Original Research Article

Adoption of Climate Smart Agricultural Practices byCharlandFarmers in Charfasson, Bangladesh

Abstract

The study was conducted in Charfassonupazila of Bangladesh to assess the farmers' perception on climate change, adoption of climate smart agricultural (CSA) practices, and food security condition. The primary data were collected from 120 sample respondents through face to face interview using a pretested questionnaire. Findings revealed that the farmers of Charland exhibited striking individual disparities in terms of their socioeconomic circumstances. Respondents identified cyclones, storm surges, sea level rise, salt intrusion, erosion, and drought as the most significant climatic catastrophes threatening agricultural production in the coastal char lands. In order to cope with the climate change effects, coastal people adopted different CSA practices such as saline tolerant rice variety, raised seedbed, planting large size amon rice seedlings, *sorjan* system, vegetables cultivation around pond, agroforestry, bottle nut, low lift pump, pheromone traps, urea deep placement, mulching, seed storage, napier grass as fodder along roadside/ails, flood resistant crops, drought resistant crop varieties, organic fertilizer, pulses, sunflower, soybean, watermelon production, respectively. Even though very few people in the study area can't afford to eat a regular meal, there is a severe lack of sufficient nutritious foods and dietary diversity. In the event of a sudden cyclone or storm surge, people are more concerned about the availability of food as they are required to evacuate to safety in shelter centres.Since rice and vegetable cultivations are major farming practices, good agricultural practices should be ensured to make these farming more climate smart and sustainable. In addition, the government's development planning can urgently include coastal embankment or dam construction and deep irrigation in coastal areas to make agricultural farming profitable and sustain food security.

Keywords: climate change, climate-smart agriculture, adoption, food security, Charland.

1. Introduction

The coastal charland of Bangladesh is a region of immense agricultural potential and significance[1,2]. However, it is also one of the most climate change vulnerable areas in the world[1,3,4]. Rising sea levels, cyclones, and salinity intrusion pose significant challenges to agriculture, affecting crop productivity and threatening the livelihoods of farmers in these areas[1,3]. Climate change also altered agricultural land uses and ecosystem services they provide to coastal people [5,6]. To address these challenges, it is essential to understand farmers' perceptions of climate change, their adoption of climate-smart agricultural practices, and the food security status [2].

Climate change perception among farmers refers to their understanding, awareness, and interpretation of climate change phenomena specific to their local context[7–9]. Factors such as changing rainfall patterns, increased frequency of extreme weather events, and rising sea levels shape farmers' beliefs, attitudes, and knowledge about climate change. Farmers' perceptions influence their decision-making processes, adaptive strategies, and willingness to adopt agriculture practices[10–12].

The adoption of climate-smart agriculture practices is crucial for enhancing the resilience of agricultural systems in the coastal charland of Bangladesh[2]. Climate-smart agriculture encompasses a range of techniques and approaches that promote sustainable and climate-resilient farming practices[13,14]. These include the use of salt-tolerant crop varieties, improved water management, integrated pest management, and agroforestry systems. Understanding the factors that influence farmers' decisions to adopt climate-smart agriculture practices is essential for promoting their uptake and scaling up sustainable agricultural practices in these vulnerable regions[10,12].

Food security is a pressing concern in the charland of Bangladesh, where agriculture plays a critical role in ensuring livelihoods and access to nutritious food[2,15]. Climate change impacts, such as saline intrusion, soil degradation, and reduced agricultural productivity, can significantly affect food availability, accessibility, and utilization. Examining farmers' climate change perception, adaptive strategies, and adoption of climate-smart agriculture practices provides valuable insights into pathways for enhancing food security and building resilience in these coastal areas.

Despite the fact that CSA farming is widely acknowledged as an important component in agriculture's adaptation to climate change[16], research on the effects of CSA adoption on food security for smallholder farmers is lacking, particularly in Bangladesh, where national development programs promoting CSA adoption are currently being implemented[13,17]. Overall, there is a scarcity of research in Bangladesh on measuring farmers' adoption of climate smart agriculture, particularly in Charland areas. There is a need to fill existing gaps in our understanding of farmers' perceptions and behaviors related to climate change and its impact on agriculture. Research in this area provides valuable insights into farmers' beliefs, attitudes, and knowledge about climate change, which can inform the design of effective interventions and policies.This study aims to explore farmers' climate change perception, adoption of climate-smart agriculture, and their food security status in a coastal charland of Bangladesh. The findings will contribute to the development of context-specific interventions, policies, and strategies to enhance agricultural resilience and food security in the face of climate change in the coastal charland of Bangladesh.

2. Objectives of the study

i. To assess the socio-economic characteristics of charland farmers and their perception onclimate change

ii. To document the adoption of different climate smart agricultural practices by the coastal charland farmers.

iii. To measure the food security status of the respondent households.

3. Methodology

3.1 Location of the project

The study was conducted in charfassonupzilla of Bhola district in Bangladesh. Three char-dominated unions from Charfassonupazilla was chosen as project locations (Figure 1). Char Fassonupazila of Bhola district covers around 1106.31 km^2 of territory in Bangladesh's coastal regions. This upazila, which has 63,740 homes, is located 75 kilometers north of Bhola district, between 22.1847°N and 90.7625°E. It is a land of rivers with abundance of grazing area that is ideal for raising buffalo. There are different small char islands in this upazilla like char Kukrimukri, char Lakshmi, char Montaz, Dhal char, etc[18].

Figure 1. Location map of the study area

3.2 Population and sampling technique

The study population included farmers who are actively engaged in agricultural operationsin two unions (Kukri-mukri Char and Char-Manika) of Charfassonupazilain Bangladesh. The study area were selected purposively. At first, Charfassonupazila was selected as one of the most vulnerable upazilla of coastal region having different small chars. Among the different chars, Char Kukri-Mukri and Char Manika were selected based on the suggestions of local extension agentns considering the study objectives. A disproportionate random sampling approach was used to choose 60 farmers from each union. As a result, there was 120 total sample farmers.

3.3 Preparation of interview schedule and pre-testing

An interview schedule was developed in order to collect data from the requisite number of respondents. Before beginning final data collection, the interview schedule was pre-tested. After pre-testing, required question additions, deletions, and modifications was made, as well as the interview schedule was finalized.

3.4 Data collection

Primary data were collected on farmer's age, education, family size, farm size, annual income, farming experience, extension contact, climate smart agricultural practices, and food security status. The data were collected using the survey technique. Face-to-face interviews were administered to obtain data from the chosen research area. All feasible attempts were taken to clarify the objective of the study to the respondents to obtain accurate and relevant information. Apart from household survey, Key Informants Interview (KII), and Focus Group Discussions (FGD) werealso conducted.

3.5 Measurement of perception, adoption, and food security

A summated rating scale (Likert type) was used to determine how farmers felt about climate change. The scale started out with a larger number of items, which were then edited and screened based on the results of pre-testing to include only the relevant items that showed both positive and negative effects on a five-point scale. The items talked about all parts of climate change. Based on the results of the pre-test, the scale was checked to make sure it was valid in terms of its content and had enough reliability. Respondent opinions were measured by giving 5 points for "strongly agree," 4 points for "agree," 3 points for "not sure," 2 points for "disagree," and 1 point for "strongly disagree" [19,20].

Twenty climate-smart farming practices were identified through Focus Group Discussions (FGDs). At the individual level, CSA adoption was measured by taking a yes/no answer for each of the selected CSA practices by asking respondents if they were using these technologies.

The Household Food Insecurity Access Score (HFIAS) and the Household Dietary Diversity Score (HDDS) are two significant indicators that were used to assess the level of household food security[21–23].

3.6 Data analysis

The data that were collected were then coded in preparation for processing and analysis. In order to carry out the data analysis, the computer application known as SPSS/PC+ was utilized. When it was essential to do so, qualitative data were translated into quantitative ones by applying an appropriate scoring system. In order to provide an accurate description of the many different dependent and independent factors, the respondents were divided into multiple categories according to each variable. For descriptive statistics, we made use of frequency counts and percentages, as well as means, standard deviations, rank order, and cross-tabulation. A correlation co-efficient, denoted by r, was computed in order to investigate the relationshipthat exists between socio-economic factors, the adoption of CSA practices, and the level of food security in households.

4. Results and discussion

4.1 Socio-demographic characteristics of the charland farmers

The purpose of studying the socio-economic characteristics of the respondents was to get an idea about the population characteristics of Charland farmers. The results showed that most of the respondents (44.17%) were in the middle age group, while 38.33% were in the older age group and 17.50% were in the younger age group. Most of the respondents (47.5%) had at least a primary level of education, 16.67% had a secondary level of education, and 1.67 % had a higher secondary level of education. Only 34.17 % of the respondents were illiterate. More than half of the respondents were from medium-sized families (55%), while 20% were from small families and 25% were from large families. Most of the respondents (56.67%) had small farms, followed by medium (38.33%) and small (5.0%) farms.About half of the respondents (49.17%) had medium-level farming experience, while 30 percent and 20.83 percent, respectively, had high-level and low-level farming experience.The majority of respondents (45%) had a moderate annual income, while 36.67 percent had a low income and 18.33 percent had a high income.The majority of respondents (55%) had moderate contact with extension agents, while 30.83 percent had low contact and 14.17 percent had high extension contact(Table 1).

Table 1. Distribution of the respondent according to their socio-economic characteristics

Character	Measuring unit	Categories	No. of respondents	Percent
Age	Actual year	Young aged (up to 35)	21	17.50
		Middle aged (36-45)	53	44.17
		Old (>45)	46	38.33
Education	Year of schooling	Illiterate (0)	41	34.17
		Primary (1-5)	57	47.50
		Secondary (6-10)	20	16.67
		Higher secondary (>10)	2	1.67
Family size	Number	Small (up to 4)	24	20.00
		Medium (5 to 6)	66	55.00
		Large (7 and above)	30	25.00
Farm size	Actual (ha)	Marginal (<.02)	06	5.00
		Small (>.02 to 0.99)	68	56.67
		Medium(1 to 2.99)	46	38.33
		Large (3 and above)	0	0
Farming experience	No. of Years	Low (up to 15)	25	20.83
		Moderate (16 to 20)	59	49.17

		High (above 20)	36	30.00
Annual income	Actual (taka)	Low (up to Tk 150000)	44	36.67
		Medium (Tk 150000 to Tk300000)	54	45.00
		High (above Tk 300000)	22	18.33
Extension contact	Score	Low contact (below 15)	37	30.83
		Moderate contact (15-25)	66	55.00
		High contact (above 25)	17	14.17

4.2 Climate change perception

Bangladesh is a showcase of global climate change and adversely affecting the life and livelihoods of the people by regular occurrence of different disaster events like floods, cyclone, drought, salinity, thunderbolt. In this study like many other study findings, respondents have perceived that cyclones, storm surges, sea level rise, salinity intrusion, erosion, and drought are major disasters in coastal charland (Table 2), that affect agricultural production (Table 3).Climate change perception is essential for driving the adoption of CSA practices and promoting food security. It shapes farmers' awareness, risk perception, adaptive capacity, sustainable resource management, and understanding of market opportunities. Policies and programs that aim to enhance climate change education, raise awareness, and provide support for CSA adoption can contribute to building more climate-resilient agricultural systems and ensuring long-term food security.Policies that promote favorable climate change perception can accelerate the adoption of CSA practices and enhance food security. By focusing on awareness, education, capacity building, financial support, infrastructure development, and knowledge sharing, policies can create an enabling environment that motivates farmers to embrace climate-resilient practices. This, in turn, contributes to building more sustainable and resilient agricultural systems and ensures long-term food security in the face of climate change challenges.

Table 2. Perception of the respondents about climate change and variability

Sl	Climatic variables	Mean perception score (1-5)
1.	Increased frequency and intensity of flood	3.81
2.	Increased frequency and intensity of drought	3.67
3.	Increased frequency and intensity of riverbank erosion	3.10
4.	Increase in sea level and reduction in freshwater availability	4.66
5.	Increase in the number of cyclones per year	3.68
6.	Rise in both day and night temperature	4.96
7.	Increase in pest attacks and incidence of diseases	4.49
8.	Increased variability in rainfall	4.47
9.	Change in the pattern of cold waves, heavy fog, and precipitation	4.49
10.	Increased phenomenon of the thunderbolt	3.96

4.4 Climate-smart agriculture adoption

In Charfassonupazila, farmers are practicing different CSA, these are saline tolerant rice variety, raised seedbed, planting large size amon rice seedlings, sorjan system, vegetables cultivation around pond, agroforestry, bottle nut, low lift pump, pheromone traps, urea deep placement, mulching, seed storage, napier grass as fodder along roadside/ails, flood resistant crops, drought resistant crop varieties, organic fertilizer, pulses, sunflower, soybean, watermelon production, respectively (Figure 2). Since, salinity is growing problem for the coastal farmers, they are adapting with salinity tolerant rice varieties. There are also some promising practices like sunflower, soybean, watermelon, and pulses to adapt with the changing climate.

It is worth noting that the successful adoption of emerging crops in the coastal chars of Bangladesh requires appropriate support and interventions. This includes providing farmers with access to quality seeds, technical knowledge, market linkages, and infrastructure for post-harvest handling and processing. Government initiatives, research institutions, and development organizations can play a vital role in facilitating the adoption and promotion of these crops through targeted programs and policies. Overall, the cultivation of emerging crops like soybean, sunflower, and pulses in the coastal chars of Bangladesh offers opportunities for diversification, economic growth, nutrition improvement, and climate resilience. By exploring and promoting these crops, farmers in coastal areas can enhance their agricultural practices and livelihoods while contributing to food security in the region.

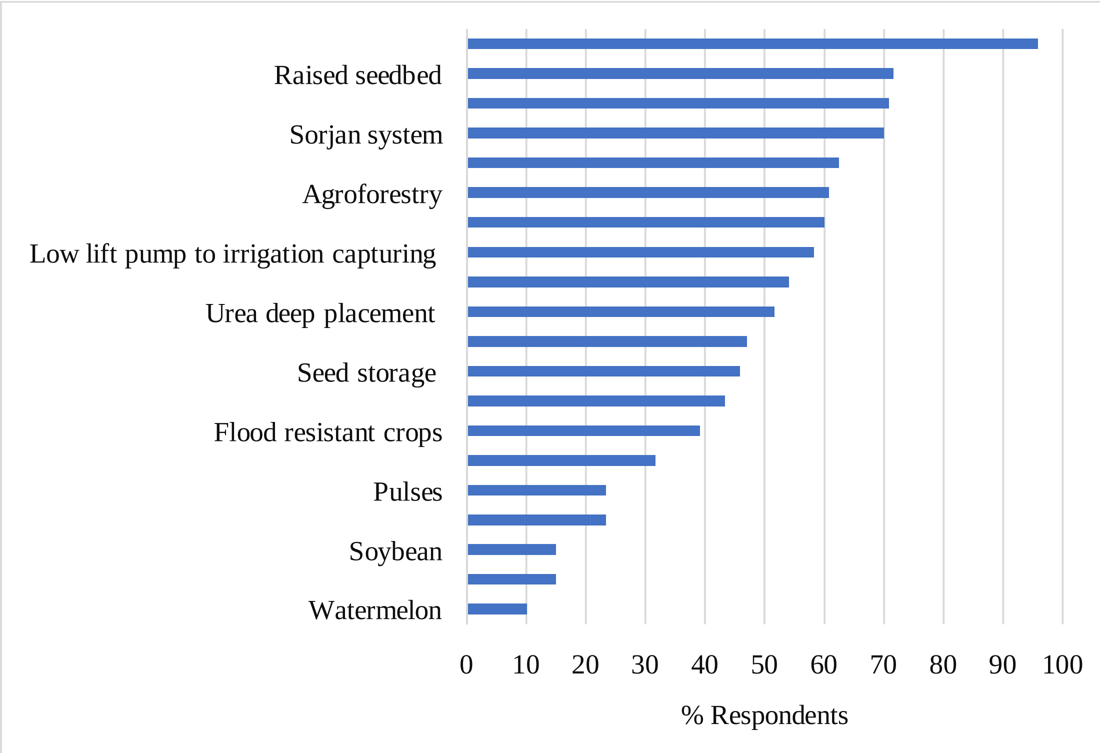

Figure 2. Climate-smart agricultural practices in coastal charland

4.4 Food security of charland farmers

Although there are various techniques of assessing food security across the globe, we have considered household food insecurity and access to food items during the data collection to comprehend the food security status. Findings revealed that, although there is no significant number of people who can't afford regular meals but the adequacy, variation of food items or food choices are limited in the study area (Figure 3). It was also evident that, as coastal Charlands are affected by sudden storm surges, and people need to evacuate to shelter centres, people more worried about the availability of foods in times of natural disasters. Even though there isnot a considerable number of persons in the study region who are unable to afford regular meals, there is a lack of adequate food items and a paucity of diversity in the food choices that are available to them. It was also revealed that people are more worried about the availability and adequacy of foods in future. This is because coastal regions are more likely to be impacted by abrupt cyclone and storm surges, and as a result, residents in these areas are required to evacuate to shelter centers.

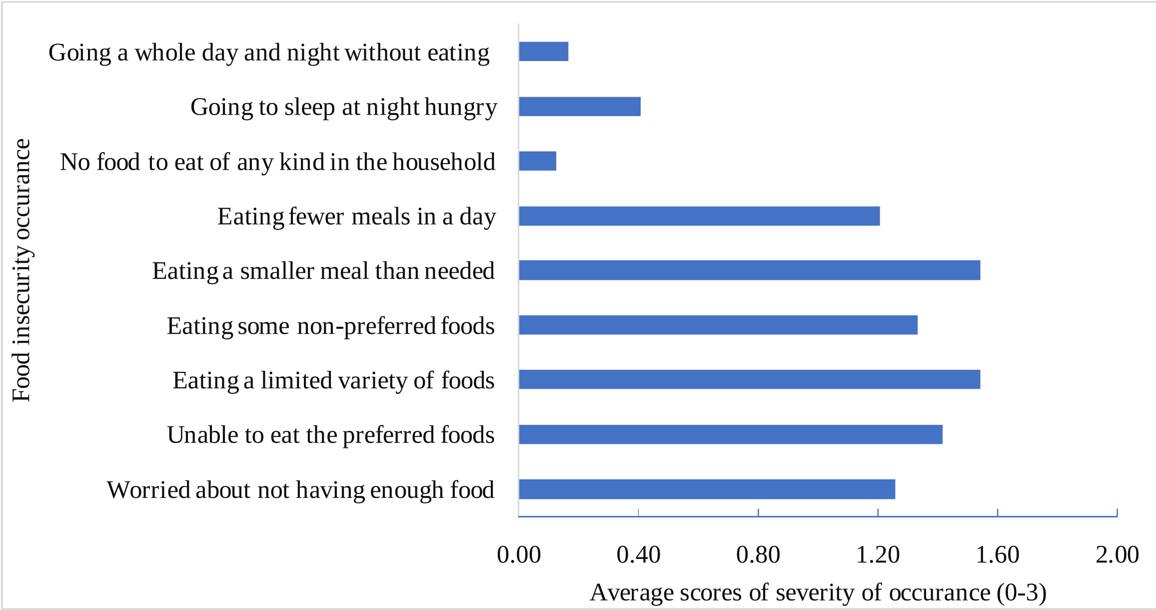

Figure 3. Food insecurity severity score

Households with few resources can save money by having a pond and a few cattle (ox, cow, and buffalo). Farmers can easily eat meat to make sure they have enough food and eat a variety of foods. They can also sell their cattle to get more money to invest in other productive areas, which can indirectly help improve their food security. The annual income of a household is another important sign of dietary diversity. When farmers' incomes went up, they had more food options to choose from, and as a result, their dietary diversity tended to go up.

Findings in Table 3 revealed that farmers had access to rice, a staple food grain in Bangladesh. Access to tubers and vegetables were found satisfactory. However, access to protein riches food items were found very low as only 9.2 of the sampled household had access to meat the day before data collection.

Table 3. Access to food items day before interview

Food items	Frequency	Percent (%)
Rice/grain	120	100.0
Potatoes/roots/tubers	105	87.5
Vegetables	115	95.8
Fruits	35	29.2
Meat	11	9.2
Eggs	95	79.2
Fish	65	54.2
Beans/peas/lentils/nuts	75	62.5
Milk/milk products	62	51.7
Oil/fat/butter	63	52.5

Sugar/honey	49	40.8
Tea/coffee	25	20.8

4.5 Factors of CSA adoption and Food Security

Farmers family size, farm size, income, and extension contact showed positive significant relationship with their adoption of CSA practices while age showed significant negative relationship(Table 4). Almost similar findings have been reported where technology adoption was positively correlated with family size [10], farm size[10,12,24], income[10,12,24], and extension contact [10–12,24]in different agro-ecological conditions. The size of a farmer's landholding can influence their ability to adopt climate-smart agricultural technologies. Larger farms generally have more resources and capacity to invest in new technologies and practices. They may have greater access to credit, enabling them to purchase equipment, inputs, and implement climate-smart techniques. Moreover, larger farms can benefit from economies of scale, making it easier to adopt advanced technologies. The size of a farmer's family can impact their labor availability and capacity to implement new practices. Larger families may have more labor resources, which can be essential for implementing labor-intensive climate-smart technologies. Additionally, family members can provide support and share knowledge about new practices within the household, facilitating adoption. Farmers' income level is crucial for their ability to afford climate-smart agricultural technologies. These technologies often involve upfront costs, such as purchasing equipment or infrastructure. Higher incomes provide farmers with the financial means to invest in these technologies, as well as to maintain and operate them effectively. Improved income can also increase farmers' willingness to take risks and try new approaches to enhance their agricultural productivity and sustainability. Extension services play a vital role in disseminating knowledge and information about climate-smart agricultural technologies to farmers. Extension agents can provide guidance on the benefits, usage, and implementation of these technologies, as well as offer training and demonstrations. Regular contact with extension services can increase farmers' awareness and understanding of climate-smart practices, making them more likely to adopt and integrate these technologies into their farming systems. In conclusion, while each of these factors—farm size, family size, income, and extension contact—has its own importance, they are interconnected and collectively influence the adoption of climate-smart agricultural technology in Bangladesh. Policies and programs should consider the diverse needs of farmers based on these factors and aim to provide targeted support, including access to credit, extension services, and training, to facilitate wider adoption of climate-smart practices.

Table 4. Relationship between farmers socio-economic characteristics and their CSA adoption and food security

Variables	CSA adoption	HFIS	HDDS
Age	-0.254**	0.044	0.002
Eduacation	0.085	-0.295**	0.199*
Family size	0.232*	0.229*	-0.061
Farm size	0.405**	-0.476**	0.218*
Income	0.238**	-0.329**	0.156
Extension contact	0.211*	-0.368**	0.119
Climate change perception	0.154	0.073	0.167
CSA adoption	1	-0.253**	0.219*
HFIS	-0.253**	1	-0.331**
HDDS	0.219*	-0.331**	1

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)
HFIS-Household Food Insecurity Status
HDDS-Household Dietary Diversity Status

Food insecurity staus of respondents decreased with increasing level of education, farm size, income, extension contact, and adoption of CSA while food insecurity was increased with increasing family size(Table 4). The level of education, farm size, income, extension contact, and adoption of CSA are interconnected factors that can collectively contribute to improving household food security. Policies and interventions should aim to enhance access to education, extension services, financial resources, and promote the adoption of CSA practices, particularly among smallholder farmers. By addressing these factors comprehensively, it is possible to enhance agricultural productivity, resilience, and food security at the household level.

Household dietary diversity was increased with increasing level of education, farm size, and CSA adoption (Table 4). It is important to note that these factors are interconnected, and their combined effect can further enhance dietary diversity. For instance, educated farmers with larger farms who adopt CSA practices are likely to have a more diversified agricultural production, leading to a broader range of nutritious foods available for household consumption. Promoting education, supporting smallholder farmers to increase their farm sizes, and encouraging the adoption of CSA practices can be effective strategies to improve household dietary diversity. Additionally, interventions such as nutrition education, market linkages, and improving access to diverse and nutritious foods can further complement these efforts and contribute to better overall nutrition and food security.

5. Conclusion

Charlandfarmers showed marked individual differences in their socio-economic characteristics. Cyclones, storm surges, sea level rise, salinity intrusion, erosion, and drought are major climatic disasters in the study area as perceived by the respondents, that affect agricultural production and farmers livelihoods. Among the different adaptable agricultural practices in the face of climate change, saline tolerant rice variety, raised seedbed, transplanting large size seedlings, sorjan system, vegetable cultivation around pond, and agroforestry practices are mostly adopted. Even though there isnot a considerable number of persons in the study region who are unable to afford regular meals, there is a lack of food adequacy, quality and dietary diversity. It was also clear that when natural disasters happen, people worry more about having enough food. This is because people who live near the coast are more likely to be affected by sudden cyclones and storm surges, so they must evacuate and relocate to shelter centres. Given that the cultivation of rice and vegetables is a significant part of farming, it is important to ensure that good agricultural practises are followed in order to make farming more environmentally responsible and sustainable. In addition, the planning of the government's development can immediately include the construction of coastal embankments or dams as well as deep irrigation in coastal areas to increase the profitability of agricultural farming and maintain food security.

6. Consent

As per international standard or university standard, respondents’ written consent has been collected and preserved by the author(s).

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