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COASTAL FARMERS' KNOWLEDGE ON CLIMATE SMART AGRICULTURE IN BANGLADESH

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Abstract

Climate smart agriculture (CSA) is highly knowledge-intensive and innovative by nature. This study aimed to assess the extent of knowledge of coastal farmers about CSA and explore the contributions of the selected characteristics of the coastal farmers to their knowledge. Data were collected by using an interview schedule from 354 coastal farmers from 3 districts, namely Satkhira, Khulna, and Bagerhat, through the multistage random sampling method from December 2021 to March 2022. Descriptive and inferential statistics were used. To explore the contribution of the predictor variables to the outcome variables, full model regression analysis was employed. Results indicate that about 14.1% of the farmers had poor knowledge, 75.1% had medium-level knowledge, and the rest, 10.7%, had high-level knowledge of CSA. Farmers' education, annual agricultural income, extension contact, decision-making ability, and benefit obtained from CSA had significant positive contributions to their CSA knowledge. The findings indicate that the government should invest in improving farmers' decision-making ability and education, including agricultural extension and advisory services, which are the cornerstones of knowledge improvement regarding CSA and like other new approaches.
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Keywords: Coastal farmers, CSA, Knowledge, Intensive, Innovative

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Introduction

The coastal zone contributes approximately 16 percent of the total rice production of the country, covering about 70 percent of the total paddy-cropped area (Huq *et al*., 2005). The entire coastal regions of Bangladesh are increasingly susceptible to flooding tropical cyclones and associated saltwater intrusion (Roy *et al.*, 2019; Ramírez-Villegas and Thornton, 2015). The impacts of coastal hazards have been diminishing the potentials of these regions and thus drawing national and international concerns for protecting coastal agriculture through implementing numerous initiatives such as formulating the Master Plan for the Southern Agricultural Development (MoA and FAO, 2013). Addressing climatic challenges will require radical changes in agricultural systems. These systems have to become more efficient and resilient at every scale from the farm level to the global level. They have to become more efficient in resource use (use less land, water, and inputs to produce more food sustainably) and become more resilient to changes and shocks. In this situation, FAO has introduced the concept of climate smart agriculture (CSA) as a way forward for food security in a changing climate. CSA aims to improve food security, help communities adapt to climate change and contribute to climate change mitigation by adopting appropriate practices, developing enabling policies and institutions and mobilizing needed finances (Mahashin and Roy, 2018). CSA is an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper *et al.*, 2014). FAO (2013) defined CSA as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces and removes Greenhouse gases (mitigation) where possible, and enhances achievement of national food security and development goals". In these definitions, the principal goal of CSA is identified as food security and development (Lipper *et al.*, 2014; FAO, 2013); while productivity, adaptation, and mitigation are identified as the three interlinked pillars necessary for achieving this goal.

Knowledge is a key factor in adoption of climate-smart technologies. Knowledge refers to what the respondents know about it (IDAF, 1994). It is the result of some activity such as generation, storage, dissemination and utilization of something that entails either information or data. It is usually based on learning, thinking, and a proper understanding of the problem area (Azad, 2013). If a farmer does not have proper knowledge on CSA, he or she will not be interested in practicing CSA. Any farmer practicing CSA without proper knowledge on it, he or she will face a lot of problem and his farming will be difficult and consequently he will lose hope and discontinue practicing CSA and finally cannot cope with changing climate, his production will be reduced. Therefore, assessing knowledge on CSA will make us understood its level in the farmers and thus help us to take necessary intervention for them. This study carried out the extent of assessing the farmers' knowledge on CSA, describing, and exploring the contributions of the selected characteristics of the coastal farmers to their knowledge on CSA.

Materials and Methods

Study area

The study area of this research was three coastal upazilas namely Tala, Dacope and Morrelgonj of the districts of Satkhira, Khulna and Bagerhat respectively. Some basic facts of the study area like agroecological zone (AEZ), area, population, literacy rate, major crops, etc. are presented in Table 1 as stated in BBS (2021).

Population and sample of the study

Out of 19 coastal districts of Bangladesh 3 districts, viz. Satkhira, Khulna and Bagerhat were purposively selected as study area. Three upazilas were randomly selected from these districts taking one upazila from each district. Nine villages from these three upazilas were again selected randomly taking 3 villages from each upazila. A total of 4489 farm families were found from selected nine villages and this number was considered as the population of the study. As the number of farmers in each of the villages was not the same, from each of the locations a 'proportionate random sampling' technique was used and the sample size was found 354. To make a respective sample from the population the formula was used as developed by Kothari (2004).

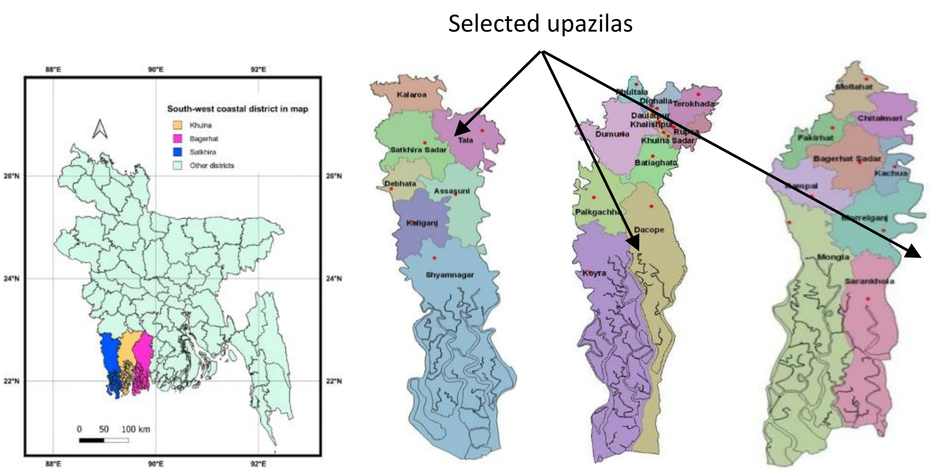

Fig. 1. A map of Bangladesh (left side) with its administrative districts. Right side: maps of three districts (Satkhira, Khulna and Bagerhat) with three upazilas (Tala, Dacope and Morrelgonj) from where data were collected

Table 1. Basic facts of the study area

Study area	AEZ	Area (km^2)	Population (000)	Literacy	Major crops	Existing major CSA practices	Cropping intensity
Morrelgonj, Bagerhat	13	460.90	295	60.7%	Paddy, Potato, sugarcane	Plastic irrigation pipe, Salinity resistant variety, Mulching, etc.	132
Dacope, Khulna	13	991.58	152	56%	Paddy, Watermelon,Potato, pumpkin	Plastic irrigation pipe, Rain water harvesting, Watermelon cultivation, etc.	114
Tala, Satkhira	11	344.15	300	50.9%	Paddy, Jute, Brinjal, Sugarcane	Ridge planting, raised bed planting, mulching, etc.	198

$n = [Z^2 P QN] / [(N\text{-}1) e^2 + Z^2 P Q]$

Where, n = Sample size

Z = Table value at 1 d.f. (1.96)

P = Probability (assume 0.5)

Q = Remaining from probability (1-P) = 0.5

N = Total population = 4489

e = The level of precision (5%)

By putting the values in the above formula, the sample size was determined as follows-

$$n = \frac{Z^2 PQN}{(N-1)e^2 + Z^2 PQ}$$

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 4489}{(4489-1) \times (0.05)^2 + (1.96)^2 \times 0.5 \times 0.5}$$

$$n = 353.95 \approx 354$$

Variables and instruments for data collection

Data were collected by the household' survey, using an interview schedule from 354 coastal farmers during December 2021 to March 2022. Coastal farmers' knowledge on CSA was the main focus of this study and it was considered as the dependent variable. Education, farm size, annual agricultural income, farming experience, extension media contact, training exposure, innovativeness, credit availability, access to market, access to ICTs, decision making ability and benefit obtained from CSA were considered as the predictor/independent variables of this study.

Measurement of the variables

Measurement of knowledge on CSA

The content of the knowledge test is composed of questions called items. Items for the test were collected from different sources, such as literature, agronomists, horticulturists, soil scientists, agricultural economists, entomologists, plant pathologists, agri-environmentalists, and agricultural extension personnel, NGO professional and progressive farmers. The questions were designed to test the climate-smart agricultural knowledge of the coastal farmers. The items were collected and prepared in relation to climate change and its impact on agriculture, productivity, adaptation and mitigation strategies for food production. According to Anderson and Krathwohl (2001), a set of 20 questions taking 4 from remembering, 4 from understanding, 4 from applying, 4 from analyzing, 2 from evaluating and 2 from creating related to CSA were asked to the respondents and a score of 2, 1 or 0 were assigned for each of the correct, partially correct and wrong answers, respectively. Then the possible knowledge score of a farmer could range from 0 to 40 where 0 indicated very poor knowledge and 40 indicated very high knowledge on CSA. Based on the previous studies, for example, Roy *et al.*, 2021; the measurement procedure of independent variables is given in Table 2 below.

Data entry and analysis

Data from all the interview schedules were coded, tabulated and analyzed in accordance with the objectives of the study. Data checking tools like outliers checking and removing multi-collinearity were employed. Pearson product-moment correlation test was initially done and found no strong correlation (r > 0.8) between two or more predictors in the regression model. The analysis was performed using SPSS software version 21. Descriptive analysis such as range, numbers and percentage distribution, mean and standard deviation (SD) were used. Full model regression analysis was used to find out the contribution of the predictor variables to the outcome variable.

Table 2. Measurement of independent variables

Variables	Measurement
Education	Number of years of schooling
Farm size	Total quantity of farming land in ha, including gardening and fishery
Annual agricultural income	Total yearly earning from farming
Farming experience	Number of years a farmer was involved in farming
Extension media contact	Total scores of a respondent on his nature and frequency of 14 selected extension media
Training experience	Total number of days that a respondent had undertaken different types of training related to agriculture/climate smart agriculture
Innovativeness	Scores assigned for respondent farmer as 5, 4, 3, 2, and 1 for innovators, early adopters, early majority, late majority and laggards respectively
Credit availability	Percentage of loan received against his/her sought amount
Access to the market	Score by using a 3-point rating scale of buying inputs and selling goods for his farming activities
Access to ICTs	Score using 4-point rating scale of selected five technologies
Decision making ability	Score obtained by using a 3-point rating scale of the six selected items
Benefit obtained from CSA	Score obtained using 4-point rating scale of 20 selected benefits

Result and Discussion

Extent of knowledge on climate smart agriculture

Coastal farmers' knowledge scores could range from 0 to 40. However, their observed knowledge scores ranged from 17 to 32, the mean was 25.45 and standard deviation was 3.86. The distribution of the farmers according to their knowledge level is shown in Table 3. The Table reveals that the majority (75.14%) of the farmers had medium-level knowledge followed by 14.13% had poor knowledge and 10.73% had high level knowledge on CSA. Farmers having poor to medium-level of knowledge constitute 89.27% of the total farmers. The adverse climatic conditions compelled majority of the farmers to practice several CSA technologies available to them and by practicing CSA they acquired some knowledge on it.

Table 3. Distribution of the coastal farmers according to their knowledge on CSA

Categories	Number	Percent	Mean	SD
Poor knowledge (<50% marks obtained)	50	14.13	25.45	3.86
Medium-level knowledge (50-75% marks obtained)	266	75.14		
High level knowledge (>75% marks obtained)	38	10.73		
Total	354	100		

Source: Authors

The education of the farmers might influence their knowledge as 12.72% (Table 3) of the farmers were illiterate this portion might have poor knowledge on CSA. Furthermore, extension contact might influence the majority of the farmers (89.27%) acquiring poor to medium-level knowledge on CSA as majority (86.15%) of the farmer had low to medium extension contact (Table 4) while extension contact had a significant positive contribution to their knowledge on CSA (Table 5). Israel (2019) and Ochieng (2015) found almost similar results regarding knowledge on climate change that the majority (72% and 81% respectively) of the respondents had poor to medium-level knowledge on climate change. Rahman (2015) and Hassan (2004) also found almost similar results regarding the knowledge of farmers that the majority (75% and 70.4% respectively) of them had medium-level knowledge on rice cultivation and partnership extension approach in their respective studies.

Selected characteristics of the coastal farmers

Table 4 indicates that only 12.71% of the farmers were illiterate and the rest 87.29% were literate which was composed of secondary education (59.32%), primary education (20.06%), higher secondary education (5.37%) and tertiary education (2.54%). Over time, through the government's initiatives, different NGOs' education programmes (e.g., BRAC school) and social involvement and the need of the farmers, they somehow obtained literacy for which literacy is little greater than the national average. About half of the respondents (50.56%) had low annual agricultural income; their annual agricultural income was up to Tk.150000. The next group were medium-income farmers (40.68%) while the lowest proportion belonged to high-income group (8.76%). Mittra and Akanda (2019) found similar results in their study that the majority (62.2%) of the coastal farmers had low annual income. The majority (68.64%) of the farmers had medium extension contact followed by low media contact (17.51%) and high media contact (13.85%). Rahman (2018) found similar results that the majority (65.1%) of the farmers had medium extension contact. The majority (69.49%) of the respondents had medium decision-making ability, while 19.49% and 11.02% had high and low decision-making ability, respectively. Hossain (2017) found almost similar results that the majority (62.9%) of the respondents had medium decision-making ability. The highest proportion (75.42%) of the farmers belonged to the category of medium-benefits obtained from CSA, while 9.32% and 15.26% belonged to low-benefit obtained and high-benefits obtained from CSA categories, respectively.

Contribution of selected characteristics of the farmers to their knowledge on CSA

Results presented in Table 5 show the summarized results of full model multiple regression analysis with 12 independent variables on the farmers' knowledge on CSA. The value of R2 is 0.494, which means that all of the 12 variables accounted for 49.4% of the variation in knowledge on CSA of the coastal farmers. The regression equation obtained is presented below-

Table 4. Salient features of the selected characteristics of the farmers (n=354)

Characteristics	Measuring unit	Range		Categories	Number	Percent	Mean	SD
		Possib	Obser ved					
Education	Year of schooling	Unknown	0-15	Illiterate (0-0.5)	45	12.71	7.53	3.51
				Primary education (1-5)	71	20.06		
				Secondary education (6-10)	210	59.32		
				Higher secondary education (11-12)	19	5.37		
				Tertiary education (>12)	9	2.54		
Farm size	Score	1-5	2-5	Marginal farmer (0.021-0.2)	36	10.20	3.26	0.73
				Small farmer (0.21-1.0)	214	60.5		
				Medium farmer (1.01-3.0)	80	22.6		
				Large farmer (> 3.0)	24	6.8		
Annual agricultural income	Score	1-10	1-10	Low-income farmer (<150)	179	50.56	3.94	1.85
				Medium income farmer (151-300)	144	40.68		
				High income farmer (>300)	31	8.76		
Farming experience	Year	Unknown	10-50	Low experienced farmer (<15)	65	18.36	24.60	9.9
				Medium experienced farmer (15-35)	247	69.77		
				High experienced farmer (>35)	42	11.87		
	S c	0	1 5	Low contact farmer (< 18)	62	17.51		

Characteristics	Measuring unit	Range		Categories	Number	Percent	Mean	SD
		Possib	Obser ved					
Extension media contact				Medium contact farmer (18-28)	243	68.64	23.13	4.66
				High contact farmer (>28)	49	13.85		
Training exposure	No. of days	Unknown	0-7	No trained farmer (0)	260	73.45	0.61	1.26
				Low trained farmer (1-2)	71	20.06		
				Medium trained farmer (3-4)	14	3.95		
				High trained farmer (>4)	9	2.54		
Innovativeness	Score	1-5	1-5	Innovator (5)	39	11.03	3.39	0.92
				Early adopter (4)	122	34.46		
				Early majority (3)	140	39.54		
				Late majority (2)	45	12.71		
				Laggard (1)	8	2.26		
Credit availability	Score	0-100	0-83	No credit farmer (0)	288	81.36	9.84	21.16
				Low credit farmer (<50)	18	5.08		
				Medium credit farmer (50-70)	43	12.15		
				High credit farmer (>70)	5	1.41		
Access to market	Score	0-20	10-17	Low access (<11)	29	8.19	13.47	1.79
				Medium access (11-15)	266	75.14		
				High access (>15)	59	16.67		
Access to ICT	Score	0-15	3-10	Low access (<5)	47	13.28	6.27	1.55
				Medium access (5-8)	274	77.4		
				High access (>8)	33	9.32		
Decision making ability	Score	6-18	11-17	Low decision making (<12)	39	11.02	13.76	1.77
				Medium decision making (12-15)	246	69.49		
				High decision making (>15)	69	19.49		
Benefit obtained from CSA	Score	0-60	34-55	Low benefit (< 40)	33	9.32	45.91	5.09
				Medium benefit (40-51)	267	75.42		
				High benefit (> 51)	54	15.26		

Source: Author

$$Y = b_{0} + b_1X_1 + b_3X_3 + b_5X_5 + b_{11}X_{11} + b_{12}X_{12} + E$$

$$Or,\ Y = 0.01 + 0.177X_1 + 0.244X_3 + 0.112X_5 + 0.817X_{11} + 0.278X_{12}$$

i.e., Knowledge = 0.01+ 0.177 (education) + 0.244 (annual agricultural income) + 0.112 (extension contact) + 0.817 (decision making ability) + 0.278 (benefit obtained from CSA)

For every 1 year of passing in schooling, an extra 0.177 knowledge score was obtained. Rahman (2015) and Mondal (2014) found that the education of the farmers had a significant positive relationship with their knowledge. It might be due to that education makes awareness in a person and leads him to acquire knowledge on a matter that he is involved. For increasing the annual income of every 1 score (Tk.50000), an extra 0.244 knowledge score was obtained. Mandal (2016), Dhali (2013) and Sharif (2011) also found in their respective studies that the annual income of the farmers had a positive significant relationship with their knowledge. This might be due to that the increased income of a farmer can inspire him to spend money to acquire knowledge on a certain subject. For increasing every 1 score of extension media contact, an extra 0.112 knowledge score was obtained. The more the number of extension media and frequency of contact is used by the respondents, the more they will obtain knowledge. Mondal (2014) found that extension contact had 1.3% of the total variation in knowledge of strawberry cultivation. This might be due to that through extension contact knowledge was disseminated and farmers were motivated to acquire knowledge on farming issues.

For increasing every 1 score of decision-making ability, an extra 0.817 knowledge score was obtained. That means that, farmers having high decision-making ability tends to have high knowledge on CSA. This might be due to that a person with higher decision-making ability can confidently involve himself in any knowledge-acquiring activity without any hesitation. For increasing every 1 score of benefit obtained from CSA, an extra 0.278 knowledge score was obtained. The reason might be that whenever a farmer gets any benefit from CSA practice, he tends to be inspired to know about it.

Table 5. Regression analysis showing the contribution of selected characteristics of the farmers to their knowledge on CSA

Variable entered	'b' Value	Value of 't' (with probability level)
Education (X_1)	0.177**	3.240 (0.001)
Farm size (X_2)	0.091	0.294 (0.769)
Annual agricultural income (X_3)	0.244*	1.977 (0.049)
Farming Experience (X_4)	-0.024	-0.840 (0.401)
Extension contact (X_5)	0.112**	2.685 (0.008)
Training exposure (x_6)	0.123	1.126 (0.261)
Innovativeness (x_7)	-0.160	-0.891 (0.374)
Credit availability (x_8)	-0.001	-0.073 (0.942)
Access to market (x_9)	0.120	1.279 (0.202)
Access to ICTs (X_{10})	0.092	0.814 (0.416)
Decision making ability(X_{11})	0.817**	7.063 (0.000)
Benefit obtained from CSA (X_{12})	0.278**	7.325 (0.000)

Multiple R = 0.703, R-square = 0.494, Adjusted R-square = 0.473, F-ratio = 23.663 at 0.000 level of significance, Standard error of estimate = 2.803, Constant = 0.010

*Significant at 0.05 Level, **Significant at 0.001 Level

Conclusion and recommendations

Three-quarters of farmers had medium-level knowledge on CSA while one-tenth had high-level knowledge. Farmers' education, annual agricultural income, extension contact, decision-making ability and benefit obtained from CSA had positive significant contributions to their knowledge on CSA. Based on the findings of the study, the following recommendations can be made-

Farmers' knowledge about CSA can be increased by investing in non-formal education. Key approaches and techniques of non-formal education include demand-driven training, commodity interest group (CIG) farmer training, exposure visits, etc. Farmers' agricultural income needed to be increased by providing subsidies or other financial support or by ensuring reasonable prices of agricultural products and services. Knowledge level on CSA can be increased through extension contact like, motivational campaigns and result and method demonstrations. A number of extension media and frequency of extension communication are to be increased for those who has less contact or who are beyond extension contact. Agricultural extension and advisory services should play a major role in improving farmers' decision-making abilities. To enhance these abilities, extension service providers should facilitate farmers' access to climate-smart productive technologies; provide knowledge on management of these technologies, and share tips and tricks for combining the available resources in an optimal way.

Conflicts of interest

The authors declare no conflicts of interest regarding publication of this paper.

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