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Research Article

ADOPTION OF CLIMATE RESILIENT CROPPING PATTERNS IN SOUTHERN COASTAL REGION OF BANGLADESH: FARMER'S' PERCEPTION

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ABSTRACT

The study was carried out in Batiaghata upazila of Khulna district to identify different climate resilient cropping patterns that had been practiced over the past three decades as well as the farmers' perception about the causes of adopting climate resilient cropping patterns. Information was collected through personal interview, focus group discussion, systematic study of available records and browsing internet. A slight change was observed regarding climate resilient cropping pattern over the last 30 years in the study area. About 30 years ago, five cropping patterns were practiced, only one pattern (Fallow-Fallow-T. Aman) was found climate resilient. About 20 years ago, 11 cropping patterns were practiced, 5 patterns (Fallow-Fallow-T. Aman, Boro-Fallow-T. Aman, Boro-Gher (vegetables)-T. Aman, Boro-Gher (vegetables)-Fallow and Fallow-Gher (vegetables)-T. Aman) were found climate resilient. About 10 years ago, 11 cropping patterns were practiced, 7 patterns (Sesame-Fallow-T. Aman, Boro-Fallow-T. Aman, Boro-Gher (vegetables)-Fallow, Fallow-Fallow-T.Aman, Boro-Jute-T. Aman, Boro-Gher (vegetables)-T. Aman and Fallow-Gher (vegetables)-T. Aman) were found climate resilient. At present, 14 cropping patterns are being practiced. Out of which, six patterns are climate resilient. Respondents justified nine causes for adopting climate resilient cropping patterns, while increase in cropping intensity was the most significant, while lower input cost was least significant. Most of the respondents (93.80%) had highly clear perception and the rest (6.20%) had moderately clear perception. A positive relationship of education and mass media exposure was observed with their perception.

Keywords: Climate, Resilient, Correlation, Cropping, Patterns, Farmers' perception

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INTRODUCTION

Bangladesh is one of the most climatic change affected countries in the world (Kreft et al., 2017). Economy of the country is based on agriculture which is very much sensitive to climate change impact. Adaptation to climate change was ignored initially, but due to the increasing vulnerability of some country's adaptation has recently been covered extensively (Kates, 2000).

During past five decades, agricultural sector in southwestern part of Bangladesh has undergone wide-ranging changes in terms of cropping pattern, cultivation technique, land ownership, intensity of cultivation, and productivity. Although Bangladesh has an agriculture-based economy, yet the contribution of agriculture in GDP has decreased during last few years and now only 16 % of GDP have to rely directly on agriculture (Anonymous, 2016).

In Bangladesh, the major cropping pattern mainly consist of rice based cereal crops (Haque, 1998) for instance, Boro-Fallow-Transplanted man was the major cropping pattern securing 2.31 million ha (27 % of Net Cropped Area of the country) including its distribution in 63 districts (Nasim et al., 2017).

The southwestern part of Bangladesh especially Khulna, Bagerhat and Satkhira districts are worst hit by water and soil salinity (SRDI, 2010). While, in past, the stress environment of these areas got very little attention. More food demand brings attention to explore the possibilities of increasing potential of saline lands for increased production of crops due to increased pressure of vast and fast-growing population. Moreover, cultivable land area is decreasing day by day in the country. In this context, there is no other alternative way but to address less favorable and unfavorable environments for food security and to adapt to the climate change. That's why farmers adopt different climate resilient cropping patterns to protect their crops because a choice of appropriate combinations of crops or cropping patterns can be used as an option to minimize the possible devastations and damages from natural calamities such as drought and floods (Mandal, 2010).

The present study was conducted with objectives to identify the cropping patterns over the last 30 years including climate resilient ones and determine farmers' perception regarding the causes of adopting climate resilient cropping patterns.

MATERIALS AND METHODS

Design and locale of the study

The present study was a descriptive and diagnostic type of research, based on collection of data by door to door interviewing of the respondents. In this study, two techniques were used: (i) a statistical survey to identify present climate resilient cropping patterns in four villages (Shoilmari, Joikhali, Raingamari and Dorgatola) of Jalma union under Batiaghata upazila of Khulna district and to assess farmers' perception regarding the causes of adopting climate resilient cropping patterns, (ii)

Focus Group Discussion (FGD) with the participation of local people to find the cropping patterns over the last 30 years.

Population and sampling

The sample was collected by following multistage disproportionate random method. For data collection, 10 % upazila (out of 9 upazila) in Khulna district were selected and then 10 % union (out of 7 union) from each upazila and 10 % villages (out of 37 villages) in each union were selected. Form 4 villages (10 % of total), 80 farmers (20 from each village) were selected.

Data collection and processing

Primary data were collected through face to face interview using interview schedule during January to March 2019.

Some of the preferred characteristics of the respondents were considered as independent variables viz. age, educational qualification, family education, family size, farm size, annual income, farming experience and exposure to mass media. Perception of the respondents regarding causes of the adopting climate resilient cropping patterns was considered as dependent variable in this study.

For analysis purpose all qualitative data were converted to quantitative form by using appropriate technique of scoring. In several instances, indices and scales were constructed through the simple accumulation of score assigned to individual or pattern of attributes.

Measurement of selected characteristics (independent variables)

Among the selected characteristics age was measured in 'actual year', educational qualification in 'years of schooling', family size in 'number', family education in 'years of schooling', farm size in 'hectare', farming experience in 'year', annual income in '000 BDT' and exposure to mass media in 'score'.

Measurement of farmer's perception (dependent variable)

A 9-item statement was used to determine the respondents' perception regarding the causes of adopting climate resilient cropping patterns. To determine the perception of the respondents' regarding causes of adopting climate resilient cropping patterns Likert's type scale such as agree, strongly agree, undecided, disagree and strongly disagree were used against each of 9 statements. A score of 5, 4, 3, 2 and 1 were assigned against rating scales respectively. The perception score regarding the causes of adopting climate resilient cropping patterns were determined by summing up all scores obtained against each of the 9-statements. The perception score of a respondent could range from 9 to 45, where '9' indicate less clear perception and '45' indicate highly clear perception. On the basis of perception score, the respondents were categorized into three groups as less clear perception (≤15), moderately clear perception (16-30) and highly clear perception (>30). To compare statements, a perception index of causes (PIC) was calculated using following formula (Ahmed, 2011):

$PIC = N_{sa} \times 5 + N_{ag} \times 4 + N_{ud} \times 3 + N_{da} \times 2 + N_{sd} \times 1$

Where, PIC = Perception Index of Causes of Adopting Climate Resilient Cropping Patterns

N_{sa}=Number of respondents indicated as strongly agree
N_{ag} = Number of respondents indicated as agree
N_{ud}= Number of respondents indicated as undecided
N_{da}= Number of respondents indicated as disagree
N_{sd} = Number of respondents indicated as strongly disagree

The PIC scores could vary from 80-400. The scores were converted to percentage for clear understanding of the causes that enhance the adoption of climate resilient cropping patterns by using the following formula (Ahmed, 2011):

$$PI = \frac{\text{Observed PIC Score}}{\text{Highest Possible PIC Score}} X\ 100$$

Data analysis

Different statistical treatments such as number, mean, standard deviation, range, minimum, maximum, rank order and percentage were used to describe the variables. To explore relationship between any two variables, Pearson Product Correlation Coefficient (for interval and ratio type of data) was used. The data were analyzed by using Statistical Package for Social Science (SPSS) 20.

RESULTS AND DISCUSSION

Facts on the selected characteristics of the respondents

Data presented in Table 1 indicated that most of the respondents (63.80 %) were old aged, while mean value (56.70) was in between the range of respondents' age (40-80). On the average, 10.18 of deviation from mean value (56.70) was found for age of respondents. Nearly half of the respondents (48.80 %) had primary level of education followed by secondary level of education (37.50 %). Mean value of respondents' education (4.85) was tilted to lower level of education, while 4.40 of deviation from mean value (4.85) was found showing most of the respondents had lower level of education. On the contrary, majority of the respondents' family (58.80 %) had secondary level of education followed by primary level of education (32.50%), with mean value in between range values. Majority of the respondents (61.30 %) had small sized family. Most of the respondents (91.30 %) had high farming experience, belonged to low income group (80 %) and had low exposure to mass media (83.80 %). Mean value of farming experience was at higher but income group and mass media exposure at lower level of range values. Pulok et al. (2008), while he carried out an experiment to find out the causes and consequences of changing cropping pattern in greater Khulna district also found that most of the respondents (68 %) were old aged. Majlish et al. (2007), found that majority (53 %) of the respondent's family had

secondary level education while he carried out an experiment on social forestry program.

Table 1. Distribution of the respondents according to their selected characteristics (N=80)

Selected Characteristics	Categories (Scores)	No. of respondents	Distribution of respondents (%)	Range	$\bar{X} \pm SD$
Age	Young (≤ 35 years)	0	0	40-80	56.70±10.18
	Middle age (36-50 years)	29	36.30		
	Old (> 50 years)	51	63.80		
	Total	80	100		
Education	No education (0)	6	7.50	0-16	4.85±4.40
	Primary (1-5)	39	48.80		
	Secondary (6-10)	30	37.50		
	Higher secondary (11-12)	2	2.50		
	Above higher secondary (> 12)	3	3.80		
	Total	80	100		
Family size	Small (1-4)	49	61.30	22-88	4.70±1.29
	Medium (5-6)	20	25.00		
	High (> 6)	11	13.80		
	Total	80	100		
Family education	No education (0)	0	0	3-15	6.88±2.49
	Primary (1-5)	26	32.50		
	Secondary (6-10)	47	58.80		
	Higher secondary (11-12)	5	6.30		
	Above higher secondary (> 12)	2	2.50		
	Total	80	100		
Farm size	Landless (< 0.02)	0	0	0.08-2.07	0.61±0.42
	Marginal (0.02-0.20)	7	8.80		
	Small (0.21-1.00)	57	71.30		
	Medium (1.01-3.00)	16	20.00		
	Large (> 3.00)	0	0		
	Total	80	100		
Farming experience	Low experience (< 17 years)	3	3.80	15-62	39.69±10.96
	Medium experience (17-28 years)	4	5.00		
	High experience (> 28 years)	73	91.30		
	Total	80	100		
Income	Low (≤ 120)	64	80.00	40-385	94.78±55.67
	Medium (121-180)	9	11.30		
	High (≥180)	7	8.80		
	Total	80	100		
Media exposure	No exposure (0)	0	0	2-21	7.45±3.12
	Low (1-10)	67	83.80		
	Medium (11-20)	11	13.80		
	High (> 20)	2	2.50		
	Total	80	100		

Climate resilient cropping patterns

In the study area, 22 cropping patterns were identified over the last 30 years, out of which only 7 cropping patterns are climate resilient according to DAE, Khulna. Before 30 years, 5 cropping patterns were practiced. Among these five (5) cropping patterns, only one (1) pattern was climate resilient (Table 2). About 20 years ago, gher was started in most of the study area and after that time a dramatical change in cropping pattern was observed in the study area. After starting gher in the study area, out of 11 cropping patterns, 5 patterns were climate resilient (Table 2). Before 10 years, out of 11 cropping patterns, 7 patterns were climate resilient (Table 2). Now-a-days, 14 cropping patterns are being practiced, out of which 6 patterns are climate resilient (Table 2).

Das et al. (2008), while he carried out an experiment to find out the causes and consequences of changing cropping pattern in greater Khulna district also found the similar cropping pattern over different years.

Table 2. Climate resilient and non-resilient cropping patterns over different years

Climate resilient and non-resilient cropping patterns of 30 years ago	
Non-resilient cropping patterns	Climate resilient cropping patterns
Sesame+Vegetables -Fallow-T. Aman	Fallow-Fallow-T. Aman
Fallow-Aus-T. Aman	
Fallow-JoliAus-Fallow	
Fallow-Jute-T. Aman	
Climate resilient and non-resilient cropping patterns of 20 years ago	
Non-resilient cropping patterns	Climate resilient cropping patterns
Sesame+Vegetables -Fallow-T. Aman	Fallow-Fallow-T. Aman
Fallow-Aus-T. Aman	Boro- Fallow- T. Aman
Boro- Aus-Fallow	Fallow-Gher (Vegetables)- T. Aman
Fallow-Jute-T. Aman	Boro-Gher (Vegetables)-Fallow
Vegetables+Mustard/Mung- Fallow-Fallow	Boro-Gher (Vegetables)- T. Aman
Wheat- Fallow-T. Aman	

Climate resilient and non-resilient cropping patterns of 10 years ago	
Non-resilient cropping patterns	Climate resilient cropping patterns
Boro- Aus-Fallow	Fallow-Fallow-T. Aman
Vegetables+Mustard/Mung- Fallow-Fallow	Boro- Fallow- T. Aman
Wheat- Fallow-T. Aman	Fallow-Gher (Vegetables)- T. Aman
Fallow- JoliAus-Fallow	Boro-Gher (Vegetables)-Fallow
	Boro-Gher (Vegetables)- T. Aman
	Sesame- Fallow-T. Aman
	Boro-Jute-T. Aman
Present climate resilient and non-resilient cropping patterns	
Non-resilient cropping patterns	Climate resilient cropping patterns
Fallow-Fallow-Vegetables	Fallow-Fallow-T. Aman (45%)
Vegetables+Sesame- Fallow-Fallow	Boro- Fallow- T. Aman (35.25%)
Vegetables+Mung- Fallow-Fallow	Fallow-Gher(Vegetables)-T. Aman (1.25%)
Mung- Fallow- T. Aman	Boro-Gher (Vegetables)-Fallow (40%)
Vegetables-Fallow-T. Aman	Boro-Gher (Vegetables)-T. Aman (1.25%)
Mustard+Mung- Fallow -T. Aman-	Sesame- Fallow-T. Aman (28.75)
Mustard+Mung- Fallow- Fallow	
Boro-Fallow-Fallow	

In the study area, at present 6 climate resilient cropping patterns are found to be adopted by the respondents in different extent. Fallow-Fallow-T.Aman was the most dominant cropping pattern which was practiced by 45 % of the respondents. The second dominant pattern was Boro-Gher (Vegetables)-Fallow which was practiced by 40 % of the respondents, followed by Boro-Fallow-T. Aman (35.25 %), Sesame-Fallow-T.Aman (28.75 %). Fallow-Gher (Vegetables)-T. Aman (1.25 %) and Boro-Gher (Vegetables)-T. Aman (1.25%) were adopted by very few respondents.
Rashid et al. (2017) also found the similar result that, Fallow-Fallow-T.Aman, Fallow-T.Aman-Boro, Boro-Fish-Fish, Fallow-T.Aman-Sesame and Gher (Vegetables)-T. Aman-Boro are the dominant cropping patterns in Khulna region.

Farmer's perception regarding the causes of adopting climate resilient cropping patterns

The overall perception scores of the respondents for causes of adopting climate resilient cropping patterns varied from 30- 40 against the possible range of 9- 45 on an

average. Mean value of clear perception (35.65) was in between range of perception of respondents (30-40). On the average, 1.89 deviation was found from mean value (35.65) of perception of respondents for causes of adopting climate resilient cropping patterns, which was very low (Table 3). An overwhelming majority of the respondents (93.80 %) had highly clear perception while the rest (6.20 %) had moderately clear perception about the causes of adopting climate resilient cropping patterns. No respondent was found to have less clear perception (Table 3), showing thereby that respondents had clear perception to adopt climate resilient cropping patterns. A similar observation was reported by Afique et al. (2006) while he carried out an experiment to determine the perception of rural women on the benefit of agricultural model farm activities of Sabalam by Unnayan Samity (SUS) also found that most (97.5 %) of the respondent rural women had highly clear perception while only 2.5 % had moderately clear perception. Majlish (2007), also found that majority (59 %) of the respondents had highly clear perception on social forestry program.

Table 3. Distribution of the respondents according to their perception for causes of adopting climate resilient cropping patterns

Categories	Score	Respondents (N=80)		$\bar{X} \pm SD$	Range
		Number	Percentage		
Less clear perception	1-15	0	0	35.65 ±1.89	30-40
Moderately clear perception	16 – 30	5	6.20		
Highly clear perception	> 30	75	93.80		
Total		80	100		

Rank order of the statements based on perception score of the farmers related to the causes of adopting climate resilient cropping patterns

Data based on the Farmers' Perception Index (PI) score (Figure 1) indicated that the farmers had almost similar perception regarding causes of adopting different climate resilient cropping patterns except lower input cost. Ranking of causes expressed by farmers were increase in cropping intensity, sustainable increase in crop production, year-round distribution of labor, the livelihood of people is increasing, and crops are less prone to natural disaster, lower yield of climate susceptible variety, neighborhood aspects and short life cycle of resilient varieties. Low input cost was expressed significantly lowest perception of cause by the farmers.

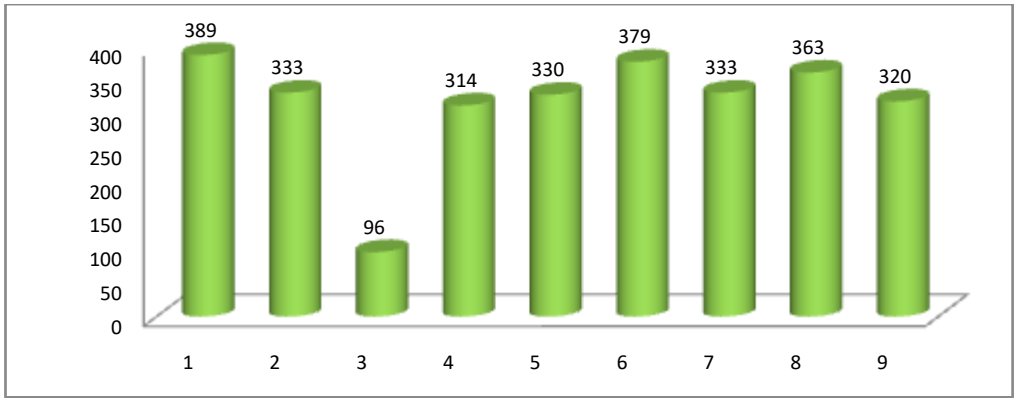

Figure 1. Relative position (rank order) of the statements related to perception regarding the causes of adopting different climate resilient cropping patterns

1 = Increase in cropping intensity (1st), **2 =** Crops are less prone to natural disaster (4th), **3 =** Lower input cost (8th), **4 =** Short life cycle of resilient varieties (7th), **5 =** Lower yield of climate susceptible cropping patterns (5th), **6 =** Sustainable increase in agricultural production (2nd), **7 =** The livelihood of people is increasing due high income from per unit area of land (4th), **8 =** The year round distribution of labor and machinery (3rd), **9 =** Neighborhood aspects: Changes in the farming practices and adoption of climate resilient cropping patterns in the neighboring areas induce other farmers to adopt (6th).

Relationship between the selected characteristics of the respondents and their perception regarding causes of adopting climate resilient cropping patterns

Data presented in Table 5 showed that among 8 selected characteristics of the respondents, only education and mass media exposure showed a significant positive relationship with their overall perception.

Table 4. Correlation between the selected characteristics of the respondents and their perception regarding causes of adopting climate resilient cropping patterns

Independent variable ((the selected characteristics)	Dependent variable (Focus variable)	Correlation coefficient (r)
Age	Perception regarding causes of adopting climate resilient cropping patterns	0.089NS
Education		0.251*
Family size		-0.039NS
Family education		0.093NS
Farming experience		0.089NS
Farm size		-0.009NS
Income		0.145NS
Mass media exposure		0.317**

NS= Non-significant, **Correlation highly significant at 1% level of probability and *Correlation highly significant at 5% level of probability.

Table 4 shows that the higher is the level of education and mass media exposure, higher is the perception regarding the causes of adopting climate resilient cropping patterns. This might be due to the fact that education and mass media exposure broadens the knowledge of the people to understand the benefits of climate resilient cropping patterns. The findings of the studies conducted by Ahmed, (2011); Adeola, (2012) and Majlish, (2007); have harmony with the present study regarding educational qualification. Similar result regarding mass media exposure were described by Karim, (2008); Chowdhury, (2009), Kamali, (2011);

CONCLUSION

An increasing trend in total number of climate resilient cropping patterns from 30 years ago to 10 years ago was observed but it was found to be decreased at present. The respondents had clearer perception regarding causes of adopting climate resilient cropping patterns. Among identified 9 causes of adopting climate resilient cropping patterns, all had almost similar PS (ranging 314-389) except that of lower cost input (96). An overwhelming majority of the farmers had highly clear perception (93.80 %). followed by moderately clear perception (6.20 %). Only education and mass media exposure of the respondents showed a significant positive relationship with their perception regarding causes of adopting climate resilient cropping patterns. Finally, it could be concluded that there are a lot of causes that affected the adoption of climate resilient cropping patterns and accelerated to change in adoption.

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