ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Association of Climate-Resilient Agricultural Management, Food Security and Natural Resource Dependency with Soil Salinity in Coastal Bangladesh

Najmus Sakib[1]

[1]Resilience, Climate Justice and Livelihood, ActionAid, Dhaka, Bangladesh

Publication Date: 2026/08/07

Abstract: Soil salinity is a major challenge to agricultural production in the coastal regions of Bangladesh threatening environment, food security and rural livelihoods. This study examined the association between climate-resilient agricultural management, household food security, natural resource dependency and soil salinity (EC) in Ramjannagar Union, Shyamnagar Upazila. A cross-sectional survey of 44 farming households was conducted and soil electrical conductivity (EC) was measured from 44 corresponding agricultural plots. A Climate-Resilient Agricultural Management Index was constructed using Principal Component Analysis (PCA), while the Natural Resource Dependency Index (NRDI) and Food Consumption Score (FCS) were used to assess household livelihood dependency and food security status. Robust Ordinary Least Squares (OLS) regression was applied to examine their associations with soil EC. The results showed that the Climate-Resilient Agricultural Management Index was negatively associated with soil EC ($\beta = -0.057$, $p = 0.052$), indicating that greater adoption of climate-resilient agricultural practices was associated with lower soil salinity. NRDI also showed a negative association with soil EC ($\beta = -10.261$, $p = 0.072$), whereas FCS was not significantly associated with soil salinity ($p = 0.115$). These findings suggest greater adoption of climate-resilient agricultural practices was associated with lower measured soil salinity in the study area. Strengthening farmers access to climate-resilient technologies and extension services may enhance the sustainability and resilience of coastal agriculture.

Keywords: *Climate Resilient Sustainable Agriculture (CRSA), Soil Salinity (EC), Food Consumption Score (FCS), Natural Resource Dependency Index (NRDI), Principal Component Analysis (PCA).*

Jel Classification: *Q15, Q18, Q24, Q54.*

How to Cite: Najmus Sakib (2026) Association of Climate-Resilient Agricultural Management, Food Security and Natural Resource Dependency with Soil Salinity in Coastal Bangladesh. *International Journal of Innovative Science and Research Technology*, 11(7), 3203-3211. https://doi.org/10.38124/ijisrt/26jul1789

I. INTRODUCTION

Shyamnagar Upazila under Satkhira District is the most severe soil salinity affected due to climate change, sea-level rise, cyclones and saline water intrusion for shrimp cultivation among the southwestern coastal region of Bangladesh. Previous studies found that high soil salinity has significantly reduced agricultural land. Moreover, it altered land-use patterns and constrained crop production in Shyamnagar (Islam et al., 2012). While seasonal assessments have shown that soil electrical conductivity (EC) increases during the dry season. As a result, it restricted the cultivation of many crops (Kumar et al., 2019). These findings reinforce earlier evidence of increasing salinity across coastal Bangladesh (Ahmed et al., 2010; Dasgupta et al., 2015; Chowhan et al., 2024).

Climate-Resilient Sustainable Agriculture (CRSA) has emerged as an important adaptation strategy against salinity. Improvement of agricultural productivity while strengthening resilience to climate-related stress is one of the objectives of CRSA. It promotes improved cropping systems, salt-tolerant crop varieties, organic soil management, water-efficient practices and crop diversification to sustain agricultural production under saline conditions (FAO, 2013). In Ramjannagar Union of Shyamnagar Upazila, Action Aid Bangladesh implemented a bundle of Climate Resilient Sustainable Agriculture (CRSA) practices through the PRAGATI project funded by Australian Aid to improve household agricultural production, food security and adaptive capacity. One of the project targets is reducing soil salinity by different direct and indirect initiatives.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Previous projects and studies have primarily examined the determinants of agricultural activities and highlighted the importance of education, farm size, extension services, institutional support, market access those influencing farmers' decisions (Feder et al., 1985; Doss, 2006; Knowler & Bradshaw, 2007; Uaiene et al., 2009; Akanda et al., 2025).

The Food Consumption Score (FCS) is used to assess household food security, while the Natural Resource Dependency Index (NRDI) measures households' dependency on natural resource extraction for their livelihoods. Among with Agricultural Management Practices Index (PCA) these indicators provide valuable insights into the adaptive capacity of farming households under climate stress (Jolliffe, 2012; WFP, 2021; Nerfa et al., 2020).

Despite the growing literature on climate-resilient agriculture, limited empirical evidence exists on the association between climate-resilient agricultural management, household food security, natural resource dependency and measured soil salinity in the coastal regions of Bangladesh.

So, this study investigates the association of Climate-Resilient Agricultural Management, Food Security and Natural Resource Dependency with soil salinity among farming households in southwestern coastal region of Bangladesh. Specifically, an Agricultural Management Index was constructed using Principal Component Analysis (PCA). While the Food Consumption Score (FCS) and Natural Resource Dependency Index (NRDI) were used to represent household food security and livelihood dependency, respectively. Robust ordinary least squares regression was employed to examine their associations with soil electrical conductivity (EC) (Wooldridge, 2019).

II. MATERIALS AND METHODS

➢ *Study Area*

The study was conducted in Ramjannagar Union of Shyamnagar Upazila, Satkhira District, Bangladesh. This is one of the most climate-vulnerable coastal regions of the country. The area is frequently affected by salinity intrusion, cyclones, tidal flooding, waterlogging and freshwater scarcity. Those significantly hamper agricultural production and rural livelihoods. Agriculture is the primary source of household income in the study area. So, making climate-resilient farming practices essential for sustaining productivity and food security.

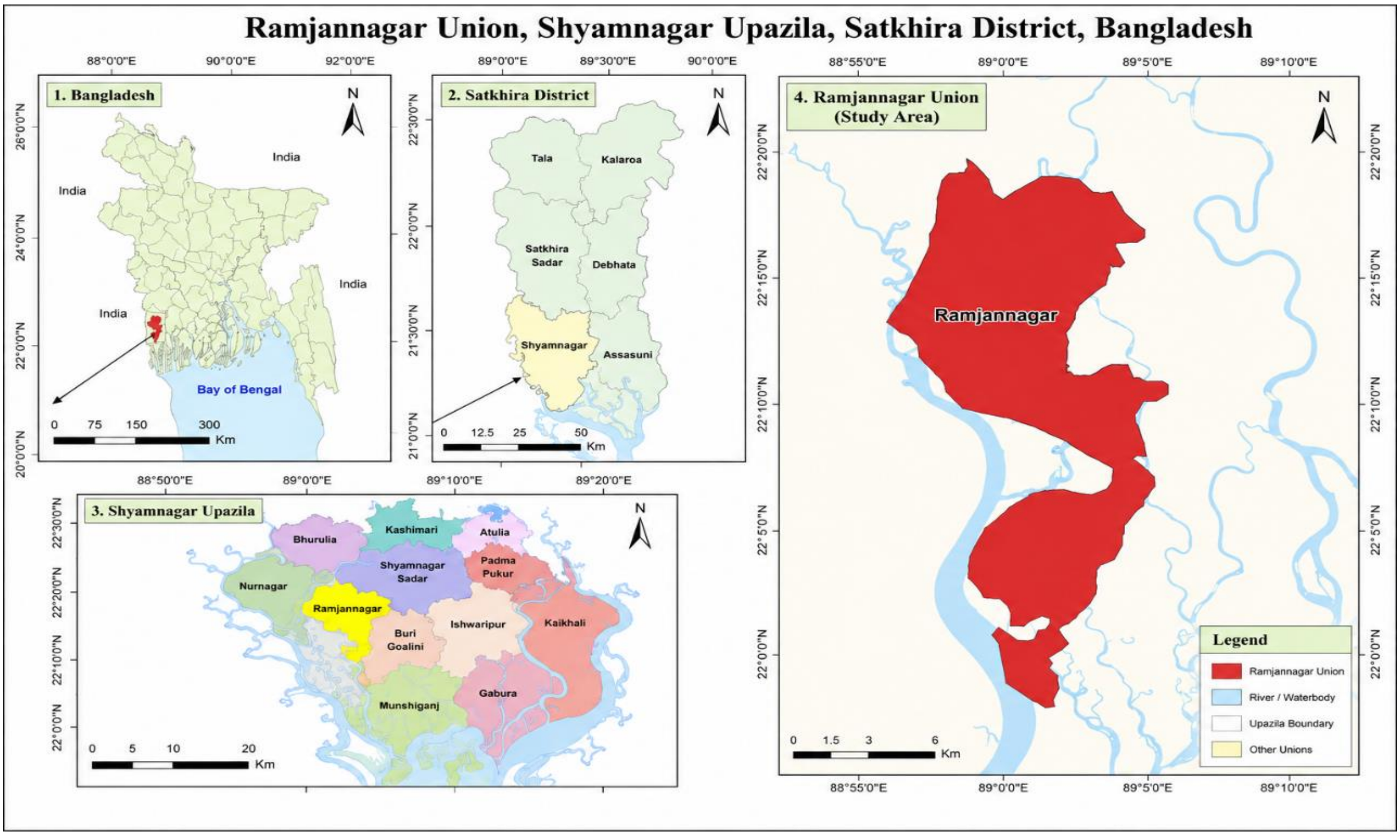

Fig 1 Study Area.

➢ *Study Design and Data Collection*

A cross-sectional household survey was conducted among 44 farming households during experimental assessment of the Climate-Resilient Sustainable Agriculture (CRSA) project. Primary data were collected using a structured questionnaire administered through KoboToolbox. The questionnaire captured household socioeconomic characteristics, agricultural management practices, food consumption, natural resource dependency and farm-level information. 44 soil samples were collected from each respondent's agricultural plot during cross sectional sampling and soil salinity was measured as electrical conductivity (EC)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

in deciSiemens per meter (dS/m) from Khulna University, Bangladesh.

- *Variables and Measurements*

The dependent variable was soil salinity, measured as soil electrical conductivity (EC, dS/m).

Three explanatory variables were included in the analysis.

Agricultural Management Index (PC1) was constructed using Principal Component Analysis (PCA).

Table 1 Variables for PCA

Sl.	Variable Name	Unit of Measurement
1	Cropping pattern	1=Kharif ii-Robi-Kharif I, 2=Kharif ii-Robi, 3=Kharif ii-Kharif I, 4= Kharif ii
2	Organic fertilizer	Kg/year
3	Bio-pesticide	Litre/year
4	CRSA technologies adopted	1 to 21
5	Agricultural labour	Hours/day
6	Agricultural land	Decimal
7	Agricultural expenditure	BDT/year
8	Crop yield	Kg/decimal
9	Compost production	Kg/year
10	Salt-tolerant varieties	Decimal
11	Savings	BDT/year
12	Mulching practice	Decimal
13	Total land	Decimal
14	Crop diversification	Number of crops/year
15	Debt	BDT
16	Saline water injection	Number of days/year
17	Natural resource labour	Hours/day

$$PC_i = \sum_{i=1}^{17} \alpha_i X_i$$

Food Consumption Score (FCS) was assessed by using World Food Programme (WFP) methodology to measure household food security.

$$FCS = \sum WFP\ Weight_i \times Frequency_i \ \ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

$$FCS = 2 \times Staples + 3 \times Pulses + Vegetables + Fruits + 4 \times Meat\_Fish\_Egg + 4 \times Milk + 0.5 \times Sugar + 0.5 \times Oil \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Natural Resource Dependency Index (NRDI) was measured to calculate the annual household income derived from natural resource extraction relative to total annual household income.

$$NRDI = \frac{\text{HH Natural Resource Extraction Income (BDT/year)}}{\text{HH Total Income (BDT/year)}}$$

- *Statistical Analysis*

Data were analyzed using Stata 18. Descriptive statistics, including means, standard deviations, minimum and maximum values were used to summarize household characteristics. PCA was applied to construct the Agricultural Management Index (PC1). Pearson correlation analysis was conducted to examine the relationships among study variables.

The association between soil salinity and the explanatory variables was estimated using a robust Ordinary Least Squares (OLS) regression model:

$$EC_i = \beta_0 + \beta_1 PC1_i + \beta_2 NRDI_i + \beta_3 FCS_i + \varepsilon_i$$

Here, EC represents soil electrical conductivity (dS/m), PC1 denotes the Agricultural Management Index, NRDI is the Natural Resource Dependency Index, FCS is the Food Consumption Score and ε is the random error term.

To assess model validity, multicollinearity was examined using the Variance Inflation Factor (VIF). The Shapiro–Wilk test evaluated the normality of residuals.

III. RESULTS

Table 2 Descriptive Statistics of Study Variables

Variable	Unit	Mean	SD	Minimum	Maximum
Soil electrical conductivity (EC)	dS/m	0.65	0.58	0.12	2.50
Food expenditure	BDT/year	30,736.36	7,447.90	12,000	48,000
Agricultural income	BDT/year	146,956.59	51,052.97	90	240,000
Monthly income	BDT/year	147,409.09	46,752.35	72,000	240,000
Agricultural expenditure	BDT/year	36,523.86	11,843.29	50	65,000

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Variable	Unit	Mean	SD	Minimum	Maximum
Total land	Decimal	95.21	54.91	17	264
Agricultural land	Decimal	123.44	41.30	20	220
Agricultural labour	Hours/day	8.64	2.01	3	12
Crop yield	kg/decimal	41.52	8.47	23	66
CRSA technologies adopted	Number	13.21	2.57	6	17
Organic fertilizer	kg/year	356.59	90.30	80	600
Bio-pesticide	L/year	250.23	76.72	30	400
Salt-tolerant varieties	Decimal	65.18	29.18	15	210
Compost production	kg/year	375.23	243.65	30	1100
Savings	BDT/year	15,095.46	6,255.42	9,600	36,000
Debt	BDT	23,674.42	16,752.71	0	49,000

Table 2 descriptive statistics of the study variables for 44 farming households. The mean soil electrical conductivity (EC) was 0.65 dS/m (SD = 0.58). The surveyed agricultural plots exhibited relatively low measured soil salinity after one year of CRSA implementation. However, this descriptive finding does not establish that CRSA caused the observed salinity levels.. Households reported an average annual agricultural income of 146,956.59 (Annual Average 300,000-550,000) BDT and a mean crop yield of 41.52 (Traditional Average 30-35) kg/decimal. Farmers adopted on average 13.21 climate-resilient agricultural management practices. It reflects a relatively high level of CRSA implementation as well as new technological adaptation culture among the people of the villages. The average annual agricultural expenditure, savings and debt were 36,523.86 BDT, 15,095.46 BDT and 23,674.42 BDT. As they are smallholder farmers and no recent anomalies arise, this investment and expenditure is good enough for agricultural production with a consistent flow.

Table 3 Distribution of Household Characteristics

Variable	Category	Frequency	Percent (%)
Food source	Mixed	29	65.9
	Own	15	34.1
Income source	Agriculture	33	75.0
	Mixed	11	25.0
Land ownership	Mixed	33	75.0
	Own	10	22.7
	Lease	1	2.3
Cropping pattern	Kharif II–Robi–Kharif I	41	93.2
	Other	3	6.8
Anticipatory action	Yes	44	100.0

Table 3 household characteristics of the surveyed farmers. Most households obtained food from both own production and market purchases (65.9%). Because crop diversification is limited. 75.0% reported agriculture as their primary source of income despite existing limitations. Mixed land tenure was the dominant farming arrangement. Because most of the big size of land is under shrimp cultivation (75.0%). Majority of the farmers (93.2%) followed Kharif II–Robi–Kharif I cropping pattern as a part of CRSA technology bundle to keep running the field economic and ecofriendly around the year. All surveyed households (100%) reported taking anticipatory actions to reduce the impacts of climate-related risks.

Table 4 Principal Component Analysis (PCA) Eigenvalues

Component	Eigenvalue	Variance Explained (%)	Cumulative Variance (%)
PC1	4.984	27.69	27.69
PC2	2.677	14.87	42.56
PC3	2.145	11.92	54.48
PC4	1.467	8.15	62.63
PC5	1.233	6.85	69.48
PC6	1.034	5.74	75.22

Table 4 presents the results of the Principal Component Analysis (PCA) used to construct the Climate-Resilient Agricultural Management Index. Six principal components had eigenvalues greater than one and together explained 75.22% of the total variation in the agricultural management variables. According to the Kaiser criterion the first principal component (PC1) had eigenvalues greater than 1 (4.984) and explained 27.69% of the total variance. Therefore, PC1 was retained as the composite Climate-Resilient Agricultural Management Index and used in the subsequent regression analysis.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Table 5 Loadings of the First Principal Component (PC1)

Ranking	Variable	PC1 Loading
1	Cropping pattern	0.369
2	Organic fertilizer	0.357
3	Bio-pesticide	0.337
4	CRSA technologies adopted	0.320
5	Agricultural labour	0.314
6	Agricultural land	0.307
7	Agricultural expenditure	0.248
8	Crop yield	0.238
9	Compost production	0.212
10	Salt-tolerant varieties	0.201
11	Savings	0.155
12	Mulching practice	0.138
13	Total land	0.126
14	Crop diversification	0.078
15	Debt	0.034
16	Saline water injection	-0.074
17	Natural resource labour	-0.214

Table 5 loadings of the first principal component (PC1), which was used as the Climate-Resilient Agricultural Management Index. Positive loadings were observed for most agricultural management variables. These variables had positive loadings on the first principal component. A greater contribution to the composite index. Actually the highest positive loadings were found for cropping pattern (0.369), organic fertilizer use (0.357), bio-pesticide use (0.337), CRSA technologies adopted (0.320) and agricultural labour (0.314). In contrast, natural resource labour (-0.214) and saline water injection (-0.074) showed negative loadings. Because this two had an inverse contribution to the index due to natural environmental negative association.

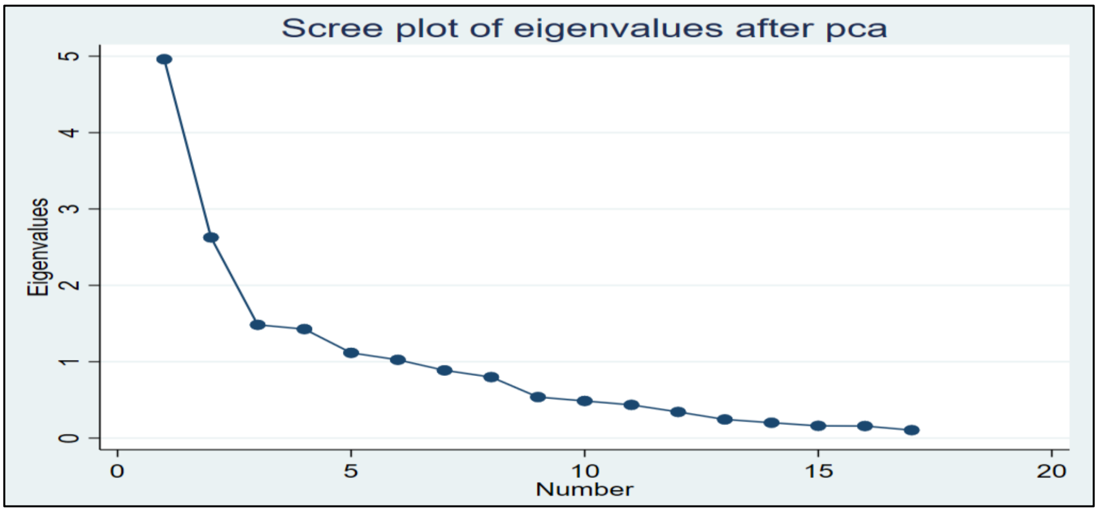

Fig 2 Principal Component Plot

Figure 2 scree plot of the principal component analysis. The eigenvalues decline sharply from the first to the second principal component. Then decrease more gradually and forming an elbow after the second component. This pattern suggests the first few principal components capture most of the variation in the agricultural management variables. According the Kaiser's eigenvalue criterion (eigenvalue > 1), the first six components were retained. Among six the very first principal component (PC1) explained 27.69% of the total variance. This was selected as the composite Climate-Resilient Agricultural Management Index for regression analyses.

Table 6 Pearson Correlation Matrix

Variables	EC	PC1	NRDI	FCS
EC	1.000			
PC1	-0.181	1.000		
NRDI	-0.093	-0.380*	1.000	
FCS	0.194	-0.054	0.159	1.000

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Table 6 the Pearson correlation coefficients among the study variables. Soil electrical conductivity (EC) showed negative and statistically non-significant correlations with the Climate-Resilient Agricultural Management Index (PC1) and the Natural Resource Dependency Index (NRDI) due to cultural tendency and natural stress. Food Consumption Score (FCS) (p > 0.05) showed positive relations. A statistically significant and negative correlation was observed between PC1 and NRDI (p < 0.05). This relation explained that higher adoption of climate-resilient agricultural management practices was associated with lower dependency on natural resources. No other significant pairwise correlations were observed.

Table 7 Robust Ordinary Least Squares (OLS) Regression Results

Variable	**Coefficient**	**p-value**
PC1	-0.057*	0.052
NRDI	-10.261*	0.072
FCS	0.007	0.115
Constant	0.241	0.327
R-squared	0.086*	0.099
Observations	44	
*** p<0.01, ** p<0.05, * p<0.1		

Table 7 the robust Ordinary Least Squares (OLS) regression. It estimates factors influencing soil salinity (EC) across the surveyed farm households in Shyamnagar. The results reveal Climate-Resilient Agricultural Management Index (PC1) has a statistically significant negative relationship with soil EC $(\beta = -0.057, p < 0.1)$. Greater household adoption of CRSA management practices was associated with lower soil electrical conductivity (EC). Additionally, NRDI exhibited a significant negative coefficient $(\beta = -10.261, p < 0.1)$ The Food Consumption Score (FCS) showed no statistically significant direct impact on EC. Overall, the model shows statistically significant association between the CRSA Management Index and soil electrical conductivity.

Table 8 Variance Inflation Factor

Variable	VIF	1/VIF
NRDI	1.22	0.820
PC1	1.17	0.855
FCS	1.05	0.955
Mean VIF	1.15	

Table 8 multicollinearity diagnostics for the explanatory variables. The variance inflation factor (VIF) values ranged from 1.05 to 1.22, with a mean VIF of 1.15. Since all VIF values were well below the commonly accepted threshold of 5. The results indicate multicollinearity was not a concern. The independent variables were suitable for inclusion in the regression model.

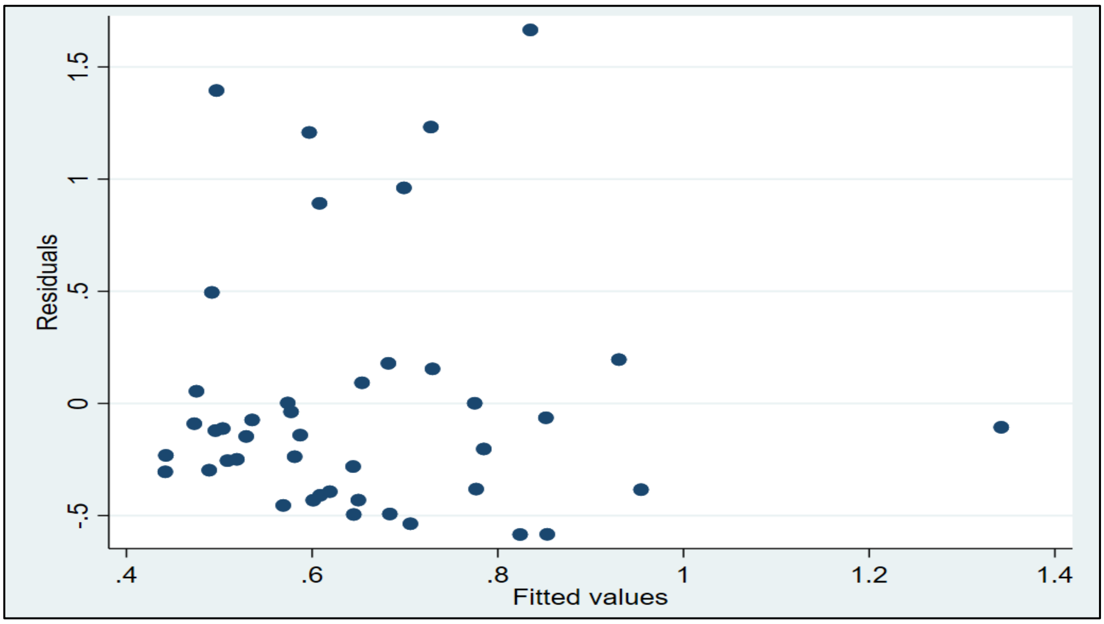

Fig 3 Model Fitness.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

To assess soil health improvements across 44 households in Shyamnagar, we ran a robust OLS regression model in Stata using KoboCollect field data. To check the model's reliability, we plotted the residuals (actual KoboCollect values minus fitted values) against the predicted outcomes. As seen in Figure 3, the points are randomly scattered around the zero line without any clear pattern or widening spread. This shows that our linear model is appropriate and free from major bias. Overall, these diagnostics confirm the model is statistically sound for evaluating the association of CRSA soil management techniques in the region.

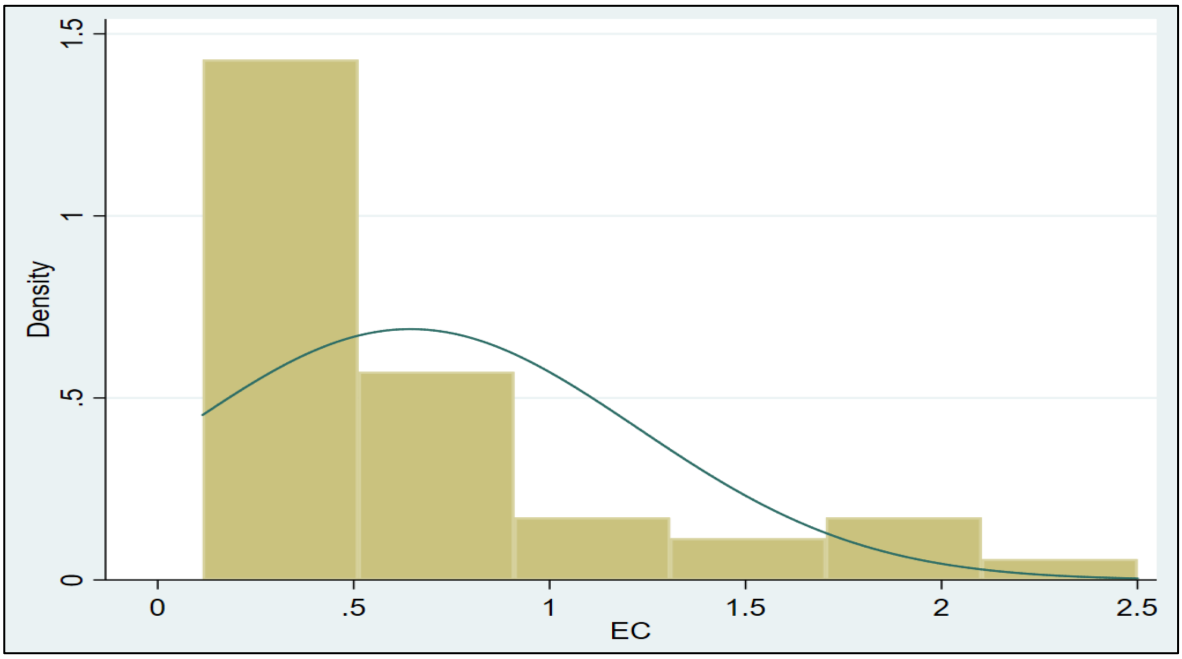

Fig 4 Soil Electric Conductivity.

Figure 4 distribution of soil electrical conductivity (EC) an indicator of soil salinity across the 44 surveyed farm plots in Shyamnagar. The data shows a right-skewed distribution. The vast majority of households recorded low EC levels (below 1.0 dS/m) with only a few plots extending into higher salinity ranges up to 2.5 dS/m. Localized salinity spikes remain a challenge for a few vulnerable plots. Most households recorded relatively low measured soil salinity who practice CRSA management as project participants since 2025.

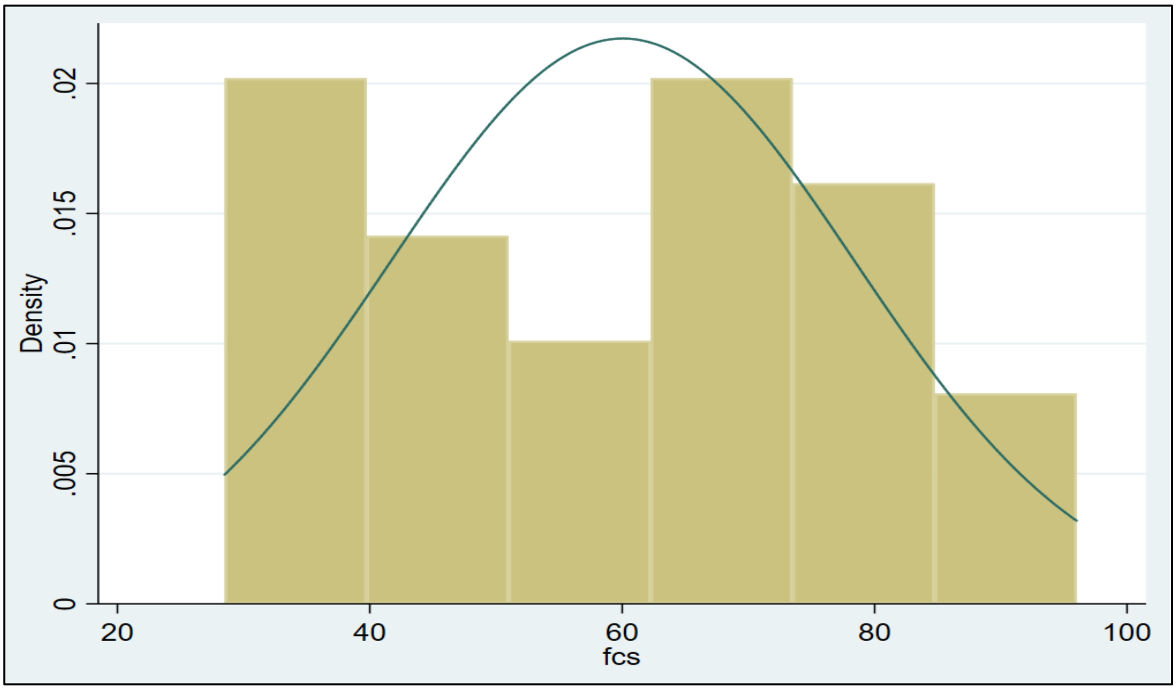

Fig 5 Food Consumption Score.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

Figure 5 distribution of the Food Consumption Score (FCS) across the surveyed households in Shyamnagar. The data follows a roughly symmetrical, bell-shaped distribution. Most households scoring between 50 and 80 within the acceptable food security threshold. Only a small fraction of households fell into the lower or upper extremes. It indicates moderate variability across the sample. Overall, these results demonstrate that participating farm families maintain relatively high dietary diversity and stable food access under the CRSA project.

IV. DISCUSSION

- *Climate-Resilient Agricultural Management (PC1)*

The regression results showed the Climate-Resilient Agricultural Management Index (PC1) was negatively associated with soil electrical conductivity (EC). This suggests farmers who adopted more climate-resilient agricultural practices tended to have lower soil salinity agricultural plot after one year of intervention. CRSA practices such as improved cropping patterns, organic fertilizer, biopesticides, compost production and salt-tolerant varieties may improve soil quality and help reduce salt accumulation over time. However, this study only shows an association and cannot confirm a causal relationship without large scale study.

- *Comparison PC1 with Previous Studies*

The findings are similar with Ahmed et al. (2010) studies that increasing salinity reduces agricultural land and crop production and vice versa. On the other hand, Kumar et al. (2019) found that soil salinity increases during the dry season due to extreme heatwave and drought. Similarly, FAO (2013) promoted climate-resilient agricultural practices to improve soil health and strengthen resilience against climate stress. Our findings are consistent with previous studies by showing that higher adoption of CRSA practices was associated with lower soil salinity. Capital and technological capacity inclusion program should be increased to reach optimal level.

- *Natural Resource Dependency (NRDI)*

NRDI showed a negative association with soil salinity. Households depended more on diversified livelihood sources and relied less on crop production in saline areas. However, this relationship should be interpreted carefully. Because other livelihood and environmental factors (saline water injection) may also influence the results.

- *Food Consumption Score (FCS)*

Food Consumption Score was not significantly associated with soil salinity. Because household food security may depend on many factors such as income, market access and food purchasing power. In addition, most households had acceptable food consumption scores. This condition reduced importance to detect further significant relationships.

- *Policy Implications*

Expanding climate-resilient agricultural practices can support sustainable farming in coastal Bangladesh. Farmers should receive greater access to climate-resilient technologies, extension services and training. At the same time, promoting diversified livelihoods can help reduce pressure on vulnerable agricultural land and improve household resilience.

- *Study Limitations*

This study has some limitations. First, the sample size was relatively small (44 households and agriculture land plot respectively). This limits the generalization of the findings. Second, the cross-sectional design identifies associations. It cannot establish cause and effect relationships. Finally, soil salinity is influenced by several environmental factors. Those were not included in the regression model. Future studies with larger samples and additional environmental variables are recommended.

V. CONCLUSION

This study examined the associations between climate-resilient agricultural management, food security, natural resource dependency and soil salinity among farming households in coastal Syamanagar. Principal Component Analysis (PCA) was used to develop a composite Climate-Resilient Agricultural Management Index. While robust ordinary least squares regression was employed to assess its relationship with soil electrical conductivity (EC). The findings estimated greater adoption and may climate-resilient agricultural management practices be associated with lower soil salinity (EC) and the relationship was significant. Similarly, natural resource dependency showed a negative association with soil EC and the Food Consumption Score was not significantly related to soil salinity. Promoting climate-resilient agricultural practices may contribute to improving soil conditions. It will reduce dependency on natural resources in saline-prone coastal areas. Strengthening farmer access to climate-resilient technologies, extension services and sustainable land management practices could enhance the resilience and sustainability of coastal agricultural systems. Future research with larger sample sizes and additional environmental variables is recommended to further validate these relationships.

REFERENCES

[1]. ActionAid International. (2014, September 22). *Climate resilient sustainable agriculture (CRSA) experiences.https://actionaid.org/publications/2014/climate-resilient-sustainable-agriculture-crsa-experiences*

[2]. Ahmed, M. F., Khanam, A., Haider, M. Z., & Rahman, M. S. (2010). *Land use pattern and socio-economic condition of the Sundarbans adjacent coastal areas of Bangladesh. Khulna University Studies*, 57–72. *https://kus.ku.ac.bd/kustudies/article/view/858?*

[3]. Arslan, A., Floress, K., Lamanna, C., Lipper, L., & Rosenstock, T. S. (2022). *A meta-analysis of the adoption of agricultural technology in Sub-Saharan Africa. PLOS Sustainability and Transformation 1(7), e0000018. https://doi.org/10.1371/journal.pstr.0000018*.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1789

[4]. Bangladesh Bureau of Statistics. (2023). *Final Report on Household Income and Expenditure Survey (HIES) 2022. Ministry of Planning, Government of the People's Republic of Bangladesh. Dhaka, Bangladesh.*

[5]. Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). *Can farmers' adaptation to climate change be explained by socio-economic household-level variables? Global Environmental Change, 22*(1), *223–235. doi: 10.1016/j.gloenvcha.2011.09.002*

[6]. Chowhan, S., Rahman, M., Sultana, R., Rouf, M., Islam, M., & Jannat, S. (2024). *Agriculture policy and major areas for research and development in Bangladesh*. *Sarhad Journal of Agriculture, 40*(3), 819–831. *doi: 10.17582/journal.sja/2024/40.3.819.831*

[7]. Dasgupta, S., Hossain, M. M., Huq, M., & Wheeler, D. (2015). *Climate change and soil salinity: The case of coastal Bangladesh*. *https://pubmed.ncbi.nlm.nih.gov/26152508/*

[8]. Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). *Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia*. *Global Environmental Change, 19*(2), 248–255. *doi*: *10.1016/j.gloenvcha.2009.01.002*

[9]. FAO. (2013). *Climate-Smart Agriculture Sourcebook*. Food and Agriculture Organization of the United Nations.

[10]. Feder, G., Just, R. E., & Zilberman, D. (1985). *Adoption of agricultural innovations in developing countries: A survey. Economic Development and Cultural Change, 33(2), 255–298. doi: 10.1086/451461*

[11]. Islam, M. S., Rahman, M. A., Sultana, N., Nath, B., & Paul, A. (2012). *Using geospatial techniques to assess the salinity impact on agricultural land use: A study on Shyamnagar Upazila, Satkhira*. *Journal of Agriculture and Environment for International Development, 106*(2), 157–169.

[12]. Jolliffe, I. T. (2002). *Principal Component Analysis (2nd ed.). Springer. https://doi.org/10.1007/b98835*

[13]. *Kumar, U., Mitra, J. R., & Mia, M. Y. (2019). Seasonal study on soil salinity and its relation to other properties at Satkhira district in Bangladesh. Progressive Agriculture, 30(2), 157–164. https://doi.org/10.3329/pa.v30i2.42488.*

[14]. Nerfa, L., Rhemtulla, J. M., & Zerriffi, H. (2020). *Forest dependence is more than forest income: Development of a new index of forest product collection and livelihood resources. World Development, 125, 104689. https://doi.org/10.1016/j.worlddev.2019.104689.*

[15]. World Food Programme. (2008). Food Consumption Analysis: *Calculation and Use of the Food Consumption Score. WFP technical guideline for FCS.*

[16]. Wooldridge, J. M. (2019*). Introductory Econometrics: A Modern Approach (7th ed.). Standard reference for OLS diagnostics and inference.*

[17]. WFP (2021). *Food Consumption Score Technical Guidance Sheet.*