Original Research Article

Implications of Climate Change on Paddy Rice (*Oryza sativa L.*) Production and Asset Ownership among Farmers in Kahama District, Tanzania.

Abstract

This study investigates the effects of climate change on farmers who produce paddy rice (*Oryza sativa L.*) and their asset ownership in Tanzania's Kahama District. The goal is to evaluate the particular risks and difficulties that farmers are facing as a result of climate change and comprehend the implications for their asset ownership. Surveys, interviews, and analysis of past climate data are some of the quantitative and qualitative research techniques used in this study. The results show that climate change directly affects the production of paddy rice, causing decreasing crop yields as a result of changes in temperature and rainfall patterns. Farmers' capacity to continue rice output and keep their asset ownership is also impacted by water scarcity and irrigation problems.Indirect effects of climate change on market conditions and production costs also have an impact on farmers' revenue and profitability. To overcome these obstacles, farmers use a variety of adaptation tactics, such as water saving techniques and revenue diversification. Farmers' vulnerabilities are further exacerbated by their limited access to financial resources, education, and market prospects. To improve farmers' resilience and promote their asset ownership in the face of climate change, addressing these issues necessitates focused interventions, such as better access to financial resources, knowledge-sharing platforms, and market links. The findings add to the body of research on the effects of climate change on the agriculture industry and offer policymakers and practitioners crucial information for creating effective strategies and policies to aid farmers in Kahama District and other similar contexts.

Key words: Climate change and variability (CCV), Impact of CCV on paddy rice production, Impact of CCV on paddy rice asset ownership, Kahama District

1. Introduction

Agriculture is just one of the many facets of human life that are significantly impacted by the worldwide phenomenon known as climate change. One agricultural industry that is particularly vulnerable to the effects of climate change is the cultivation of paddy rice. Many farmers in Tanzania's Kahama District depend heavily on paddy rice farming as a source of income, and their asset ownership is closely linked to rice output. Besides, the effects of climate change on agriculture globally, especially rice production, have been the subject of numerous studies. According to the Intergovernmental Panel on Climate Change (IPCC), crop yields would be negatively impacted by changes in temperature and rainfall patterns as a result of climate change (IPCC, 2014; Dahiya, 2023). Due to shorter grain filling times and detrimental impacts on plant growth and development, higher temperatures can reduce rice yield (Mkonda. 2022; Paoshkar and Kumar, 2014). Rice production may be negatively impacted by changes in precipitation patterns, such as an increase in the frequency and severity of floods and droughts (IPCC, 2014; Dahiya, 2023).

Several Tanzanian regions, notably Kahama District, have observed adverse effects of climate change on paddy rice output. According to studies carried out in nearby locations, changes in temperature and rainfall patterns have resulted in lower rice yields and greater farmer vulnerability (Dahiya, 2023; Mkonda, 2022; Mwanaumo*et al*., 2011; Mkoga, 2016). Given that the production of rice is frequently a key source of income and wealth accumulation in rural regions, these effects have considerable consequences for farmers' asset ownership.Additionally, there is rising concern over how climate change may affect the water supply for paddy rice farming in the Kahama District. Water scarcity might impact farmers' ability to irrigate their rice crops due to changes in precipitation patterns and elevated evapotranspiration rates (Nyiwul, 2021; Mkoga, 2016). Water scarcity may lower crop yields, lower farm income, and make farmers more vulnerable, which may ultimately have an impact on their asset ownership.

Farmers in Kahama District also deal with a number of indirect effects on their asset ownership in addition to the direct effects of climate change on rice output. Changes in market dynamics, such as shifting rice prices and heightened competition, are among them (Ntali*et al*., 2022; Mkoga, 2016). These might have an impact on farmers' income and profitability. In addition, changes in the dynamics of pest and disease brought on by climate change may also result in lower rice yields and higher production costs for farmers (Pelser and Chimukuche, 2022; IPCC, 2014).Understanding the specific effects of climate change in this context is essential given the significance of paddy rice production for farmers' asset ownership in Kahama District and the established effects of climate change on rice output internationally and in Tanzania. In Kahama District, Tanzania, this study attempts to evaluate the effects of climate change on paddy rice production and its consequences for farmers' asset ownership.

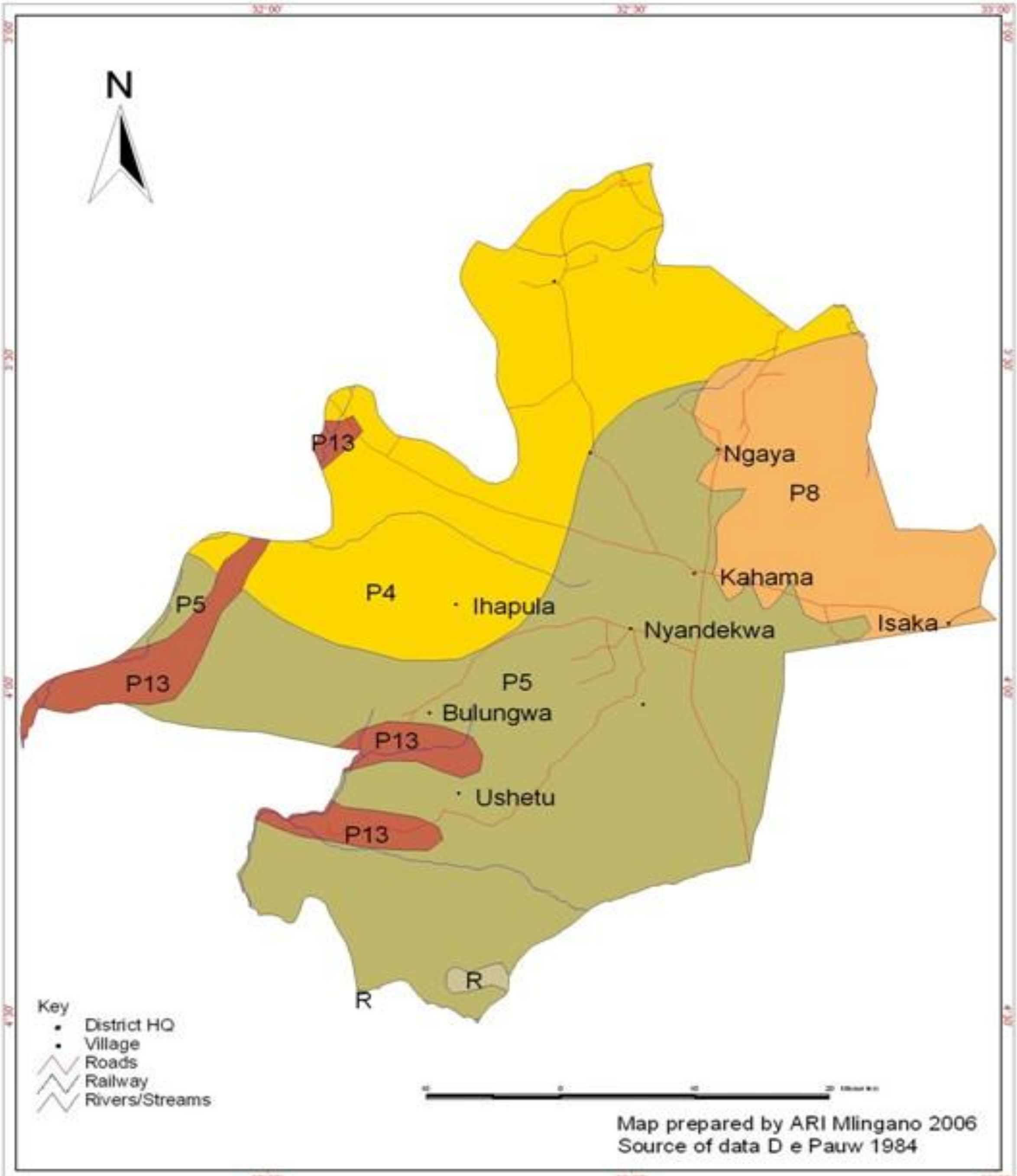
It is anticipated that the study's findings would provide important light on the specific effects of climate change on the paddy rice industry in Kahama District and how these effects affect farmers' asset ownership. The findings will contribute to the body of knowledge on Tanzania's agricultural sector's effects of climate change and influence policy and adaptation initiatives to help farmers cope with the effects of climate change. Thus, climate change has an impact on farmers' asset ownership and provides substantial hurdles to the production of paddy rice in Tanzania's Kahama District. Understanding these effects is essential for creating measures that will effectively reduce the negative effects of climate change and improve the livelihoods and resilience of the district's rice farmers.

2. Materials and Methods

2.1 Materials

The study was carried out in Shinyanga Region's Kahama District. Three councils include Kahama, Msalala, and Ushetucombined to establish the Kahama District. The five wards of Mondo, Kagongwa, Ntobo, Chela, and Nyamilingano each included two villages that were purposely chosen for data collection, namely Mondo, Bumbiti, Kagongwa, Gembe, Ntobo A, Kalagwa, Chela, Chambaga, Nyamilingano, and Ididi (Figure 1). Selected communities top the nation in paddy output and are severely impacted by CCV.

KAHAMA DISTRICT AGRO-ECOLOGICAL ZONE



Aez_code	Altitude (masl)	Rainfall (mm/year)	Physiography
P13	900-1200	900-1200	Flat, seasonally inundated plains with permanent or semi-permanent swamps
P4	1200-1300	1200-1300	Flat to gently undulating plains with scattered hill-footslope associations
P5	1100-1300	1100-1300	Gently undulating plains mostly well drained developed on granites and gneisses
P8	1000-1200	1000-1200	Flat to gently undulating plains developed partly on granites and on colluvium
R			Rocky terrain

Figure 1: The map of study area

2.2 Methods

2.2.1 Data collection methods

Data were gathered from primary and secondary sources. checklist of items/indicators for direct field observation, checklist of questions for in-depth interviews with key informants, checklist of themes for focus group discussions, and semi-structured questionnaire for household questionnaire survey. Climate data were gathered from the Tanzania Metrological Authority (TMA). Review of documents was utilized to get secondary data.

Sample and Sampling Procedures

From the three councils (Kahama, Msalala, and Ushetu) that make up Kahama District, five wards were specifically chosen. Mondo, Kagongwa, Ntobo, Chela, and Nyamilingano were the chosen wards. Two villages from each ward, namely Mondo, Bumbiti, Kagongwa, Gembe, Ntobo A, Kalagwa, Chela, Chambaga, Nyamilingano, and Ididi, were specifically chosen for a full examination. The list of households in the study villages served as the sample frame for the study. The household serves as the study's sampling unit. A household is described as a collection of individuals who reside together and elect one person to serve as the head household. The sampling frame was helpful in choosing a representative sample and determining the sample size. It was discovered that there were 8,832 households altogether in the chosen communities. Twenty key informants were chosen using a judgmental selection technique. Distribution of the sample frame in the study communities is shown in Table 1. The equation for calculating sample size for a known population and proportion is given by Kothari (2004) and is as follows:

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2 \left(N-1\right) + z^2 \cdot p \cdot q}$$

Where:
n = Sample size
z = Standard variate at a given confidence level (which is 1.96 at 95% confidence level basing on table of area under normal curve)
p = Sample Proportion
q = 1 – p
N = Size of population (Number of farmer households)
e = Precision (acceptable error)

Data for the calculation were:
z = 1.96
p = 0.7 (Population varies in terms of practicing paddy farming or otherwise)
q = 0.3
N = 8,832
e = 5% (0.05)

Inserting data into the equation:

$$n = \frac{(1.96)^2 (0.7)(0.3)(8832)}{(0.05)^2 (8832) + (1.96)^2 (0.7)(0.3)} = 311.32 \approx 312$$

Thus, structured interviews with 312 respondents were conducted. Through proportionate stratified sampling, which allowed for sampling of the proportional number of respondents from each village according to its population size, the number of respondents from each village was established. Salland (2010)'s equation for proportionate sampling was utilized:

$$P_i = \frac{N_i}{N} n$$

Where, P_i = Proportional sample of each village
N_i = Number of household in each village
N = Total household forming the sampling frame
n = Sample size.

The computations and sample size for each study village depicted in Table 1. These sample units in each village was randomly selected using rottenly system from updated village households list

Table 1: Distribution of households and proportional sample in study villages

Council	**Wards**	**Villages**	**Number of households**	**Sample size**
Kahama	Mondo	Mondo	770	770/8832 x 312 = 27
		Bumbiti	608	608/8832 x 312 = 21
	Kagongwa	Kagongwa	3,585	3585/8832 x 312 = 127
		Gembe	698	698/8832 x 312 = 25
Msalala	Ntobo	Ntobo A	802	802/8832 x 312 = 28
		Kalagwa	665	665/8832 x 312 = 23
	Chela	Chela	638	638/8832 x 312 = 23
		Chambaga	597	597/8832 x 312 = 21
Ushetu	Nyamilingano	Nyamilingano	216	216/8832 x 312 = 8
		Ididi	253	253/8832 x 312 = 9
Total			**8,832**	**312**

2.2.2 Data analysis

Statistical analysis was done on quantitative data from a household survey using the SPSS and Excel programs. Measures of central tendencies and dispersion were obtained using descriptive statistical analysis. Utilizing Excel, climatological data from TMA were statistically analyzed. Direct field observation, focus group discussions, and key informant interviews were used to gather qualitative data that was then subjected to content analysis.The Percent of Normal Precipitation Index (PNPI) was used to examine the intensity and frequency of droughts as part of the evaluation of drought severity. The

Microsoft Excel application was used to calculate the PNPI. The intensity of rainfall and drought was then classified using the derived PNPI values. The PNPI was calculated using the following equation:

$$\text{PNPI} = \frac{\text{Actual Rainfall} - \text{Normal Rainfall}}{\text{Normal Rainfall}} \times 100$$

Climate change experts suggest that changes in rainfall between +20% and -20% on the PNPI scale imply normal circumstances, whereas deviations below -20% indicate drought, according to Kuma *et* al. (2009). However, if the rainfall deviation falls below -25%, a country may declare a drought. Based on its ability to compare drought intensities over various years at a single place, the PNPI index was chosen to analyze drought. The PNPI index is also thought to be understandable and appropriate for efficiently disseminating research findings (Keyantash and Dracup, 2002; Agwata, 2014).

3. Results and Discussion

3.1 Socio-demographic characteristics of respondents

In many elements of climate change, the socio-demographic characteristics of respondents are quite important. Age, sex, and family size are just a few examples of the variables that may have an impact on how well people are able to adapt to the effects of climate change. The socioeconomic traits of the respondents were examined in this study (Table 2). The results show that 73.7% of the household heads who were interviewed were between the ages of 25 and 54, showing that the study area's active working population is primarily involved in agricultural operations. This is significant since this group has seen past examples of climate variability and change.In addition, it was found that all of the respondents—81.1% of them men—were married. This is consistent with the cultural norms of the study area, where getting married denotes adulthood, especially for men who are regarded as mature adults. Additionally, household heads made up 96.5% of the respondents, which is important for plans for adaptation and mitigation to climate change because they are familiar with local historical patterns and indigenous technical knowledge (ITK).

The study also discovered that a sizable portion of respondents (84.3%) had spent no more than 30 years living in the study villages. This is crucial for identifying and comprehending climatic variability, which can be identified across shorter time frames than climate change, which normally necessitates at least 30 years of data. The study villages also showed substantial household sizes, with 54.5% of households having 4-6 people and 44% having at least 6 people. This can be related to the polygamy that is practiced there, which leads to a greater number of dependents that need to be maintained and taken care of. Besides, the bulk of the questioned population (77.3%) had at most completed their primary schooling. This is caused by a dearth of educational institutions, especially primary schools, which requires kids to travel great distances to attend school. As a result, those with less education have a harder time finding work outside of agriculture and frequently land in low-paying positions.

The study also showed that immigrants who were born within the same district but outside the study villages made up the majority of respondents (80.1%). As demonstrated by 73.7% of the immigrants (Table 2), these people were drawn to settle in the study villages because of things like the study villages' better agricultural weather than their home towns.Additionally, the survey discovered that small-scale farming operations accounted for the majority of households' average monthly income. A minimum daily income of TZS 3,500 was earned by 83.6% of households, or approximately TZS 100,000 (Table 3). This shows that households in the study villages are barely making ends meet and that some of their income comes from small-scale farming. To maintain long-term human welfare, it is necessary to increase agricultural productivity and production, market farming, and improve general agricultural practices.

Table 2: Socio-demographic characteristics of respondents

	Kahama				Msalala				Ushetu		
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
Information	**Mondo n=27**	**Bumbiti n=21**	**Kagongwa n=127**	**Gembe n=25**	**Ntobo A n=28**	**Kalagwa n=23**	**Chela n=23**	**Chambanga n=21**	**Nyamilingano n=8**	**Ididi n=9**	**Total N=312**
Age class: 15-24 Years	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	2(0.6)
25-34 Years	9 (2.9)	0(0)	0(0)	10 (3.2)	7 (2.2)	4 (1.3)	0(0)	6 (1.9)	2 (0.6)	2 (0.6)	40(12.8)
35-44 Years	0(0)	5 (1.6)	25 (8)	10 (3.2)	14 (4.5)	3(1)	4 (1.3)	5 (1.6)	2 (0.6)	3(1)	71(22.8)
45-54 Years	8 (2.6)	7 (2.2)	76 (24.4)	0(0)	0(0)	4 (1.3)	10 (3.2)	10 (3.2)	4 (1.3)	0(0)	119(38.1)
55-64 Years	1 (0.3)	5 (1.6)	0(0)	5 (1.6)	7 (2.2)	8 (2.6)	9 (2.9)	0(0)	0(0)	1 (0.3)	36(11.5)
≥ 65 Years	9 ((2.9)	4 (1.3)	26 (8.3)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	0(0)	1 (0.3)	44(14.1)
Sex of respondent: Male	18 (5.8)	16 (5.1)	102 (32.7)	25 (8)	21 (6.7)	23 (7.4)	23 (7.4)	21 (8.7)	2 (0.6)	2 (0.6)	253(81.1)
Female	9 (9.7)	5 (1.6)	25 (8.0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	6 (1.9)	7 (2.2)	59(18.9)

Table 2: Socio-demographic characteristics of respondents

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	**Bumbiti n=21**	**Kagongwa n=127**	**Gembe n=25**	**Ntobo A n=28**	**Kalagwa n=23**	**Chela n=23**	**Chambanga n=21**	**Nyamilingano n=8**	**Ididi n=9**	
Marital status: Married	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21(6.7)	8 (2.6)	9 (2.9)	312(100)
Status of the respondent: Head	27 (8.7)	16 (5.1)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3 (1)	301(96.5)
Spouse	0(0)	5 (1.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5 (1.6)	10(3.2)
Brother/sister	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Household size: 1-3 Persons	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	1 (0.3)	5(1.6)
4-6 Persons	19 (6.1)	13 (4.2)	75 (24)	20 (6.4)	7 (2.2)	19 (6.1)	0(0)	10 (3.2)	2 (0.6)	5 (1.6)	170(54.5)
7-9 Persons	0(0)	8 (2.6)	0(0)	5 (1.6)	14 (4.5)	4 (1.3)	10 (3.2)	11 (3.5)	6 (1.9)	3(1)	61(19.6)
≥ 10 Persons	8 (2.6)	0(0)	52 (16.7)	0(0)	7 (2.2)	0(0)	9(2.9)	0(0)	0(0)	0(0)	76(24.4)
Education background: Incomplete primary	1 (0.3)	16 (5.1)	51 (16.3)	18 (5.8)	0(0)	16 (5.1)	0(0)	0(0)	0(0)	4(1.3)	106(34)
Complete primary	17 (5.4)	5 (1.6)	26 (8.3)	7 (2.2)	21 (6.7)	3(1)	23 (7.4)	21 (6.7)	8 (2.6)	4 (1.3)	135(43.3)
Incomplete secondary	9 (2.9)	0(0)	50 (16)	0(0)	7 (2.2)	4 (1.3)	0(0)	0(0)	0(0)	0(0)	70(22.4)
Complete secondary	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	(0.3)	1(0.3)
Village's living period: 1-10 Years	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	9(2.9)

Continued……

Table 2: Socio-demographic characteristics of respondents

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
-2 110 Years	18 (5.8)	21 (6.7)	76 (24.4)	20 (6.4)	14 (4.5)	20 (6.4)	4 (1.3)	0(0)	8 (2.6)	0(0)	181(58)
21-30 Years	9 (2.9)	0(0)	26 (8.3)	5 (1.6)	0(0)	0(0)	9 (2.9)	21 (6.7)	0(0)	3(1)	73(23.4)
31-40 Years	0(0)	0(0)	0(0)	0(0)	7 (2.2)	3(1)	10 (3.2)	0(0)	0(0)	2 (0.6)	22(7.1)
41-50 Years	0(0)	0(0)	25 (8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	26(8.3)
> 50 Years	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Place of origin: Born in the village	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	0(0)	0(0)	0(0)	3(1)	38(12.2)
Born outside the village but within the district	27 (8.7)	21 (6.7)	102 (32.7)	25 (8)	21 (6.7)	20 (6.4)	0(0)	21 (6.7)	8 (2.6)	5 (1.6)	250(80.1)
Born outside the region	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	23 (7.4)	0(0)	0(0)	1(0.3)	24(7.7)
Average household's income per month: ≤ TZS 100,000	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	4 (1.3)	0(0)	0(0)	9 (2.9)	20(6.4)
TZS 100,001-199,999	26 (8.6)	12 (3.8)	102 (32.7)	25 (8)	7 (2.2)	12 (3.8)	5 (1.6)	6 (1.9)	8 (2.6)	0(0)	203(65)
TZS 200,000-299,999	1 (0.3)	9 (2.9)	25 (8)	0(0)	7 (2.2)	8 (2.8)	9 (2.9)	15 (4.8)	0(0)	0(0)	67(21.5)
≥TZS300,000	0(0)	0(0)	0(0)	0(0)	7 (2.2)	3(1)	5 (1.6)	0(0)	0(0)	0(0)	22(7.1)

[1] Figures outside and inside the parentheses are frequencies and percentages respectively.

Additionally, Table 3's data indicate that the majority of respondents (73.7%) mentioned a bad climate as the main reason they left their prior hamlet. This suggests that the decision to relocate was significantly influenced by the climate. Changes in rainfall patterns, a rise in the frequency of extreme weather events, extended droughts, or other climate-related problems can all have a detrimental effect on agricultural output, livelihoods, and general quality of life. These findings highlight the significance of comprehending the relationship between climate change and migration, as people and communities frequently migrate in search of better living conditions and employment opportunities as a result of the environmental deterioration brought on by climate change and its effects on their way of life.

It is essential to deal with the problems brought on by bad climatic conditions in order to prevent or reduce forced migration. More favourable and sustainable living conditions can be achieved through increasing resilience to climate change, promoting climate-smart farming practices, and putting sustainable land and water management techniques into practice. It is also crucial for the development of those communities in their current places to assist those affected by advers climatic conditions. Access to climate-resilient infrastructure, the promotion of climate-smart farming practices, and chances for income diversification are some examples of how to achieve this.

Effectively addressing climate-induced migration requires a comprehensive strategy that combines social and economic interventions with measures to adapt to and mitigate the effects of climate change. The needs and wellbeing of people and communities affected by unfavorable climate conditions should be given top priority in this strategy. By doing this, it is feasible to lessen the need for forced migration while also fostering sustainable development and climate change resistance.

Table 3: Main reasons for emigration from previous village

	Kahama				**Msalala**				**Ushetu**		
	Mondo		**Kagongwa**		**Ntobo**		**Chela**		**Nyamilingano**		
Emigration reasons	**Mondo n=27**	**Bumbiti n=21**	**Kagongwa n=102**	**Gembe n=25**	**Ntobo A n=21**	**Kalagwa n=20**	**Chela n=23**	**Chambanga n=21**	**Nyamilingano n=8**	**Ididi n=6**	**Total N=274**
Agriculture land	0(0)	0(0)	0(0)	10 (3.6)	0(0)	4 (1.5)	4 (1.5)	0(0)	0(0)	3 (1.1)	17(6.2)
Business opportunities	0(0)	0(0)	0(0)	0(0)	0(0)	5 (1.8)	5 (1.8)	0(0)	0(0)	0(0)	5(1.8)
Following relatives	0(0)	0(0)	0(0)	0(0)	0(0)	9 (3.3)	9 (3.3)	0(0)	0(0)	0(0)	9(3.3)
Marriage	0(0)	0(0)	25 (9.1)	0(0)	0(0)	0(0)	0(0)	0(0)	6 (2.2)	3 (1.1)	34(12.4)

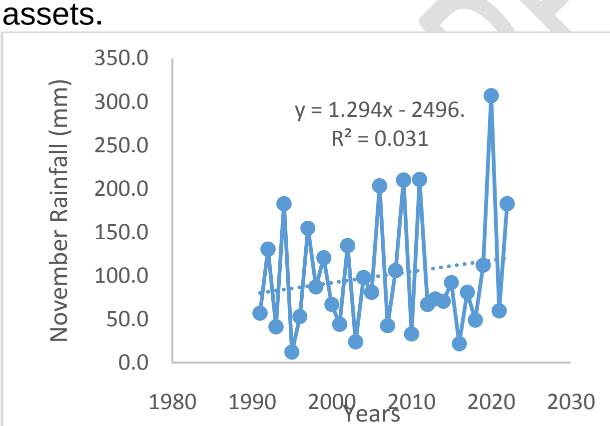
Employment	0(0)	0(0)	0(0)	0(0)	7(2.6)	0(0)	0(0)	0(0)	0(0)	0(0)	7(2.6)
Unfavorable climate	27 (9.9)	21 (7.7)	77 (28.1)	15 (5.5)	14 (5.1)	20 (7.3)	5 (1.8)	21 (7.7)	2 (0.7)	0(0)	202(73.7)

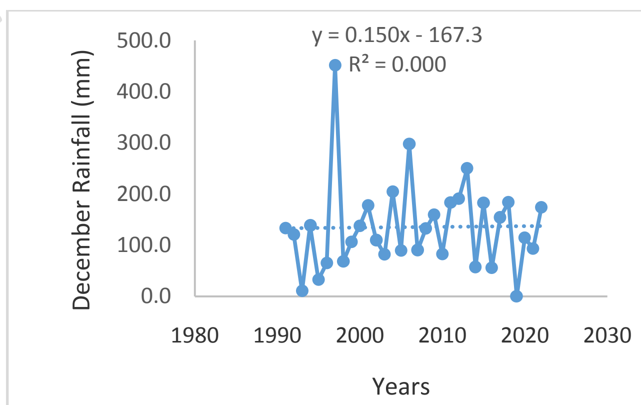
3.2Climatic trends at Kahama District

Based on the study's findings (Figure 2), it was found that the region's annual and monthly rainfall decreased at varied rates during the rainy season. The years with the lowest average monthly rainfall for the wet seasons were specifically 2005 (49 mm), 2010 (64.9 mm), and 2013 (65.6 mm). Conversely, the years with the highest average monthly rainfall were 2009 (130 mm), 2019 (127.4 mm), and 2020 (185.3 mm).

Additionally, over the course of the study period, the study found a pattern of rising annual average minimum temperature and falling annual average maximum temperature (Figures 3&4). The yearly maximum temperature increased by 0.6 ^{o}C between 1991 and 2002, then 0.3 ^{o}C between 2003 and 2012, and then 0.8 ^{o}C between 2013 and 2022. The annual minimum temperature, on the other hand, showed a fall of 0.2 ^{o}C between 1991 and 2002 and an increase of 0.4 ^{o}C between 2013 and 2022.

These results show that the study area experiences both climate variability and change. For paddy rice farmers, the changing rainfall patterns and temperature fluctuations can have a big impact on their agricultural production and asset ownership. It is essential to comprehend how these climatic changes and unpredictability affect paddy farming in order to create appropriate adaptation methods to reduce any potential harm to farmers' assets.





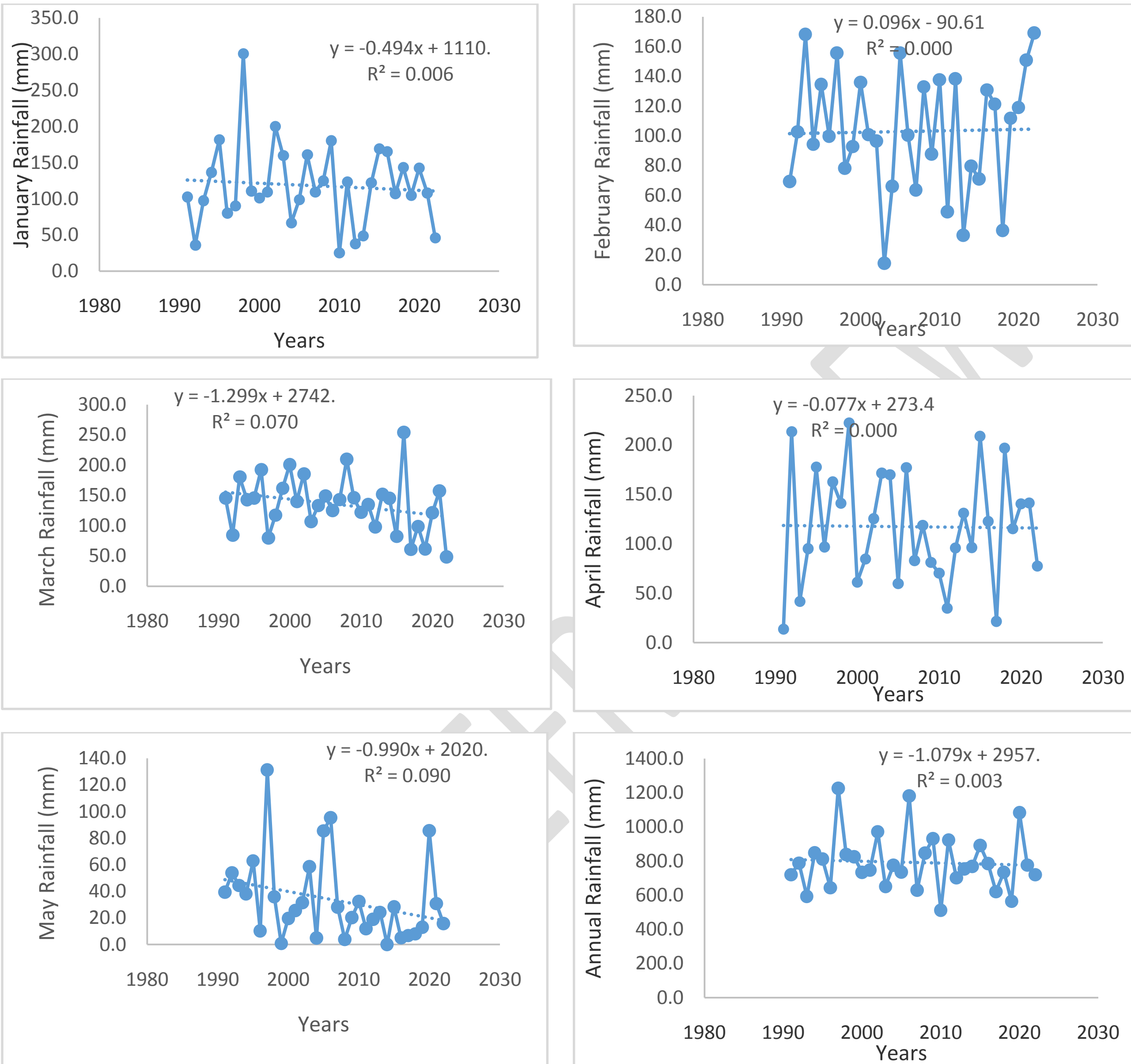
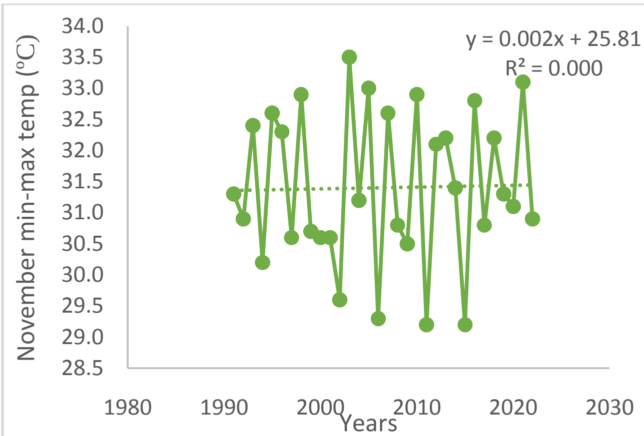
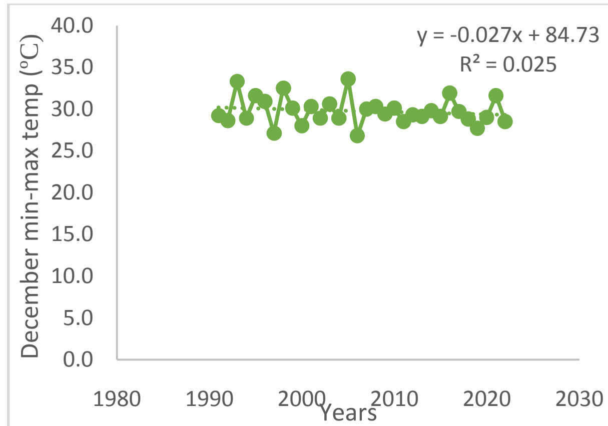
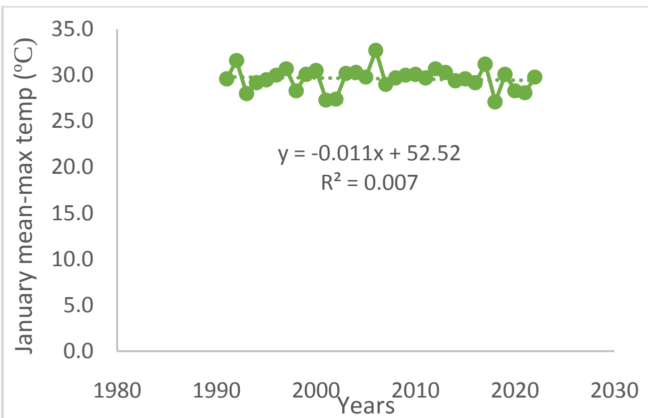


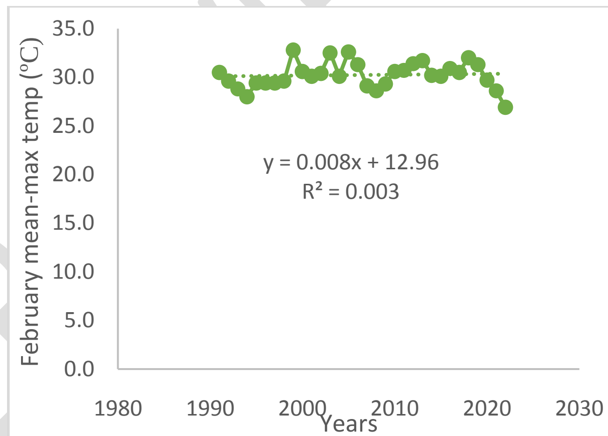
Figure 2: Kahama District annual and monthly (January – May & November-December) rainfall (mm) for the period 1991-2022

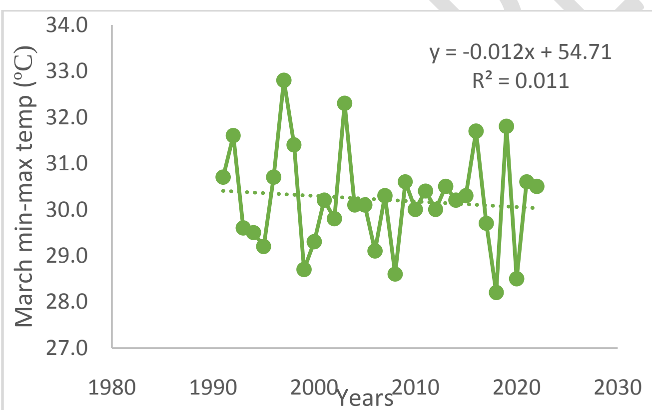
Source: Tanzania Meteorological Authority (TMA) (2023)

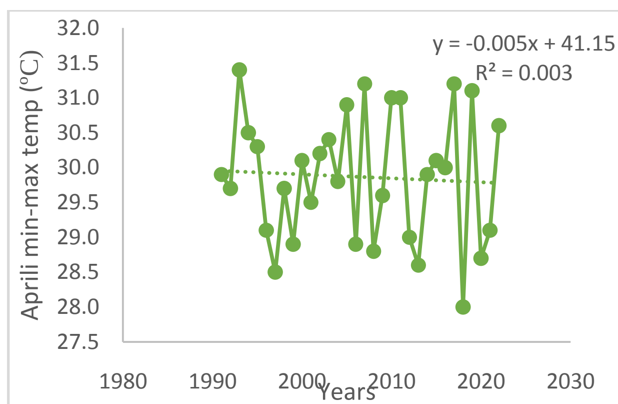

November min-max temp (ºC)
34.0
33.5
33.0
32.5
32.0
31.5
31.0
30.5
30.0
29.5
29.0
28.5
1980
1990
2000
2010
2020
2030
Years
y = 0.002x + 25.81
R² = 0.000


December min-max temp (ºC)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1980
1990
2000
2010
2020
2030
Years
y = -0.027x + 84.73
R² = 0.025


January mean-max temp (ºC)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1980
1990
2000
2010
2020
2030
Years
y = -0.011x + 52.52
R² = 0.007


February mean-max temp (ºC)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1980
1990
2000
2010
2020
2030
Years
y = 0.008x + 12.96
R² = 0.003


March min-max temp (ºC)
34.0
33.0
32.0
31.0
30.0
29.0
28.0
27.0
1980
1990
2000
2010
2020
2030
Years
y = -0.012x + 54.71
R² = 0.011


Aprili min-max temp (ºC)
32.0
31.5
31.0
30.5
30.0
29.5
29.0
28.5
28.0
27.5
1980
1990
2000
2010
2020
2030
Years
y = -0.005x + 41.15
R² = 0.003

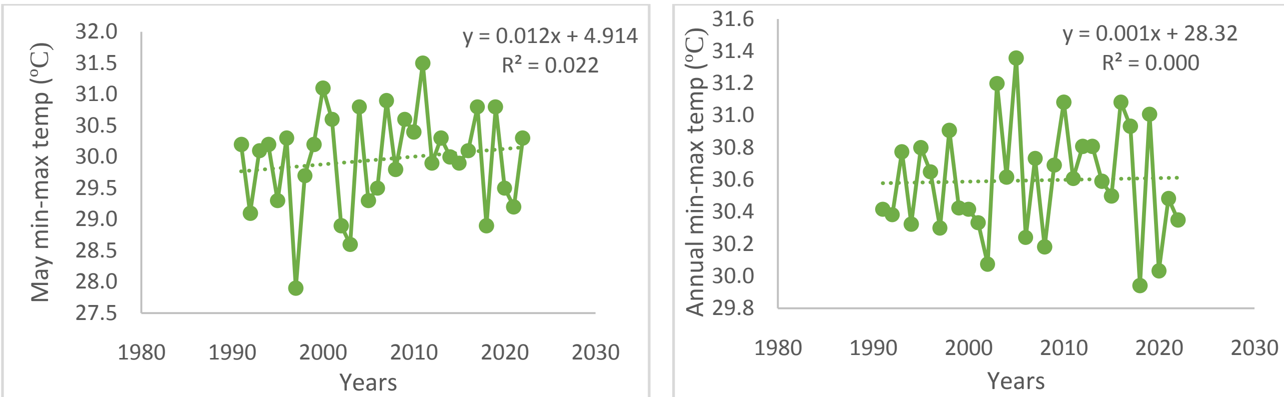
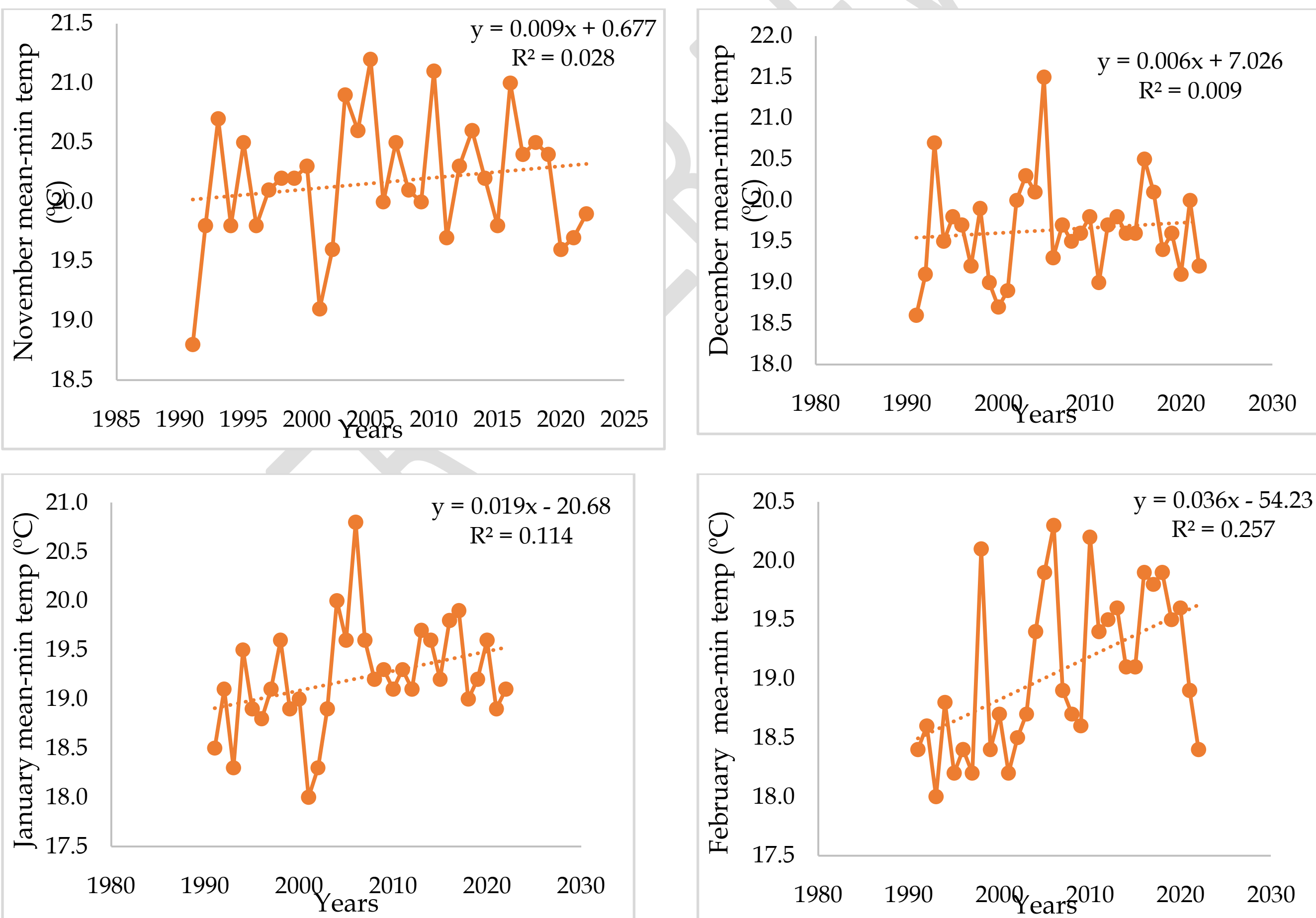


Figure 3: Kahama District annual and monthly (January – May & November-December) mean maximum temperature (ºC) for the period 1991-2022

Source: Tanzania Meteorological Authority (TMA) (2023**)**



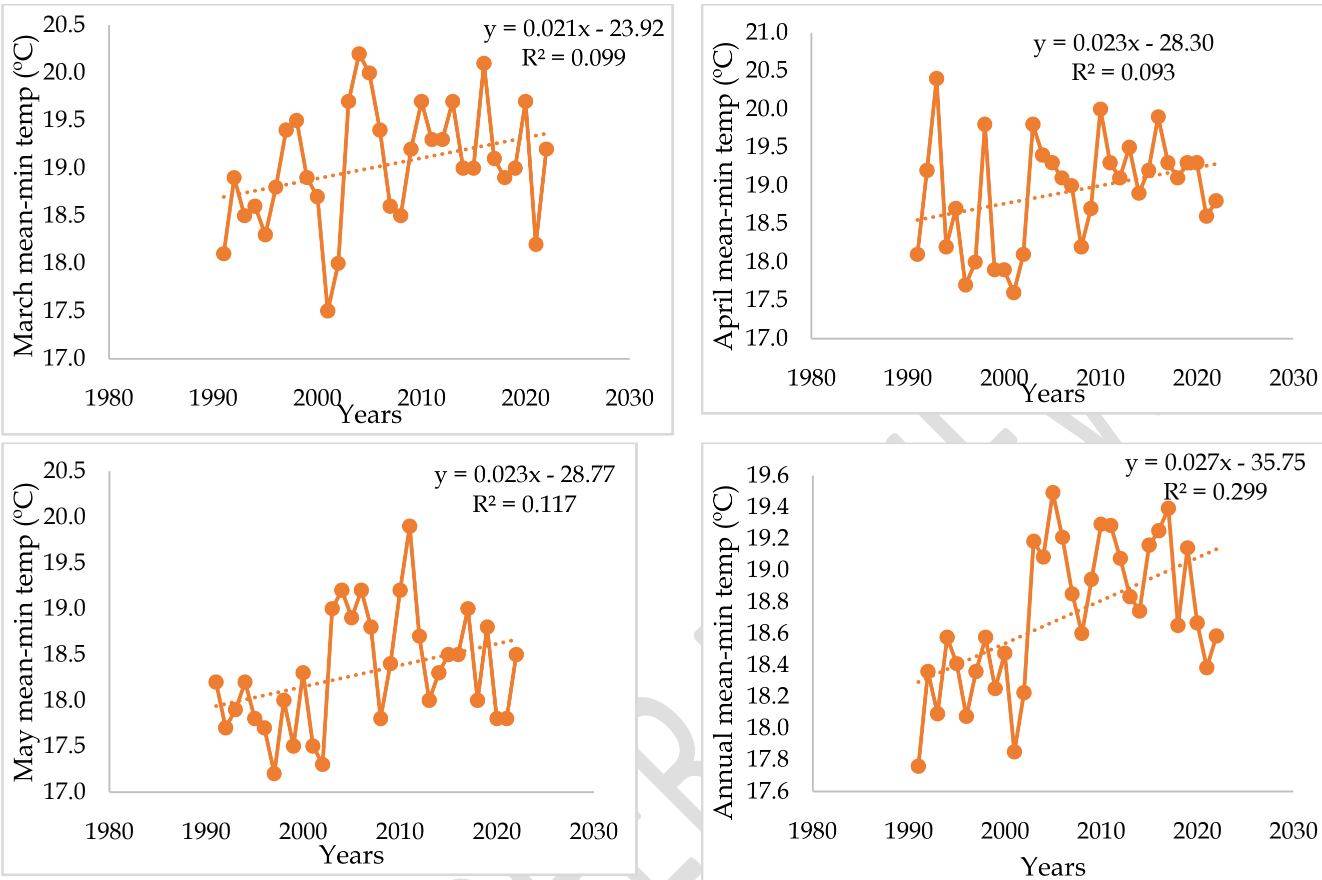


Figure 4: Kahama District annual and monthly (January – May & November-December) mean minimum temperature (ºC) for the period 1991-2022
Source: Tanzania Meteorological Authority (TMA) (2023)

Furthermore, the Percentage of Normal Precipitation Index (PNPI) was used to gauge the extent of the drought according to the local communities. Previous research has shown that PNPI values between +20% and -20% are deemed normal (Kumar *et al*., 2009). Drought conditions are indicated by values below -20%, and the severity increases if the divergence from the normal rainfall surpasses -25% (called severe drought) or falls between -20.1% and -24.9% (considered moderate drought). Based on these evaluations, the study identified years with rainfall above average, moderate drought, and severe drought, as indicated in Table 4. It was clear that these changes in rainfall had a detrimental effect on local livelihoods. Similar results have been reported in other studies carried out in other locations, however there may be a few minor deviations because of variances in geographic location and unique meteorological features of the study area (Lusiru and Malekela, 2022; Ntali*et al*., 2023).

These results highlight the major effects of climate change and variability on the asset ownership of paddy farmers. Agriculture's productivity and means of subsistence are seriously threatened by the increased frequency and severity of drought, irregular rainfall patterns, floods, high temperatures, and the spread of illnesses that affect humans, livestock, and crops. It is crucial to put into practice efficient climate change adaptation techniques in order to lessen these effects and safeguard paddy farmers' asset ownership. Adopting resilient agricultural practices, such as water-efficient irrigation methods and kinds of crop resistant to drought, may fall under this category. The harmful consequences of climate-related pests and diseases can be reduced with the support of integrated pest and disease management and strong healthcare systems.

Additionally, promoting community-level initiatives and support structures can assist reduce dependency on climate-sensitive activities and improve overall asset ownership and livelihoods while also enhancing the resilience of paddy farmers. To preserve the long-term viability of paddy farming, it is critical to encourage sustainable land and water management practices and invest in climate-smart agricultural technologies. As well, reducing the effects of climate change on the asset ownership of paddy farmers requires tackling the fundamental causes of climate change, such as greenhouse gas emissions. The mitigation of global climate change can be aided by initiatives to increase renewable energy, lessen deforestation, and support sustainable land-use practices. Furthermore, in order to implement comprehensive and successful strategies to address the impacts of climate change on the asset ownership of paddy farmers, cooperation and coordination among stakeholders at different levels, including farmers, local communities, governmental organizations, and international organizations, are essential. These programs must to take into account the wisdom and experiences of the local population, encourage adaptability, and guarantee the fair distribution of resources and advantages.

The study's findings show the negative effects of climate fluctuation and change on paddy farmers' asset ownership. Understanding these effects and putting the right adaptation and mitigation strategies in place would help paddy farmers become more resilient and improve their quality of life, ensuring sustainable agricultural output and resource management in the face of climate change.

Table 4: Values of the percentage of the normal precipitation index in the study area

Year	Actual rainfall (A)	Normal rainfall (B)	A- B	(A-B)/A	PNPI	Classification
1991	719.4	843.8	-124.4	-0.1	-14.7	Normal
1992	787.2	843.8	-56.6	-0.1	-6.7	Normal
1993	592.2	843.8	-251.6	-0.3	-29.8	Drought
1994	847.6	843.8	3.8	0.0	0.5	Normal
1995	811.2	843.8	-32.6	0.0	-3.9	Normal
1996	643.1	843.8	-200.7	-0.2	-23.8	Drought
1997	1225.8	843.8	382.0	0.5	45.3	Wet
1998	838.2	843.8	-5.6	0.0	-0.7	Normal
1999	825.0	843.8	-18.8	0.0	-2.2	Normal
2000	733.2	843.8	-110.6	-0.1	-13.1	Normal
2001	747.0	843.8	-96.8	-0.1	-11.5	Normal

2002	971.1	843.8	127.3	0.2	15.1	Normal
2003	650.6	843.8	-193.2	-0.2	-22.9	Drought
2004	774.9	843.8	-68.9	-0.1	-8.2	Normal
2005	735.0	843.8	-108.8	-0.1	-12.9	Severe drought
2006	1181.1	843.8	337.3	0.4	40.0	Wet
2007	628.5	843.8	-215.3	-0.3	-25.5	Drought
2008	845.6	843.8	1.8	0.0	0.2	Normal
2009	930.6	843.8	86.8	0.1	10.3	Normal
2010	511.0	843.8	-332.8	-0.4	-39.4	Severe drought
2011	922.3	843.8	78.5	0.1	9.3	Normal
2012	700.9	843.8	-142.9	-0.2	-16.9	Normal
2013	753.7	843.8	-90.1	-0.1	-10.7	Normal
2014	768.1	843.8	-75.7	-0.1	-9.0	Normal
2015	890.5	843.8	46.7	0.1	5.5	Normal
2016	784.8	843.8	-59.0	-0.1	-7.0	Normal
2017	619.9	843.8	-223.9	-0.3	-26.5	Drought
2018	734.3	843.8	-109.5	-0.1	-13.0	Normal
2019	563.4	843.8	-280.4	-0.3	-33.2	Severe drought
2020	1082.9	843.8	239.1	0.3	28.3	Wet
2021	775.5	843.8	-68.3	-0.1	-8.1	Normal
2022	719.5	843.8	-124.3	-0.1	-14.7	Normal

3.3 Households' asset ownership

The findings from the study, as presented in Table 5a, indicate that a significant proportion of respondents (64.7%) owned land less than 5 acres. Furthermore, almost all respondents (98.1%) owned land within the study villages, with the majority having acquired their land through purchasing (95.8%). Regarding the condition of the owned land, the majority of respondents considered it to be average (92%). These findings suggest that most households have limited land available for cultivation, which is susceptible to climate risks. This prompts households to seek additional land through renting, as indicated in Table 5b. It is noteworthy that a substantial portion (92.3%) of the rented land is used for paddy production, which is a climate-sensitive crop. This signifies the challenges faced by farmers in expanding their cultivation areas to cope with the impacts of climate change.

In terms of livestock ownership (as shown in Table 6a), a considerable number of households owned at least5 cattle (62.1%), at least 5 goats (67.6%), and at least 10 chickens (78.9%). The means of acquiring livestock mostly involved buying, with 45.5% for cattle, 86.9% for goats, and 82.4% for chickens, as depicted in Table 6b. However, these livestock assets are impacted negatively by climate change, particularly in relation to the availability of land for paddy production and pasture for livestock. Changes in rainfall patterns, temperature fluctuations, and other climate-related factors can lead to reduced forage availability, water scarcity, and increased prevalence of diseases, all of which can affect livestock health and productivity.

Additionally, the difficulties brought on by climate change and the restricted supply of land put additional strain on farmers and their assets. The possibility of increasing agricultural production to lessen the effects of climate change is constrained by the modest landholdings. This emphasizes the demand for cutting-edge land management techniques and climate-resilient farming methods that can optimize land use, boost productivity, and reduce exposure to climate threats.

The study's findings, in light of the detrimental effects of climate change on livestock and land ownership, show the limitations that households confront. These restrictions highlight how urgent it is to put adaptive measures in place that deal with livestock vulnerability and land availability in order to improve agricultural resilience and maintain livelihoods in the face of climate change consequences.

Table 5a: Land ownership

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
Land owned: < 5 Acres	27 (8.7)	13 (4.2)	77 (24.7)	25 (8)	28 (9)	7(2.2)	9 (2.9)	10 (3.2)	4 (1.3)	2 (0.6)	202(64.7)
5-10 Acres	0(0)	8 (2.6)	50 (16)	0(0)	0(0)	16 (5.1)	9 (2.9)	11 (3.5)	4 (1.3)	7 (2.2)	105(33.7)
>10 Acres	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5 (1.6)	0(0)	0(0)	0(0)	5(1.6)
Location of land owned: Within the village	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	306(98.1)
Both within the village and next village	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	6 (1.9)	6(1.9)
Means of acquiring land: Inherited	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	4 (1.3)	0(0)	0(0)	1 (0.3)	12(3.8)
Purchased	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	21 (6.7)	23 (7.4)	19 (6.1)	21 (6.7)	8 (2.6)	7 (2.2)	299(95.8)
Hiring	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Condition of owned land: Good	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	18 (5.8)	0(0)	2 (0.6)	2 (0.6)	22(7)
Average	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	5 (1.6)	21 (1.9)	6 (1.9)	4 (1.3)	287(92)
Bad	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(1)	3(1)

Table 5b: Rented land

Information	Kahama				Msalala				Ushetu		Total N=297
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	**Bumbiti n=21**	**Kagongwa n=127**	**Gembe n=25**	**Ntobo A n=28**	**Kalagwa n=20**	**Chela n=13**	**Chambanga n=21**	**Nyamilingano n=8**	**Ididi n=7**	
Rented land: < 5 Acres	27 (9.1)	13 (4.4)	127 (42.8)	25 (8.4)	28 (9.4)	20 (6.7)	8 (2.7)	21 (7.1)	8 (2.7)	4 (1.3)	281(94.6)
5-10 Acres	0(0)	8 (2.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(1)	11(3.7)
>10 Acres	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5 (1.7)	0(0)	0(0)	0(0)	5(1.7)
Price of rented land per acre: < 50,000 TZS	27 (9.1)	21 (7.1)	102 (34.3)	25 (8.4)	28 (9.4)	20 (6.7)	9(3)	21 (7.1)	8 (2.7)	6(2)	267(89.9)
50,000 – 100,000 TZS	0(0)	0(0)	25 (8.4)	0(0)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	1 (0.3)	30(10.1)
Location of rented land: Within the village	27 (9.1)	21 (7.1)	127 (42.7)	25 (8.4)	28 (9.4)	20 (6.7)	13 (4.3)	21 (7.1)	8 (2.7)	4 (1.3)	294(99)
Next village within the ward	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(1)	3(1)
Condition of rented land: Good	27 (9.1)	21 (7.1)	127 (42.7)	25 (8.4)	28 (9.4)	20 (6.7)	13 (4.3)	21 (7.1)	8 (2.7)	6(2)	296(99.7)
Average	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Crops grown in the rented land: Paddy	27 (9)	21 (7)	127 (42.3)	25 (8.3)	14 (4.7)	20 (6.7)	4 (1.3)	21 (7)	8 (2.7)	7 (2.3)	274(92.3)
Maize	0(0)	0(0)	0(0)	0(0)	14 (4.7)	0(0)	9(3)	0(0)	0(0)	0(0)	23(7.7)

Table 6a: Livestock ownership

Information	Kahama		Msalala		Ushetu	Total N=312
	Mondo	Kagongwa	Ntobo	Chela	Nyamilingano	

	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
Cattle: None	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	18 (5.8)	0(0)	0(0)	4 (1.3)	57(18.3)
< 5 Cattles	0(0)	0(0)	25 (8)	5(1.6)	14 (4.5)	4 (1.3)	0(0)	10 (3.2)	2 (0.6)	1 (0.3)	61(19.6)
5-10 Cattles	27 (10.6)	21 (8.2)	77 (24.7)	20 (6.4)	7 (2.2)	16 (5.1)	0(0)	11 (3.5)	6 (1.9)	4 (1.3)	189(60.5)
>10 Cattles	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5(1.6)	0(0)	0(0)	0(0)	5(1.6)
Goats: None	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	18 (5.8)	0(0)	0(0)	4 (1.3)	57(18.3)
< 5 Goats	9 (2.9)	8 (2.6)	25 (8)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	44(14.1)
5-10 Goats	18 (5.8)	13 (4.2)	77 (24.7)	25 (8)	21 (6.7)	20 (6.4)	5(1.6)	21 (6.7)	6 (1.9)	3(1)	209(67)
>10 Goats	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	2(0.6)
Sheep: None	18 (5.8)	21 (6.7)	102 (32.7)	10 (3.2)	21 (6.7)	19 (6.1)	14 (4.5)	10 (3.2)	6 (1.9)	7 (2.2)	228(73.1)
< 5 Sheep	9 (2.9)	0(0)	0(0)	15 (4.8)	0(0)	0(0)	0(0)	11 (3.5)	0(0)	0(0)	35(11.2)
5-10 Sheep	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	4 (1.3)	5 (1.6)	0(0)	2 (0.6)	2 (0.6)	45(14.4)
>10 Sheep	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	0(0)	4(1.3)
Donkeys: None	18 (5.8))	21 (6.7)	102 (32.7)	25 (8)	14 (4.5)	23 (7.4)	23 (7.4)	10 (3.2)	4 (1.3)	7 (2.2)	247(79.2)
< 5 Sheep	9 (2.9)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	11 (3.5)	0(0)	2 (0.6)	29(9.3)

Table 6a: Livestock ownership

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
Cattle: None	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	18 (5.8)	0(0)	0(0)	4 (1.3)	57(18.3)
5-10 Sheep	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	34(10.9)
>10 Sheep	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	2(0.6)
Chickens: None	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	2 (0.6)	3(1)	12(3.8)
< 10 Chickens	9 (2.9)	0(0)	25 (8)	0(0)	7 (2.2)	0(0)	0(0)	11 (3.5)	2 (0.6)	0(0)	54(17.3)
10-20 Chickens	9 (2.9)	13 (4.2)	50 (16)	15 (4.8)	7 (2.2)	7 (2.2)	14 (4.5)	10 (3.2)	4 (1.3)	2 (0.6)	131(42)
>20 Chickens	9 (2.9)	8 (2.6)	52 (16.7)	10 (3.2)	7 (2.2)	16 (5.1)	9 (2.9)	0(0)	0(0)	4 (1.3)	115(36.9)

Table 6b: Means of livestock ownership

Information	Kahama		Msalala		Ushetu	Total N=312
	Mondo	Kagongwa	Ntobo	Chela	Nyamilingano	

	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
Cattle: Inherited	1 (0.3)	8 (2.6)	25 (8)	20 (6.4)	7 (2.2)	7 (2.2)	0(0)	11 (3.5)	0(0)	0(0)	79(25.3)
Given by clan	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	4 (1.3)	0(0)	0(0)	0(0)	0(0)	36(11.5)
Bought	26 (8.3)	13 (4.2)	52 (16.7)	5 (1.6)	7 (2.2)	12 (3.8)	5 (1.6)	10 (3.2)	8 (2.6)	4 (1.3)	142(45.5)
Others	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	0(0)	18 (5.8)	0(0)	0(0)	5 (1.6)	55(17.6)
Goats: Inherited	0(0)	0(0)	0(0)	5 (1.6)	7 (2.2)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	14(4.5)
Given by clan	1 (0.3)	8 (2.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	9(2.9)
Bought	26 (8.3)	13 (4.2)	127 (40.7)	20 (6.4)	14 (4.5)	23 (7.4)	13 (4.2)	21 (6.7)	6 (1.9)	8 (2.6)	271(86.9)
Others	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	10 (3.2)	0(0)	0(0)	1 (0.3)	18(5.8)
Sheep: Inherited	0(0)	0(0)	0(0)	15 (4.8)	0(0)	0(0)	0(0)	11 (3.5)	0(0)	0(0)	26(8.3)
Given by clan	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	2(0.6)
Bought	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	4 (1.3)	9 (2.9)	0(0)	0(0)	2 (0.6)	47(15.1)
Others	27 (8.7)	21 (6.7)	102 (32.7)	10 (3.2)	21 (6.7)	19 (6.1)	14 (4.5)	10 (3.2)	6 (1.9)	7 (2.2)	237(76)
Donkeys: Inherited	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	11 (3.5)	0(0)	1 (0.3)	19(6.1)
Given by clan	9 (2.9)	0(0)	25 (8)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	2 (0.6)	0(0)	43(13.8)
Others	5 (5.8)	21 (6.7)	102 (32.7)	25 (8)	14 (4.5)	23 (7.4)	23 (7.4)	10 (3.2)	6 (1.9)	8 (2.6)	250(80.1)

Table 6b: Means of livestock ownership

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	
Chickens: Inherited	0(0)	0(0	0(0)	20 (6.4)	0(0)	0(0)	0(0)	11 (3.5)	0(0)	0(0)	31(9.9)
Given by clan	9 (2.9)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4 (1.3)	0(0)	13(4.2)
Bought	18 (5.8)	21 (6.7)	127 (407)	5 (1.6)	21 (6.7)	23 (7.4)	23 (7.4)	10 (3.2)	4 (1.3)	5 (1.6)	257(82.4)
Others	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	0(0)	4 (1.3)	11(5.5)

4. Conclusion and Recommendations

4.1 Conclusion

The study's findings imply that farmers who grow paddy rice in the study area are negatively impacted by climate change in terms of asset ownership. The difficulties experienced by farmers in extending their cultivated fields to mitigate climate threats are shown by limited land ownership and the requirement to rent more land. Additionally, the vulnerability of farmers' assets is made worse by the negative effects of climate change on livestock ownership, particularly due to decreased pasture availability and an increase in disease prevalence.

4.2 Recommendations

The study recommends to the government and other stakeholders the following:

(i) Strengthen land tenure security: Steps should be done to give farmers more assurance about their ownership of their land, such as putting in place laws and other procedures that safeguard their legal rights.

(ii) Climate-smart farming methods: Encourage the use of climate-smart farming methods, such as better water management strategies, drought-tolerant crop types, and efficient soil conservation procedures. This can assist farmers in reducing the effects of climate change on the yield of paddy rice.

(iii) Diversification of income sources: Promote farmers' efforts to diversify their sources of income by looking into alternatives to paddy rice farming, such as agroforestry, horticulture, or animal husbandry. Diversification can lessen reliance on the paddy rice industry and reduce the dangers brought on by climate change.

(iv) Access to credit and insurance: Make it easier for farmers to obtain credit and insurance services that are especially suited to managing climate risk. As a result, farmers may be able to make investments in resilient farming techniques, buy essential inputs, and lessen the financial effects of climate-related catastrophes.

(v) Strengthen extension services: Improve extension services to give farmers knowledge and instruction on methods for coping with and mitigating climate change. Farmers may thus be better able to defend their assets and way of life by adopting sensible judgments and practices.

Policymakers, agricultural extension services, and other relevant stakeholders can assist paddy rice producing farmers by putting these ideas into practice to lessen the effects of climate change on asset ownership and increase their resilience to climate risks.

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