazards compared to the past. In addition to climatic challenges, other major constraints included seed shortages, inadequate irrigation facilities, and high production costs. Although 56.7% of the farmers adopted certain adaptation strategies, these were found to be neither climate-smart nor nutrition-sensitive. Moreover, only 53.3% of farmers diversified their cropping systems by cultivating oilseeds, pulses, or vegetables alongside Boro rice. A key barrier to adopting climate-resilient practices was the lack of technological knowledge. The trends of both vegetable cultivation and consumption among Haor farmers were notably low, contributing to nutritional deficiencies such as vitamin A and C shortages. However, farmers expressed a willingness to cultivate nutrition-sensitive and high-value crops, provided that adequate technical support is made available. Overall, the study highlighted that the major strengths of Haor agriculture lie in its fertile soils and surplus rice production. Conversely, its principal weaknesses include the prevalence of monocropping and widespread malnutrition.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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