

Paddy Farmers Perceptions on Climate Change and Adaptation Strategies in Pemba Island

Abstract

Climate change is already exerting its impact on smallholder farmers, necessitating their acknowledgment of these changes and investment in adaptation strategies. The perception of climate change among farmers plays a crucial role in determining their willingness to adapt. This study focuses on the perceptions of paddy farmers regarding climate change and their responses to its impacts. Specifically, the study aims to answer the following questions: How do paddy farmers perceive climate change? To what extent do demographic characteristics influence the adoption of adaptation strategies in response to climate change impacts? How do paddy farmers respond to the impacts of climate change? The study was conducted in Wete District, North Pemba Region on Pemba Island. A cross-sectional research design was used, employing multistage cluster sampling along with purposive and simple random techniques. Both qualitative and quantitative data were collected, with questionnaire surveys used for quantitative data and key informant interviews for qualitative data. Quantitative data were analyzed using the statistical package for social sciences software, while qualitative data were analyzed using content analysis. The study findings reveal that paddy farmers in the study area perceive an increase in temperature, changes in rainfall patterns, an increase in dry spells, and a rise in sea level. The study also identifies various strategies used by paddy farmers to cope with the impacts of climate change, including the construction of ridges, the use of pesticides, irrigation, and skipping meals. However, the construction of ridges to prevent seawater intrusion into paddy farms was found to be less effective. Therefore, the study recommends that the Revolutionary Government of Zanzibar should consider building a sea wall to help paddy farmers build resilience against the current and future impacts of climate change. Paddy farmers in Pemba Island are also advised to adopt transformative adaptation strategies that are more sustainable and capable of withstanding the projected harsh climate changes in the future.

Key words: perception; adaptation; climate change; paddy farmers; Wete district; Pemba Island.

1.0 Introduction

Climate change impacts are already being experienced and are expected to have even greater consequences in the future (Legesse *et al.*, 2012). The ongoing shifts in global climate patterns are increasing the vulnerability of communities, particularly in developing countries, endangering their livelihoods (Hisaliet *et al.*, 2011). The African continent has been consistently warming, with an average rate of +0.3 °C per decade between 1991 and 2022, compared to +0.2 °C per decade between 1961 and 1990. This recent trend is slightly higher than the global average warming trend of +0.2 °C per decade for the same period (WMO, 2023). Despite agriculture being a vital sector for Africa's economy, supporting 55% to 62% of the workforce in sub-Saharan Africa alone, agricultural productivity growth has declined by 34% since 1961 due to the impact of climate change (WMO, 2023). Agricultural drought predominantly affects individuals employed in the agricultural sector, as insufficient water supply inhibits plant growth and diminishes production (Woetzel *et al.*, 2020). Additionally,

rising sea levels resulting from oceanic thermal expansion and melting ice pose a threat to coastal agricultural lands, particularly in regions with limited capacity for implementing or modifying sea defenses (Webster, 2008).

It is essential for smallholder farmers, including paddy farmers in Pemba, to recognize the existing climate changes in their respective areas and make appropriate investments towards adaptation (Komba and Muchapondwa, 2012). The ability of farmers to perceive climate change is a fundamental requirement for them to choose to adapt (Acquah and Onumah, 2011; Mengistu, 2011; Moyo *et al.*, 2012; Kitinyaet *al.*, 2012). The coping and adaptation strategies of smallholder farmers depend largely on their level of knowledge regarding climate change and the sources of information available to them (Bello *et al.*, 2013). Those who perceive changes hypothetically adopt one or more climate-smart agriculture practices to mitigate the negative impacts associated with climate change (Nyang'au *et al.*, 2021).

Implementing strategies for adapting to climate change has the potential to mitigate its adverse effects on agriculture and other sectors (Smit and Pilifosova, 2001). These adaptation strategies also aid farmers in achieving their objectives of food security, income, and livelihoods under extreme weather conditions, such as droughts and floods (Hassan and Nhemachena, 2008). The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as "adjustments in ecological, social, or economic systems in response to actual or projected climate stimuli and their effects" (Smit and Pilifosova, 2001). Adaptation can be classified as either autonomous or planned. Autonomous adaptation occurs without conscious response to climatic stimuli, but rather in response to ecological changes in natural systems or market and welfare changes in human systems. It is also known as spontaneous adaptation (Smit and Pilifosova, 2001). On the other hand, planned adaptation is the result of deliberate policy decisions made when it is recognized that conditions have changed or are about to change, and action is necessary to achieve, maintain, or restore a desired state. Autonomous adaptations are typically reactive and are often initiated by private actors such as individuals, households, or private companies, as opposed to government-led initiatives. Planned adaptations, on the other hand, are referred to as public adaptations and are initiated and implemented by governments at all levels (Smit and Pilifosova, 2001).

Pemba Island is highly vulnerable to climate change and its impacts due to its geographical positioning as an island with limited land area. Key threats include sea level change, extreme events, and seawater intrusion into underground aquifers. The intrusion of saltwater into natural wells and agricultural lands has resulted in increased water stress and reduced crop productivity on Pemba Island. Like other Small Island Developing States (SIDS) worldwide, Pemba Island is expected to be severely impacted by rising temperatures, changing precipitation patterns, and sea level rise due to its high vulnerability stemming from sensitive ecological and economic systems and other interacting stressors (Mangoraet *al.*, 2015; Bakari, 2015; Makame, 2013). Shifts in the timing and amount of rainfall have detrimental effects on freshwater resources, which are crucial for island living and activities such as agriculture (Lazrus 2012). This, in turn, has potential adverse impacts on island economies and food security.

Paddy farming, like other agricultural crops in Pemba and developing countries, is being significantly affected by the impacts of climate change and variability. The success of crop production in Pemba, including paddy farming, relies heavily on favorable weather and climate conditions. However, the island is frequently subjected to extreme weather patterns such as floods, droughts, storms, and rising sea levels, which further exacerbate the

challenges faced by farmers. Despite extensive research on climate change and adaptation in the region, there is limited empirical evidence regarding how paddy farmers in Pemba Islands perceive and adapt to these impacts. Therefore, it is crucial to understand the perceptions and adaptation strategies of paddy farmers in Pemba Islands towards climate change and its variability. This study aims to address the perceptions of paddy farmers regarding climate change and explore their adaptation strategies to mitigate its impacts in the study area.

2.0 Methodology

The study was conducted in the Wete District, North Pemba Region, Pemba Island, Zanzibar, Tanzania. Pemba Island is one of the two main islands that form part of the Zanzibar Archipelago. The other main island is Unguja, and together with several small islands, they make up Zanzibar. The island is situated in the western parts of the Indian Ocean, between latitudes 4 and 6 south of the Equator, and longitudes 39 and 40 east of Greenwich. It is located 40 to 60 kilometers off the coast of East Africa. The main activities carried out on Pemba Island are crop farming, livestock keeping, fishing, and trade, all of which are climate-sensitive. Pemba Island acquired the nickname "Green Island" from an Arab writer due to its history of supplying agricultural produce, including rice, grains, and cereals, to Malindi and Mombasa (Pollard, 2009).



Map 1: Wete District – Pemba Island

Pemba has a tropical climate, which is slightly milder than the mainland of Tanzania and milder than Unguja Island. The average temperature is 25.5°C (78°F), and the average annual rainfall is 1,364 mm. The monthly average temperatures usually range between 24 and

27.4°C (75°F and 81°F). There are two rainy seasons, with the majority of rainfall occurring between April and May, and a smaller rainy season between November and December. The drier months are January and February, with a longer dry season from June to October.

There are two main reasons for choosing Pemba Island for this study. Firstly, historically, Pemba Island has been a supplier of agricultural produce, including rice, grains, and cereals, to Malindi and Mombasa. However, due to rising sea levels, changes in precipitation patterns, increasing temperatures, and floods, Pemba Island is more vulnerable to the impacts of climate change compared to other areas in Zanzibar. Secondly, like other smallholder farmers in Tanzania, paddy farmers in Pemba Island rely on rainfed agriculture. This practice makes them particularly vulnerable to the impacts of climate change.

A cross-sectional research design was used for this study, as it allowed for the collection of multiple cases at a single point in time (Babbie, 1990; Bailey, 1998). A multistage cluster sampling procedure was employed to select districts, wards, shehias, and households. This procedure allowed for the use of multiple sampling methods. Wete District was purposively selected based on its location and the presence of paddy farmers. Wards, shehias, and households were then selected randomly. 71 respondents, based on Cochran's formula, were randomly chosen to ensure that each household had an equal chance of being selected (Cochran, 1977).

Both quantitative and qualitative data were collected for this study. Quantitative data was gathered through a household questionnaire survey, with the questionnaire serving as the tool for this method. The questionnaire was pre-tested and revised to produce the final version that was administered to the heads of household paddy farmers in Wete District, North Pemba Region. Qualitative data was obtained through key informant interviews, specifically from experienced paddy farmers who had several years of experience working on farms. A descriptive analysis was conducted using the Statistical Package for Social Sciences (SPSS) software to analyse the quantitative data, while the qualitative data was analyzed using content analysis, which involved coding and drawing conclusions based on the themes of the study.

3.0 Results and Discussions

3.1 Paddy Farmers' Perception of Climate Change

Farmers have varying perceptions of climate change, and their understanding of climate variables is crucial for rain-fed agriculture. This is because farmers respond and adapt to climate change based on their own interpretations of shifting climate patterns.

3.1.1 Temperature Increase

The study findings indicate that paddy farmers in the study area perceive a significant increase in temperature. According to the data presented in Table 1, approximately 79 percent of respondents reported an increase in temperature, while 20 percent disagreed with this perception. These findings align with a study conducted by Kihupiet *et al.* (2015a) in Ismani Division, Iringa District, Tanzania, which also found that smallholder farmers perceived a rise in temperature. Similarly, a study by Nyang'au *et al.* (2021) in Masaba Sub-county, Kisii, Kenya, revealed that farmers in that region also perceived an increase in temperature. These findings were further supported by an informant interview conducted in the study area.

"There has been a significant increase in temperature, resulting in the drying up of plants and yellowing of paddy crops, as well as an excessive dryness of the soil."

Rao *et al.* (2017) asserted that the increasing temperatures associated with climate change are expected to have a detrimental impact on crop production, as evidenced by the negative effects experienced by paddy farmers in Pemba.

3.1.2 Changes in rainfall pattern

The findings of the study demonstrate that paddy farmers in Pemba Island have observed changes in the rainfall pattern. Approximately 49 percent of the respondents (as shown in Table 1) agreed that there was a noticeable shift in the rainfall pattern. However, 47 percent of the respondents remained undecided, while 4 percent did not agree with the notion of change. These findings align with the results of a study conducted by Nyang'au *et al.* (2021) in Masaba Sub-county, Kisii, Kenya, as well as with findings from Apac district in Northern Uganda by Atubeet *et al.* (2022). In all these studies, farmers reported perceiving a decrease in rainfall. These findings are consistent with a study carried out by Antwi-Agyei and Nyantakyi-Frimpong (2021) in Northern Ghana, which also highlighted farmers' observations of changes in rainfall patterns. The impact of these changes on agricultural crops is significant, particularly for paddy farmers in the study area who face the challenges associated with unpredictable rainfall. The findings were further supported by an informant interviews conducted in the study area, as illustrated below:

"The rainfall is unreliable and unpredictable. Sometimes it arrives early, sometimes it is delayed. When it does come, it is often heavy, resulting in flooding in low-lying areas."

Table 1: Perception of Climate Change among Paddy Famers in Wete - Pemba Island

Variables	Disagree	Undecided	Agree
The temperature is increasing	20	1	79
There are changes in rainfall pattern	4	47	49
There is rise in sea level	9	25	66
There is increase in pests	38	4	58
There is increase in dry spells	15	34	51

Source: Field Survey

3.1.3 Increase in dry spells, pests and rise of sea level

The findings indicate that paddy farmers have observed an increase in dry spells. Approximately 51 percent of the respondents (see table 1) reported experiencing an increase in dry spells during the rainy season. These findings align with a study conducted in Ismani Division, Iringa District by Kihupiet *et al.* (2015a), which also found that smallholder farmers perceived an increase in dry spells during the rainy season. Additionally, the findings show that there has been an increase in pests infesting paddy crops due to rising temperatures. This finding is consistent with a study conducted in Northern Uganda (2021) by Atubeet *et al.*, which

revealed that smallholder farmers perceived an increase in pests. Furthermore, the study found that 66 percent of the respondents acknowledged a rise in sea levels in the study area. These findings were further supported by informant interview conducted in the study area, as confirmed by one of the informants.

"The salinity of seawater continues to rise over time, often encroaching upon our rice fields and devastating our crops. Additionally, high temperatures can lead to excessive soil dryness, resulting in the formation of cracks. Furthermore, there has been a noticeable increase in pest infestations that pose a threat to our paddy crops."

3.2 Demographic Characteristics of Respondents

The results indicate that over 64 percent of respondents were found to be illiterate, as shown in Table 2. It was observed that the level of education has a significant influence on farmers' decision to adopt adaptation strategies in response to the impacts of climate change. Specifically, farmers with higher levels of education are more likely to adapt to climate change compared to those with lower levels of education. This finding is consistent with a study conducted in southeast Asia, as noted by Nor Diana *et al.* (2022), which found that individuals with higher education had a greater tendency to adopt adaptation measures compared to those with lower education levels. Consequently, it can be inferred that the majority of paddy farmers in Wete Pemba have a low probability of adapting. Table 3 presents the various adaptation strategies implemented by paddy farmers in the study area to mitigate the impacts of climate change.

Table 2: Demographic characteristics of Respondents (n = 71)

Education level of respondent		
	Frequency	Percentage
Illiterate	46	64.8
Primary	17	23.9
Secondary	8	11.3
Total	71	100.0
Marital status of respondent		
married	54	76.1
Single	2	2.8
Widow/widower	9	12.7
Divorced	3	4.2
Separated	3	4.2
Total	71	100.0
Age of respondents		
20 - 29	4	5.6
30 - 39	21	29.6
40 - 49	38	53.5
50 - 59	7	9.9
60 +	1	1.4
Total	71	100.0

Source: Field survey

The findings of the study indicate that approximately 76 percent of the respondents (see Table 2) were married. It was observed that married heads of household were more inclined

to adopt various adaptation strategies compared to those with different marital status. This finding aligns with a similar study conducted in Northern Uganda by Atubeet *et al.* (2021), which found that married heads of household were more likely to adopt multiple adaptation strategies compared to their unmarried counterparts. Furthermore, the findings are consistent with a study conducted in Southern Ethiopia by Gebre *et al.* (2019), which highlighted the significant association between marital status and household decisionmaking regarding adaptation strategies against the impacts of climate change.

The years of farming experience of household heads have a significant influence on adaptation strategies. More than 53 percent of the respondents (see Table 2) were between the ages of 40 and 49. Farmers within this age range possess considerable farming experience, are energetic, and are more likely to adopt a range of adaptation and coping strategies to mitigate the impacts of climate change. This finding is consistent with the study conducted in Northern Uganda by Atubeet *et al.* (2021), which identified the influence of years of farming experience on the adoption of various adaptation strategies by heads of households. Similarly, the findings are in line with a study conducted in the Dejen District of the Nile Basin in Ethiopia (2018) by Amare *et al.*, which revealed that as farmers gain more experience in farming, their likelihood of adopting improved farming practices increases. This may be attributed to the fact that experienced farmers possess a greater knowledge of indigenous practices and information about climate changes and agronomic practices that facilitate adaptation.

3.3 Paddy Farmers Adaptation and coping Strategies against Impacts of Climate Change

Paddy farmers in Pemba Island are employing a range of adaptive measures and coping strategies in response to the effects of climate change, as depicted in Table 3.

3.3.1 Construction of embankments

Paddy farmers observed the rise in sea levels and its impact on their farms. The research findings indicated that paddy farmers in Pemba Island are taking adaptive measures to mitigate the effects of climate change by constructing ridges along the coastline to prevent the intrusion of seawater into their paddy farms. Over 60 percent of the respondents reported that they have constructed ridges for this purpose. These findings were further supported by a informant interviewed in the study area who said:

"I construct substantial embankments, like others do, to provide some degree of control over the influx of seawater into our paddy fields. Nonetheless, paddy crops located in close proximity to the ocean succumb to the deleterious effects of saltwater intrusion, irrespective of the presence of these embankments. Regrettably, there is no viable solution at my disposal to aid those particular paddy crops."

Based on the key informant statement provided, it becomes evident that the construction of ridges as a strategy to prevent the ingress of seawater into paddy farms is not highly effective. As a result, it is imperative to implement more efficient measures to address this issue.

3.3.2 Application of pesticides

Paddy farmers in the study area have reported an increase in pests as one of the several impacts of climate change affecting paddy production. More than 51 percent of respondents stated that they use pesticides to combat the pests that affect their paddy crops. These findings are consistent with a study conducted by Kihupiet *al.* (2015b) in Ismani - Iringa District, which revealed that farmers used pesticides to address the issue of increased pests damaging their crops. Furthermore, these findings are supported by a study conducted in Northern Uganda (2021) by Atubeet *al.*, which indicated that smallholder farmers adopt intensive insecticide use to control the growing pest infestations in their crops. Key informant interviews conducted in the study area also confirmed these findings, as one of the informants stated:

“When we have sufficient funds, we purchase pesticides and apply them to our paddy farms in order to safeguard the paddy crops from pest infestation.”

3.3.3 Irrigating paddy farms during dry spells

Dry spells were identified as one of the major factors affecting paddy production in the study area. A significant proportion of respondents (more than 22 percent) confirmed that they employed irrigation methods to mitigate the stress caused by dry spells on their crops. These findings are consistent with a study conducted in Isimani - Iringa District by Kihupiet *al.*, (2015b). The key informant interviews conducted in the study area also supported these findings. One of the informants stated the following:

“We construct water ponds for irrigation purposes during periods of drought in order to reduce heat stress on our crops.”

Table 3: Paddy Farmers Adaptation and Coping Strategies in Wete-Pemba Island (n=71)

Adaptation&coping strategies	Frequency	Percent of cases
Irrigating farms during dry spells	15	22.7
Construction of embankments	40	60.6
Involving in casual labour	1	1.5
Ask for financial help from relatives	5	7.6
Less than three meals per day	9	13.6
Migration for men	6	9.1
Use of pesticides	34	51.5
Use of fertilizers	1	1.5
Construction of water reservoir for irrigation	2	3.0
Pray to God so that he can have mercy on us	26	39.4
Plant cassava	9	13.6
Glowing vegetables	6	9.1

Source: Field survey

3.3.4 Other adaptation and coping strategies

Table 3 presents additional adaptation and coping strategies employed by paddy farmers in the study area to mitigate the effects of climate change. These strategies include engaging in casual labour, utilizing social networks, skipping meals, migrating, using fertilizers,

cultivating cassava, and growing vegetables. These findings align with a study conducted in Northern Ghana by Antwi-Agyei and Nyantakyi-Frimpong (2021), which also identified skipping meals as a coping strategy for climate change impacts among farmers. Praying to seek divine intervention was another strategy adopted by paddy farmers to address the challenges of climate change, with more than 39 percent of respondents indicating its use. These findings were further supported by informant interviews conducted in the study area, as outlined below:

"We, as human beings, have committed many sins against God, resulting in the current events we are facing. Consequently, there is little we can do to resolve this situation, as God is the ultimate authority and is punishing us for our transgressions. Our only recourse is to pray to God, seeking His forgiveness and mercy, in the hope that He will deliver us from our present circumstances."

"When faced with limited or no food supply in our household, we practice meal skipping in order to stretch the duration that the available food can sustain us. Occasionally, I provide my children with a single serving of porridge per day, to last them until the next day."

4.0 Conclusion

The study findings reveal that paddy farmers in the study area perceive increased temperatures, changes in rainfall patterns, more frequent dry spells, and rising sea levels. The study also identifies various strategies used by paddy farmers to mitigate the impacts of climate change, such as constructing ridges, applying pesticides, using irrigation, and skipping meals. However, the construction of ridges to prevent seawater intrusion proved to be ineffective, as saltwater from the ocean still managed to affect some paddy crops. This highlights the need for more effective measures to improve the current situation of paddy farmers and address the projected impacts of climate change in the future. In general, climate change poses significant threats to rainfed agriculture and islander communities, hindering the achievement of Sustainable Development Goals, particularly those related to poverty reduction (Goal 1: End poverty in all its forms everywhere) and food security (Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture). Therefore, this study recommends that the Revolutionary Government of Zanzibar construct a sea wall to help paddy farmers build resilience against the impacts of current and future climate changes. Additionally, the study suggests that paddy farmers in Pemba Island adopt transformative adaptation strategies that are more sustainable and can withstand the projected harsh climate changes in the future.

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