

Regular Research Paper

A gendered analysis of climate change adaptation strategies among smallholder Farmers in Rufiji District, Tanzania

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Climate change intensifies globally, yet the gendered ways farmers adapt, especially in coastal communities, remain poorly understood. This study from Tanzania's Coast Region explores these differences. Through surveys and discussions with 375 farmers, we found that while both men and women take action, deliberate adaptation is more common among men (82%) than women (72%). Significant gender gaps exist in specific strategies. Women were far less likely to adopt irrigation or practices like organic farming and tree planting. This suggests that climate change is confining men and women to traditional roles rather than creating a new division of labour. Furthermore, uncoordinated government support hampers information flow for all. Findings of this study underscore the need for policies that are gender-responsive and built from the ground up, ensuring that local, lived experience guides climate adaptation planning.

Key words: Climate change, adaptive/adaptation strategies, gender, agriculture.

INTRODUCTION

Climate change stands among the most pressing global threats, posing serious risks to water supply systems and human livelihoods. In Sub-Saharan Africa (SSA), it presents unique challenges, particularly to smallholder farmers whose primary source of income and subsistence depends on small-scale agriculture. Eastern Africa is one of the region's most severely affected and highly vulnerable to the impacts of climate variability. Research indicates that many communities in SSA rely heavily on rain-fed agriculture for food security (Joshua et al., 2016; Mango et al., 2018). According to Mugabe (2020), approximately 75.5 million people in the region depend on agriculture as their main livelihood source. This heavy dependence on rain-fed farming systems exposes many sub-Saharan countries to the devastating

consequences of extreme climate events, such as droughts and floods. Notably, about 95% of food production in the region is under rain-fed conditions, leaving it highly susceptible to irregular rainfall patterns, prolonged dry spells, and droughts, all of which significantly constrain agricultural productivity (Mashizha, 2019).

In Tanzania, agriculture remains one of the leading sectors contributing to employment and the Gross Domestic Product (GDP) (Sanga & Elia, 2020). The United Republic of Tanzania (URT, 2019) estimates that the sector contributes around 26.7% of GDP and accounts for about 40% of export earnings. However, like other developing nations, Tanzania faces frequent climate-induced challenges, including floods, droughts,

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crop failures, and the spread of climate-related diseases. The United States Agency for International Development (USAID, 2018) ranks Tanzania as the 26th most climate-vulnerable country, projecting an increase in annual temperatures by 1.4 to 2.3°C, longer heat waves and dry periods, intensified rainfall, and a sea-level rise between 15 and 42 cm by 2050. These climatic shifts threaten not only agriculture and food systems but also water resources, energy production, infrastructure, ecosystems, and human health (Bender, 2021). Moreover, climate change is expected to heighten rainfall variability, resulting in more prolonged dry periods and heavier downpours during rainy seasons (Bender, 2021).

Like many other parts of the world, Tanzania's coastal regions are particularly at risk due to their reliance on natural coastal resources for food production, freshwater access, and livelihoods (Armah et al., 2015). Predictions indicate that these zones will experience multiple climate-induced effects such as sea-level rise, ocean acidification, changes in water temperature, species migration, and disruption of coastal ecosystems (Mustelin et al., 2010). Consequently, climate change poses severe implications for coastal livelihoods and food security (Gwambene & Karata, 2019). Importantly, adaptive capacity across these areas is not uniform, with disparities influenced by socio-economic and gender-related factors.

Rufiji District, situated in Tanzania's Coast Region, exemplifies these vulnerabilities, facing recurrent water shortages due to its semi-arid climatic conditions (Ndesanjo et al., 2018; Wagner & Sallema-Mtui, 2016). The farming communities in Rufiji rely heavily on agriculture for survival, yet their livelihoods are increasingly threatened by climate variability and water scarcity. Although several studies have examined climate change impacts and adaptation in Rufiji (Ndesanjo et al., 2018; Wagner & Sallema-Mtui, 2016), few have explored these dynamics through a gender lens. This gap is significant because gender dimensions play a central role in determining access to resources, adaptive capacity, and decision-making processes in climate change adaptation. Moreover, despite the availability of general data on the impacts and adaptation mechanisms in the district, there is a notable lack of gender- and sex-disaggregated data essential for developing inclusive adaptation strategies. Despite growing research on climate change impacts and adaptation in Tanzania, limited attention has been given to understanding how gender influences adaptation practices, access to climate information, and the division of labour within agriculture-dependent communities. Rufiji District's dependence on rain-fed agriculture, combined with its ecological vulnerability and socio-economic diversity, makes it a critical area for studying the gendered dimensions of climate adaptation. Addressing this research gap is vital for designing equitable and context-specific strategies that enhance resilience among both men and women

farmers in coastal regions. The study was guided by the following research questions;

- i) What are adaptive strategies used by each sex?
- ii) How does climate change influence the division of labour and workload in agriculture activities between men and women?
- iii) How do support systems for climate change adaptation in agriculture vary by sex, and what is the role in enhancing resilience?
- iv) How does access to information on climate-resilient agricultural practices differ between men and women, and what are the implications on adoption rates?

The findings from this study can drive planning and decision-making for effective adaptation and resilience enhancement measures to climate change impacts in the coastal regions.

Theoretical framework

This study is anchored in the combined perspectives of Feminist Political Ecology (FPE) and Critical Realism. FPE emphasises that gender constructed and reinforced by social and political systems plays a crucial role in shaping how individuals experience and respond to environmental change. It highlights that men and women often have unequal access to resources, rights, and responsibilities, which results in gender-specific vulnerabilities and adaptation strategies when facing climate-related challenges such as floods and droughts. This perspective underscores that environmental issues are inseparable from the power relations and cultural values embedded in daily life. To complement this lens, Critical Realism offers a philosophical approach for examining the underlying causes of observed phenomena. It distinguishes between the observable events and the deeper, often hidden, social structures like gender norms or land ownership systems that drive them. This theory encourages a deeper exploration of why gendered disparities in climate adaptation persist, by revealing the generative mechanisms that reproduce social inequality.

Combining these two theoretical frameworks, the study goes beyond surface-level description to provide a more comprehensive explanation of the socio-environmental dynamics in Rufiji. FPE highlights the influence of gender and power relations, while Critical Realism enables an examination of the structural and institutional forces shaping those experiences.

Together, they offer a robust framework for understanding how factors such as patriarchal systems and economic policies interact to produce distinct adaptation patterns among male and female farmers, ultimately guiding more inclusive and equitable climate policy responses.

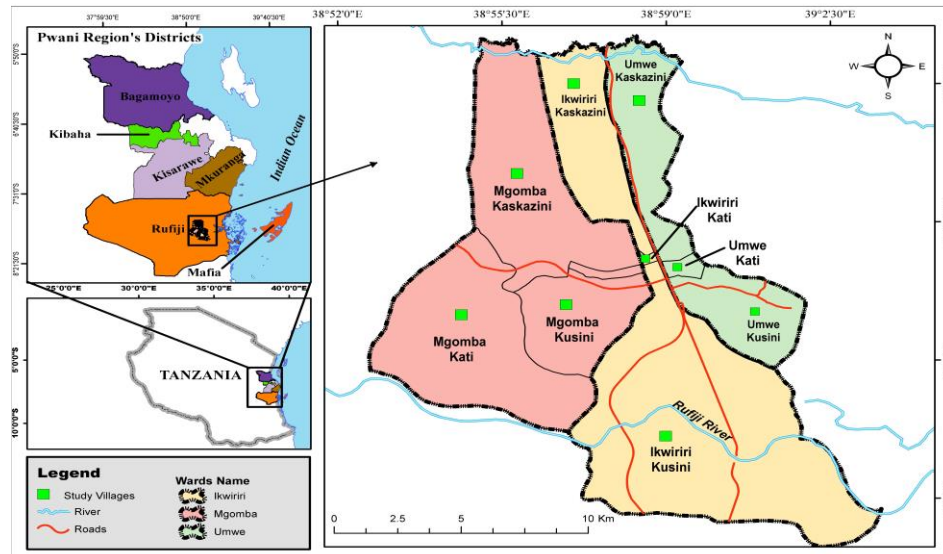


Figure 1. Map showing the study sites.

MATERIAL AND METHODS

Description of the study area

The study was conducted in Tanzania's Rufiji District, an area within the Coast Region situated at approximately 7.9575° S and 38.7266° E, which features a tropical climate marked by a single rainy season and an average of 872 mm of annual rainfall. The district's agricultural viability is heavily dependent on both this limited precipitation and the seasonal flooding of the Rufiji River, which is vital for supporting local biodiversity and livelihoods. The economy is predominantly agrarian, with cropping patterns across three growing seasons and artisanal fishing being influenced by seasonal floods and rainfall, while recent population growth has intensified pressure on land and resources. For the purposes of this study, nine villages were purposively selected from three different wards based on their varying proximity to the Rufiji River, a criterion anticipated to affect agricultural engagement and the gendered division of labour within agricultural production. Figure 2 shows the map showing the study sites.

Research design and approach

This study adopted an explanatory research design and a mixed methods approach to provide a holistic understanding of gendered climate change adaptation strategies. The integration of quantitative and qualitative data allowed for cross-verification and deeper interpretation of findings. Quantitative data helped identify measurable patterns and relationships, while qualitative insights explained the underlying reasons behind those patterns. As Creswell and Plano Clark (2018) emphasize, combining these approaches strengthens research outcomes because numerical results often require qualitative evidence for meaningful interpretation.

Population, sampling, and sample size

The study population comprised all household heads from selected villages. A simple random sampling technique was used to ensure

equal participation opportunities. With support from Village Executive Officers (VEOs), data on village populations and household counts were obtained to create the sampling frame. Using Yamane's (1973) formula with a precision level of 0.05, a total of 375 respondents were selected from 6,015 households, distributed proportionally across the villages. Random selection was achieved through drawing names without replacement. Before data collection, enumerators were trained and the questionnaire was pre-tested on ten respondents for clarity and reliability. The final survey was administered **face-to-face**, enabling enumerators to clarify questions when necessary.

Data sources, types, and collection methods

Data were collected using a mixed methods approach to ensure triangulation and a well-rounded understanding of the study issues. Quantitative data were gathered from 375 households using structured questionnaires focusing on adaptive strategies, division of labour, support systems, and access to climate information. Qualitative data were obtained through 72 Focus Group Discussions (FGDs) and 24 Key Informant Interviews (KIIs). The FGDs, conducted in all study villages with 8–12 participants (at least 30% women), explored gender roles, workloads, and local adaptation practices. KIIs involved Agricultural Extension Officers, Village Executive Officers, Community Development Officers, and district-level officials to provide institutional and policy perspectives. Both FGDs and KIIs were guided by checklists, and discussions were recorded with consent and transcribed for thematic analysis.

Data analysis and presentation

Data analysis combined qualitative thematic analysis with quantitative statistical techniques. Qualitative data were categorised into themes aligned with study objectives, highlighting key issues in gender and adaptation. Quantitative data were analysed using descriptive statistics (frequencies, percentages, means, and standard deviations) and inferential statistics to test associations among variables. Normality tests guided the choice of analytical tools at a 95% confidence level. One-way ANOVA compared ages

Table 1. Demographic information.

Variable	Category	Male (%)	Female (%)	Total (%)
Sex		50.93	49.07	100
Age (Years)	Mean (SD)	38 (11.181)	40 (12.601)	—
	Minimum	22	22	—
	Maximum	71	70	—
Education level	Primary	53.2	62.0	57.6
	Secondary	29.0	26.7	27.9
	Diploma	6.9	9.1	8.0
	Bachelor's degree	6.9	2.1	4.5
	Master's degree	2.7	—	1.4
Marital status	Single	24.5	22.1	23.3
	Married	75.5	57.8	66.8
	Separated/Divorced/Widowed	—	15.5	7.8

Source: Field data (2021).

Table 2. Adaptive responses to climate change effects according to gender.

Adaptation strategy	Males (N=188)	%	Females (N=187)	%
Organic farming	34	7.4	9	4.8
Zero tilling through cultivation and mulching	31	16.5	22	11.8
Mixed cropping	94	50.0	101	54.0
Irrigation	31	16.5	36	19.3
Soil conservation	10	5.3	14	7.5
Afforestation	8	4.3	5	2.7
Total	188	100	187	100

Source: Field data (2021).

between male and female respondents, Chi-square tests assessed variations in adaptation responses, while multinomial and binary logistic regression examined gender-specific factors influencing adaptive strategies. All analyses were performed using SPSS version 20 and Microsoft Excel, with results presented in tables and figures.

RESULTS

Demographic information

Out of 375 respondents, 49.07% were females and 50.93% males. The average age of females was 40 years (SD=12.601) while that of males was 38 years (SD=11.181), indicating moderate variations in age among respondents. The minimum age was 22 years for both sexes, and the maximum was 71 for males and 70 for females. Education levels varied, with 53.2% of men and 62.0% of women attaining primary education, 29% of men and 26.7% of women attaining secondary education, and 6.9% of men and 9.1% of women attaining diplomas.

Moreover, 6.9% of men and 2.1% of women attained bachelor's degrees, while 2.7% of men attained master's degrees. Regarding marital status, 24.5% of men and 22.1% of women were single, 75.5% of men and 57.8% of women were married, and 15.5% of women were separated, divorced, or widowed (Table 1).

Climate change adaptive strategies by sex

The adaptive strategies practiced by respondents are summarized in Table 2. Mixed cropping and irrigation were the most common practices among both men and women. More females (19.3%) than males (16.5%) practiced irrigation, while more males (16.5%) than females (11.8%) practiced zero tillage through cultivation and mulching. The Chi-square test revealed no significant variation between men and women in the adoption of adaptation strategies ($P=0.467>0.05$). The Multinomial Logistic Regression Model (Table 3) indicated that women had higher odds of practicing zero tillage

Table 3. Multinomial Logistic Regression Model for Levels of Adaptive Capacity.

Adaptation strategies	B	Std. Error	Wald	Df	Sig.	Exp(B)	95% CI for Exp(B) (Lower–Upper)
Zero tilling (Female)	-0.533	0.391	1.859	1	0.173	0.587	0.272–1.263
Irrigation (Female)	-1.458	0.472	9.557	1	0.002	0.233	0.092–0.586
Others (Organic farming, soil conservation, planting trees)	-0.921	0.453	4.128	1	0.042	0.398	0.164–0.968

Source: Field survey (2021).

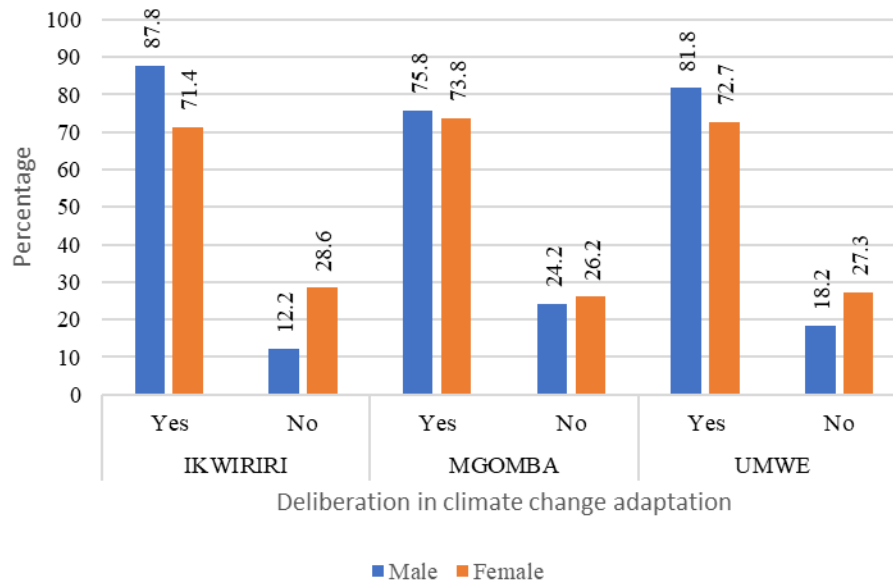


Figure 2. Deliberate efforts toward climate change adaptation.
Source: Field survey (2021).

(Exp(B)=0.587) but were less likely to adopt irrigation compared to men (Exp (B)=0.233, $p=0.002$).

Deliberate adaptation efforts and division of labour

About 82% of men and 72% of women reported making deliberate efforts to adapt agricultural practices to climate change (Figure 2).

Influence of climate change on the division of labour and workload in agriculture

Regarding division of labour, 64.4% of men and 65.2% of women engaged in agriculture, 28.2% of men and 27.3% of women engaged in fisheries, while 7.4% of men and 7.5% of women were in wage employment (Figure 3).

Support Systems and Climate Change Adaptation

Available support systems included AMCOS (7.4% males, 5.9% females), Red Cross (8% males, 22%

females), and VICOBA (8% males, 7.5% females). Figure 4 shows the proportion of respondents participating in social networks. Resilience enhancers were categorized as economic, environmental, and socio-cultural factors. Economic and socio-cultural factors were more reported by men (52.1%), while environmental factors were more reported by women (50.8%) ($P=0.00<0.05$) (Table 4).

Decision-making on resource ownership

Men dominated decision-making on resource allocation and utilization (80%) compared to women (20%), with a significant relationship between gender and decision-making ($P=0.011<0.05$) (Table 5).

Access to information and climate resilience

Information on climate adaptation was mainly accessed through mobile networks (86.1% males, 81.9% females), radio (86.1% males, 83% females), and TV (68.9% males, 66.5% females). Figure 5 shows the respondents

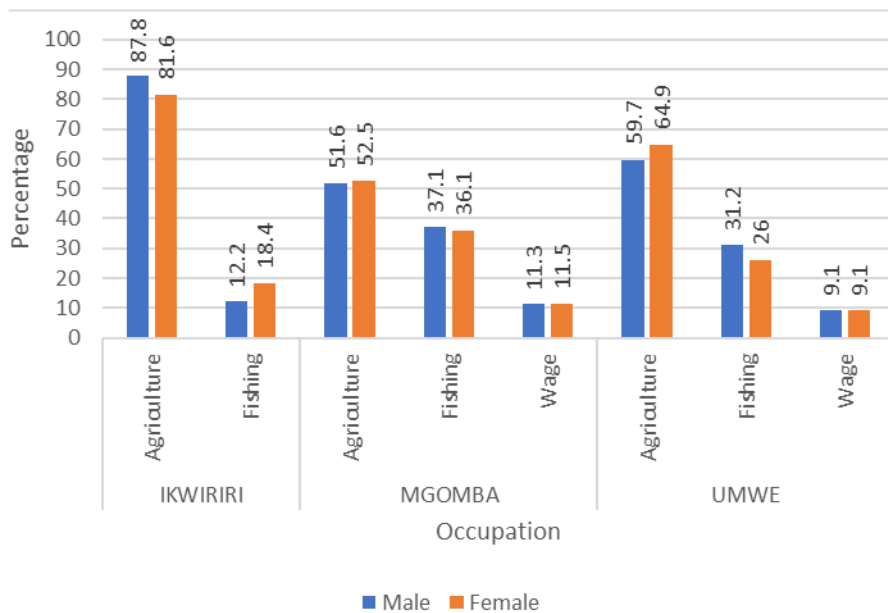


Figure 3. Proportion of respondents engaged in different sources of income. Source: Field data (2021).

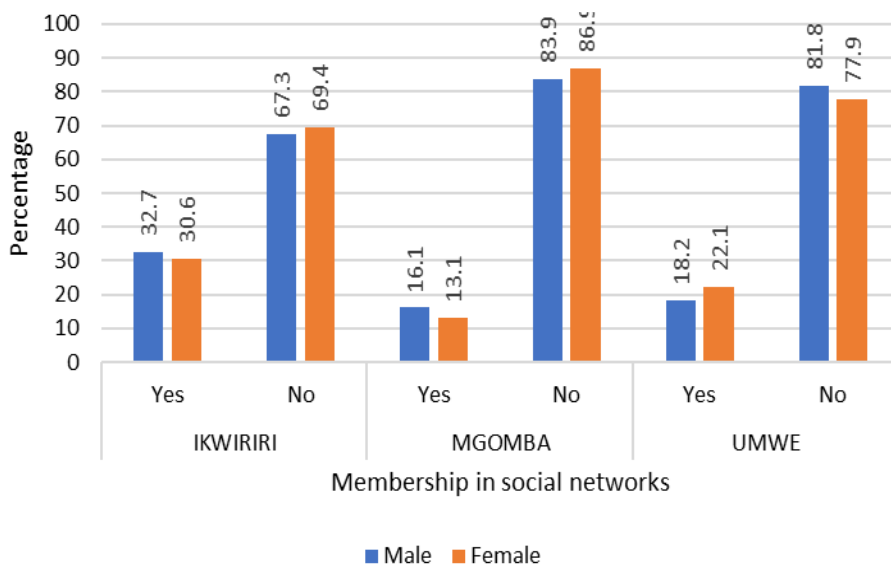


Figure 4. Proportion of respondents participating in social networks. Source: Field data (2024).

Table 4. Perceived enhancers of resilience to climate change effects.

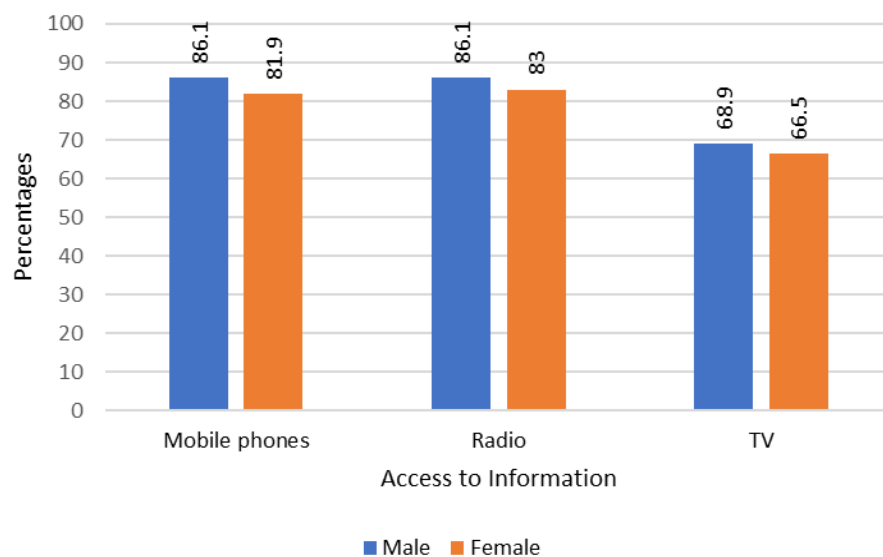
Enhancers of resilience	Males (N=188)	%	Females (N=187)	%
Economic and socio-cultural	98	52.1	60	32.1
Environmental	63	33.3	95	50.8
Status, behaviour, roles, power	27	14.4	32	17.1
Total	188	100	187	100

Source: Field data (2021).

Table 5. Decision-making on resource allocation and utilization.

Decision maker	Males	%	Females	%	Total	%
Women	47	25	28	15	75	20
Men	141	75	159	85	300	80
Total	188	100	187	100	375	100

Source: Field data (2021).

**Figure 5.** Respondents receiving information on climate adaptation.
Source: Field survey (2024).**Table 6.** Factors influencing adoption of information for climate adaptation.

Factor	Men	%	Women	%	Total	%
Financial	55	29.3	42	22.5	97	25.9
Level of Education	97	51.8	105	56.1	202	53.9
Technologies	26	13.8	33	17.6	59	15.7
Cultural	10	5.3	7	3.7	17	4.5
Total	188	100.0	187	100.0	375	100.0

Source: Field data (2021).

receiving information on climate adaptation. Adoption of information was influenced by financial, educational, technological, and cultural factors, with no significant gender differences ($P=0.332>0.05$) (Table 6).

DISCUSSION

Gender-specific adaptive strategies

The findings indicate that men and women in Rufiji District utilize a range of strategies to adapt to climate

change, such as mixed cropping, irrigation, zero tillage, soil conservation, organic farming, and afforestation. A gendered pattern of adoption was evident, with women practicing mixed cropping and irrigation more frequently, while men were more engaged in zero tillage, organic farming, and tree planting. This was further clarified by a multinomial logistic regression, which revealed that women had a higher likelihood of adopting zero tillage but a lower likelihood of adopting irrigation compared to men. These gender-specific patterns are shaped by disparities in resource access and socioeconomic constraints. The

results align with studies from Ghana and Tanzania, which found that women often adopt mixed cropping and other low-input strategies aimed at ensuring household food security, whereas men tend to pursue more resource-intensive practices like irrigation and soil fertility management (Adawla et al., 2019; Assan et al., 2018; Wrigley-Asante et al., 2019). This suggests that gendered access to land, capital, and labor fundamentally influences the choice of adaptation strategies, even when both sexes are actively involved in agriculture.

The impact of climate change on labor division and workload

The study results show that climate change has reshaped the division of labor, leading to nearly equal participation from both men and women in farming, fishing, and wage labor. This represents a shift from traditional Islamic cultural norms in coastal Tanzania, which typically assigned domestic responsibilities to women. Environmental pressures, including unpredictable floods and droughts, have necessitated a more balanced sharing of tasks, with women now actively complementing men's efforts in agriculture to secure household food supplies. This finding challenges the common perception of women being confined to domestic roles and supports the observation by Conway and Vincent (2021) that climate change can reconfigure socially constructed gender roles, often compelling women to diversify income sources and engage more in labor-intensive agricultural work.

Support systems for climate adaptation and their role in resilience

Although support systems such as cooperative unions (AMCOS), social networks like the Red Cross, and Village Community Banks (VICOBA) exist to provide material, informational and financial aid, participation rates for both men and women were low, and limited resources hampered their effectiveness. The benefits of these systems were gendered; men tended to gain more from economic and socio-cultural factors, while women were more affected by environmental constraints. This reflects the underlying gendered division of responsibilities and resource access. While these institutions are critical for building adaptive capacity by facilitating access to knowledge, inputs, and social capital, their potential is curtailed by weaknesses such as inadequate extension services and dysfunctional cooperatives.

This corroborates findings by Huynh and Stringer (2018) and Brooks and Adger (2000), who stress that robust, gender-sensitive institutional support, is crucial for effective adaptation.

Access to climate adaptation information and implications for adoption

Access to information on climate-resilient practices was primarily achieved through mobile social networks, radio, and television. Although men received slightly more information, likely due to better device access and greater mobility, statistical analysis showed no significant gender difference in overall access. The study confirms that access to information promotes the adoption of resilient practices, but its effectiveness is mediated by financial, technological, and cultural barriers, which disproportionately affect women. Consequently, men are often better positioned to implement strategies like irrigation or soil management, while women predominantly adopt low-cost practices such as mixed cropping. This underscores that effective adaptation requires not only information but also the resources to act upon it, a view supported by Dasgupta et al. (2014), Füssel and Klein (2006), and Yanda et al. (2021), who contend that timely information coupled with institutional support is essential for fostering resilience and the uptake of climate-smart agriculture.

Conclusions

This study investigated the climate change adaptation strategies of farmers in Rufiji District, Tanzania, highlighting gender-based comparisons. The findings reveal a general convergence in the adaptation approaches used by men and women, with only slight variations. The most prevalent strategy was mixed cropping, which was adopted by 54% of women and 50% of men. While limited support systems and information access constrain adaptive capacity, climate change has also prompted increased agricultural involvement from both sexes, thereby eroding some traditional divisions of labour. The study concludes that enhancing climate adaptation requires gender sensitive interventions and locally-driven initiatives, with a particular focus on empowering women and tackling existing inequalities to build resilience at the household and community level.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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