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Farmers' extent of adaptation strategies towards salinity effects in agriculture

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ABSTRACT

*Climate change has emerged as one of the greatest environmental challenges facing the world today. Salinity intrusion in soil is one of the major concerns of climate change, which mainly caused due to cyclone and sea level rise. Salinity influences unfavorable environment and hydrological situations that directly restrict the normal crop production and indirectly fall affects income which leads poor socio-economic status. The study was about extent of adaptation strategies of farmers' who were struggling to adapt salinity effects in agriculture day by day. The purpose of the study was to describe the socio-economic profile of the salinity affected farmers in the study area; to determine farmers' extent of adaptation strategies towards salinity effects in agriculture and to explore contributing relationship between the selected characteristics of the salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture. The study was undertaken purposively in Kalapara upazila under Patuakhali district of Bangladesh. Validated and well-structured interview schedule (questionnaire) was used to collect data from 131 farmers. The findings showed that majority of the farmers (48.1 percent) had medium level adaptation towards salinity effects in agriculture. The results also showed that farmers' age (.001**), educational background (.039*), farming experience (.033*), agricultural extension contact (.007**) and farmer's category (.000**) were significant factors for farmers' extent of adaptation strategies towards salinity effects in agriculture; and within this, age, agricultural extension contact and farmer's category were the most significant contributing factors. It is concluded that, the study area's farmers had an opportunity to enhance their knowledge through proper school or mass education that made them enthusiastic and interested to take risk and motivated them to come out from traditional practices in agriculture and using innovative adaptive strategies to cope with salinity effect on the agriculture sector.*

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I. Introduction

Climate change is now a prominent concern throughout the world and according to geographical location, Bangladesh is one of the major susceptible countries for present climatic situation. The tropical climate, overwhelming floodplain area, minimum level of exaltation, extremity of sea level; the high population density; and limited technological capacities to offset climate change effects are the major responsible issues for its vulnerability towards climate change (MOEF, 2009; DOE, 2007; Shahid and Behrawan, 2008; Pouliotte et al., 2009). According to the Global Climate Risk Index 2017, Bangladesh ranked ninth as the most vulnerable country and as the worst affected country by extreme weather (Eckstein et al., 2018) The last era the country has faced devastating *Sidr* in November 2007, Aila in April 2009, sequence of flood in 2004, 2007 and 2009, *Nargis* in 2010 and *Mahasen* in May 2013 (Ahmed, 2010; MOEF, 2009). The most enduring influences of worst climatic conditions are global warming, sea-level rise, salinity intrusion, drought, heat waves, cold waves, etc. The coastal zone of Bangladesh is worldwide recognized as an extremely susceptible area influenced by climate change and sea level rise which have real consequences on the livelihoods of the coastal people especially in agricultural activities through salinity intrusion, temperature and rainfall fluctuation, flooding, soil erosion, scarcity of soil water, storm surges and cyclone (Hasan et al., 2013). In Bangladesh, 83.3 million hectares of land was affected by salinity in 1973, which increased to 102 million hectares in 2000 and 105.6 million hectares in 2009. Over the last 35 years, salinity has increased to 26% within the country (SRDI, 2010). About 29000 square km lands occupies the coastal area that cover more than 30% of the cultivated land area of the country and among them about 53% of the lands are affected by salinity (Haque, 2006) which is reducing the agricultural productivity and putting far-reaching impacts on the livelihood strategies of resource poor farmers (Hassnain et al., 2005). According to World Bank (2000), the sea level will rise up to 0.10 m, 0.25 m and 1 m in 2020, 2050 and 2100 accordingly, and it may affect 2%, 4% and 17.5% of total land mass correspondingly 1 cm per year sea level rise in Bangladesh.

Salinity intrusion rate in coastal Bangladesh was predicted too much higher than thinking a decade ago (Agrawala et al., 2003). The factors which contribute significantly to the development of saline soil are tidal flooding, submersion by saline water, and upward or lateral movement of saline ground water during rainy and thirsty season (Rasel, 2013). Salinity problem in Bangladesh may acute with the desiccation of the soil (Haque, 2006). The major concern of salinity is reduction in crop yield that create critical environmental and hydrological situation throughout the year (Karim, 1990). In the coastal and offshore areas cover about 0.83 million hectors are arable lands which are affected by varying degree of salinity and tidal submerges (Karim et al., 1990). It has been estimated that every minute the world is losing, on average, 10 ha of cultivable land, due to salinization (Kabata and Pendias, 1984), which is equivalent to a loss of about 1500000 ha per year. Intergovernmental Panel on Climate Change (IPCC, 2000) highlights that crop yield could fall by up to 30% by 2050 as a result of salinity intrusion. The large portions of saline land fall in the districts of Satkhira, Khulna, Bagerhat, Patuakhali, Barguna, Pirojpur and Bhola. After 2009 cyclone-AILA, the farmers of Bangladesh were confronted with severe salinity in their cultivable land which affects their socioeconomic status compared to last five years (Rabbani et al., 2013). Due to salinity crop production is reduced and off-firm activities are increased but it cannot contribute same as well from agricultural activities. CCC (2007), study identified salinity intrusion as the most pressing problem for yield reduction in coastal agriculture and found that in coastal Bangladesh about 830,000 million ha of land were severely affected by soil salinity with varying degrees of intensity. It is estimated that due to 0.3 m sea level rise, a net reduction of 0.5 million MT of rice production would take place in coastal areas of Bangladesh (WB, 2000).

So, confronted with this condition now adaptation is the situation demand to reduce the impacts of salinity on farmers' livelihood. Adaptation strategies are activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive) (Mcdowell and Heiss, 2012). Adaptation is a spontaneous and planned response to anticipation of change in conditions (Watson et al., 1996). In agricultural purpose adaptation means a decision making process according to the perception of climate change (Bryant et al., 2000). Adaptation can be a specific action like a farmer changing crops, a systemic change like diversifying livelihoods or an institutional reform like changing resource management practices. It can also denote the whole process, including learning about risks, evaluating response strategies, mobilizing resources, implementing adaptations and revising choices with new learning (Leary et al., 2008). The main goal of adaptation towards salinity effects is reducing vulnerability and builds resilience to the impacts bought by salinity. Salinity rise is a boisterous

component of climate change which affects farmers seriously in socio-economic aspects. It is now a recurrent phenomenon which is an alarming discussion to every country in the world. People are taking indigenous adaptive measures against salinity effects which need to be enhanced scientifically to reduce its impact. In our country, Government and Non-Government organization have carried out a different policy to mitigate the problem by enhancing and adopting some important adaptive measures by the farmers. According to above mentioned salinity related difficulties, the researcher had set the following specific objectives: a. To define socio-economic status of the salinity affected farmers; b. To explain the extent of farmers' towards adaptation strategies against salinity effects in agriculture; and c. To explore the contributing relationship between the selected characteristics of salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture.

II. Materials and Methods

Locale of the study

The study was conducted purposively in selected areas of Kalapara upazila under Patuakali District. There are 12 unions among those two unions namely Latachapli and Dhulasor were also purposively selected which is severely affected by salinity; again two villages namely Khajura and Noyapara from Latachapli union, and Anantopara and West Dhulasor from Dhulasor union were selected randomly as the locale of the study. A Map of study area was given in Figure 01.

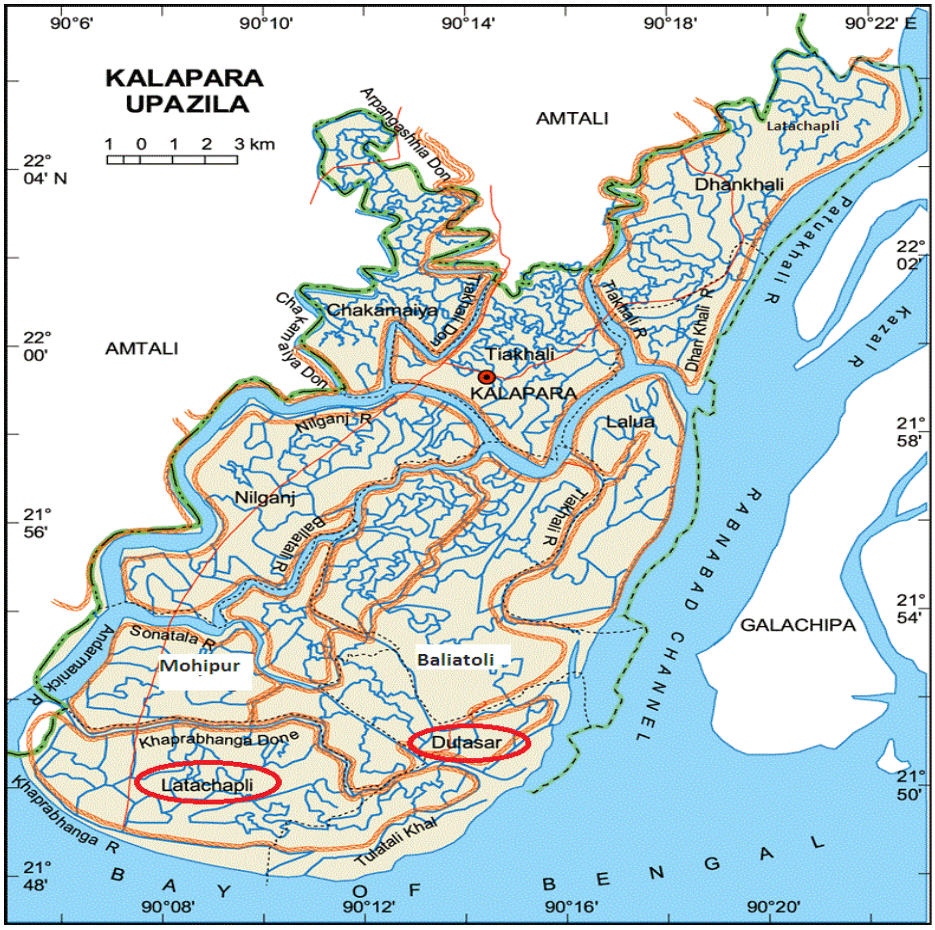

Figure 01. Map of Patuakhali District showing Kalapara Upazila

Population and Sampling

According to the help of Upazila Agriculture Officer, Local leaders and concerned Sub-Assistant Agriculture Officer (SAAO) was collected an updated list of farmers of the selected villages. The farmers of the selected four villages constituted the population of the study. The total numbers of farm families head in four villages were 1022 (Table 01). According to Yamane's (1967) formula, sample size was 131

at 8% precision level, 50% degree of variability and the value of the standard normal variable (Z)=1.96 at 95% confidence level. The given formula is stated as:

$$n = \frac{Z^2P(1-P)N}{Z^2P(1-P)+Ne^2}$$

Where,

n = sample size
N= population size
e = the level of precision
Z = the value of the standard normal variable given the chosen confidence level (e.g. Z = 1.96 with a confidence level 95%)
P = the proportion or degree of variability

Table 01. Distribution of study area's population and sample

District	Upazila	Union	Village	No. of farm family head(N)	Sample size (n)	Reserve farm family head
Patuakhali	Kalapara	Latachapli	Khajura	400	51	8
			Noyapara	252	32	5
		Dhulasor	Anontopara	210	27	4
			West Dhulasor	160	21	3
Total:				1022	131	20

Measurement of Variables

Measurement of independent variables

Sl. No	Variable	Measurement technique
1	Age	Year
2	Education	Schooling year
3	Farming experience	Year of experience
4	Training experience	Number of days
5	Farm size	Area of land in hectare
6.	Annual income	1 was assigned for each thousand Taka
7.	Agricultural extension contact	5 point rating scale. 4 for high and 0 for no uses.
8.	Innovativeness of farmer	5 points rating scale. 5-Innovator, 4-Early adopter, 3-Early majority, 2- Late majority, 1-Laggards

Measurement of dependent variable

The dependent variable of the study was farmers' extent of adaptation strategies towards salinity effects in agriculture. The variable was measured on the basis of 10(ten) adaptation strategies followed against salinity effects in agriculture by the farmers. The strategies are: 1. Cultivating short duration crops, 2. Practicing crop diversification, 3. Homestead cultivation, 4. Practicing intercropping, 5. Use of saline tolerant varieties, 6. Zero tillage, 7. Mulching, 8. Alternative irrigation system, 9. Reducing salinity by organic or chemical method, 10. Making embankment around land to control saline water intrusion Adaptation score was made in percentage based on her/his response (yes/no)against each strategy. Score one (01) was given to 'yes' and zero (0) was given to 'no' response. In this study Ten (10) strategies were selected by pre survey technique and if one respondent follow or adapt 1 (one) strategies in her/his farm level activities then her/his adaptation score would be

$$\frac{1}{10} \times 100 = 10\%$$

Data collection

A well-structured interview schedule (Questionnaire) was developed based on the objectives of the study for collecting information. The schedule contained direct and simple with open form and closed form questions. The interview schedule was pre-tested with 20 farmers by the researcher. The pre-test facilitated the researcher to identify faulty and unnecessary questions in the draft schedule and hence,

necessary additions, corrections and modifications were made in the schedule on the basis of the pre-test results. Data collected from the respondents were coded, compiled, tabulated, and analyzed in accordance with the objectives of the study. Qualitative data were converted into quantitative form by assigning suitable score whenever needed. The biasness of usage or uniformity of interview was prohibited.

Statistical analysis

The statistical measures such as range, means, standard deviation, number and percentage distribution were used to describe the variables. Multiple linear regression analysis was done for explore contributing relationship between variables. Statistical package for social sciences (SPSS) version 24 was used for analysis of data. Throughout the study $P<0.05$ as 95% of probability was used as a basis for rejecting or accepting the null hypothesis.

III. Results and Discussion

Socio-economic profile of farmers

Age: On the basis of their age, farmers were classified into three categories considering National Youth Policy: "young" (18 to 35 years), "middle aged" (36 - 50 years) and "old" (above 50 years). It was found that 17.6 percent of the farmers were young aged, 74 percent were middle aged and the rest 8.4 percent were old aged (Table 02). Here data revealed that most of the farmers in the study area were middle aged. It might be due to the middle aged farmers comparatively give more preference to agricultural activities than the young old aged farmers as they had more good health. Acquah (2011) found that the adaptation to climate change effect in agriculture sector is more adopted by middle to young age farmers then old aged.

Educational background: Educational background of the farmers were classified into four categories namely can sign only (0.5), primary level (1-5), secondary level (6-10) considering their level of schooling. Data showed that highest portion (81.7 percent) farmers in this study area had low level education (Table 02). It seemed to be the majority of the farmers of the study area could not reach the above level from primary level due to various socio-economic problems. It should be enhance education at higher level among the farmers which helps the farmer to broaden their outlook and expand mental horizon by helping them to develop favorable attitude. Quayum and Ali (2012) found that if the farmers are become educated then their adoption level for climate resilient coping strategies in agriculture sector will be increased accordingly and also explored that the educational level of farmers were positively related with the awareness on farming environment.

Effective farm size: On the basis of the respondent's effective farm size they were classified into four categories as suggested by DAE (1999): i. Marginal (land ownership up to 0.20 hectare), ii. Small (land ownership 0.201-1 hectare), iii. Medium (land ownership 1.01-3 hectares) and iv. Large (land ownership above 3 hectares). Data revealed that the highest portion (74 percent) of the farmers had small to medium farm size (Table 02). It might be the farmers in the study area were facing land erosion due to tidal surges which resulting from cyclone, flood that was appeared comparatively every year in coastal area. Acquah (2011) explored that the adoption of climate resilient agricultural practice will be increased with the decrease of farm size, because larger farms require inputs such as seeds, fertilizer, pesticides, irrigation facilities, and more at rates which are stressors on farm budgets.

Farming experience: On the basis of farming experience farmers were classified into three categories: 'Low farming experience' (experience up to 18 years), 'Medium farming experience' (experience 19 -30 years), and 'High farming experience' (experience above 30 years) considering Mean ±1sd. Data showed that highest portion (84.7 percent) of farmers had low to medium farming experience (Table 02). It was assumed that, farmers in the study area were engaged in farming activities for a long time. It might be that, farmers in the study area depended mostly on agriculture and they were engaged long time in farming activities. Rokonuzzaman et al. (2006), the farmers who have long term farming experience, they are more practicing different sustainable agriculture strategy in their cultivable land.

Table 02: Salient features of the selected characteristics of farmers

SI	Characteristics	Unit of measurement	Possible range	Observed range	Categories	Percentage	Mean	Standard Deviation
1	Age	Year	unknown	25-56	Young aged (18 to 35) Middle aged (36-50) Old aged (above 50)	17.6 74 8.4	42.09	6.57
2	Educational background	Level of schooling	unknown	0.5-10	Can sign only (0.5) Primary level (1-5) Secondary level (6-10)	14.5 67.2 18.3	3.55	2.63
3	Effective farm size	Hectare	unknown	0.06-4.65	Marginal (up to 0.20) Small (0.201-1) Medium (1.01-3) Large (above 3)	19.8 41.2 32.8 6.1	1.07	1.05
4	Farming experience	No. of years	unknown	8-40	Low (up to 18) Medium (19-30) High (above 30)	19.8 64.9 15.3	24.54	6.84
5	Annual family income	'000'Taka	unknown	40-420	Low income (up to 140) Medium income (141-280) High income (above 280)	62.6 31.3 6.1	130.28	90.53
6	Training experience	No. of days experience	unknown	0-12	No (0 day experience) Low (1-3 days) Medium (4-8 days) High (above 8 days)	4.6 54.2 36.6 4.6	3.65	2.46
7	Agricultural extension contact	Score	0-40	7-30	Low (up to 11) Medium (12-21) High (above 21)	31.3 48.1 20.6	16.21	5.88
8	Farmer's category based on their innovativeness	Score	1-5	1-5	Innovator (5) Early Adopter (4) Early Majority (3) Late Majority (2) Laggards (1)	6.1 6.9 28.2 26.7 32.1	2.28	1.17

Annual family income: On the basis of their observed annual family income scores farmers were classified into three categories; 'low income' (up to Taka 140 thousands), 'medium income' (Taka 141-280 thousands) and 'high income' (above Taka 280 thousands). Highest portion of farmers (93.9 percent) were in low to medium income category (Table 02). It might be the farmers were low to medium income because of they could not cultivate crops without difficulty due to salinity effects which causes low production in agriculture. A farmer with low income could not invest large amount of money in farming activities also another hindering factors to their income development. Kim et al. (2012) found that household income positively influences the adoption of adaptive measures to climate change on their farm land, while Gbetibouo (2009), explained that wealthier farmers are more interested to adapt by changing planting practices, using irrigation, and altering the amount of land farmed.

Training experience: On the basis of their training experience scores farmers were classified into four categories: 'No training experience (0 day experience)', Low training experience (1-3 days experience)', 'Medium training experience (4-8 days experience)', and 'High training experience (above 8 days experience). Data furnished that a vast portion of the respondents (54.2 percent) had low training experience while 4.6 percent had high training experience (Table 02). It seemed to be the training experience of farmers was low because of institutional co-operation, farmer's lack of consciousness or proper motivation towards training. Training enhances farmer's knowledge, attitude, and perception and enables to show skill which is important to make positive decision to adapt against effects of climatic variation. So, it should be increased training experience among farmers by offering them training on current issue such as salinity effects and its adaptation. Uddin et al. (2014), revealed that the probability of adopting adaptive strategy is higher for those farmers who have connections with different

Agricultural extension contact: On the basis of respondent's agricultural extension contact scores they were classified into four categories: 'low agricultural extension contact (score up to 11), 'medium agricultural extension contact (score 12-21)', 'high agricultural extension contact (score above 21)' considering Mean ±1sd. Data revealed that highest portion of farmers (79.4 percent) possess low to medium agricultural extension contact with various communication sources (Table 02). It might be the farmers in the study area had low contact due to inappropriate communication, though agricultural extension contact was gradually increased to medium category. So, it should be increased to high category by proper policy implications by both GO and NGO in the area.

Farmer's category based on their innovativeness: On the basis of their categorical score based on innovativeness the farmers were classified into five categories were: a) Innovator, b) Early adopter, c) Early majority, d) Late majority, and e) Laggards. Data indicated that the majority of the respondent (32.1 percent) were 'Laggards' while 6.1 percent farmers were 'Innovator', 6.9 percent were 'Early adopter', 28.2 percent were 'Early majority' and 21.4 percent were 'Late majority' category (Table 02). It seemed to be that the highest portion farmers were laggards for their average below social status, little financial liquidity and they were adopted an innovation more than above 4 years of hearing. So, it should be increased by proper financial and technical support and motivation to them.

Farmers' extent of adaptation strategies towards salinity effects in agriculture

Farmers' adaptation strategies was categorized into three categories: low adaptation strategies (score up to 41), medium adaptation strategies (score 42-79) and high adaptation strategies (score above 79) considering Mean ±1sd (Table 02). Data revealed that the observed range of adaptation of farmers was 40 to 90 percent against the possible range of 0 to 100 percent with mean 60.46 and standard deviation was 19.45.

Table 03: Distribution of farmers according to their adaptation score

Adaptation (Score)	Number	Percent	Mean	Standard deviation
Low level adaptation (Up to 41)	31	23.7		
Medium level adaptation (42-79)	63	48.1	60.46	19.4
High level adaptation (above 79)	37	28.2		

In Table 03, it was showed that majority of the farmers (48.1 percent) had medium level adaptation while 23.7 percent of farmers had low level adaptation and 28.2 percent had high level adaptation. Data also showed that the highest portion of farmers (76.3 percent) had medium to high level adaptation. It was assumed that maximum farmers were taken adaptive strategies against salinity effects for maximize their production. Majority portion of them had medium level adaptation which indicates that they had been facing obstacles to make decision to adapt strategies. Salinity is an alarming problem in coastal agriculture and for sustainable production farmers need to be high adapted against it. For adaptation towards salinity effects in agriculture, farmers need to be motivated towards adaptation in an appropriate way. Experts GO and NGO representatives in collaboration with the farmers can play a key role in this regard and their knowledge and communication exposure should be improved through individual and group discussions.

Relationship between selected characteristics of farmers and extent of adaptation strategies towards salinity effects in agriculture

This section deals with the findings exploring the contributing relationship between the selected characteristics of farmers and their extent of adaptation towards salinity effects in agriculture. The contributing factors were age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact, and farmer's category based on their innovativeness. Assessing contributing relationship between selected characteristics of farmers and their extent of adaptation strategies towards salinity effects in agriculture, a multiple linear regression analysis was done. The multiple linear regressions results have been shown in the Table 04.

Table 04. Multiple linear regression coefficients of contributing variables of farmers' extent of adaptation strategies towards salinity effects in agriculture

Dependent variable	Independent variables	B	*p*	R^2	Adj. R^2	F	*p*
Farmers' extent of adaptation strategies towards salinity effects in agriculture	Age	.342	.001**	.763	.747	49.09	.000**
	Educational background	.153	.039*				
	Effective farm size	-.153	.478				
	Farming experience	-.214	.033*				
	Annual family income	.060	.788				
	Training experience	.046	.580				
	Agricultural extension contact	.297	.007**				
	Farmer's category based on their innovativeness	.480	.000**				

** Significant at $p<0.01$, * Significant at $p<0.05$

The findings of the study revealed that, the eight (08) characteristics of the farmers were taken as independent variables together were effective in predicting farmers' extent of adaptation strategies towards salinity effects in agriculture. The observed F ratio was significant at 0.01 level of significance which was an indication that the combination of the independent variables in farmer's adaptation was effective. 76.3 percent (%). (R^2 =.763) of the variation in the respondents' adaptation can be attributed to their age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact and farmers' category based on their innovativeness making contribution on farmers' extent of adaptation strategies towards salinity effects. However, each predictor may expound some of the variance in respondents' adaptation conditions simply by chance. The adjusted R-square value penalizes the addition of external predictors in the model, but values of .747 still show that the variance in farmers' extent of adaptation strategies towards salinity effects in agriculture can be attributed to the predictor variables rather than by chance and the F value indicate that the model was significant ($p<0.01$) .

From Table 04, it was observed that age, educational background, farming experience, agricultural extension contact and farmer's category based on innovativeness of farmers had significant contribution on Farmers' extent of adaptation strategies towards salinity effects in agriculture. Data also showed that here age, agricultural extension contact and farmers' category based on their innovativeness (innovator, early adopter, early majority, late majority and laggards) had most significant contribution at 1% ($p<0.01$) level of significance on adaptation of farmers. It was also showed that farmer's farming experience, educational background had also significant contribution at ($p<0.05$) 5% level of significance on their extent of adaptation strategies towards salinity effects in agriculture. Data furnished from Table 04 that, farmer's age was positively influenced on farmer's extent of adaptation strategies and it could be said that young and middle aged farmers were given more preference to agricultural activities than the old aged. The study was found that most of the farmers in study area were middle aged. It might be that the middle aged farmers were more conscious about farming than young and old aged farmers for their comparative good health condition.

Farmer's category had positive influence on farmers' extent of adaptation strategies towards salinity effects in agriculture. It might be the innovators had more adaptive capacity due to their highest financial liquidity, had interest to take risk and they possess fast (adopted an innovation within 1 year of hearing) and high level adaptation. Data revealed from Table 04 showed that, farmer's agricultural extension contact positively influenced on farmers' extent of adaptation strategies towards salinity effects in agriculture. It might be that, communication with extension media enhances farmers' knowledge, attitudes, perception to innovation which was suitable for her/his problem to be solved. Farming experience showed negative influence on adaptation. It could be said that sometimes new technologies were not accepted by high experienced farmer compared to traditional ones and they might be faced obstacles sometimes to take new decision for going outside from traditional practices considering benefit. Data revealed from Table 04 showed that, farmer's educational background was positively influenced on their adaptation. It seemed to be the educated farmers had more knowledge, a greater ability to understand and respond to anticipated changes, were better able to forecast future

scenarios and, overall, have greater access to information and opportunities than others, which might encourage adaptation.

IV. Conclusion

The study revealed that most of the farmers of this area are middle aged and they had medium farming experience. But most of them were primary level educated and very low training experience, so that they were very laggard in farming innovativeness and their level of adaptation was medium. The study also explored that age, educational background, farming experience, agricultural extension contact and farmer's category based on innovativeness of farmers had significant contribution on Farmers' extent of adaptation strategies towards salinity effects in agriculture. Among them age, education, agricultural extension contact and farmer's innovativeness were positive contributor and farming experience was negative contributor on farmer's extent of adaptation strategies towards salinity effects in agriculture. Majority of the farmers of the study area were found to have medium level adaptation strategies towards salinity effects in agriculture. As salinity is an alarming problem in coastal agriculture so that adaptation towards salinity effects in agriculture, farmers need to be motivated towards adaptation in an appropriate way. Experts GO and NGO representatives in collaboration with the farmers can play a key role in this regard and their knowledge and communication exposure should be improved through individual and group discussions. Beside more Agricultural extension contact increases farmers' diversified knowledge and make them able to cope with adverse situations. So, policies should be taken to engage farmer's with diversified extension media to broaden their outlook and to develop positive attitude on their adaptation.

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