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Coping strategy for rice farming in Aila affected South-West region of Bangladesh

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ABSTRACT

Key Words:

Adaptation, Coastal
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Crop production and livelihood practices in coastal communities of Bangladesh are seriously impacted by natural calamities, triggered by salinity intrusion, shrimp farming and drainage congestion. The study was conducted in three villages of Koyra upazilla under Khulna district in 2014 which were affected severely by cyclone Aila on 25th May 2009. The study explores the potential factors, local practices and coping strategies the rice farming communities experienced during livelihood recovery process after cyclone Aila. The study also measures how their adopted practices contribute to the production of rice in coastal areas. Total 96 rice farmers were interviewed with snowball sampling technique and 3 Focus Groups Discussion (FGD) were conducted with 29 farmers in study areas. The study reveals that at least 12 hazards always disturb coastal farmer to cultivate rice of which five hazards have impacts ranging medium to high level. Result shows that rice farmers have experienced at least 16 different adaptation practices for rice cultivation which play potential roles at different scales. The study also represents that different factors of production have positively influence Aman rice production, use of fertilizer influence rice production significantly at 5% level of significance. Study also tested that production of rice on alleviated land (high land) is 22% higher than the beel land. Most importantly it has shown the statistical significance of production performance for adopting different adaptation practices that influence rice production at 5% level of significance. So for the rice production along with the use of different inputs, different adaptation options have to be strategically furnished as community based practices. Besides, the study also reveals the importance of Government and private sectors initiatives to support rice farming communities for higher production through proper planning and technical support.

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I. Introduction

Bangladesh is predominantly an agrarian based country and agriculture is the driving force of the rural economy. Agriculture contributes to 20.24% gross domestic product (GDP), and around 48.1% of the labor force depends on agriculture for employment [7]. Besides, agriculture is directly related to the issues like poverty alleviation and rising of standard of living and increased generation of employment [11]. 19 districts constitute coastal zone of Bangladesh covers about 20% of the country and over 30% of the net cultivable area [14]. Miah et al. (2004) mentioned that the land of coastal area is mainly used for agriculture. Coastal regions of Bangladesh contribute 16% of the total rice production of the country [30]. In coastal districts, transplanting Aman rice is the dominant crop that covers about 70% of the rice cropped area, Aus rice covers 16% and Boro rice 14%. About 60% of the paddy cropped area is planted with local varieties, adapted to poor water management (water logging, salinity) [37]. Saadat and Islam (2011) also studied that livelihoods of coastal people is dominated by agriculture, agriculture related activities, aquaculture or fisheries and related business [44]. Where adaptive rice farming is overwhelmingly understood primary livelihood option for the coastal community. Though shrimp cultivation had been converted large areas of traditional rice fields in different coastal districts in Bangladesh [32]. Haque (2006) found that the livelihoods of coastal inhabitants are also varied and some are very specific that, they are often influenced by different coastal phenomena [14]. The coastal zone of Bangladesh is determined by the influence of tidal waters, salinity intrusion and cyclones/storm surges [33]. According to salinity survey findings and monitoring information about 1.02 million ha (about 70%) of the cultivated land in the coast are affected by varying degree of soil salinity [51]. Islam (2006) also mentioned that different environmental threats affect almost every aspect of life and limit livelihoods choice of people [21]. Rabbani et al. (2013) mentioned that both slow onset and rapid onset of disasters are the part of lives of southwest coastal community of Bangladesh [38]. The study also mentioned that cyclone and storm surges damage crops not only in the year when the cyclone hits, but for several years afterwards. According to Cell (2009), numbers of rapid and slow-onset climatic events affect rice production and related agricultural livelihoods [7]. Rahman (2011) stated that Bangladesh faced two devastating tropical cyclones ‘Sidr’ and ‘Aila’ in 2007 and 2009 respectively that caused extensive loss and damages [39]. Cyclone Aila hit the south western coastal part of Bangladesh on 25th May 2009 and around 3.9 million people became the victims of cyclone Aila [22]. UN (2010) showed that, transplanting Aman rice cultivation has not been possible during 2009 due to increased level of salinity in the soil and regular inundation by tidal water [52]. So, it is evident that coastal community are vulnerable to different climatic hazards at different extend. Several studies reflect on coastal hazards and climate change impact scenarios in coastal Bangladesh [47]; [41]. Rabbani et al. (2013) have studied salinity induce loss and damage depicting impact of cyclone ‘Sidr’ and cyclone ‘Aila’ [38]. Besides several literature state that natural hazards, climatic variability’s have potential impact on crop agriculture and rice production also [46]; [47]. Different strategies were found at community level on practices to responses to and cope up with slow and rapid onset climatic disaster. These community practices vary sectors by sectors and depending on the economic and social conditions of the people. Different adaptation options related to crop agriculture and rice farming are available in literatures [40]; [46]; [47]. Besides, different coping pattern in the case of post cyclone and disaster have been mentioned in different literatures of [35]; [46] focusing more on preparedness issues for pre and during hazardous events as well as immediate after the events. Paul and Routray (2011) showed that, although a good number of studies have been conducted in Bangladesh covering at different issues of coastal flood, tidal surges, cyclone and storm surges, the systematic documentation of indigenous knowledge and practices, identification of how different underlying factors influence coping pattern is still lacking [35]. However, a few studies have been carried out on post cyclone and induced surges event’s long term coping pattern focusing on rice farming communities. The study on rice farmer coping strategies and enabling factors to response big climatic disaster has not been conducted for the coastal communities of Bangladesh. Besides a lot of studies at national cases and other countries are available on rice production function considering different inputs and factors of production, considering climatic

variability's [3]; [6]; [13], but very few studies have considered social, management and adaptation options related factors that significantly contribute to increasing efficiency of rice production in coastal areas. Sarker and Rashid (2012) pointed out the weakness of relevant study mentioning that no empirical studies have employed econometric techniques to examine the effects of climatic variables on rice yield in the context of Bangladesh [46]. Different studies found that, rice and non-rice crop adaptations and cropping pattern in coastal saline soil. The big cyclone Aila hit on 25th May caused tremendous damages in south-west coastal communities and demolished physical structures a lot. After cyclone 'Aila' the community struggled for a long time to come back to their normal living condition by adopting different strategies and practices. The study was conducted to identify potential factors as resilience features helped the communities to come back to normal rice production process after big disaster. The study has identified local practices and coping strategies for rice cultivation in cyclone Aila affected coastal community. This study looked into those experiences that farming communities gained during the recovery process from cyclone 'Aila' effect. Secondly, the study measured how their adopted practices contribute to the production of rice in coastal areas. These factors and coping experiences as solution would be milestones for the researchers, development practitioners and policy makers.

II. Materials and Methods

The study was conducted in Koyra upazilla of Khulna district located in the south-west Bangladesh and close to Bay of Bengal surrounded by the Sundarban at the south. The study period was from February to July 2014. Koyra upazilla is located between 22°55'N Latitude and 89°15'E Longitude with an altitude of 3.0-3.5 m from MSL. These communities were seriously affected by cyclone Aila in 2009 and faced enormous suffering to come back to normal lives [42]. The communities had to struggle for a long time to revive rice based livelihoods. Three unions i.e., Koyra Sadar, North Betkashi and Moharajpur at Koyra upazilla of Khulna district were selected for the study considering its geo-physical characteristics i.e., location, physical characteristics and relative vulnerability. Out of three villages in two villages irrigation facility is not available due to underground salinity. These villages are dominated by single rice crop with a rotation of controlled shrimp farming in one village. Both primary and secondary data were collected following quantitative and qualitative method of data collection. Primary data was collected by household questionnaire survey and following focus group discussions (FGD). The questionnaire survey helped to get detail idea of farmer's on two categories of variables. Purposive sampling technique was applied to select unions and villages. One village from each of three unions was selected purposively considering relative vulnerability and hazards. Total 96 households were identified taking 36 households from each village following snowball sampling method. Two types of farmers were considered i.e., those cultivate rice in alleviated (raised) land is called high land and those cultivate rice in the plain land of crop field here by it is called *beel* land. Out of total 96 HHs, 48 farmers were for high (alleviated) land & other 48 farmers were for *beel* (low land) land. SRDI (2001) defines high land normally do not flooded during monsoon season that is hereby called high land [50]. Here the author considered medium high land as *beel* land which normally flooded up to 90 cm depth during monsoon for more than two weeks to few months. 3 FGDs were conducted in three studied villages in presence of average 8-10 community people to resolve the issues not been able to cover by household questionnaire survey. Secondary information was collected from published documents using internet search, published relevant papers, unpublished reports, journals and having communicated with Koyra Upazila UNO Office, Koyra Upazila Department of Agriculture Extension Office under the district of Khulna.

Variables for Socio-economic Status, Hazard Impacts and Factors helped livelihood restoration and Copping Practices of Rice Farmer: To fulfill the first objectives different variables and indicators were considered. These variables were taken to determine household socio-economic status, farmer knowledge on hazards, impact of hazards on coastal rice production, potential factors contributed to rice cultivation and the household coping strategies the communities experienced from the cyclone Aila response. Variables for Rice Production and Main Factors of Production: These Variables were used to define main factor of production and to estimate rice production. In this study an empirical model i.e., Cobb-Douglas production function was used, because the function was widely used in agricultural study

for its simplicity [6]. Furthermore, this function allows either constant, increasing or decreasing marginal productivity, or not all the three and even any two at the same time. The model specified is given below:

$$Y_i = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} X_8^{\beta_8} D_1^{\beta_9} D_2^{\beta_{10}} \mu$$

Above mentioned model can be estimated by using Ordinary Least Square Model (OLS) method. The Cobb-Douglas production function was transferred into log-linear form as:

$$\ln Y_i = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \beta_7 \ln(X_7) + \beta_8 \ln(X_8) + \beta_9 D_1 + \beta_{10} D_2 + \mu$$

Where,

Y_i = Production of *Aman* rice (In mounds), β_0 = Intercept, X_1 = Area of Rice Cultivation (Acre), X_2 = Seed and Seedling Cost (tk.), X_3 = Human Labor (Man hours), X_4 = Tillage Cost (tk.), X_5 = Use of Fertilizer (kg), X_6 = Use of Pesticide (gm.), X_7 = Knowledge and Skill (years), X_8 = Adaptation Practices (no. of adaptation options), D_1 = Land Types (High land =1; *Beel* land =0), D_2 = Rice Variety (HYV=1; Local =0), $\beta_1 - \beta_{10}$ = Elasticity of coefficients, μ = Error term.

Data obtained was analyzed using both descriptive and inferential statistics. Collected data was processed and written by using the computer program like MS Word, MS Excel, SPSS-20 and STATA. All socio-economic data was analyzed following descriptive statistics considering frequency, mean, median and using cross tabulation and ranking. Prioritization of potential factors was done based on its roles in helping rice farmers to come back to rice based livelihoods. Response scores were placed on a continuum (likert scale) as Very high, High, Medium, Less, Very Less and No response through assigned to responses are 5, 4, 3, 2, 1 and 0. Cross tabulation was done to assess knowledge level of farmers with adaptation practices. Household's experiences to practices different coping strategies for rice farming were weighted by using likert-type scale. A correlation was drawn for adaptation options and for rice production. Un-paired t-test is done to estimate and compare production from high land and *beel* land. The report of this study was analyzed and written by following different analytical framework like likert scale, Cobb- Douglas production functions, Ordinary Least Square (OLS) analysis to find the share of inputs variables to rice production. Besides, the effect of different coping strategies and local practices on rice production was estimated by using linear regression.

III. Results and Discussion

Primary information was collected from 96 households including three focus group discussions. Socio-economic status, idea on hazards, hazard impacts on rice production, community based practices, analysis of rice production trend and analysis roles of different factors were conducted following descriptive statistics. Results were presented both tabular and graphical form. Rice production was measured considering main factors of production and adaptation options as another factor of production.

Primary information of rice farming communities

Land holding status and occupation of farmers: 96 Households were taken to conduct the study from three villages. The study reveals that almost 84% rice farmers fall marginal farmers to small holders including landless category. Very few farmers fall in medium to large farm categories. The study reveals that 64% farmers were involved with rice cultivation as primary occupation and 23% as secondary occupation. Besides, 15% were engaged with non-agriculture labour as primary level occupation following by small trade, fish farming, livestock rearing, service, handicraft, etc. Similarly 18% were engaged with small trade as second level, 17% with fish farming as third level, 11% with agriculture labour as fourth level secondary occupation following by non-agriculture labor, others, poultry and livestock, sharecropper and handicraft.

Income, expenditure and saving status of the farmer: The study reveals that 21% farmers have income range up to tk. 50000, 46% has income range 50001-100000 and 33% has income more than tk. 10000 per annum. In contrast 10% has expenditure range up to 50000, 70% has expenditure range 50001-100000, 20% has expenditure over tk. 100000 per annum. Total 47% farmers don't have

surplus income; while 53% have less income than their expenditure. So their other coping strategy is to reduce consumption.

Farmer's idea on hazards and its impact on their livelihood

People's idea on hazards and its impact plays important roles in adapting different practices. Majority of the farmers could not relate climate change and its specific impact on rice production but they talked about the impacts of salinity, water logging and erratic rainfall, tidal surges on rice production. The study shows that 37% farmers have medium idea, 22% possess good idea and only 13% has very good idea on hazards and its impacts on livelihoods. Though, around 28% farmers possess poor idea on this. The experiences of cyclone Aila has helped them to learn about climatic consequences. Otherwise they would not have explained climate change impacts or related hazards.

Types of hazards and its impacts on rice farming communities

12 hazards were identified to be affected rice production and related livelihoods. Extent and severity of these hazards vary considering the locations of the communities, time and situation. **Figure 01** illustrates the scales of impacts of 12 hazards on rice cultivation. It is observed that embankment failure or river bank erosion possess the highest ranking value (4.28) ranging high to very high index value. It also implies that impact of salinity; water logging and drainage problem, insect attack and cyclonic events possess ranking values medium to high range. Besides saline water intrusion for shrimp farming, heavy rainfall, water surges possess low to medium impact values, while drought, late rain, high tides and other hazards possess low level impacts on rice cultivation. SRDI (2012) also has shown different hazards very similar to this study [51].

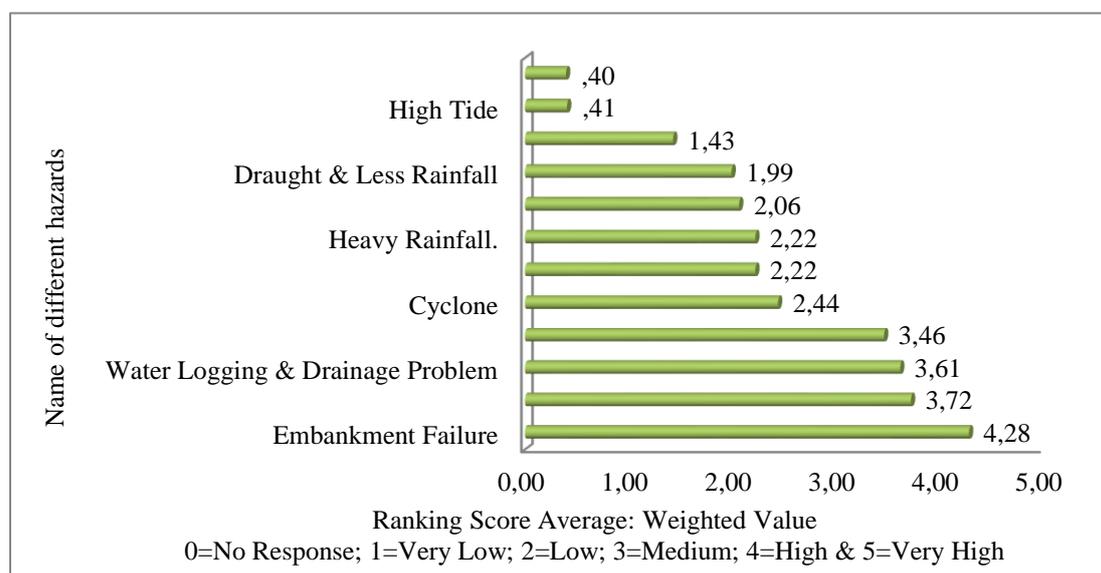


Figure 01. Rating impacts of different hazards on rice production.

Rice cultivation trend analysis

The questionnaire survey helped to collect rice cultivation status before and after the cyclone Aila. The study reveals that before cyclone Aila almost all interviewed farmers used to cultivate rice. **Figure 02** shows that after cyclone Aila in 2009 nobody could cultivate rice either in high land or in *beel* land followed by the year of 2010 and 2011. Though only 1% farmers had cultivated rice in 2011 and about 68% in 2012 followed by 100% interviewed farmers in 2013. The study states that in case of big disaster like cyclone Aila about 3 to 4 years is required for farmers to come back to rice cultivation and related livelihoods. KUDAEO (2014) report has also shown same result [25].

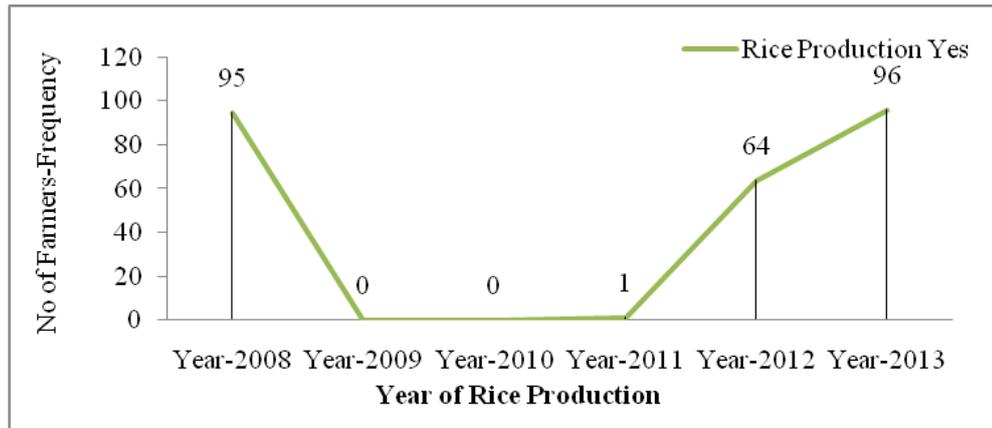


Figure 02. Rice production trend in study area.

FGD result shows that before cyclone Aila the farmers in 3 No Koyra and *Batul Bazar* villages used to cultivate HYV in high land and *beel* land close to their homestead. Almost 84% respondent mentioned that the most common Aman rice varieties in relatively high land were BR-11, BR-22, BRRI Dhan-30, BRRI *Dhan-41*, small scale BRRI *Dhan-49* and *Shat Dhan (Gota IRRI)*, etc. About 76% respondent opined that in high risk places having water logging and salinity problems they used to cultivate HYV rice like BR-10, BR-23, etc. with local rice varieties like *Patnai, Kaksail, Talmugur, Tike balam, Jamaibabu* rice, etc. The study finding reveals that *Moharajpur* village is relatively more hazardous. The farmers used to cultivate HYV of rice in high land, nearby homestead and used to cultivate local varieties of rice with small scale BR-23 in *beel* land. The FGD result indicates that after cyclone Aila a significant number of farmers in two villages could have started rice cultivation in advance for one reason is that many of those farmers cultivated salt tolerant local rice varieties in *Beel land*. Almost 65% opined that local rice varieties have relatively more adaptive capacity against multiple hazards than HYV of rice.

Factors played roles to revive rice cultivators in Aila affected areas

Main factors potentially contributed to come back to rice cultivation: The study areas were fully submerged by tidal water and used to inundate repeatedly by tidal water about two years. Different initiatives of the Government and NGOs helped the communities to survive in these locations. Factors in figure-3.3 helped the communities to cope up with and come back to rice farming. Figure 03 also recognized those important factors that coastal communities experienced and learned from livelihood restoration process. These factors played significant roles in helping community to come back to rice cultivation. It found reconstruction of embankment to be ranked first with highest index value-3.9. The figure also illustrates that renovate sluice gate and improving drainage network played second most important role as shown index value 3.1. Here, sufficient rainfall (value-2.7) and cultivation of rice on alleviated land (value-2.2) seems another important factor. Besides, support from the government (value-1.7), NGO support with index value 1.5, usage of underground water (value-1.4) and support from relative played important roles for rice cultivation later stage.

Other factors: Rice farmers in study areas did not only rely on rice cultivation for their livelihood rather had to depend on other livelihoods. So some other factors contributed to livelihood restoration of rice farmers. Figure 04 represents the scale of contribution (as index value) of other factors for livelihood restoration. It shows that cash for work contributed more to livelihood restoration which has index value-2.9. Similarly relief support has index value 2.7, alternative livelihood has index value 2.4, salt tolerant crop cultivation has index value 2.2, catch fishes has value 2.1 played important to more important roles for their livelihood. Besides, temporary migration value 1.6, VGD and VGF support value 1.5 played nearly important roles while dependency on the Sundarban with index value 1.3, sales of asset with index value 0.9 and other played roles but less importantly for livelihood restoration of rice farmers. So, higher values indicates more important role.

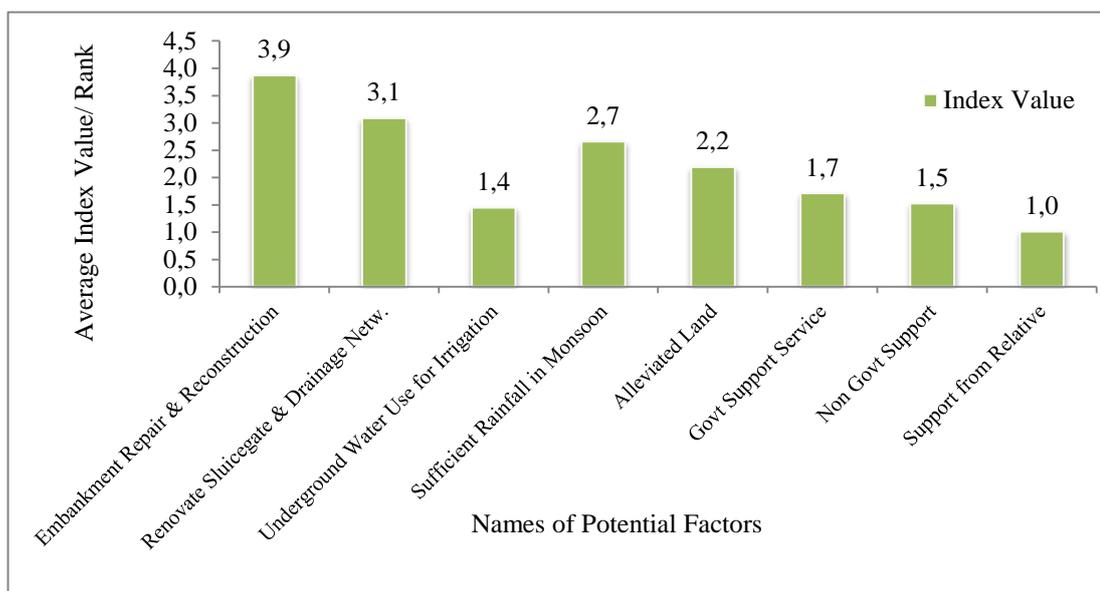


Figure 03. Factors helped farmers to come back to rice cultivation.

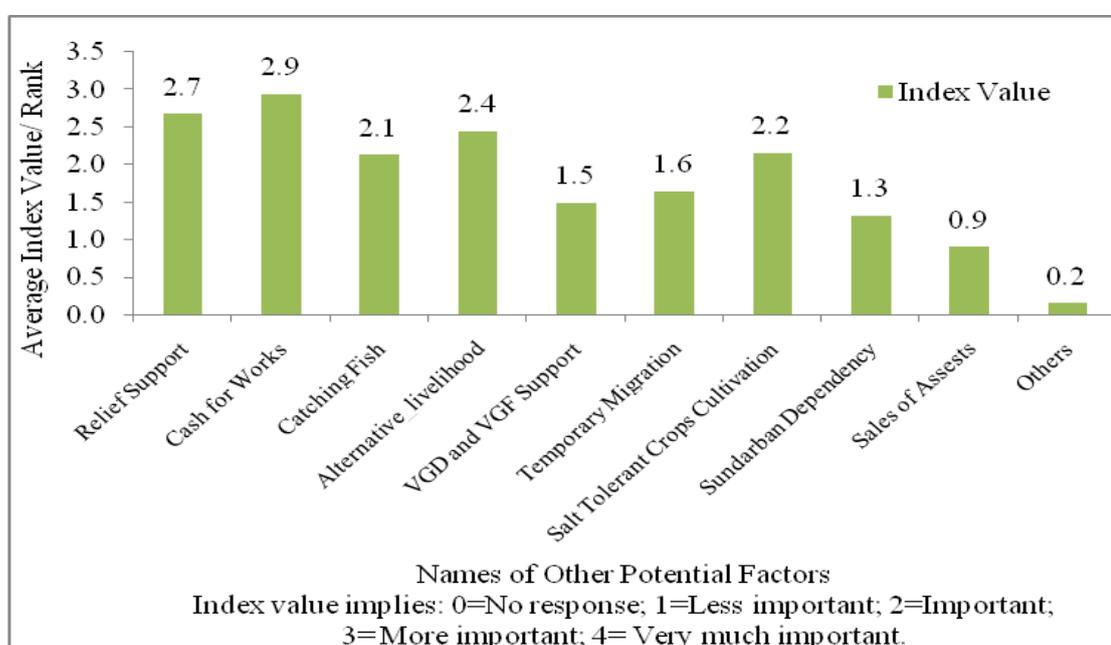


Figure 04. Other factors helped rice farmer for the livelihood restoration.

Community based practices for rice cultivation in south-west Bangladesh

Coastal community follows different strategies and local practices to cultivate rice within stressed condition prevailing in the areas. The study has shown such types of 16 different local level practices in the study locations. Based on the scale of use and its importance it has been stated that cultivation of High Yielding salt tolerance varieties of rice show maximum value 4.3 means very often in practice. The Figure 05 also shows that the farmers often practice cultivation of rice in raised land (value-3.8), cultivation of different types of rice (value 3.6), take ideas from neighbors (value 3.4), community based water level management in *beel* (value 3.3), rain water storage in ponds or ditches (value 3.1), cultivate short duration rice (value 3.0) to adapt within hazardous condition. Besides, wash soil salinity and early cultivation of rice both have value 2.7, communication with service providers value 2.6, local salt tolerance rice cultivation value 2.5, rice-fish cultivation value 2.3 are less often practiced for the adaptation. In addition to this membership with association value 1.6, follow crop rotation value 1.3, use of underground water value 1.1 and late cultivation of rice value 0.6 are practices very less in the study areas.

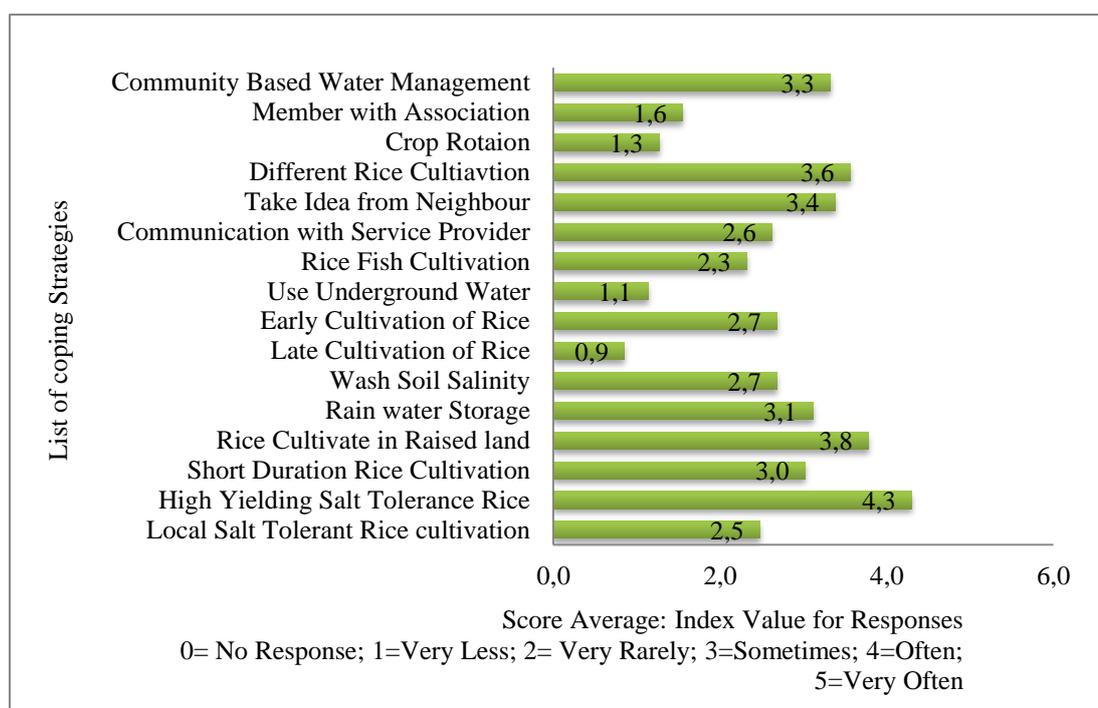


Figure 05. Degree of response as local coping practices in study areas.

Table 01.1: T-test result for the production of rice in high land and *beel* land

T-test Total Rice Production by (Land Types)						
Two-Sample t-test with Equal Variance						
Group	Obs.	Mean	Std. Err.	Std. Dev.	(95% conf. Interval)	
0	48	39.155	1.735707	12.02533	35.66321	42.64679
1	48	47.78583	1.452638	10.06417	44.8635	50.70816
Combined	96	43.47042	1.209652	11.85212	41.06895	45.87188
Diff.		-8.630834	2.263368		-13.1248	-4.136863

Diff = mean (0) - mean (1), t = -3.8133, Ho: diff = 0, Degree of freedom = 94, Ha: diff < 0, Ha: diff != 0, Ha: diff > 0, Pr (T < t) = 0.0001, Pr (|T| > |t|) = 0.0002, Pr (T > t) = 0.9999

Table 1.2: T-test Result for Production of HYV rice and Local Varieties Rice

T-test Total Rice Production by (Rice Types)						
Two-Sample t- test with Equal Variance						
Group	Obs	Mean	Std. Err	Std. Dev	(95% Conf. Interval)	
0	16	30.76375	1.49181	5.967238	27.58403	33.94347
1	80	46.01175	1.239562	11.08698	43.54446	48.47904
Combined	96	43.47042	1.209652	11.85212	41.06895	45.87188
diff		-15.248	2.85904		-20.92469	-9.571308

diff = mean (0) - mean (1), t = -5.3333, Ho: diff = 0, Degree of freedom = 94, Ha: diff < 0, Ha: diff != 0, Ha: diff > 0, Pr (T < t) = 0.0000, Pr (|T| > |t|) = 0.0000, Pr (T > t) = 1.0000

Here, in the first case the calculated t^* value is 3.81 and tabulated value at 94 degree of freedom and 1% level of significance is 3.31. The mean $t^* > t$, so null hypothesis is rejected. Hence, $H_0: Y_{HL} - Y_{BL} = 0$ is rejected; it implies that there is statistically significant difference in mean output between High land and *beel* land (Table 01).

Hypothesis

This study also tested two hypotheses one for comparison of rice production in high land and *beel* land and secondly comparison of production for adopting HYV and local varieties. The null hypothesis for first test is zero so the alternative hypothesis is accepted. Table 01 for t-test result shows that rice production difference between high land and *beel* land is significant at 1%. Because, average rice production for high land is 47.79 mounds per acre and for *beel* lands is 39.16 mounds per acre.

Correlation analysis

The study attempts to evaluate the effectiveness and correlation of different adaptation options and Aman rice production. The assessment of this effectiveness was carried out based on 9 independent adaptation practices and one dependent variable (rice production). Table 01 reveals the results of Pearson correlation of the variables with corresponding level of significance. In Table 01 it is shown that, correlation at 1% level of significance exist between land alleviation with HYV of rice, short duration rice and rice production but relation of land alleviation with rice fish cultivation is significantly negative. According to the correlation table types of rice i.e., cultivation of HYV is correlated at 1% level of significance with short duration varieties of rice and rice production. Again, cultivation of salt tolerant rice has no significance relationship with other variables. The table also shows that cultivation of short duration varieties of rice is correlated at 1% level of significance with total rice production and at 5% level of significance with access to government agriculture department. Additionally practices of rain water storage are also correlated with access to government agriculture department and integrated rice fish cultivation at 5% level of significance. More ever communication with different service providers is correlated with access to government agriculture office at 1% level of significance and with rice production at 5% level of significance. Besides, access to government agriculture department is correlated with rice production at 1% level of significance. Access to agriculture officer also play important roles to influence farmers to cultivate short duration varieties of rice, practice of rain water storage in pond or ditches and better production. The table also shows that integrated rice fish cultivation is negatively correlated with rice production at 5% level of significance. The relation can also be shown other way also as *ceteris paribus*.

Table 02. Minimum, Maximum and mean values of dependent and independent variables

Description of Variables.	Descriptive Statistics				
	N	Minimum	Maximum	Mean	Std. Deviation
Dependent variables					
Rice Production in Mound per Acre		17.68	72.73	43.47	11.85
Independent variables					
Land size in Acres	96	.12	1.66	.50	.36418
Seed and Seedling Cost in Tk. per Acre		519.00	3500	1700.34	686.12
Labor Use in Man hour per Acre		81.20	255.0	190.48	28.19
Tillage Cost per Acre in Tk.		731.71	2777.78	1710.79	375.28
Fertilizer Use in Kg. per Acre		24.00	220.83	112.17	46.76
Insecticide Use in gm. per Acre		15.04	250.00	77.76	40.24
Experiences in Years		5.00	36.00	15.48	6.16
Types of Land		1	2	0	0

Estimation of production function of aman rice

Estimation of input and output level of independents and dependents variables: The rice production in Aman season is dependent on different factors. These factors are related to input supply, management practices, knowledge of the farmers and different bio-physical and environmental conditions prevailing in the areas. The average production of Aman rice in the study area is 43.47 Mounds per acre. Rice farmers used different types of inputs hereby mentioned as independents

variables as presented in Table 02. It has been estimated that per acre seed and seedling was tk. 1700, mean man hour was 190, tillage cost was tk. 1711, fertilizer was 112.2 kg and insecticide was 77.8 gm. Besides, it has been also estimated that average farmer experiences were 16 years. Additionally, the below Table 03 also represents mean, minimum and maximum values of dependent and independent variables.

Table 03. Estimation of production function of aman rice

Variable Symbol	Description of Variables	Model (1)	Model (2)	Model (3)
		Ln_Y	Ln_Y	Ln_Y
X ₁	Land size (Acre.)	0.104 (0.088)	0.062 (0.089)	0.0298 (0.0885)
X ₂	Seed and Seedling Cost	0.116 (0.135)	0.005 (0.133)	0.00359 (0.131)
X ₃	Labor Use Man Hours	0.231 (0.170)	0.071 (0.168)	0.0523 (0.165)
X ₄	Tillage Cost in Tk.	0.232* (0.132)	0.261** (0.128)	0.209 (0.128)
X ₅	Fertilizer Use in Kg.	0.247*** (0.066)	0.130* (0.071)	0.143** (0.0697)
X ₆	Insecticide Use in gm.	0.016 (0.074)	0.045 (0.071)	0.0356 (0.0702)
X ₇	Experiences in Years		0.015 (0.068)	0.0235 (0.0666)
D ₁	Land Type_ high/beel		0.078 (0.055)	0.0448 (0.0568)
D ₂	Rice Type_ HYV/Local		0.240*** (0.083)	0.170* (0.0890)
X ₈	Adaptation Options			0.194** (0.0964)
	Constant	-1.169 (1.375)	0.374 (1.377)	0.596 (1.358)
	Observations	96	96	96
	R-squared	0.300	0.391	0.419

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

*** implies significant at 1% level, ** implies significant at 5% and * implies significant at 10% level of significance.

Analyze production functions of aman rice: In this study, an empirical model i.e., Cobb-Douglas production function was used. The function was found to use in agricultural studies for its simplicity [6]. This function allows either constant, increasing or decreasing marginal productivity, or not all the three and even any two at the same time. The share of input variables to *Aman* rice production was estimated by using ordinary least square (OLS) techniques. The analysis was done by making it three models where the main factors of productions are considered in first model (Model-1), main factors of production and farmer's experiences, land types and varieties of rice cultivated are considered in model-2, thirdly in addition to the independent variables used in first and second model another adaptation variables are considered in model-3. The model is significant at 5% level of significance. The value of R² are 30, 39 and 42 for three models which reveals that the model has explained 30%, 39% and 42% variation in *Aman* rice production due to the variation in area, cost of seed and seedlings, labour use in man hours, cost for tillage, fertilizer use in Kg., insecticide use in gm., land types and linkage with service provider considering model-1, model-2 and model-3 respectively. Though Model-2 considered years of experiences, land types and rice types in addition to model-1 and Model-3 considered adaptation options in addition to Model-2. According to Gujrati (2007), the coefficient of determinant (adjusted R²) is a summery measure that tells how well the sample regression line fits with data [12]. The coefficient of *Aman* rice production is negative and not significant which implies that, other factors keeping constant, one percent increase in area would result in subsequent percentage of increase in *Aman* rice production. Table 03 shows that the use of fertilizer in kg is significant at 1%

(model-1), 10% (model-2) and 5% (model-3) level, which reveals that other factors keeping constant; when 1% increases in fertilizer application the production of Aman rice would be increased by .66% (model-1), .71% (model-2) and .70% (model-3). Besides, adoption of different types of adaptation options is significant at 1% level of significant. It means that local practices play important role for rice production. The study also reveals that the cost for tillage is also related to rice production at 10% level for model-1, 5% level for model-2 and not significantly related to model-3. As per the model-1, other factors represent positive relation with rice production but don't have significant relationship. Besides, costs of seed and seedling, labor hour for cultivation of rice, use of pesticides have positive relationship with rice production but not significantly (model-1). Similarly for the variation of experiences of farmers in years, land size and types of land (high land or beel land), the author could not find any significant influence in *Aman* rice production but have also positive relationship with rice production. The study also shows that the cultivation of HYV of rice is positive and significantly (at 5% level) related to rice production. The farmers cultivate both HYV and local varieties of rice though local rice varieties have been replacing gradually. The regression model explain that undertaking of different adaptation options is positive and significantly (at 5% level) related to rice production performance. It implies that the probability of getting more production than those practices more number of adaptation options.

IV. Conclusion

Different natural hazards are common in coastal areas though other manmade hazards like saline water shrimp farming and blockage of drainage channel exacerbate the overall vulnerability of coastal community. Most of the rice farmers do not have enough idea on impact of hazards on their livelihoods. So, capacity building with awareness is required for risk and vulnerability assessment and adaptation planning. It also examined that after big disaster the communities need to wait for three to four years for coming back to rice cultivation. Different factors like repair and re-building of embankment, renovation of sluice gate and drainage network found so important to start rice farming. Local level planning and physical infrastructure developments found so important for the coastal people to come back to rice farming. Subsequently, appearance of sufficient rainfall helped to wash out soil salinity for creating scope for rice cultivation in high (alleviated) land. But the availability of underground irrigation water helped them very much for rice cultivation quite early and even within one year after the flood water is receded. Community led water level controlling facilities in rice land was very important practice for better utilization of rain water for rice cultivation. The cultivation of local rice varieties was very important to test and start rice cultivation in many part of Aila affected areas. There is need to conserve local salt tolerant rice varieties through government initiatives. Besides, cultivation of salt tolerant HYV of varieties and short duration rice cultivation helped enough to get good rice production. From the study it is also concluded that only main factors of production (input supply) cannot ensure rice production in coastal areas but also different physical setting, management system and local practices (adaptation) options should have to be made available for rice cultivation and increased production. Besides, there is a need to bridge local coping strategies with scientific practices through integration of technologies and ideas.

V. Reference

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