Socio-demographic determinants of climate change adaptation practices in agro-ecological zones: A case study of Chamwino and Igunga districts, Tanzania

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ABSTRACT

The global impacts of climate change have led to the development of various adaptation strategies, including Climate Change Adaptation (CCA) practices. In Tanzania, the introduction of CCA practices through eco-village projects between 2011 and 2019 reflects ongoing efforts to combat climate change effects. However, scientific understanding of the socio-demographic factors influencing households' decisions to adopt CCA practices remains limited. This study investigates the influence of socio-demographic factors on the adoption of CCA practices in the agro-ecological zones of Chamwino and Igunga districts, representing central and western Tanzania. Data were collected from 295 respondents through household surveys, complemented by key informant interviews (KIIs) and focus group discussions (FGDs). Socio-demographic factors such as gender, age, education level, land ownership, and training attendance were analyzed using descriptive statistics. Pearson's Chi-square test was employed to assess the statistical significance of the association between socio-demographic factors and agro-ecological zones, while a multivariate probit model was used to analyze the impact of socio-demographic factors on the adoption of CCA practices. The findings reveal that CCA adoption varies across zones, with the western zone showing a higher adoption rate. Chi-square results indicated significant associations between CCA adoption and factors such as soil water conservation, farmyard manure, mixed cropping, plant spacing, and the use of improved seeds and breeds ($p<0.05$). The multivariate probit model showed that gender, experience, land ownership, and training attendance significantly influenced adoption, with these factors promoting more practices compared to age, marital status, and education level. These insights are crucial for policymakers and local agencies to ensure that CCA initiatives are inclusive and address the diverse needs of different demographic groups.

Keywords: Adoption Practices, Agro-Ecological Zones, Climate Change Adaptation, Eco Village, Socio-Demographic Factors

I. INTRODUCTION

Climate change impacts are increasingly evident worldwide, with disruptions in global weather patterns leading to more frequent extreme events such as floods and droughts (Patt & Schröter, 2008; Savo et al., 2016). These climatic variations pose significant threats to natural systems, economies, and communities, exacerbating vulnerability and creating challenges for adaptation (Mora et al., 2018; Pasquier et al., 2020). Essentially, the impact of climate change has affected all socio-economic sectors, both in urban and rural areas, at varying degrees (Watson, 2000). Approximately 75% of the worst-affected individuals are rural communities in developing countries (Nyanga et al., 2011). As these communities are often highly dependent on natural resources for their livelihoods, they are particularly vulnerable to climate variability and its cascading effects.

In response to these escalating risks, climate change adaptation (CCA) has emerged as a critical focus area. Increasing public and private investments in sustainable adaptation practices aim to mitigate the multifaceted impacts of climate change. Global efforts, supported by institutions such as the World Bank and the Asian Development Bank, have provided financial and technical assistance for CCA initiatives (Gopalakrishnan, 2018; Nurhidayat & Setiawan, 2015). Similarly, local donors like Community-Based Organizations (CBOs) and Non-Governmental Organizations (NGOs) have contributed to funding projects addressing climate resilience. Despite a 35% increase in adaptation finance between 2015 and 2018, the annual investment of $30 billion falls significantly short of the $140–$300 billion required by 2030 (United Nations Environment Programme [UNEP] & International Union for Conservation of Nature [IUCN], 2018). For countries like Tanzania, donor-supported CCA programs target rural and arid regions where communities face severe livelihood threats due to climate change (Khisa, 2014; Baark & Heeks, 1998).

Tanzania began implementing CCA practices in 2011, with the introduction of eco-villages in different agro-ecological zones to empower vulnerable communities (United Republic of Tanzania [URT], 2012a, 2014b). Eco-villages, distinguished by their focus on building capacity for community-driven adaptation, were introduced in regions such as Dodoma, Tabora, Morogoro, Tanga, and Zanzibar (Njau, 2014a, 2014b; URT, 2012a, 2014b). These projects, funded by entities such as the European Union and the Alliance for a Green Revolution in Africa (AGRA), introduced numerous CCA practices, including ox-drawn tillage, soil water conservation, solar-powered water pumps, and afforestation initiatives (Lamhauge et al., 2018; URT, 2013b, 2014b).

Scholars have extensively examined the adoption of CCA practices. For instance, Kurgat et al. (2020) studied Climate Smart Agriculture (CSA) adoption in Tanzania, while Oyewole et al. (2019) explored CSA drivers in Nigeria. Other studies in Kenya, Zimbabwe, and Malawi have assessed household-level adoption decisions and socio-economic factors influencing adaptation practices (Mapanje et al., 2021; Ogada et al., 2020; Mgomezulu et al., 2018). Socio-demographic factors such as age, gender, education, land ownership, and experience are frequently cited as determinants of adoption (Rithaa et al., 2023; Huda et al., 2016). Gender roles, in particular, influence participation in adaptation practices, as secure land tenure and education levels, which enhance the ability to process information (Anang & Yeboah, 2019; Kalumanga, 2014; Enimu & Onome, 2018). Although the observation from mentioned studies explains the determinants of implementation of practices, there is still a gap in understanding how the socio-demographic factors contributed to the adoption of Climate Change Adaptation Practices in Tanzania’s distinct agro-ecological zones. Through this study socio-demographic factors influencing the adoption of CCA practices were examined in eco villages of Chamwino and Igunga districts, located in central and western Agro-ecological zones respectively. Specifically, the study focuses on how gender, age, marital status, education level, experience, land ownership, and training attendance shaped household decisions to adopt various CCA practices.

Therefore, by examining these factors the study adds value to the growing body of knowledge on adaptation strategies, with practical understandings on adoption of the interventions in the areas, including scaling up to other areas with similar socio-economic and environmental contexts. The linkages between socio-demographic factors and CCA practices are expected to enable more targeted and impactful interventions that build resilience among vulnerable communities in Tanzania. The findings are also expected to provide guidelines to climate adaptation stakeholders in considering Socio-Demographic factors when designing and implementing CCA initiatives. Moreover, the study provides basic recommendations for policymakers and local institutions that can help in development of effective and inclusive Climate Change Adaptation policies, programs and projects.

1.1 Statement of the Problem

Climate change poses significant threats to rural livelihoods, particularly in semi-arid regions like Chamwino and Igunga districts in Tanzania (URT, 2014b; Mora et al., 2018). To enhance resilience, Climate Change Adaptation (CCA) practices were introduced through eco-village projects between 2011 and 2019 (Njau, 2014a; URT, 2012a). Despite these efforts, the adoption of CCA practices remains inconsistent across agro-ecological zones. Existing studies suggest that socio-demographic factors, including gender, age, education level, land ownership, and training attendance, influence CCA adoption (Rithaa et al., 2023; Huda et al., 2016; Anang & Yeboah, 2019). However, the extent and nature of these influences in Tanzania’s eco-villages remain inadequately explored. Without a nuanced understanding of these factors, adaptation strategies risk being poorly targeted, reducing their effectiveness and long-term sustainability. This study addresses this knowledge gap by examining the influence of socio-demographic determinants on the adoption of CCA practices in Chamwino and Igunga. The findings aim to inform more inclusive, context-specific adaptation interventions that reflect the needs and capabilities of diverse demographic groups, ultimately enhancing climate resilience in Tanzania’s vulnerable rural communities.

1.2 Research Objectives

i. To examine the socio-demographic characteristics of eco-village households and their association with agro-ecological zones.
ii. To assess the types and adoption rates of climate change adaptation (CCA) practices among households across different agro-ecological zones.
iii. To determine the relationship between training attendance, land ownership, years of participation, and the adoption of CCA practices in agro-ecological zones

II. METHODOLOGY

2.1 Research Design and Study Area

This study employed a cross-sectional research design, which involves collecting data at a single point in time. This design was selected for its efficiency in capturing comprehensive data within a fixed timeframe and its ability to explore relationships between variables effectively (Kothari, 2004).

The research was conducted in eco-villages located within the Central and Western Agro-Ecological Zones of Tanzania. Specifically, Chamwino District in Dodoma Region and Igunga District in Tabora Region were purposively selected due to their active participation in Climate Change Adaptation (CCA) initiatives under the ECO ACT and

IACCA projects, implemented between 2015 and 2019. Four eco-villages—Idifu, Miganga, Mbutu, and Mwabakima—were randomly selected to ensure diverse representation. The inclusion of these villages enabled the study to analyze experiences across varying agro-ecological contexts and capture insights from respondents actively involved in the projects from their inception to the post-funding period.

2.2 Sampling Process

The study population comprised household heads involved in adopting CCA practices in the selected eco-villages. The villages were chosen from two distinct agro-ecological zones to ensure a comprehensive assessment of beneficiaries' experiences under diverse environmental conditions. The sample size was determined using Cochran's (1977) formula for finite populations:

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

$$= \frac{(1.96)^2 . (0.5). (0.5). (1115)}{(0.05)^2 . (1115-1) + (1.96)2. (0.5). (0.5)} = 295$$

Where:

n is the sample size,
N is the total number of beneficiary households in the four villages (1,115),
e is the level of precision (0.05),
p is the sample proportion (0.5),
q is 1 - *p*,
z is the z-value for the confidence level given (1.96 for 95% confidence).

Applying the formula resulted in a sample size of 295 respondents. Proportional sampling was used to allocate respondents across the villages based on the number of beneficiaries. Specifically, 137 respondents were drawn from Idifu and Miganga in Chamwino District, and 158 respondents from Mbutu and Mwabakima in Igunga District. This proportional approach ensured the sample accurately reflected the distribution of beneficiaries across study areas (Table 1).

Table 1
Study Respondents by District, Ward and Villages

District	Ward	Village	Total beneficiaries	Sample size
Igunga	Mbutu	Mbutu	355	158
		Mwabakima	230	
Chamwino	Idifu	Idifu	429	137
		Miganga	101	
TOTAL			1,115	295

2.3 Data Collection Methods and Instruments

Data collection employed a mixed-methods approach, incorporating the following tools and techniques:

Structured Household Questionnaire: A structured questionnaire was administered to household heads to gather socio-demographic information and data on the adoption of CCA practices. The instrument was pre-tested on 30 respondents in Chololo Village (Dodoma Region) to ensure clarity, relevance, reliability, and validity.

Key Informant Interviews (KIIs): Ten key informants were interviewed, including six local government representatives (e.g., ward extension officers, and political leaders), two project implementers (from IRDP in Dodoma and Heifer in Igunga), and two NGO representatives.

Focus Group Discussions (FGDs): Four FGDs were conducted (one per eco-village), each involving 10 purposively selected participants. The FGDs provided in-depth insights into the adoption and experiences with CCA practices.

Observations: Site visits to respondents' homes and farms were conducted to document CCA practices and related infrastructure visually. Observations were supported by photographs and notes to contextualize qualitative data.

Secondary Data: Secondary data were obtained from project documents, relevant websites, and local government offices involved in eco-village projects. This information complemented primary data by providing background details on the projects and CCA practices adopted.

2.4 Data Processing and Analysis

Data analysis was conducted using a combination of descriptive and econometric techniques, facilitated by IBM SPSS Version 20 and Stata Version 16. This dual approach enabled a comprehensive examination of the data, capturing both general trends and deeper insights into factors influencing the adoption of Climate Change Adaptation (CCA) practices.

Descriptive Statistics: Frequencies and percentages were calculated to summarize key socio-demographic characteristics of the respondents, including age, gender, education level, marital status, and training attendance. These statistics provided a foundational understanding of the sample's composition and variations across different agro-ecological zones.

Chi-Square Test: The Chi-square test was used to evaluate associations between socio-demographic factors and agro-ecological zones. This statistical test helped determine whether the observed distributions of categorical variables significantly differed from expected distributions. The formula for the Chi-square statistic is:

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

Where O_i denotes the observed frequency and E_i the expected frequency, and was conducted at a 95% confidence level ($p < 0.05$) to ensure robust statistical significance. The Chi-square test enabled the identification of whether there was a significant association between socio-demographic factors and agro-ecological zones (Central and Western)

2.4.1 Multivariate Probit Econometric Model

To analyze the factors influencing the adoption of CCA practices, a multivariate probit model was employed. This model is particularly suitable for situations where dependent variables are binary, and multiple correlated outcomes are analyzed jointly. The multivariate probit model accounts for the interdependence of unobserved factors, offering a nuanced understanding of decision-making processes (Belderbos et al., 2004; Lin et al., 2005).

The model is expressed as:

$$Y_{ij}^* = X_i'\beta_j + \epsilon_{ij}$$

Where Y_{ij}^* is the latent (unobserved) variable for the adoption decision of practice j by individual, X_i is a vector of independent variables while βj are coefficients for independent variables effect on the adoption of practice j and ϵ_{ij} is the error term, that assumed to be normally distributed with mean 0 and variance-covariance.

The dependent variables in this study comprised ten distinct CCA practices, including ox-drawn tillage, soil water conservation, use of improved seeds, and energy-efficient cooking stoves. Socio-demographic factors, such as gender, age, marital status, land ownership, and training attendance, were treated as independent variables. Each CCA practice was treated as a binary outcome, with “1” indicating adoption and “0” indicating non-adoption.

III. FINDINGS & DISCUSSION

3.1 Socio-Demographic Characteristics of Respondents and their Association with Agro-Ecological Zones

The socio-demographic characteristics of the respondents provided critical insights into the dynamics of eco-villages across the agro-ecological zones studied (Table 2). Gender distribution was nearly balanced, with males comprising 50.2% and females 49.8%. The age distribution revealed a significant concentration of respondents aged 46–60 years (47.8%), highlighting the active participation of older adults in adopting climate change adaptation (CCA) practices. This aligns with findings by Alemayehu and Bewket (2017), who observed that older individuals, due to their life experiences, are more likely to adopt adaptive strategies.

The Chi-square test revealed significant associations between age distribution and agro-ecological zones (χ^2 = 15.328, df = 4, p = 0.004), indicating variations in age-related participation across the zones. In contrast, marital status (χ^2 = 4.904, df = 3, p = 0.179) and gender distribution (χ^2 = 0.582, df = 1, p = 0.445) did not exhibit significant associations, suggesting consistency in these demographics across the zones.

Educational attainment was predominantly at the primary level (75.6%), with minimal representation of tertiary education (1.4%). A significant association was observed between education levels and agro-ecological zones (χ^2 = 22.373, df = 3, p = 0.000). Eco-villages in the central zone had a higher prevalence of informal education, which could influence the effectiveness of training programs and subsequent adoption of CCA practices. This observation is consistent with findings by Mosello and Oates (2017) and Tey et al. (2017), who highlighted the critical role of education in improving adaptive capacity and understanding climate-resilient practices.

Land ownership was notably high (93.2%), providing respondents with the resources to implement CCA practices. The significant association between land ownership and agro-ecological zones (χ^2 = 7.035, df = 1, p = 0.008) indicates disparities in land availability, with implications for adaptation efforts. Moreover, training attendance was robust, with 86.7% participation, showing a significant association with agro-ecological zones (χ^2 = 9.72, df = 1, p = 0.002). This finding aligns with Deressa et al. (2009) and Trinh et al. (2017), who emphasized the importance of capacity-building initiatives in enhancing adaptive strategies.

The experience of respondents in implementing CCA practices also varied significantly across zones (χ^2 = 38.217, df = 2, p = 0.000), with 84.7% having participated for 4–8 years. This highlights the importance of sustained engagement for successful adaptation. Strong associations were observed between socio-demographic factors such as age, education level, and experience, with moderate to weak associations for land ownership and training attendance. For instance, the Phi coefficient of 0.578 indicates a strong positive relationship between age and eco-village participation, with individuals aged 40–60 years being more active. Similarly, education level and CCA experience showed moderate associations (*Phi* = 0.275 and 0.470, respectively), while land ownership and training attendance exhibited weaker associations (*Phi* = 0.154 and -0.183, respectively).

The observed patterns suggest that tailored approaches are necessary to address specific socio-demographic characteristics and maximize the adoption of CCA practices.

Table 2

Socio-Demographic Characteristics of Respondents (n=295)

Variable	Category	Central zone		Western zone		Total		Pearson Chi-Square Tests			Cramer's V
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)	χ2	df	Sig.	
Gender	Male	76	48.1%	72	52.6%	148	50.2%	0.582	1	0.445	-0.044
	Female	82	51.9%	65	47.4%	147	49.8%				
Age category	18 - 28	3	1.9%	3	2.2%	6	2.0%	15.328	4	0.004*	0.578
	29 - 35	14	8.9%	25	18.2%	39	13.2%				
	36 - 45	36	22.8%	48	35.0%	84	28.5%				
	46 - 60	88	55.7%	53	38.7%	141	47.8%				
	Above 60	17	10.8%	8	5.8%	25	8.5%				
Marital status	Single	7	4.4%	13	9.5%	20	6.8%	4.904	3	0.179	0.129
	Married	119	75.3%	98	71.5%	217	73.6%				
	Widow/Widower	28	17.7%	19	13.9%	47	15.9%				
	Separated	4	2.5%	7	5.1%	11	3.7%				
Education level	Primary level	109	69.0%	114	83.2%	223	75.6%	22.373	3	0.000*	0.275
	Secondary level	13	8.2%	15	10.9%	28	9.5%				
	Tertiary level	1	.6%	3	2.2%	4	1.4%				
	Informal	35	22.2%	5	3.6%	40	13.6%				
Years in the project	Below 4 years	16	10.1%	3	2.2%	19	6.4%	38.217	2	0.000*	0.470
	4 - 8 years	142	89.9%	108	78.8%	250	84.7%				
	Above 8 years	0	0.0%	26	19.0%	26	8.8%				
Land ownership	Yes	153	96.8%	122	89.1%	275	93.2%	7.035	1	0.008*	0.154
	No	5	3.2%	15	10.9%	20	6.8%				
Training attendance	Yes	128	81.0%	127	93.4%	255	86.7%	9.72	1	0.002*	-0.183
	No	30	19.0%	9	6.6%	39	13.3%				

*. The Chi-square statistic is significant at the .05 level.

The findings reveal that older individuals are more inclined to adopt CCA practices, likely due to their accumulated knowledge and direct experience with climate variability. Younger individuals were less engaged, often due to aspirations to migrate to urban areas, a factor that could undermine the sustainability of adaptation strategies in rural communities. Addressing this gap requires targeted interventions that engage youth, such as incorporating climate resilience into school curricula and vocational programs.

Education emerged as a pivotal factor influencing adaptation. Individuals with higher educational attainment demonstrated greater access to resources and a better understanding of adaptive strategies, as supported by studies from Moyo et al. (2017), and Mutambara and Munodawafa (2014). Addressing literacy gaps through tailored educational programs and community workshops could significantly enhance adaptive capacity.

Land ownership was another critical factor, with secure land tenure encouraging the adoption of long-term adaptive measures. This aligns with findings by Alemayehu and Bewket (2017), who noted that perceived land tenure security positively impacts adaptation efforts. Policies promoting equitable land distribution and security could further enhance adaptation outcomes.

Training attendance was significantly associated with CCA practice adoption, emphasizing the importance of capacity-building initiatives. Farmers who participated in training programs were better equipped to implement adaptive strategies, as noted by Deressa et al. (2009) and Trinh et al. (2017). Expanding access to both short-term and long-term training programs tailored to specific agro-ecological zones could bridge knowledge gaps and sustain adoption.

Climate Change Adaptation Practices Adopted by Households and Their Association with Agro-Ecological Zones

The analysis of Climate Change Adaptation (CCA) practices across agro-ecological zones revealed significant variations in adoption rates between the central and western zones (Figure 1 and Table 2). Notably, improved seeds, plant spacing, and tree planting emerged as the most commonly adopted practices among households. Specifically, the adoption rate for improved seeds stood at 71%, with a slightly higher prevalence in the western zone (53.1%) compared to the central zone (46.9%). Similarly, plant spacing was adopted by 71% of households, with 55.7% in the western zone and 44.3% in the central zone. Tree planting was adopted by 70% of households, showing near-equal distribution between the western (50.5%) and central (49.5%) zones.

Other widely adopted practices included farmyard manure application, mixed cropping, and ox-drain tillage. Farmyard manure was utilized by 68% of households, with adoption higher in the western zone (56.0%) than in the central zone (44.0%). Mixed cropping exhibited a 66% adoption rate, favoring the western zone (59.7%) over the central zone (40.3%). Ox-drain tillage, adopted by 52% of households, was more common in the central zone (51.3%) compared to the western zone (48.7%).

Less commonly adopted practices included energy-efficient cooking stoves (43%), where adoption was higher in the central zone (53.2%) than in the western zone (46.8%), and soil water conservation (40%), which showed greater uptake in the western zone (59.8%) than in the central zone (40.2%). The least adopted practices were water harvesting (16%) and keeping improved goat breeds (14%). Interestingly, water harvesting was more prevalent in the western zone (58.3%) compared to the central zone (41.7%), while keeping improved goat breeds was predominantly practiced in the central zone (92.9%).

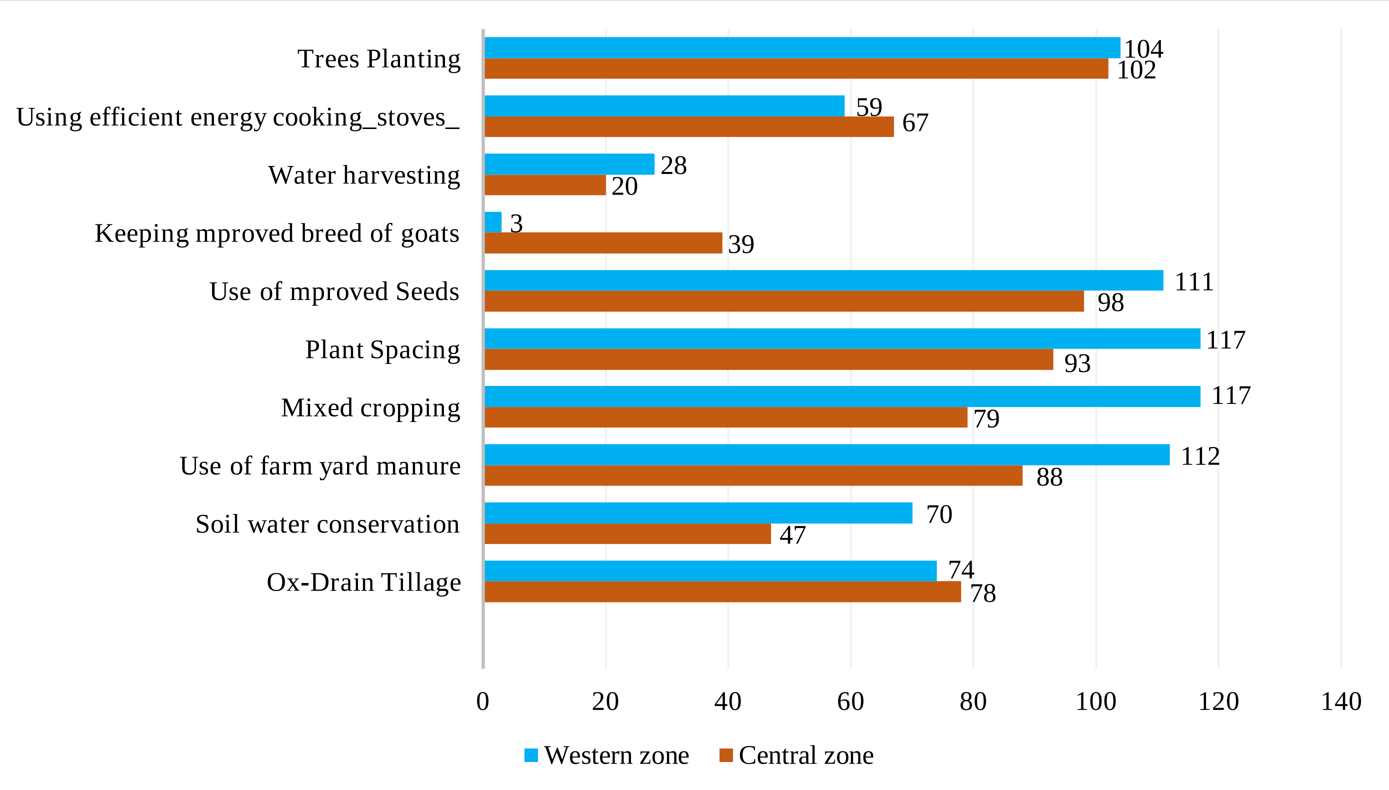

Figure 1
Adoption Pattern of CCA Practices across the Zones

The Chi-square test results (Table 3) revealed statistically significant associations between CCA practices and agro-ecological zones for several practices. Notably, soil water conservation, farmyard manure application, mixed cropping, plant spacing, use of improved seeds, tree planting, and keeping improved goat breeds all demonstrated significant relationships ($p < 0.05$). For example, the adoption of farmyard manure was significantly associated with zones ($\chi^2 = 34.7$, $p < 0.05$, Cramer's V = 0.278), indicating higher adoption in the western zone. Similarly, mixed cropping ($\chi^2 = 54.7$, $p < 0.05$, Cramer's V = 0.374) showed a strong association, again favoring the western zone.

Conversely, ox-drain tillage, water harvesting, and energy-efficient cooking stoves showed no statistically significant associations ($p > 0.05$), suggesting their adoption is independent of agro-ecological zones.

Table 3

Association between CCA Practices Adoption and Agro-Ecological Zones (n=295)

Practices	Adopters		Central zone		Western zone		Chi Square			Cramer's V
							χ2	df	Sig.	
	N	%	n	%	n	%				
Ox-Drain_Tillage_	152	52	78	51.3	74	48.7	16.1	3	0.426	0.46
Soil_water conservation	117	40	47	40.2	70	59.8	19	3	0.000*	0.218
Use of farm yard manure	200	68	88	44.0	112	56.0	34.7	3	0.000*	0.278
Mixed_cropping	196	66	79	40.3	117	59.7	54.7	3	0.000*	0.374
Plant Spacing	210	71	93	44.3	117	55.7	28.3	3	0.000*	0.292
Use of improved Seeds	209	71	98	46.9	111	53.1	14.6	3	0.000*	0.208
Keeping improved breed of goats	42	14	39	92.9	3	7.1	35.3	3	0.000*	-0.321
Water harvesting	48	16	20	41.7	28	58.3	14.6	3	0.071	0.105
Using efficient energy cooking stoves	126	43	67	53.2	59	46.8	10.1	3	0.909	0.007
Tree Planting	206	70	102	49.5	104	50.5	17.5	3	0.034	0.123

The higher adoption rates of practices like soil water conservation, mixed cropping, and tree planting in the western zone can be attributed to better water availability, which supports activities like tree nurseries and irrigation. In contrast, the central zone's limited water resources and erratic rainfall patterns constrained the adoption of these practices. Instead, households in the central zone leaned towards practices such as ox-drain tillage and keeping improved goat breeds, which align better with their resource constraints and focus on non-agricultural activities or cash crop production.

The adoption of energy-efficient cooking stoves was higher in the central zone due to its emphasis on reducing reliance on scarce firewood, a critical issue in the area. Conversely, the western zone's greater focus on agricultural and environmental practices was supported by more favourable climatic and ecological conditions.

These findings highlight the importance of region-specific strategies to enhance the adoption of CCA practices. For the central zone, interventions should focus on addressing water scarcity through investments in water harvesting infrastructure and promoting drought-resistant crops. In the western zone, efforts should aim at sustaining and scaling successful practices, such as soil water conservation and tree planting, to further bolster climate resilience. Therefore, this study underscores the significance of tailoring climate adaptation strategies to the unique socio-ecological dynamics of each region, ensuring their effectiveness and sustainability in mitigating the adverse effects of climate change.

The Influence of Socio-Demographics on the Adoption of Climate Change Adaptation Practices

A multivariate probit regression model was employed to examine the influence of socio-demographic factors on the adoption of Climate Change Adaptation (CCA) practices. The Wild Chi-square test results indicated that the independent variables in the model were significantly different from zero, affirming that CCA practices are influenced by at least one of the variables analyzed. The following subsections detail the specific findings from Table 4:

Table 4

Multivariate Probit Regression Modelling the Influence of Socio-Demographic Factors on Adoption of Climate Change Adaptation Practices

Variables	Ox-drain tillage	Soil water conservation	Use of Farm yard manure	Mixed cropping	Plant spacing	Using improved seeds	Keeping improved breed of goats	Water harvesting	Energy efficient cooking stoves	Trees Planting
	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)	β (Se)
Gender	-0.511* (0.156)	0.074 (0.157)	0.249 (0.161)	-0.011 (0.162)	-0.039 (0.170)	0.001 (0.167)	0.034 (0.190)	-0.173 (0.189)	0.670* (0.157)	-0.410* (0.166)
Age category	-0.010 (0.007)	-0.006 (0.007)	-0.017* (0.007)	-0.012 (0.007)	-0.015* (0.007)	-0.011 (0.007)	0.008 (0.008)	-0.004 (0.008)	0.004 (0.007)	-0.020* (0.007)
Marital status	0.200* (0.138)	-0.122 (0.135)	0.006* (0.144)	0.109* (0.146)	-0.070 (0.147)	-0.056 (0.141)	0.123 (0.171)	0.231 (0.158)	0.087* (0.137)	-0.108 (0.144)
Education level	0.032* (0.074)	0.038 (0.075)	-0.013 (0.076)	0.104* (0.078)	0.011 (0.079)	0.004* (0.077)	0.175* (0.101)	0.182* (0.110)	-0.041 (0.075)	0.068* (0.076)
Experience	0.165* (0.052)	0.202* (0.059)	0.104* (0.051)	0.226* (0.054)	0.285* (0.056)	0.259* (0.055)	0.029 (0.059)	0.201* (0.074)	0.053 (0.050)	0.117* (0.052)
Land ownership	0.384* (0.314)	-0.745* (0.326)	-0.227 (0.323)	0.370* (0.377)	0.063* (0.379)	-0.627* (0.320)	-0.143 (0.389)	-0.269 (0.364)	-0.730 (0.347)	-0.317 (0.331)
Training attendance	-0.176 (0.238)	0.293* (0.248)	-0.400* (0.235)	-0.304 (0.236)	-0.123 (0.238)	-0.267 (0.237)	0.427 (0.270)	-0.209 (0.333)	-0.316 (0.240)	-0.453 (0.238)

*Note ***, ** and * indicate Statistical significance at 1%, 5% and 10% levels respectively*

3.1.1 Gender

Gender emerged as a significant determinant of specific adaptation practices. Men were more likely to adopt practices such as *ox-drain tillage, soil water conservation*, and *plant spacing,* while women showed higher adoption rates for *energy-efficient cooking stoves* and *tree planting*. However, gender had no statistically significant influence on practices such as *improved seeds, improved goat breeds,* and *water harvesting*. These findings align with Traore et al. (2020), who noted gendered differences in adaptation, with men adopting more technologies than women. Similarly, Nchanji et al. (2022) observed that men often had greater access to resources, including mobile phones and group memberships, facilitating adoption.

3.1.2 Age

Age had a statistically significant negative influence on the adoption of *farmyard manure*, *plant spacing,* and *tree planting*, suggesting that older individuals were less likely to adopt these practices. For *mixed cropping*, the effect was marginally significant. This indicates that younger farmers may be more inclined to adopt innovative practices, consistent with O'Shea et al. (2018), who found older farmers to be more risk-averse and less likely to embrace new technologies due to uncertainties.

3.1.3 Marital Status

Marital status significantly influenced the adoption of practices like *ox-drain tillage*, *farmyard manure, mixed cropping,* and *energy-efficient cooking stoves*. Married individuals were more likely to adopt these practices, possibly due to their greater responsibilities, decision-making authority, and access to resources. In contrast, marital status had no significant effect on practices such as *soil water conservation, plant spacing,* and *improved seeds*. These results corroborate findings by Achuk et al. (2022), Duong et al. (2020), and Mabuku et al. (2019), who highlighted that married farmers are better positioned to implement climate adaptation strategies due to resource pooling and shared responsibilities.

3.1.4 Education Level

Educational attainment was positively associated with the adoption of *mixed cropping, improved goat breeds, water harvesting*, and *tree planting*. Educated individuals were more likely to adopt these practices, possibly due to their enhanced ability to process and utilize information, as noted by Sahoo and Moharaj (2022). Bhattacharyya et al. (1997) also emphasized that education enables critical analysis of alternatives and better forecasting of expected benefits. However, education did not significantly influence practices like *plant spacing, farmyard manure,* and *soil water conservation*, suggesting these practices might be more skill-based or traditional.

3.1.5 Experience

Experience significantly influenced the adoption of several practices, including *water harvesting, tree planting, intercropping, plant spacing, improved seeds,* and *soil water conservation*. Farmers with more experience were more likely to adopt these practices. However, *energy-efficient cooking stoves* and *improved goat breeds* showed no significant association with experience. Kassie et al. (2012) noted that experienced farmers tend to selectively adopt practices aligned with their existing knowledge and perceived benefits, while Sahoo and Moharaj (2022) highlighted a similar trend in seed and crop diversification adoption.

3.1.6 Land Ownership

Land ownership positively influenced the adoption of practices such as *improved seeds*, *mixed cropping*, *plant spacing*, *ox-drain tillage*, and *soil water conservation*, likely due to greater control over resources and long-term investment incentives. Conversely, practices like *energy-efficient cooking stoves, water harvesting,* and *tree planting* were not significantly influenced by land ownership. These findings resonate with studies by Kamwamba-Mtethiwa et al. (2012) and Ngwira et al. (2014), which highlighted the role of land tenure in enabling investment in conservation agriculture.

3.1.7 Training Attendance

Training attendance was positively associated with the adoption of practices like *soil water conservation, improved seeds, water harvesting,* and *energy-efficient cooking stoves,* emphasizing the importance of capacity-building initiatives. However, practices like *plant spacing, mixed cropping,* and *ox-drain tillage* were not significantly influenced by training. Mgomezulu et al. (2023) similarly reported that training enhances farmers' capacity to adapt to climate change through improved awareness and skills.

IV. CONCLUSION

This study examined the influence of socio-demographic factors on the adoption of climate change adaptation practices in Chamwino and Igunga districts, situated in the central and western agro-ecological zones of Tanzania, respectively. The findings reveal significant variations in the adoption of practices between the two zones. The western zone demonstrated higher adoption rates of practices such as farmyard manure application, mixed cropping, and soil water conservation. Conversely, the central zone exhibited greater adoption of energy-efficient cooking stoves and ox-drawn tillage. Practices such as water harvesting and improved goat breeds had the lowest adoption rates across both zones, underscoring the need for targeted efforts to address these gaps.

The study highlights the significant influence of socio-demographic factors on the adoption of adaptation practices. Multivariate probit analysis revealed that gender, farming experience, land ownership, and training attendance were key drivers of adoption, enabling households to implement multiple practices effectively. Factors such as age, marital status, and education level played a comparatively moderate role. Notably, education facilitated the adoption of both common and newly introduced practices, indicating its potential as a critical leverage point for enhancing adaptation. The Central zone, characterized by lower education levels, presents unique challenges that call for tailored programs to address specific regional needs.

Training attendance emerged as a vital factor for adopting practices perceived as new technologies, such as soil water conservation, improved seeds, energy-efficient cooking stoves, water harvesting techniques, and improved goat breeds. This finding underscores the importance of providing households with training to build their capacity and confidence in implementing unfamiliar practices. Land ownership, on the other hand, was closely associated with the adoption of farming-specific practices, such as ox-drawn tillage, mixed cropping, and plant spacing. Households with secure and larger landholdings were more likely to invest in these practices, highlighting the critical role of land access in supporting climate adaptation efforts.

V. RECOMMENDATIONS

From the study findings, discussion and conclusion, the study recommends development of zonal-specific interventions to reflect the socio-demographic and ecological conditions unique to each region, towards enhancing of climate change adaptation practices,. In the Central zone, where land ownership is less prevalent, alternative strategies such as community land-sharing initiatives or targeted support for land access should be explored. District councils and relevant stakeholders should prioritize capacity-building programs that focus on increasing awareness and providing practical training tailored to the needs of each zone. These programs should emphasize practices with low adoption rates to ensure equitable adaptation across the regions.

Additionally, fostering community involvement in resource ownership is critical for ensuring sustainable adoption. Regional resource allocation should be guided by local contexts, addressing disparities in land ownership and resource availability. Support mechanisms, such as financial assistance programs, subsidies, or microfinance initiatives, should be designed to aid low-income households in accessing technologies and resources needed for climate adaptation.

Effective monitoring and evaluation mechanisms should be established to track the implementation of practices, gather feedback, and adjust strategies based on evolving circumstances. Community-driven initiatives that promote the sharing of experiences and local knowledge among residents should also be encouraged, as they can foster collective resilience and strengthen adaptation efforts.

Finally, this study provides valuable insights for policymakers and development practitioners, emphasizing the importance of integrating socio-demographic considerations into national development policies and climate adaptation programs. By understanding the unique needs of diverse demographic groups and regional characteristics, policymakers can design inclusive initiatives that enhance resilience and promote sustainable development in agro-ecological zones.

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