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Climate Smart Agriculture in Golapganj Upazila, Sylhet Bangladesh: Farmers Perspectives and Challenges

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Abstract

The farmers of Golapganj upazila in Sylhet district were surveyed on the views of climate-smart agriculture (CSA) practices and their difficulties. A survey was conducted with sixty randomly selected farmers from Gondamara and Turupbag villages in Bagha union, Golapganj upazila, Sylhet district. Validation was conducted using a focus group discussion. The investigation revealed 17 CSA practices in the study area. These practices were high-yielding variety (78.3%), perching (63.3%), adjusting planting time (51.6%), mulching (46.6%), farm yard manure (46.6%), short-duration varieties (46.6%), IPM (43.3%), intercropping (38.3%), crop rotation (38.3%), pheromone trap (35%), local pesticides (35%), improved livestock breed (25%), agroforestry (23.3%), vermicomposting (23.3%), Sorjan (21.6%), light trap (13.3%), rice-cum-fish farming (10%). The adoption of CSA practices was found to be insufficient, with several key techniques underutilized. Respondents valued strip cropping (60.6%), integrated nutrient management (INM) (60%), water harvesting, and pit planting (53.3%) among twelve CSA techniques. The research area did not use seven climate-smart methods for resilient agriculture—strip cultivation, INM, biochar, solar-based irrigation, sandbar cropping, terrace farming, and pit planting. Intervention is possible in both research and extension. They had problems with animal breed (60.6%), technical expertise, and capital (56.6%). A three-tier up-scaling approach (information transfer, entrepreneur development, and policy inclusion) was proposed to enhance CSA adoption in the study area.

Keywords: Climate smart agriculture, Climate change, Constraints, Sylhet

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Introduction

According to the Food and Agriculture Organization (FAO), climate-smart agriculture (CSA) is defined as agriculture that develops opportunities to reduce greenhouse gas (GHG) emissions from agriculture compared to past trends, adapts and builds resilience to climate change from the farm to national levels, and sustainably increases productivity to support equitable increases in incomes, food security, and development (e.g., Ruba and Talucder, 2024; Talucder and Ruba 2023; Ruba and Talucder, 2023; Lipper et al., 2014). The three key goals of climate-smart agriculture are to reduce greenhouse gas emissions whenever possible, adapt to climate change, build resilience, and increase agricultural output and incomes in a sustainable manner. By implementing appropriate practices, policies, and investments, the agriculture sector can transition towards circular economy (CSA) pathways. This would mitigate short-term food insecurity and poverty while mitigating the long-term threat of climate change to food security (Talucder et al., 2021; Lipper et al., 2014). Bangladesh ranked sixth globally in terms of climate vulnerability in 2017, according to the Global Climate Risk Index (GCRI) (Kreft et al., 2017). Moreover, Bangladesh's early agricultural practice stage's inadequate infrastructure development fundamentally constrains the upkeep and advancement of agricultural activity, with markets for input procurement, organizations for obtaining the necessary irrigation infrastructure, and communication channels for transportation services all playing a significant role. Bangladesh's population is growing at a startling rate, while the country's arable land is disappearing as a result of industrialization and urbanization. This is worsening food shortages and increasing crop losses due to natural disasters. Climate-smart farming strategies must be implemented and studied for crop production to meet the Eastern Indo-Gangetic Plain's increasing food demand and maintain resilient agriculture, given the inability to entirely eliminate or manage climatic dangers.

Onyeneke et al., (2017) have identified five broad and significant practices that are pertinent to climate-smart agriculture. These practices include: modifying agricultural production systems; moving around and utilizing social networks; managing farm finances; diversifying both within and outside the farm; and managing knowledge and regulations. Farmers use early and late planting techniques as a climate-smart tactic (Paul et al., 2018; Afrin et al., 2017). Sustainable crop production, climate-smart agricultural methods play a major role in ensuring food security in Bangladesh (Billah and Hossain, 2017; Hasan et al., 2018). Paul (2018) listed thirteen climate-smart practices for growing boro rice, including planting trees on cropland, vermicomposting, green manuring, alternate wetting and drying (AWD), modifying planting time, HYV in Sylhet Sadar upazila, perching, light trap, crop rotation, rice-cum-fish farming, rice-cum-duck farming, ratoon crop, and urea super granule. The research area's adoption of climate-smart boro rice management practices, according to the author, was not up to par. As a result, a study was conducted in Golapgonj upazila, Sylhet district, to determine the state, attitudes, and limitations of climate-smart farming methods. This study will provide a paper regarding the state of CSA practices that the farmers in Golapgonj Upazila have implemented for future research (Datta et al., 2023). In order to come up with a good up-scaling framework, the study's specific goals were to find out how people thought certain weather events changed and how they affected farming, as well as how people thought certain CSA practices in the study area were important and how much they limited things.

Materials and Methods

Study area

The study was conducted in the Sylhet district's Golapganj upazila. A study was conducted on two randomly selected villages from the Bagha union (Turupbag and Gondamara) among the unions of Golapganj upazila. The data collection in 2018 took place from January through July. Figure 1. show a map of Golapganj upazila showing Bagha union and a map of Sylhet district showing Golapganj upazila showing Bagha union.

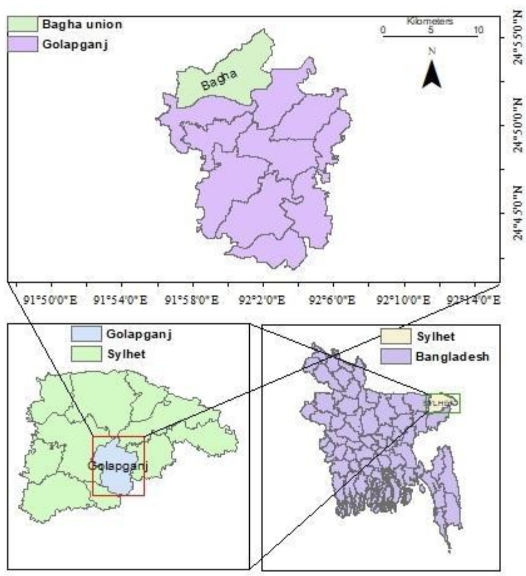

Fig. 1. A Map of Study Site

Population and sample

Two villages were selected randomly from the upazila of Golapganj. In this study, the population consisted of farmers from these two communities. Thirty farmers from each hamlet were randomly selected to serve as the study's sample. Thus, 60 became the sample size. A backup list of ten respondents was created in case any went missing.

Result and Discussion

Socio-economic characteristics of the respondents: The mean age was 45.02 and the standard deviation was 14.33 for respondents aged 20–75. The respondents' educational levels ranged from 0 to 16, with a mean of 5.42 and an SD of 3.82. The respondents' household income ranged from BDT 24-1080.00, with a mean of 272.1 and a standard deviation of 293.7. None of the respondents got credit. 55% had agricultural training. The study area has plain (76.6%) and slope (8.3%) topography. The maximum responses (93.3%) were erosion-free. The results showed that 68.3% of respondents had access to weather forecast services and 31.6% did not.

Table 1. Salient features of the selected Socio-economic characteristics of the farmers in Golapganj upazila

Characteristics	Response	Frequency	Percentage	Mean	Standard deviation
Age (Years)	Young aged (18-35)	14	23.33		
	Middle-aged (36-50)	24	40.00	45.02	14.33
	Old aged (above 50)	22	36.67		
Education level (Schooling years)	Illiterate (0)	10	16.67		
	Primary (1-5)	25	41.67	5.42	3.82
	Secondary (6-10)	22	36.67		
	Higher studies (11 & above)	3	5.00		
Family size (Number)	Small family (<5)	15	25		
	Medium family (5-8)	23	38.33	6.88	3.33
	Large family (>8)	22	36.67		
Farm size(acre)	Landless & marginal (<0.21)	12	20.0		
	Small (0.21-1.0)	17	28.3	2.11	4.18
	Medium (1.1-3.0)	21	35		
	Large (>3.0)	10	16.6		
Annual family income (Thousand ‘000’ TK.)	Low income (Up to 100)	20	33.33		
	Medium income (101-200)	13	21.67	272.1	293.07
	High income (above 201)	27	45.00		
Credit received	Received	0	0		

Characteristics	Response	Frequency	Percentage	Mean	Standard deviation
	Not Received	60	100.00		
Agricultural training	Received	33	55.00		
	Not Received	27	45.00		
Extension contact	Contact	60	100		
	No contact	0	0		
Land topography	Plain	46	76.6		
	Slope	5	8.3		
	Both	9	15		
Erosion hazard	Found	4	6.7		
	Not Found	56	93.3		
Access to weather forecast services	Yes		68.3		
	No		31.6		

Farmers' perception of experiencing climate change and its impact

Perceptions on experiencing climate change: In Table 2, farmers respond to specific weather events. Here, all responders reported increased lightning, rainfall, unpredictable rain, earthquakes, fog, and a foggy sky. According to 85% of respondents, lighting increased at all events. 73.3 percent reported increased rainfall. Paul (2018) in “Status of Climate Smart Practices in Boro Rice Cultivation at Sylhet Sadar Upazila” found increasing temperature along with decreasing rainfall might enhance water scarcity resulting in drought, which, in turn, may affect crop production. In the Bagha Union of Golapganj Upazila, it was found that drought was not their main concern of climatic events. The majority of farmers believed that rising rainfall, lightning, earthquakes, a gloomy sky, and unpredictable rain could impair crop productivity. According to research, 90% of respondents reported flash floods diminishing. Lowering flash floods may help farmers meet production targets.

Table 2. Farmers' perceptions of changes in particular climatic events in Golapganj Upazila (n = 60)

Climatic Events	Respondents (%)							
	Increased		Decreased		No change		Don't know	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Lightening	51	85.0	0	0.0	0	0.0	9	15.0
Rainfall	44	73.3	4	6.7	0	0.0	12	20.0
Temperature	14	23.3	14	23.3	2	3.3	30	50.0
Drought	14	23.3	14	23.3	2	3.3	30	50.0
Flash flood	0	0.0	54	90.0	2	3.3	4	6.7
Hailstorm	24	40.0	1	1.7	29	48.3	6	10.0
Unpredictable Rain	22	36.7	1	1.7	0	0.0	7	11.7
Earthquake	17	28.3	0	0.0	0	0.0	13	21.7
Fog	0	0.0	13	21.7	0	0.0	17	28.3
Cloudy Sky	12	20.0	0	0.0	0	0.0	18	30.0
Speedy wind	11	18.3	0	0.0	0	0.0	19	31.7

Perceptions regarding the impact of climate change on the farming system: Findings revealed that 98.3% of respondents believed that increasing the impact of insect assaults and crop production costs would have the greatest overall impact. Soil fertility has declined, according to 98.3% of respondents. Table 3 shows that 38.3% of respondents said there has been less crop failure. The efforts are needed to encourage farmers to use this technique, which improves soil fertility and structure at a low cost of production, as crop production costs and pest attacks rise.

Table 3. Responses of farmers on the impact of climate change on farming systems in Golapganj upazila (n=60)

Types of impact	Respondents (%)							
	Increased		Decreased		No change		Don't know	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Crop failure	11	18.3	23	38.3	0	0	26	43.3
Cost of crop production	59	98.3	0	0.0	0	0	1	1.7

Types of impact	Respondents (%)							
	Increased		Decreased		No change		Don't know	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Pest attack	58	96.7	0	0.0	0	0	2	3.3
Soil fertility	0	0.0	59	98.3	0	0	1	1.7
Others	0	0.0	0	0.0	0	0	0	0.0

Existing climate-smart agricultural practices: Malozo (2017) stated that the agricultural sector must become climate-smart to successfully tackle current food security and climate change challenges. The farmers in the research area were asked questions about eighteen CSA practices, whether they practiced them or not. Each of them had done seventeen CSA practices. Table 4 shows that 78.3% of the participants used high-yielding varieties (HYV), whereas 10% and 11.6% had medium and low usage, respectively. Malozo (2017) stated that one key technology is improved seeds which are early-maturing and drought-tolerant crop varieties. Hasan et al., (2018) stated about an early variety of rice (110–120 days) which can be harvested before cyclones that are likely to hit in November. Regarding improved livestock breeds, a sizable portion of respondents (28.3%) are ignorant. 51.6% of respondents significantly altered the crop varieties' planting times, according to the survey. 38.3% of respondents highly adopted crop rotation, while 23.3% did not accept it at all. While 20% of the respondents did not use mulching at all, 46.6 percent of them strongly adopted the practice. Hasan et al., (2018) also identified the sorjan method, urea deep placement, organic fertilizer, mulching, use of pheromone trap, and rainwater harvesting as CSA practices in Kalapara upazila in Patuakhali, Bangladesh. 61.6% of respondents did not embrace vermicomposting at all, whereas just 23.3% used it highly, 8.3% at a medium level, and 6.6% at a low level. Hammermeister et al. (2004) showed that vermicompost manure have high level of N then the regular manure. 46.6% of respondents used FYM at a high level, whereas 68.2 percent used farm yard manure overall. The majority of farmers (76.6%) did not practice rice cum fish farming in the fields. 43.3% of the respondents highly embraced integrated pest management (IPM), 13.3% adopted it moderately, 8.3% adopted it lowly, and 35% did not adopt it at all. Hasan et al., (2018) stated that pheromone trap is used to control insect pests in crops and vegetables. Sheikh et al., (2016) stated that terrestrial insects are the most diverse groups of animals and contribute to biodiversity to a large extent. In their fields, however, a sizable percentage of farmers did not employ the light trap (81.6%) or pheromone approach (45%). Malozo (2017) stated that agroforestry systems play important roles in increasing the resilience to climate change impacts for small-scale farmers and in large landscape approaches. The respondents' adoption rates of high-level agroforestry (23.3%) and intercropping (38.3%) were rather low. All respondents

(100%) completely avoided using the alternative wetting and drying (AWD) approach. Among the respondents, employing local pesticides (35%) and short-duration varieties (46.6%) was also not very common. Onyeneke et al., (2017) stated that the use of local pesticides increases yields, and increases resilience against climate change. While 51.6% of them did not use the Sorjan approach at all, it is crucial to do so in order to improve productivity and soil fertility. The aforementioned practices are thought to have been applied to (i) improve agricultural productivity and food security for resilient agriculture, (ii) adapt agriculture to climate change, and (iii) modify agriculture to mitigate climate change (Talucder et al., 2021; Lipper et al., 2014).

Table 4. Status of existing climate-smart agricultural practices

Agricultural practices	Percent (%) respondents			
	High	Medium	Low	Not at all
High yielding variety	78.3	10.0	11.6	0.0
Improved livestock breed	25.0	16.6	30.0	28.3
Adjusting planting time	51.6	18.3	25.0	5.0
Crop rotation	38.3	15.0	23.3	23.3
Mulching	46.6	26.6	6.6	20.0
Application of vermicompost	23.3	8.3	6.6	61.6
Farmyard manure	46.6	10.0	11.6	31.6
Rice-cum-fish farming	10.0	5.0	8.3	76.6
Integrated pest management	43.3	13.3	8.3	35.0
Pheromone trap	35.0	15	5.0	45.0
Light trap	13.3	0.0	5.0	81.6
Perching	63.3	16.6	10.0	10.0
Intercropping	38.3	26.6	13.3	21.6
Agroforestry	23.3	20.0	15.0	41.6
Alternate wetting and drying	0.0	0.0	0.0	100
Short duration varieties	46.6	23.6	6.6	23.6
Sorjan method	21.6	20.0	6.6	51.6
Local pesticides	35.0	21.6	11.6	31.6

Farmers perception of potential CSA practices: McCarthy and Brubaker (2014) stated that Conservation Agriculture (CA) is promoted as one of the most important, triple-win, CSA practices, and includes the three core principles of minimum soil disturbance; permanent soil cover; and crop rotation. The respondents were asked to express their opinions on the significance of CSA procedures, using a four-point rating system that included very important, somewhat significant, less important, and not at all. For 45 percent of the responses, zero tillage was not as important. For sixty percent of the respondents, integrated nutritional management (INM) was crucial. Kurbah (2016) stated that Integrated Nutrient Management proved to be the best approach for sustainable crop production as well as reducing environmental pollution. 53.3% of the respondents placed a high value on water harvesting due to its potential to apply to fields and reduce the expense of extra irrigation. Though a sizable portion of respondents (56.6%) were undecided, applying biochar to agricultural soils has the potential to decrease carbon and nitrogen release. Although a sizable percentage of respondents (33.3%) were undecided, those who are landless can utilize a floating seed bed to grow seedlings on floating surfaces. Fifty-three percent of the respondents stated that pit planting was very important. 36.6% of the respondents deemed mounding extremely significant for crop growth in barren areas. Although 40% of respondents were unaware of its significance, terracing will reduce erosion by preventing heavy rains from building velocity as they roll down the slope. Conversely, 66.7% of respondents, the largest percentage, expressed concern about the significance of stripping. Francis et al., (1986) said that strip cropping has the potential to reduce erosion on hilly lands, to allow a crop rotation in the field if strips are changed from one season to the next, and to increase total system yields.

Table 5. Farmers' perception towards potential climate-smart agricultural practices

CSA practices	Percent (%) respondents			
	Very Important	Moderately Important	Less Important	No opinion
Zero tillage	28.3	20	45	6.6
Integrated Nutrient Management	60.0	23.3	6.6	10.0
Solar-based irrigation	30.0	20.0	23.3	26.6
Water harvesting	53.3	16.6	28.3	1.6
Biochar	26.6	1.6	15.0	56.6
Floating bed fodder cultivation	35.0	8.3	28.3	1.6
Floating seed bed	36.6	10.0	20.0	33.3
Sandbar cropping	36.6	11.6	26.6	25.0
Pit planting	53.3	21.6	20.0	5.0
Mound	36.6	23.3	16.6	23.3
Terrace	35.0	15.0	10.0	40.0
Strip Cropping	66.7	15.0	1.6	16.6

Constraints in using Climate Smart Agricultural Practices: In the study area, the farmers were facing very constraints in livestock breed (60.6 %), necessary knowledge (56.6%), capitals (56.6%), and improved variety (51.6%). On the other hand, they were facing fewer constraints in advice in proper time (38%), training (28.3%), irrigation water (25%), and farm inputs & incentives (43.3%).

Table 6. Farmers' perception regarding constraints in using climate smart agricultural practices

CSA practices	Percent (%) respondents			
	Very constraint	Moderate constraint	Low constraint	No opinion
Lack of improved variety	51.7	13.3	21.6	13.3
Lack of improved livestock breed	66.7	15.0	10.0	8.3
Lack of technical necessary knowledge	56.6	16.6	15.0	11.6
Lack of advice at the proper time	38.3	18.3	16.6	26.6
Lack of training	28.3	38.3	16.6	16.6
Lack of incentives	43.3	8.3	15.0	33.3
Lack of capitals	56.6	25.0	10.0	8.3
Lack of irrigation water	25.0	25.0	16.6	33.3
Unavailability of farm inputs	43.3	18.3	11.6	26.6

Pools of existing CSA practices: The study area's current CSA methods were categorized into six groups: knowledge smart, pest smart, weather smart, nutrition smart, carbon smart, and water smart. Six pools of CSA alternatives were also revealed by Paudel et al., (2017): carbon smart, nutrient smart, water smart, weather smart, knowledge smart, and energy smart. Nevertheless, no practices falling under the energy smart pool were discovered.

Table 7. Pools of existing Climate Smart Agricultural practices in Golapganj upazila of Sylhet district

Pools	Existing practices
Pest smart	Perching, IPM, Crop rotation, Pheromone trap, Light trap, Use of local pesticide
Carbon smart	Zero tillage, Rice-cum-fish farming
Nutrient smart	Farmyard manuring, Vermicomposting, Agroforestry
Water smart	Water harvesting, Sorjan method, Mulching
Weather smart	Adjusting planting time
Knowledge smart	High-yielding varieties, Improved livestock breed, Short duration varieties, Intercropping

Attributes of existing practices under the CSA framework: Table 8 displays the CSA practices that were reported in the research region. The CSA framework's current methods have the potential to lower greenhouse gas emissions while also adjusting to climate change and boosting agricultural productivity in a sustainable manner.

Table 8. Attributes of existing CSA practices at Golapganj Upazila

Existing practices	Attributes of the existing CSA practices		
	Sustainably increasing agricultural productivity	Adapting and building resilience to climate change	Opportunities to reduce GHG emissions
High yielding variety	√		
Improved livestock	√	√	
Adjusting planting time		√	
Crop rotation		√	
Mulching	√	√	
Vermicomposting	√		√
Farmyard manuring	√		
Rice-cum-fish farming	√		√
Integrated pest management (IPM)	√	√	
Pheromone trap	√	√	
Light trap	√		
Perching	√	√	
Intercropping	√	√	√
Agroforestry	√	√	
Short duration varieties	√	√	
Sorjan method		√	
Use of local pesticides	√		√

Key challenges associated with adopting CSA Practices: It was mentioned that implementing the current CSA methods in the research sector presented certain difficulties. Table 9 lists the difficulties in implementing current CSA procedures.

Table 9. Challenges associated with adopting existing CSA practices at Golapganj upazila of Sylhet district

CSA Practices	Challenges reported
High yielding varieties	Poor quality and higher price of HYV. Pest and disease susceptibility.
Improved livestock	Quality, price, and unavailability of new breeds.
Adjusting planting time	Lack of information.
Crop rotation	Lack of information.
Mulching	Lack of information.
Vermicomposting	Lack of information and skill.
Farmyard manuring	Lack of proper knowledge and skill.
Rice-cum-fish farming	Lack of proper knowledge and skill.
IPM	Lack of proper knowledge and skill.
Pheromone trap	Lack of proper knowledge and skill.
Light trap	Lack of proper knowledge and skill.
Intercropping	Lack of information.
Agroforestry	Insufficient information and lack of skill.
Short duration varieties	Lack of information and availability.
Use of local pesticides	Lack of information and supply.

Proposed approach for up-scaling potential CSA options: The term "approach for up-scaling" refers to the series of actions taken in order to encourage the extension and demonstration of promising CSA technologies in cooperation with regional communities and government stakeholders in order to help them make decisions about agriculture's adaptation to climate change. A three-tier up-scaling approach was proposed consisting of different time scales for the study area. A three-tier upscaling approach was also put forth by Paudel et al., (2017) for CSA choices in Nepal and Afrin et al., (2017) in Jaintiapur, Bangladesh. The "up-scaling approach" that has been suggested is a crucial strategy for tackling the problems posed by climate change and agricultural variability. The proposed approach for up-scaling potential CSA options is shown in Table 10.

Table 10. Proposed approach for up-scaling potential CSA options at Golapganj upazila of Sylhet district

Up-scaling Approach	Examples of proposed CSA options	Time scale	Role of contributors
Information-transfer approach	Community seed banks, Vertical drainage, pH management, Sandbar cropping, Rice-cum-fish farming, Case-fish farming, Farmer managed natural regeneration, Agroforestry, etc.	Short term	Support for extension and information dissemination through demonstration and training with financial incentives to target the local community.
Entrepreneur development approach	Biochar, water-saving laser land leveling, Improved cook stoves, etc.	Short and/or mid-term	Attract entrepreneurs by providing financial support and removing barriers.
Policy inclusion approach	Solar-based irrigation, Agricultural insurance, site-specific real-time-based time-based agro-advisory services, weather forecasts, Incentive for CSA practices, etc.	Long term	Framing the situation, describing the dynamics, and synthesizing the understanding into a policy framework for priority and investment

Conclusion

Bangladesh is among the most climate-vulnerable nations. Farmers introduced several climate-smart agricultural improvements on their own and with government and non-government financial and technical backing. Based on findings, policies should engage farmers in different organizations and societies to broaden their outlook, develop positive adaptation attitudes, and promote climate-smart technologies and practices through training, radios, seminars, demonstrations, FFS, and integrating approaches. Here, GOs and NGOs can also be crucial. The research identified and analyzed promising CSA technologies in a short time. Scaling CSA is a long-term, non-linear process that often includes multiple actions. Future studies should develop policy measures, document CSA practices in different agricultural production systems, examine CSA technology adoption and spread in different bio-physical and socio-economic conditions, and identify CSA adoption drivers.

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