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RESEARCH ARTICLE

Adoption of Climate-Resilient Cropping Patterns for Sustainable Crop Production

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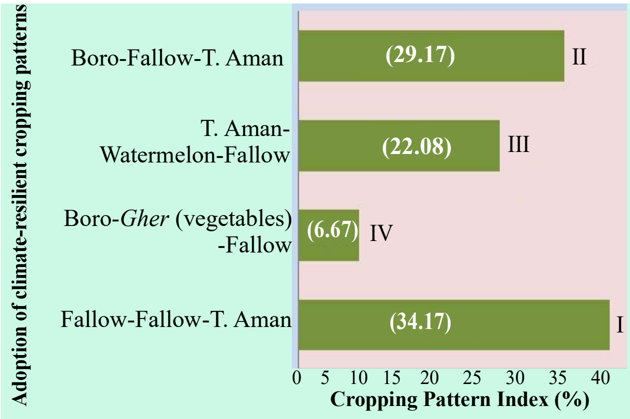
HIGHLIGHTS

- Climate resilient cropping pattern is the need of the hour to avert the risk of climate change in agriculture
- Among four climate-resilient cropping patterns, the greatest extent of adoption was observed in the case of Boro-Gher (vegetables)-Fallow
- Adoption of climate-resilient cropping patterns will help in increasing cropping intensity

GRAPHICAL ABSTRACT



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ABSTRACT

Introduction: Bangladesh has experienced wide-ranging changes in terms of climate-resilient agricultural technologies, climate-resilient crop varieties, cropping patterns, cultivation practices, productivity, and intensity of cultivation.

Context: Climate resilient cropping pattern is the need of the hour for sustainable food production and rejuvenating resilience, the climate-smart cropping pattern needs to be adopted by the smallholders of Bangladesh.

Objective: To recognize climate-resilient cropping patterns adopted by the farmers.

Methods: Information was collected from 80 farmers of five villages of Bangladesh by the researcher herself using an interview schedule.

Results and Discussion: Among 4 climate resilient cropping patterns, the highest extent of adoption was observed in the case of Boro-*Gher* (vegetables)-Fallow while the lower extent of adoption was found in the case of Fallow-Fallow-T. *Aman*. The majority of the respondents showed medium adoption behavior regarding climate-resilient cropping patterns. Increasing cropping intensity was the main cause for adopting climate-resilient cropping patterns while high-yielding cropping pattern was the less important cause for adopting climate-resilient cropping patterns. Among 13 chosen characteristics of the respondent farmers, level of education, experience in the adoption of resilient technology, farm size, annual family income, cosmopolitanism, innovativeness, extension contact, training exposure and knowledge were emphatically related to the adoption of climate-resilient cropping pattern. Adoption of climate-resilient cropping patterns will help in increasing cropping intensity which ultimately will result in sustainable crop production.

Bangladesh is recognized as one of the foremost vulnerable countries to climate change impact. Its national economy emphatically depends on farming which is outstandingly fragile to climate change effects. Adoption of climate change did not get much consideration within the first years of the universal climate change studies, where there was more focus on moderation and impacts, but adoption has recently been secured more broadly due to the expanding vulnerability of a few countries (Kates, 2000). During the past five decades, the agriculture segment in the southwestern region of Bangladesh has experienced wide-ranging changes in terms of ownership of land, climate-resilient agricultural technologies, cropping patterns, cultivation practices, productivity, and intensity of cultivation. Bangladesh has an agrarian economy, even though the share of agribusiness to GDP has been diminishing over the last few years. However, it overwhelms the economy since 16% of GDP needs to depend directly on farming (Anonymous, 2016).

The coastal locale of the country has generally been recognized as a disadvantaged locale in terms of poverty, food uncertainty, natural vulnerability and limited livelihood opportunities. Agrarian land utilized within the coastal areas is exceptionally poor. The average cropping intensity of the country was 200% in 2014, though it is 128-147% in the southern locale (BBS, 2014). The major portion of this locale is influenced by different gradients of saltiness. The low land utilized within the locale is basically due to saltiness and unconventional hydrology, waterlogging in Kharif II and early Rabi seasons and the need of quality irrigation water (drought) in Rabi and Kharif I seasons, and tidal storms (Rahman and Ahsan, 2011).

The southwestern portion, Khulna, Bagerhat and Satkhira locale are the most noticeably awful hit by water and soil saltiness (SRDI, 2010). The stressful environment of the southern portion of the country had gotten very small consideration in the past. The expanded pressure of the growing population demands more food which brings consideration to investigate the possibilities of expanding the potential of the saline lands for increased production of crops. In addition, cultivable land is decreasing day by day within the country. In this context, there's no other option but to address less favorable and unfavorable situations for food security and to adapt to the climatic inconstancy. That's why farmers adopt distinctive climate resilient cropping patterns to ensure their crops since a choice of correct combinations of crops or cropping patterns can be utilized as a valuable tool to minimize the conceivable devastations and harms from droughts and floods (Mandal, 2010).

Many climate-resilient agricultural technologies (especially cropping patterns) have been prescribed for moderating the impacts of climate alteration on agrarian production and for sustainable crop production. Climate-smart agriculture (CSA) practices (cropping patterns) that coordinated the benefits of an economic increment in agricultural efficiency, the adaptation and building of resilient agricultural and food security frameworks, as well as the diminishment of GHG emanations from agricultural activities, have shown up to be exceptionally promising (FAO, 2013; Lipper *et al.,* 2014)

Saline water intrusion is a common issue within the coastal areas of Bangladesh. Climate change-induced hazards including sea level rise, tornados, storm surges and tidal inundation are contributing to this problem causing salinity ingression into water and land (Baten*et al.,* 2015). The southwestern coastal locale of Bangladesh may be a food shortage zone where net food production and the differences in food production have declined essentially over recent decades due to the salinity issue. Regular devastating cyclonic storm surges, sea level rise and tidal inundation have changed the level of salinity and these have increased the risks associated with normal crop production. The impacts of climate change on coastal locales incorporate immersion from sea level rise, damage from storm surges and loss of water bodies and increased salinity of land from saltwater ingression. Including the coastal region of Bangladesh, around the world almost 600 million individuals currently occupy low-elevation coastal zones that will be influenced by progressive sanitization (Wheeler, 2011).

Large numbers of crops are grown under distinctive cropping pattern in different parts of Bangladesh with changeability from one locale to another. More noteworthy Khulna comprises of both saline and non-saline ecosystems. Agriculture of this locale is ruled by rice and fish (shrimp and others) culture. Year-round vegetable cultivation as a dyke cropping is also regularly watched in the Rice-Fish framework for both biological systems (Sarker*et al.,* 1997). The term cropping pattern alludes to the list of ordinary crops that are grown in an agrarian region, without considering their spatial dissemination or arrangement (Singh *et al*., 2001). The cropping pattern and the changes in that depend on an expansive number of variables like climate, soil type, rainfall, pest incidence, availability of technologies, availability of irrigation facilities and other inputs, marketing and transport facilities, subsistence pressure, and the growth of agro-industries (Neema, 1998, Gadge, 2003, Rashid *et al.*, 2005). Different types of crops are practiced in Dumuriaupazila of Khulna district. The major cropping pattern of the area is Fallow-T.*Aman*-Fallow. There are three cropping seasons namely Kharif-1(mid-March to mid-July), Kharif-2 (mid-July to mid-October) and Rabi (mid-October to mid-March). During the Kharif-1 season, farmers cultivate aus rice, oil seeds, and different types of vegetables. During the Kharif-2 season, T.*Aman* is the prevailing crop. Different varieties of T *Aman* rice such as BR 10, BR 11, BRRI dhan30, Swarna and local varieties are practiced during this season In the Rabi season, Boro rice such as BRRI *dhan*28, BRRI *dhan*29 and hybrid rice Heera is practiced. Other crops that are practiced are mustard, pulses and different types of vegetables. The area and production of HYV Boro rice in Khulna region were 280210 acres and 551345 metric tons, meanwhile, HYVI *Aman* rice was 1517075 acres and 1698337 metric tons, respectively (BBS, 2015).

The present study was conducted to explore the adoption of climate-resilient cropping patterns for sustainable crop production, the causes of adoption and problems in adopting climate-resilient cropping patterns by the farmers, in South Western Coastal region of Khulna district.

METHODOLOGY

Locale of the study: The study was conducted at 5 villages of Dumuriaupazila under Khulna district. The study area consists of 240 villages. But only 5 villages namely Khornia, Kholshi, Mirzapur, Dumuria and Gutudiawere selected purposively.

Population and sampling: The farmers of the study area who were the adopters of climate resilient agricultural technologies were treated as population of this study. Eighty (80) farmers were selected as sample following purposive sampling method.

Selection and measurement of variables: The selected characteristics of the farmers were considered as independent variables, whereas adoption of climate resilient cropping pattern was the focused (dependent) variable of the study.

Measurement of adoption of climate resilient cropping pattern (dependent variable): Several four (4) climate-resilient cropping patterns (Figure 1) were considered for study purposes by reviewing the findings of Sultalna *et al.* (2020) and consultation with Upazila Agriculture Officer (UAO) of Dumuria upazila (sub-district) of Khulna district to determine their adoption. Based on adoption score, the respondents were categorized into three categories such as low (<5), medium (5-8), high (>8). A 4-point modified rating scale such as highly adopted, sometimes adopted, rarely adopted and not at all adopted were employed against the 4 climate resilient cropping patterns and a score of 3, 2, 1 and 0 was employed against each of the rating scales. Each of the respondents was asked to indicate the level of adoption of climate-resilient cropping patterns. The adoption score was computed by adding all the scores obtained by a respondent against the 4 climate resilient cropping patterns. The adoption score related to climate-resilient cropping patterns could range from 0 to 12 where "0" indicates not at all adopted and "12" indicates high adoption of climate-resilient cropping patterns. To identify the important climate-resilient cropping pattern, a climate-resilient cropping pattern index was calculated by using following formula:

$$(\%)\text{CRCPI} = \frac{\text{OCRCPIS}}{\text{HPCRCPIS}} \times 100$$

CRCPI = Climate resilient cropping pattern index

OCRCPIS= Observed climate resilient cropping pattern index score

HPCRCPIS= Highest possible climate resilient cropping pattern index score

Besides, OCRCPIS= $N_{ha} \times 3 + N_{sa} \times 2 + N_{ra} \times 1 + N_{na} \times 0$

Where,

N_{ha}= No. respondents who frequently adopted the climate resilient cropping patterns

N_{sa}= No. respondents who sometimes adopted the climate resilient cropping patterns

N_{ra}= No. respondents rarely adopted the climate resilient cropping patterns

N_{na}= No.respondents not at all adopted the climate resilient cropping patterns

OCRCPIS could range from 0 to 240 where "0" indicates no adoption and "240" indicates a high adoption cropping pattern. Based on the (%) CRCPI, the adoption of climate-resilient cropping patterns was ranked.

Causes of adopting climate-resilient agricultural technologies: A 7-item statement was used to determine the causes of adopting climate-resilient agricultural technologies. Based on the adoption scores, the respondents were grouped into three categories as shown in Figure.2. A 5-point Likert's type modified scale such as strongly agree, agree, undecided, disagree and strongly disagree were employed against each of 7 statements to determine the extent of causes of adopting climate resilient agricultural technologies. A score of 5, 4, 3, 2 and 1 were assigned against the rating scales. To identify the most important causes of adopting climate-resilient agricultural technologies, a cause of adoption index (CAI) was determined by using the following formula:

$$(\%)\ \mathrm{CAI} = \frac{\mathrm{OISCA}}{\mathrm{HPISCA}} \times 100$$

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

Where,

OISCA= Observed Index Score for Causes of Adoption

HPISCA= Highest Possible Index Score for Causes of Adoption

N_{sa} = No. of respondents indicated as strongly agreed

N_{ag} = No. of respondents indicated as agreed

N_{ud} = No. of respondents indicated as undecided

N_{da} = No. of respondents indicated as disagreed

N_{sd} = No. of respondents indicated as strongly disagreed

The CAI scores could vary from 80-400 where “80” indicates a low number of causes for adoption and “400” indicates a high number of causes for adoption. Based on the (%) CAI, the causes were ranked.

Problems confronted by the farmers during adopting climate resilient agricultural technologies : A number of twelve (12) problems were considered for study purpose (Figure 3). Each of the respondents was asked to express the problems he faced during adopting climate resilient agricultural technologies along with their extent of severity. The severity scale designed as highly severe problem, moderately severe problem, less severe problem and not at all problems respectively. And a score of 3, 2, 1 and 0 were assigned against the severity scales respectively. To identify the major problems that hindered for adopting climate resilient agricultural technologies, a problem confrontation index (PCI) was calculated by using the following formula:

$$(\%)\ \mathrm{PCI} = \frac{\mathrm{OPCIS}}{\mathrm{HPPCIS}} \times 100$$

$\mathrm{OPCIS} = N_{hsp} \times 3 + N_{msp} \times 2 + N_{lsp} \times 1 + N_{nap} \times 0$

Where,

OPCIS= Observed problem confrontation index score

HPPCIS=Highest Possible problem confrontation index score

N_{hsp} -No. of respondents indicated as highly severe problem

N_{msp} - No. of respondents indicated as moderately severe problem

N_{lsp} -No. of respondents indicated as a less severe problem

N_{nap} -No. of respondents indicated as not at all problem

The PCI scores could vary from 0-240 where “0” indicates no problem confronted and “240” indicates high problem confronted. Based on the (%) PCI, the problems were ranked.

RESULTS

Adoption of climate-resilient cropping patterns : The respondent farmers adopted the four selected climate-resilient cropping patterns to a different extent (Figure 1). Boro-*Gher* (vegetables)-Fallow was adopted to the highest extent (34.17%) while it was lowest in the case of Fallow-Fallow-T. Aman (6.67%). The other cropping patterns were Boro-Fallow-T. Aman (29.17%) and T. Aman-Watermelon-Fallow (22.08%) were adopted by the farmers (Figure 1).

Distribution of respondents according to their adoption of climate-resilient cropping patterns : The majority (58.8%) of the respondents belonged to a medium extent of adoption, 21.2 per cent of the respondents showed a high extent of adoption whereas 20 per cent of them showed a low extent of adoption about climate-resilient cropping patterns (Table 1).

Causes of adoption of climate-resilient agricultural technologies (including cropping patterns) : Most (86.50%) of the respondents adopted climate-resilient agricultural technologies for increasing cropping intensity followed by crops that are less prone to natural disasters (74.75%) and neighborhood aspects (73.75%). Climate-resilient high-yielding cropping pattern (56.75%) was the less important cause for its adoption (Figure 2).

Problems in adopting climate resilient agricultural technologies (including cropping patterns) : The highly severe problem for adopting climate resilient agricultural technology (cropping pattern) was saline soil (89.58%) followed by jow condition (field capacity moisture content) comes late (77.92%), problem of pest and diseases (76.25 %),unavailability of fresh irrigation water (72.5%), lack of information about long term climate change (67.92%) while lower yield of resilient variety (32.5%) was the less severe problem faced by the respondents during adoption of climate resilient agricultural technologies (Figure 3).

Selected characteristics of the respondents : The highest proportion (47.50%) of the respondents was

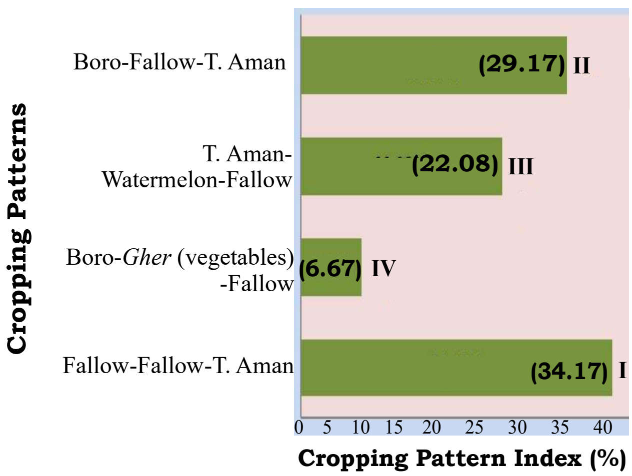

Figure 1. Adoption of climate-resilient cropping patterns

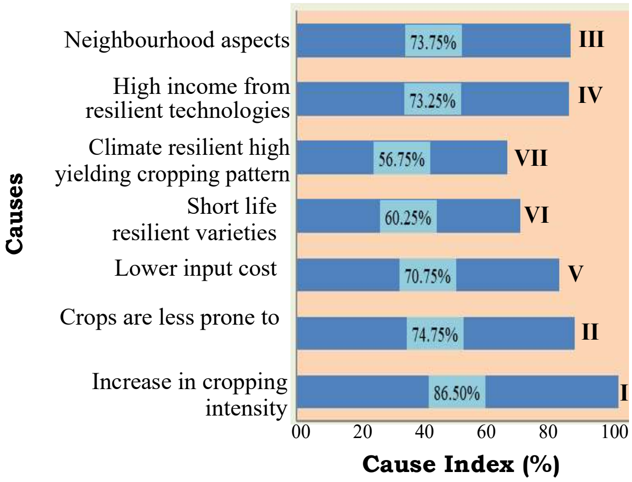

Figure 2. Rank order of causes of adopting climate resilient agricultural technologies adopted by the respondent farmers based on adoption index

Table 1. Distribution of respondents according to their cropping pattern adoption

Categories	Scores	Respondents (N=80)	
		No.	%
Low	<5	16	20
Medium	5-8	47	58.8
High	>8	17	21.2
Total		80	100
Range			
	Min	0	
	Max	7	
Mean	2,81		
SD	2.04		

middle-aged category compared to young (28.75%) and old (23.75%). The highest proportion (48.75%) of the respondents belonged to the secondary level of education category while 27.50 per cent, 12.50 per cent, 5 per cent and 6.25 per cent of the farmers belonged to primary level, higher secondary level, above higher secondary level and illiterate categories respectively. The highest proportion (43.75%) of the respondents belonged to small size family while 35 per cent and 21.25 per cent of the respondents belonged to medium size family and large size family respectively (Table 2). The majority (67.50%) of the respondents possessed small farm sizes while 15.00 per cent and 16.25 per cent belonged to marginal and medium farms respectively, 1.25 per cent of them possessed large farms and no farmers were landless. The majority (52.50%) of the respondents belonged to low income (≤150000 BDT) whereas 40.00 per cent belonged to medium income (151000-300000 BDT) and 7.50 per cent of respondents showed high income (>300000 BDT) category. The majority (62.50%) of the respondents had medium farming experience followed by 33.75 per

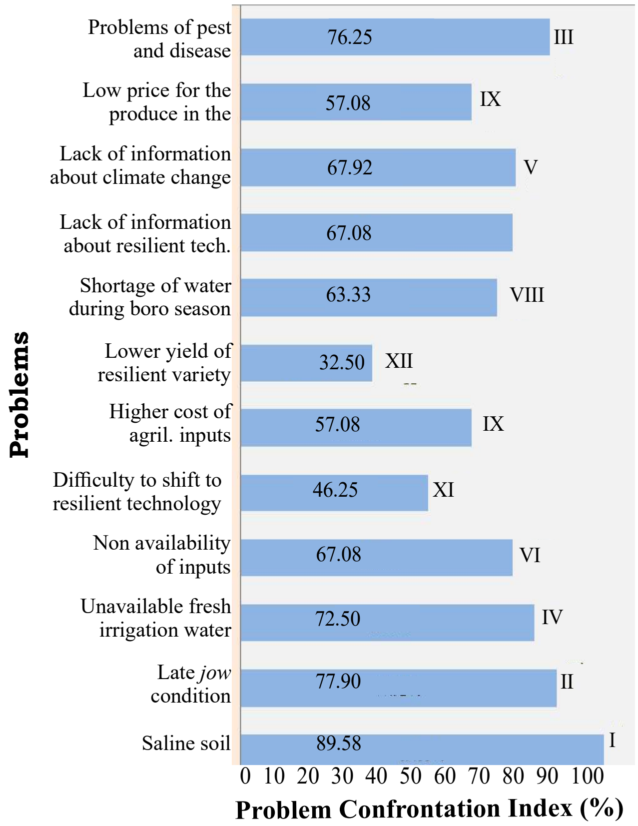

Figure 3. Rank order of problems in adopting climate-resilient agricultural technologies

cent who belonged to high farming experience and 3.75 per cent showed low farming experience. The majority (51.25%) of the respondents showed a medium experience of adopting climate resilient technologies whereas 30.00 per cent and 18.75 per cent showed high and low experience respectively. The majority (52.50%) and 27.50 per cent of the respondents belonged to the early adopter and early majority categories respectively while 5.00 per cent were innovators, 3.75 per cent were the late majority and 11.25 per cent of the farmers were laggards. The majority (68.75%) of the farmers belonged to low extension contact compared to 27.50 per cent and 3.50 per cent of the respondents who possessed medium and high extension contact respectively. Most (85.00%) of the respondents showed low cosmopolitanism followed by medium cosmopolitanism (11.25%) and high cosmopolitanism (3.75%). The highest proportion (33.75%) of the respondents belonged to medium training exposure whereas a similar per centage (31.3) of the respondents belonged to the no training and low training exposure categories. On the other hand, 3.75 per cent of them belonged to high training exposure. The majority (63.75%) of the respondents had medium knowledge about climate resilient agricultural technologies and 15.00 per cent had low knowledge whereas 21.5 per cent possessed high knowledge about climate resilient

Table 2. Facts on the selected characteristics of the respondents

Characteristics	Categories	Scores (Years)	Respondents		Range		Mean	SD
			No.	%	Min	Max		
Age (Year)	Young	≤35	23	28.75	30	70	45.9	10.36
	Middle aged	36-50	38	47.50				
	Old aged	>50	19	23.75				
Level of Education (Year of Schooling)	Illiterate	0	5	6.25	0	16	7.35	3.78
	Primary	1-5	22	27.50				
	Secondary	6-10	39	48.75				
	Higher Sec	11-12	10	12.50				
	Above HS.	≥13	4	5.00				
Family Size (Number)	Small	<5	35	43.75	3	10	5.26	1.56
	Medium	5-6	28	35.00				
	Large	≥7	17	21.25				
Farm Size(Hectare)	Landless	<0.02	0	0.00	0.03	3.07	0.712	0.498
	Marginal	0.02-0.20	12	15.00				
	Small	0.21-1.00	54	67.50				
	Medium	1.01-3.00	13	16.25				
	Large	>3.00	1	1.25				
Annual family Income ('000' BDT)	Low income	≤150	42	52.50	49	392	161.99	80.89
	Medium	151-300	32	40.00				
	High	>300	6	7.5				
Farming Experience (Year)	Low	<16	3	3.75	12	55	28.77	9.8
	Medium	16-30	50	62.50				
	High	>30	27	33.75				
Experience in ACRAT* (Year)	Low	<8	15	18.75	4	20	11.46	3.8
	Medium	8-14	41	51.25				
	High	>14	24	30.00				
Innovativeness (Score)	Innovator	5	4	5.00				
	Early adopter	4	42	52.50				
	Early majority	3	22	27.50				
	Late majority	2	3	3.75				
	Laggard	1	9	11.25				
Extension Media Contact (Score)	Low	<20	55	68.75	4	47	18.22	8.56
	Medium	20-38	22	27.50				
	High	>38	3	3.75				
Cosmopolitanism (Score)	Low	<9	68	85.00	1	19	4.92	3.7
	Medium	9-16	9	11.25				
	High	>16	3	3.75				
Training Exposure (number)	No	0	25	31.25	0	4	1.3	1.19
	Low	1	25	31.25				
	Medium	2-3	27	33.75				
	High	≥4	3	3.75				
Knowledge about ACRAT* (Score)	Low	<6.98	12	15.00	3	14	9.84	2.86
	Medium	6.98-12.69	51	63.75				
	High	≥ 12.69	17	21.25				
Attitude towards ACRAT* (Score)	Highly Unfavorable Attitude	<14	0	0	25	54	48.79	4.9
	Unfavorable Attitude	14-26	1	1.25				
	Neutral Attitude	27-39	4	5.00				
	Favorable Attitude	40-52	68	85.00				
	Highly Favorable Attitude	>52	7	8.75				

*ACRATs= Adopting Climate Resilient Agricultural Technologies agricultural technologies. Most (85%) of the respondents possessed favorable attitudes compared to highly favorable attitudes (8.75%) towards the adoption of climate-resilient agricultural technologies (Table 2**).** Very few **(**1.25 and 5.00%) of them have unfavorable and neutral attitudes.

Relationships between the selected characteristics of the respondent farmers and their adoption of climate-resilient cropping patterns : Among 13- selected characteristics of the respondent farmers' level of education, farm size, annual family income, farming experience, experience in adopting climate resilient technologies, extension contact, innovativeness, cosmopolitanism, training exposure and knowledge were positively correlated with the adoption of climate-resilient cropping patterns (Table 3).

DISCUSSION

Adoption of climate-resilient cropping patterns : Formerly, the farmers of the study area followed only Fallow-Fallow-T. Aman because of the intrusion of saline water in the crop field during the 1950s. During mid-July, the farmers cultivated T. Aman due to rainfall which reduces the saltiness. To increase cropping intensity and address the saltiness, the farmers transform from a mono-crop-based cropping pattern to a multiple crops-based cropping pattern like Boro-*Gher* (vegetables)-Fallow. Inclusion of vegetable in cropping pattern reported to increase cropping intensity as well as food and nutritional security at household level (Noopur *et al.,* 2023a) and also an important component of self-reliant nutritional kitchen garden (Noopur *et al.,* 2021) and they are the major driver of sustainable agriculture, however there a number of constraints in vegetable production necessitating the need to address them for enhanced area and production of vegetables (Noopur *et al.,* 2023b). Marbaniang *et al.,* (2020) stated that vegetables being perishable and are sold under financial urgency and can be sold out through village trader to fetch higher price.

Distribution of respondents according to their adoption of climate-resilient cropping patterns : The majority (58.80%) of the respondents belonged to the medium extent of adoption. The findings of the present study disagree with the findings of Shiduzzaman *et al.* (2018). They found that the majority (68.8%) of the respondents had low adoption followed by medium (26.3%) and high (5%) adoption.

Causes of adoption of climate-resilient agricultural technologies (including cropping patterns) : Most (86.50%) of the respondents adopted climate-resilient agricultural technologies for increasing cropping intensity. This might be due to the inclusion of more than one crop to increase cropping intensity and ensure sustainable crop production in case of failure of one crop of the cropping pattern. Besides, neighbors and the inclusion of high-yielding crops in the cropping patterns also influenced the farmers to adopt climate-resilient cropping patterns (technologies).

Table 3. Relationships between the selected characteristics of the respondent farmers and their adoption of climate-resilient cropping patterns respectively

Characteristics	(r) value
Age	.158^{NS}
Level of education	.442**
Family size	-.056^{NS}
Farm size	.443**
Annual family income	.305**
Farming experience	.230*
Experience in CRAT	.414**
Innovativeness	.436**
Extension contact	.544**
Cosmopolitanism	.384**
Training exposure	.471**
Knowledge about CRAT	.470**
Attitude towards CRAT	.147^{NS}

CRAT= Climate resilient technologies

Problems in adopting climate-resilient agricultural technologies (including cropping patterns) : The highly severe problem for adopting climate-resilient agricultural technology (cropping pattern) was saline soil (89.58%). The reason behind this might be that salinity hinders the inclusion of varieties of crops in the cropping pattern.

Selected characteristics of the respondentsn : There exists a consistency between the age and farming experience of the farmers as the highest proportion (47.50%) of the respondents was middle-aged and a majority (62.50%) of them belonged to medium farming experience farming. In this study, the highest proportion (48.75%) of the respondents belonged to the secondary level of education category, but Sultana *et al.*(2020) found that the highest proportion (48.80 percent) of the respondents belonged to the primary level of education. The highest proportion (43.75%) of the respondents in this study belonged to small size family, but Salahuddin *et al.* (2010) found highest proportion/almost half (49.1 percent) of the respondents belonged to medium families. A majority (67.50%) of the respondents possessed small farms consequently majority (52.50%) of them had low income (≤150000 BDT). A majority (51.25%) of the respondents showed a medium experience of adopting climate-resilient technologies which is also consistent with experience in general farming. The percentage of innovators (5%) and early adopters (52.50%) is higher than that of Rogers's (1983) findings. He found 2.50 percent and 13.50 as innovators and early adopters in his study. The percentage of laggard (11.25%), late majority (3.75%) and early majority (27.50%) are lower than those of Rogers's (1983) findings. He found 16, 34 and 34 per cent as laggards, late majority and early majority in his study. It means that the farmers in the study are more innovative. The majority (68.75%) of the farmers belonged to low extension contact which is in harmony with *Mou et al.* (2019) and Sultana *et al.* (2020). They found that the majority (57.5%) and most (83.8%) of the respondents had low extension contact and low media exposure respectively. Most (85.00%) of the respondents of this study showed low cosmopolitanism which has little bit similarity with the finding of Shiduzzaman *et al.* (2018) but dissimilarity with the finding of Mou *et al.* (2019). They found that the majority i.e 71.2 and 57.5 per cent of the respondents showed low and medium cosmopolitanism respectively. The highest proportion (33.75%) of the respondents belonged to medium training exposure whereas the majority of the respondents had low (66.25%) and no (59.2%) training as reported by Shiduzzaman *et al.* (2018) and Mou *et al.* (2019). The majority (63.75 percent) of the respondents had medium knowledge of climate-resilient agricultural technologies. This finding is in harmony with the finding of Shiduzzaman *et al.* (2018). He found that most (88.75%) of the respondents had medium knowledge of vermicompost. Most (85 percent) of the respondents possessed favorable attitudes compared to highly favorable attitudes (8.75%) towards the adoption of climate-resilient agricultural technologies (Table 4). These findings have similarities with the findings of Mou *et al.* (2019). They reported that all (100%) of the respondents expressed medium to highly favorable attitudes towards vermicompost.

Relationships between the selected characteristics of the respondent farmers and their adoption of climate-resilient cropping patterns : Out of 13, selected characteristics of the respondent farmers' level of education, farm size, annual family income, farming experience, experience in adopting climate resilient technologies, extension contact, innovativeness, cosmopolitanism, training exposure and knowledge were positively correlated with the adoption of climate resilient cropping patterns. Devi *et al*. (2022) stated that majority of the farmers had adaptive capacity of resilience to climate change under agro-climatic conditions of North East India. Rahman (2001) observed a significant relationship between the annual family income of the farmers and their adoption. Reza (2007), Hossain (2006) and Miajy (2005) found that knowledge showed a significant relationship with farmers' adoption. Mou *et al.* (2019) found that respondents' education, farm size, extension contact and training exposure showed positive significant relationships with their adoption of the recommended fertilizer dose. Shiduzzaman *et al.* (2018) also found a positive and significant relationship between respondents' education, extension media contact, cosmopolitanism knowledge on vermicompost and training on vermicompost with their adoption of vermicompost. He also observed negative significant relationships between age, family size, farming experience of the respondents and their extent of adoption of vermicompost.

CONCLUSION

The highly followed climate-resilient cropping pattern was Boro-*Gher* (vegetables)-Fallow (34.17%) while the less followed/adopted pattern was Fallow-Fallow-T. *Aman* (6.67%). The majority (58.8%) of the respondents showed medium adoption behavior regarding climate-resilient cropping patterns. The most important cause for adopting a climate-resilient cropping pattern was increasing cropping intensity (86.50% followed by crops included in the cropping pattern are less prone to natural disasters (74.75%) and neighborhood aspects (73.75%). The main hindering factor for adopting climate-resilient cropping patterns was saline soil (89.58%) followed by moisture conditions late (77.92%), problems of pests and diseases (76.25 %). Farmers' level of education, farm size, annual family income, farming experience, experience in adopting climate-resilient technologies, extension contact, innovativeness, cosmopolitanism, training exposure and knowledge was positively correlated with the adoption of climate-resilient cropping patterns.

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Author's contribution:

Ist author did the research, collected all data and write the thesis and draft paper. IInd author finalized the draft paper and prepared it to submit it to the IRJEE. IIIrd author is helped to review the literature related climate resilient cropping patterns. IVth author helped in improving the write up. Vth author helped in collecting reviews and preparing the interview schedule.

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