

Influence of relative user satisfaction on sustainability of climate change adaptation practices: insights from Chamwino and Igunga agro-ecological zones, Tanzania

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ABSTRACT

The aim of this study was to examine the influence of Relative User Satisfaction (RUS) on the sustainability of Climate Change Adaptation (CCA) practices in agro-ecological zones of Tanzania. Supported by the Technology Acceptance Model (TAM), this study focus on determining the influence of self-efficacy, subjective norms, usage experience, perceived risks, output quality, results demonstrability, perceived image, compatibility, usability and relevance, on sustainability of CCA practices. The study employed a cross sectional research design, involving 295 respondents who are households heads adopted CCA practices in Chamwino and Igunga districts, with data collected through household questionnaires, Focus group discussions (FGDs), and key informant interviews (KIIs). Statistical analyses, including Descriptive statistics, Multiple Correspondence Analysis (MCA) and Multivariate Ordered Probit model (MOVP) were performed. Results from the descriptive analysis indicated high preference of practices including Trees Planting and use of Farmyard manure after funding, reasons being their simplicity, immediate benefits and alignment with local knowledge. The findings from inferential analysis revealed that self-efficacy, perceived image, subjective norms, usability and usage experience were positively and statistically influencing the sustainability of CCA practices after funding period. Results from Multivariate Ordered Probit revealed Self-efficacy to have significant influence on soil water conservation practices ($\beta = 1.07$, $p < 0.001$), Trees planting ($\beta = 1.02$, $p < 0.001$) and the use of farmyard manure ($\beta = 0.99$, $p < 0.001$). Perceived image was also found statistical significant in influencing practices, with statistical significance p-value of 0.001. Subjective norms was found crucial in influencing Ox-drain tillage practices ($\beta = 0.99$, $p < 0.001$), while usage experience and usability showed moderate effects with statistical significance p-value of 0.01 and 0.05 respectively. The study finds that Self-efficacy, Perceived image, Subjective norms and Usage experience serves as essential RUS factors in influencing the sustainability of CCA practices after funding period. The study concludes that, ensuring sustainability of the practices require enhancing community participation, simplicity of the practices and consideration of socio-economic factors. The study proposes establishment of targeted training, role models system, incentive systems, monitoring frameworks and user-friendly guidelines to enhance self-efficacy, social influence, and Usability for long-term implementation.

Keywords: Agro-Ecological Zones, Climate Change Adaptation Practices, Perceived Ease of Use, Perceived Usefulness, Relative User Satisfaction, Technology Acceptance Model

I. INTRODUCTION

Climate change (CC) has widespread with several impacts all over the world, affecting different sectors including livelihoods, health, food security, and biodiversity (United Nations Framework Convention on Climate Change [UNFCCC], 2007; Costello, 2009). The effects in developing countries have been observed, with approximately 75% of the most affected populations residing in rural areas (Nyanga, *et al*, 2011). Impacts of climate change has contributed to a decline in agricultural productivity by 15-35% and decreased water availability in countries found in Sub Sahara region (McCarthy *et al.*, 2011; Stern *et al.*, 2006). Forestry sector which supplies over 90% of wood fuel in Africa and Asia, has experienced substantial biomass degradation, loss of biodiversity, and ecosystem shifts from forests to woodlands or grasslands (McMichael *et al.*, 2007). These challenges underline the serious need for effective adaptation strategies, especially in rural and urban settings.

As a result of the impacts of climate change, some international organizations, multilateral agencies, donors as well as financial institutions, have already started paying attention to Climate change challenges (Reid *et al.*, 2009). The UNFCCC outlines two fundamental response strategies which are mitigation and adaptation. While mitigation seeks to reduce the emission of greenhouse gases and increase the sinks for carbon dioxide, adaptation seeks to lessen the negative impacts of climate change by undertaking specific actions appropriate for the context (Füssel & Klein, 2006). Focus on adaptation strategies to combat the impacts of Climate Change has been increasing recently in different

countries governments, with formulation of various policies, programs and projects (United Nations Development Programme [UNDP], 2010).

Evolution of eco-villages and using them as avenue for enabling the communities to combat the Impacts of climate change through adaptation of various practices started in the 1960s. This resulted to focus shift towards enabling local communities to better adapt to climate change (Mswima, 2022). Eco-village projects aimed at enhancing the adoption and practice of various CCA measures in different sectors of agriculture, livestock, energy, and ecosystem management (Breidenich *et al.* 1998; Kimbowa *et al.*, 2011). Practices such as Crop farming improvements, livestock enhancement, energy efficient stoves, alternative energy, water management and integrated forest conservation are included in these initiatives (Kunze & Avelino, 2015). Studies in different parts of the world have shown that the implementation of these measures has enhanced resilience to climate change. In South Asia, the Eco-village Development (EVD) Projects has achieved higher productivity in organic farming, better irrigation water use efficiency, improved livestock management, and employment creation through biogas plants, smokeless stoves, solar energy, and roof-water harvesting (Myles *et al.*, 2015). Also in Africa the CCA practices in Eco-villages in countries like Senegal and Gambia have improved local agricultural production, food security, and self-sufficiency in energy efficient technologies

Tanzania embarked on Climate change adaptation through Eco-villages in 2011, where areas like Dodoma, Tabora, Morogoro, Tanga, and even Zanzibar were targeted by projects, with the aim of empowering marginalized communities (Njau, 2014a, 2014b; URT, 2012a, 2014b). With support from international donors such European Union and the Alliance for a Green Revolution in Africa (AGRA) various practices and technologies were introduced, including Ox-drawn tillage, Soil and water conservation techniques, Solar water pumps, and Afforestation (URT, 2013b, 2014b). Despite the achievements shown by these initiatives in their initial goals, the gap still remains in understanding their long-term sustainability and effectiveness in tackling climate change impacts, hence needs further investigation.

The sustainability of the climate change adaptation initiatives after funding period is of significant importance because it helps to determine whether the efforts can continue over time so as to strive and meet their goals when funding is no longer available (Komalawati, 2008). In the context of projects, sustainability is determined as the ability by the project practices or activities to meet objectives after active implementation period which imply ending of financial support from donors (Hofisi & Chizimba, 2013). According to Scheirer and Dearing (2016), sustainability involves the ongoing use of program elements to achieve positive outcomes. For this study, sustainability specifically refers to the ongoing adoption of CCA practices after the funding period. Although there has been considerable research on the early stages of adopting CCA practices (Guillen-Royo, 2015; Njau, 2014b; Olivier, 2015), there is a lack of empirical evidence regarding the sustainability of these practices once donor funding stops (Mdoe & Kilawi, 2014). User's satisfaction have been identified among key measures of systems success in the information system projects and other .Various Researches indicates that aspects like perceived effectiveness, access to training and institutional support significantly impact the user satisfaction, which in turn influences the likelihood of ongoing system or practice adoption (Mtwanga *et al.*, 2022; Sewando, 2023).The overall satisfaction of users with the system were found to occur when they find it ease to use and useful (Petter *et al.*, 2013; Dalcher, 2003; Doll *et al.*, 2004). This relationship has also been observed at in the context of adoption of climate adaptation practices, where user satisfaction from ease of use and usefulness are thought to impact the ongoing adoption of various practices (Sun *et al.*, 2008; Hong *et al.*, 2006).

By exploring the relationship between Relative User Satisfaction and Sustainability of Climate change Adaptation practices, this paper aims to answer important questions on continuity of the CCA practices after funding period. The focus being in Eco-villages located in the Chamwino and Igunga districts of central and western Tanzania. The paper specifically looks into factors like self-efficacy, subjective norms, user experience, output quality, demonstrable results, perceived image, and usability to understand their influence on ongoing adoption of CCA practices. This research builds on the work of Mngomezulu *et al.* (2023), who examined the sustainability of agricultural practices by looking at their continued implementation and use three years after the project wrapped up.

Findings from this study are expected to contribute to the growing body of research on post-funding sustainability of Climate Change Adaptation strategies, through providing deep understandings into Relative User Satisfaction in influencing community members to continue implementing Climate CCA practices after funding period. The study also aims to provide a guide for policy frameworks, future researches, and extension strategies that focus on ensuring the sustainability of CCA practices, eventually fostering more resilient communities as they face the challenges from the impacts of climate change.

1.2 Research Objectives

- i. To examine the prevalence of Climate Change Adaptation practices (CCA) implemented by communities after the funding period in Agro-ecological zones of Chamwino and Igunga in Tanzania
- ii. To analyze the interrelationship among various CCA practices to understand how they complement each other in enhancing resilience

- iii. To assess the underlying dimensions and internal consistency of Relative User Satisfaction constructs influencing the sustained use of CCA practices.
- iv. To determine the extent to which Relative User Satisfaction constructs (such as self-efficacy, subjective norms, and usage experience) influence the sustainability of specific CCA practices in the study areas

II. LITERATURE REVIEW

2.1 Theoretical Review

This study used the Technology Acceptance Model (TAM) as a framework to dive into what drives Relative User Satisfaction (RUS) and how it affects the sustainability of Climate Change Adaptation (CCA) practices. TAM, which was introduced by Davis back in 1986 is known as one of the common models for explaining why people accept and use technology (Ma & Liu, 2004). The model is composed of two key factors of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), which explain the reasons behind someone's decision to accept or continue using a technology or practice. PEOU is explained as feelings that a certain technology or practices is ease to use while PU is defined as feelings that accepting or using a certain technology will provide real benefits or improve performance.

As Davis explained in 1989, users are willing to adopt technology if they find it easy to use and useful in their daily life. TAM has been used by various scholars to explain both short-term actions, like adopting and accepting technology, and long-term behaviors, such as ongoing usage (Morris & Venkatesh, 2000). However, some researchers have critiqued TAM for not fully capturing the changing psychological factors, like user satisfaction, that affect long-term technology use (Khoza *et al.*, 2021). Even with these critiques, TAM still holds its ground in explaining why people continue to adopt technologies, as it recognizes that user satisfaction and perceived benefits are vital for ongoing use.

The use of TAM in this study is influenced by its ability to provide a theoretical foundation for influence of Relative User Satisfaction (RUS) on the sustainability of CCA practices in Chamwino and Igunga Districts, Tanzania. Various researches applied TAM to explain technology adoption and sustained usage, including Oguntuase *et al.*, (2023) who predicted the intention to adopt bioeconomy technologies as part of efforts to combat climate change in Lagos, Nigeria. Similarly, Hong *et al.*, (2006) used TAM and found that Perceived Ease of Use positively influenced user satisfaction in the context of information technology usage, while Sun *et al.*, (2008) explains Perceived Usefulness as a predictor of user satisfaction in e-learning contexts. Incorporating psychological factors such as user satisfaction through TAM offers valuable insights into the continued adoption of practices that aim to mitigate the impacts of climate change in rural communities.

2.2 Conceptual Framework

The conceptual framework of this study (Figure 1) informs Technology Acceptance Model (TAM), that explains the factors behind people's adoption behavior of a technology. The framework illustrates the relationship between Relative User Satisfaction and the Sustainability of Climate Change Adaptation (CCA) practices. From TAM concept Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) are regarded as two key elements that influence the technology acceptance and usage behavior (Davis, 1986). The independent variables of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) were used as proxy indicators of Relative Users Satisfaction (RUS). The sustainability of CCA practices is measured by whether the practices are continued beyond the funding period influenced by independent and background variables in Figure 1.

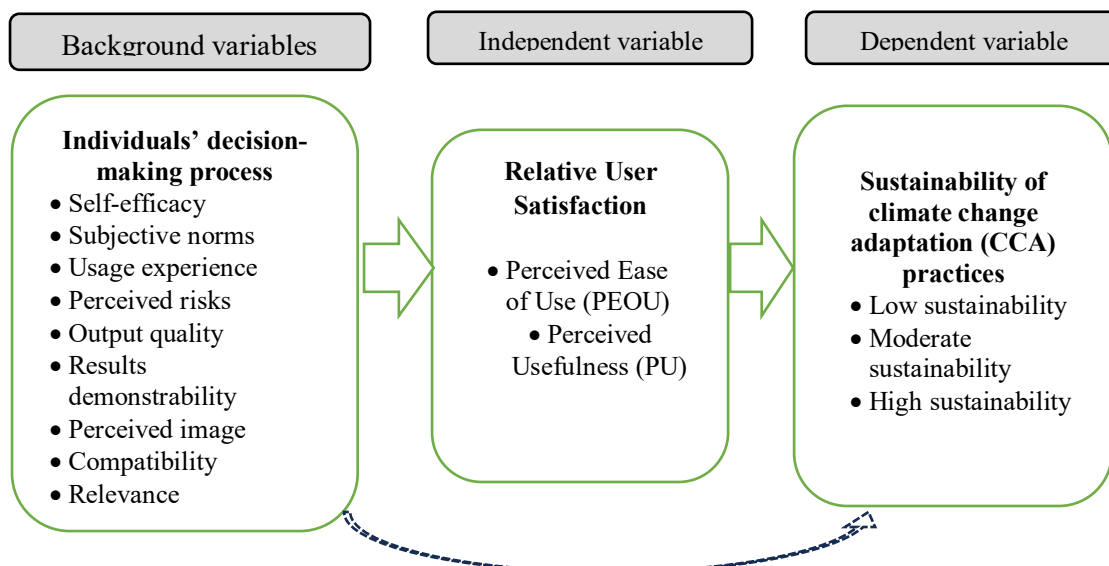


Figure 1
Conceptual Framework on the Influence of Relative User Satisfaction on the Sustainability of CCA Practices

III. METHODOLOGY

3.1 Study Design and Study Area

Cross-sectional research design was employed whereby data were collected at one specific point in time. This design has a broader scope to enable the incorporation of many variables at one specific time (Kothari, 2014). The design also allows collection of both qualitative and quantitative data at one point in time (Bailey, 1998). Data collection was conducted between November 2023 and January 2024 in eco-villages of Chamwino and Igunga Districts of Dodoma and Tabora Regions. These areas which are located in central and western agro-ecological zones were chosen because they both participated in the ECO-ACT (Eco-Adaptation to Climate Change in Central Tanzania) and IACCA (Integrated Approaches for Climate Change Adaptation) projects from 2015 to 2019. The eco-villages studied included Idifu, Miganga, Mbutu and Mwabakima in which climate change adaptation practices were introduced and adopted by community members.

3.2 Sampling Process

The study targeted households within the selected villages that had adopted CCA practices. A total of 295 respondents, comprising household heads who were direct beneficiaries of the adaptation interventions were sampled. The sample size was determined using Cochran’s (1977) formula, which provided a strong basis for estimating the number of respondents needed to ensure statistical reliability:

$$\frac{n = z^2 \cdot p \cdot q \cdot N}{e^2 (N - 1) + z^2 \cdot p \cdot q} = \frac{(1.96)^2 \cdot (0.5) \cdot (0.5) \cdot (1115)}{(0.05)^2 \cdot (1115 - 1) + (1.96)^2 \cdot (0.5) \cdot (0.5)} = 295$$

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 $1 - p$, and
- z is the confidence level given (1.96 for 95% confidence).

A sample size of 295 respondents was obtained in two districts by applying the formula, with 137 in Chamwino and 158 in Igunga district. The sample in each district were distributed proportionally into four eco villages as indicated on 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

3.3 Data Collection Methods and Instruments

A mixed-methods approach was utilized, incorporating household surveys, KIIs, FGDs, and literature review. A structured questionnaires was administered to household heads to collect data on the prevalence of CCA practices post-project termination. The questionnaire was pre-tested with 30 respondents in Chololo Village (Dodoma Region) to assess its clarity, relevance, reliability, and validity. Ten key informants were interviewed, including six local government representatives (ward extension officers, and political leaders), two project implementers (from IRDP in Dodoma and Heifer in Igunga), and two NGO representatives. To get in-depth insights into the implementation of CCA practices, four FGDs were conducted, each involving 10 purposively selected participants. Site visits for observation, supported by photographs and notes, were conducted at respondents’ homes and farms to document CCA practices and related infrastructure. 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.

3.4 Data Processing and Analysis

STATA software version 18 was employed for data processing and analysis, facilitating both descriptive and econometric analyses. This approach enabled a comprehensive examination of the data, capturing both the prevalence of CCA practices and the influence of relative user satisfaction (RUS) on sustainability. Frequencies and percentages were calculated to describe the prevalence of CCA practices five years after project termination. The correlation matrix (rho) was performed to get insights into the interrelationships among various climate adaptation practices while Multiple Correspondence Analysis (MCA) was employed to reduce redundancy and enhance construct validity by selecting the most influential RUS indicators. The final seven constructs Self-Efficacy, Subjective Norms, Usage Experience, Output Quality, Results Demonstrability, Perceived Image, and Usability—were retained after good scores of Cronbach’s Alpha > 0.7. Marginal effects (dy/dx) were computed to determine how one unit change in Relative user satisfaction affects the probability of change of each sustainability (low, moderate, or high) level in the long run.

3.4.1 Multivariate ordered probit model

To determine the influence of Relative User Satisfaction (RUS) on the sustainability of climate change adaptation practices, Multivariate Ordered Probit (MVOP) model was used by the study. The model was opted because the dependent variables to be used are of ordinal nature which involve classifying sustainability into low, moderate, and high levels. The MVOP model is particularly useful as it also accounts for the correlation among multiple climate adaptation practices sustained by the household beneficiaries. Previous studies including ones by Sosa-Rubi *et al.*, (2009) and Candelon *et al.* (2013) have confirmed the robustness of the multivariate probit models. The dependent variables in this study consisted of five key climate adaptation practices, namely Ox-Drawn Tillage, Tree Planting, Energy-Efficient Cooking Stoves, Use of Farmyard Manure, and Soil Water Conservation. Sustainability was measured based on how the practices persisted until the study period on the post-project termination period. The sustainability levels were categorized as

$$\text{follows: } Y_{ij} = \begin{cases} 1, & \text{if } Y_{ij}^* \leq \tau_1 \quad (\text{Low sustainability}) \\ 2, & \text{if } \tau_1 < Y_{ij}^* \leq \tau_2 \quad (\text{Moderate sustainability}) \\ 3, & \text{if } Y_{ij}^* > \tau_2 \quad (\text{High sustainability}) \end{cases}$$

Where Y_{ij}^* represents the latent sustainability level for adaptation practice j for farmer i , and τ_1 and τ_2 are estimated threshold parameters.

The Multivariate Ordered Probit Model was specified as:

$$Y_{ij}^* = X_{ij}\beta + \epsilon_{ij}$$

Where:

Y_{ij}^* is the latent sustainability score of climate adaptation practice j for farmer i ,

X_{ij} is a vector of RUS indicators,

β is the vector of estimated coefficients, and

$\epsilon_{ij} \sim N(0,1)$ is the error term.

The model was estimated using Maximum Likelihood Estimation (MLE), with Wald chi-square tests used to test the joint significance of explanatory variables.

IV. FINDINGS & DISCUSSION

4.1 Prevalence of Climate Change Adaptation Practices after Funding Period

The implementation of CCA practices after funding period was observed to vary across the agro ecological zones, with some showing highest prevalence compared to others. High prevalence in implementation was observed on trees planting which scored 84.8%, suggesting that the community members were able to implement the practice, with understanding and awareness on the role of trees in enhancing soil fertility which is important for increasing crop yields. The use of farmyard manure also indicated high prevalence with 84.54% of respondents, indicating that respondents were aware of it as an alternative to expensive modern fertilizers which some of them cannot afford. A study by Tiltonell *et al.* (2010) support these findings with observation that smallholder farmers prefer organic manure because it is cost effective, easy to access and have ability to maintain soil properties which results to high yields. The livestock keeping culture influenced the prevalence of Ox-drawn tillage practices by 78.2% across the agro ecological zones due to availability of oxen in some families. Soil water conservation and the use of energy-efficient cooking stoves was observed to have a slight lower preference of 72.7% and 72.11% respectively in the agro ecological zones after funding explaining the awareness on necessity of both practices in combating the impacts of Climate Change. The findings are the same as study by Rockström *et al.*, 2008 who found that soil water conservation important for enhancing soil moisture retention and reducing runoff. The lower adoption rate of energy-efficient cooking stoves compared to other practices explains that cost and expertism in making the infrastructure, and cultural preferences play a significant role in sustainability (Gifford *et al.*, 2011).

Table 2

Descriptive Statistics of Multiple Responses on Prevalence of Climate Change Adaptation Practices

Practices	Frequency	Percent (%)
Tree Planting	250	84.80
Use of Farmyard Manure	249	84.54
Ox-Drawn Tillage	231	78.20
Soil Water Conservation	215	72.77
Energy-Efficient Cooking Stoves	213	72.11

In general the study findings provide a convincing sustainability trend for the CCA practices which were sustained after funding period in Chamwino and Igunga agro-ecological zones. As some practices exhibited high implementation prevalence and others low there is a need for targeted interventions to improve sustainability of the lower scoring practices and others to maintain high scoring practices. Strategies such as improved extension services and financial incentives can be among proper measures to support long-term sustainability in climate adaptation efforts.

4.2 Interrelationship among Climate Change Adaptation Practices

Interrelationship among CCA practices implemented after funding period was determined using correlation analysis. Findings from the study observed statistically significant correlations between Soil Water Conservation and other practices such as Ox-Drawn Tillage ($\rho = 0.271$, $p < 0.001$), Tree Planting ($\rho = 0.168$, $p < 0.05$), and Farmyard Manure Application ($\rho = 0.202$, $p < 0.01$). This interrelationship explains the existing linkages between measures for conservation and soil fertility, as ox-drawn tillage enhances soil aeration and organic matter incorporation, which results to better water infiltration and reduced soil erosion (Kassie *et al.*, 2013). Strong positive correlation was observed between the use of farmyard manure and Ox-Drawn Tillage with coefficient ($\rho = 0.289$, $p < 0.001$), and Tree Planting with coefficient ($\rho = 0.204$, $p < 0.01$). The findings indicates the possibility of farmers who uses organic manure to implement agroforest and sustainable tillage practices for enhancing soil fertility and long-term soil stabilization. This interrelationship is important as the use of organic manure contributes to soil structure while trees planting contribute to soil water conservation and prevent soil erosion (Muthee *et al.*, 2021). Findings from the study reveals statistically significant correlations between Soil Water Conservation and other practices such as Ox-Drawn Tillage ($\rho = 0.271$, $p < 0.001$), Tree Planting ($\rho = 0.168$, $p < 0.05$), and Farmyard Manure Application ($\rho = 0.202$, $p < 0.01$). This interrelationship explains the existing linkages between measures for conservation and soil fertility, as ox-drawn tillage enhances soil aeration and organic matter incorporation, which results to better water infiltration and reduced soil erosion (Kassie *et al.*, 2013). Strong positive correlation was observed between the use of farmyard manure and Ox-Drawn Tillage with coefficient ($\rho = 0.289$, $p < 0.001$) and Tree Planting with coefficient ($\rho = 0.204$, $p < 0.01$). The findings indicates the possibility of farmers who uses organic manure to implement agroforest and sustainable tillage practices

for enhancing soil fertility and long-term soil stabilization. Energy-Efficient Cooking Stoves showed significant correlations with Ox-Drawn Tillage ($\rho = 0.315$, $p < 0.001$) and Tree Planting ($\rho = 0.227$, $p < 0.01$), indicating that households using energy-efficient stoves may prefer to implement afforestation practices to combine dual benefits of reduced firewood dependency and environmental conservation (Gebreegziabher et al., 2018). A research conducted by Masera et al. (2015) support the findings where by improved cooking technologies were found to work well together with tree conservation efforts for reducing deforestation. Positive correlation of Trees Planting on Ox-Drawn Tillage ($\rho = 0.301$, $p < 0.001$) showed the importance of mixing environmental conservation and sustainable agricultural practices for climate resilience. The reason behind being that, trees planting has been widely recognized for its role in mitigating soil erosion, improving water retention, and providing shade for crops in semi-arid environments (Nyong et al., 2007).

Table 3*Correlation Matrix (rho) of Climate Adaptation Practices*

Practices	Ox-Drawn Tillage	Tree Planting	Cooking Stoves	Manure Application	Soil Water Conservation
Soil Water Conservation	0.271 (0.084) ***	0.168 (0.092) *	0.109 (0.078)	0.202 (0.091) **	1
Manure Application	0.289 (0.091) ***	0.204 (0.095) **	0.122 (0.082)	1	
Cooking Stoves	0.315 (0.097) ***	0.227 (0.099) **	1		
Tree Planting	0.301 (0.096) ***	1			
Ox-Drawn Tillage	1				

4.2.1 Multiple Correspondence Analysis (MCA) Results

To test the association among Relative User Satisfaction constructs and reduce dimensions of data, the Multiple Correspondence Analysis (MCA) was used in the study. The results showed high construct validity and internal consistency among the constructs, with Self-Efficacy ($\alpha = 0.79$), Subjective Norms ($\alpha = 0.76$), and Perceived Image ($\alpha = 0.77$) showing strong reliability. The observed Cronbach's alfa ($\alpha > 0.7$) means that the selected constructs are influential to sustained implementation of CCA practices in the agro-ecological zones.

Table 4*Multiple Correspondence Analysis (MCA) for Relative User Satisfaction Constructs*

Construct	Dimension 1	Dimension 2	Cronbach's Alpha
Self-Efficacy	0.72	0.51	0.79
Subjective Norms	0.69	0.48	0.76
Usage Experience	0.63	0.45	0.74
Output Quality	0.58	0.42	0.71
Results Demonstrability	0.66	0.49	0.73
Perceived Image	0.71	0.50	0.77
Usability	0.68	0.46	0.75
Perceived Risks*	-	-	0.68
Relevance*	-	-	0.67
Compatibility*	-	-	0.69

*Dropped Constructs (Cronbach's Alpha < 0.7)

Factor extraction analysis indicated that two dimensions sufficiently represented the underlying constructs, with cumulative variance explained at 67.2%. The eigenvalues (2.81 and 1.97) reinforced the importance of these dimensions. The Kaiser–Meyer–Olkin measure of sampling adequacy (KMO=0.79) confirmed a strong suitability of the dataset for factor analysis, while the Cronbach's Alpha of 0.72 further emphasized presence of strong internal consistency of the constructs measured.

Table 5*Factor Extraction Summary*

Measure	Value
Eigenvalues (Largest, Smallest)	(2.81, 1.97)
Variance Explained (%)	43.5%
Cumulative Variance Explained (%)	67.2%
Cronbach's Alpha	0.72
Kaiser–Meyer–Olkin (KMO) Test	0.79

Eigenvalues > 1 suggest retention of two dimensions; Variance explained (67.2%) confirms adequate construct validity; Cronbach's Alpha (0.72) indicates good internal consistency; KMO = 0.79 confirms sufficient sample adequacy for factor analysis.

4.3 The Influence of Relative User Satisfaction on the Sustainability of CCA Practices

Findings from the Multivariate the Ordered Probit Regression model applied in the study highlight the influence of Relative User Satisfaction on the Sustainability of Climate Change Adaptation Practices. Self-Efficacy significantly influenced all five adaptation practices, with the strongest effect observed on Soil Water Conservation ($\beta = 1.07$, $p < 0.01$) and the lowest on the use of Energy-Efficient Cooking Stoves ($\beta = 0.84$, $p < 0.05$). This suggests that individuals with higher confidence in their ability to implement adaptation strategies are more likely to sustain them. The findings align with studies by Alharbi and Drew (2019) and Ung *et al.* (2015), who found that self-efficacy is crucial for the adoption and continued use of technological solutions. Additionally, Narayan-Parker (2005) emphasized that self-efficacy enhances adaptive capacity, reinforcing the role of psychological determinants in sustainability. Subjective Norms played a significant role in influencing CCA sustainability, with the strongest effect on Ox-Drain Tillage ($\beta = 0.75$, $p < 0.01$) and highest significance on Trees Planting ($\beta = 0.71$, $p < 0.001$). This indicates that social influences play a vital role in sustaining adaptation practices and is consistent with Nugraha *et al.* (2024) who demonstrated that farmers' adoption of Climate-Smart Agriculture (CSA) is largely influenced by peer opinions, community support, and social networks. The study also found a moderate impact of Usage Experience on sustainability, with the highest coefficient for Ox-Drain Tillage ($\beta = 0.63$, $p < 0.05$), while the influence on Cooking Stoves was insignificant. These results indicate that prior experience with a practice supports its continued use but is less influential than other factors. Output Quality exhibited a weak influence across all adaptation practices, with the highest impact on Tree Planting, though it was statistically insignificant.

This suggests that, while perceived effectiveness of an adaptation strategy is important, it does not strongly dictate its sustainability. This finding aligns with Sang *et al.* (2009), who found that, while output quality contributes to e-government adoption, it was less influential in mobile commerce and payment technology (Faqih & Jaradat, 2015). Results Demonstrability significantly influenced Tree Planting ($\beta = 0.61$, $p < 0.05$) and Farm Yard Manure ($\beta = 0.60$, $p < 0.05$). This indicates that individuals are more likely to sustain adaptation practices when they can clearly observe tangible benefits. Makate *et al.* (2018) noted that smallholder farmers are more inclined to adopt CSA practices when they see direct improvements in food security, income, and resilience to climate shocks. Perceived Image emerged as the most influential predictor, with all the coefficients exceeding $\beta = 1.0$ and being significant at the $p < 0.01$ level across all adaptation practices. The strongest effect was observed on Soil Water Conservation ($\beta = 1.20$, $p < 0.01$), indicating that individuals were more likely to continue practices that enhanced their social status or reputation. These findings align with Chismar and Wiley-Patton (2003), who noted that perceived image influences the adoption of CSA technologies, as farmers associate their use with improved social standing. Usability had a moderate effect, with coefficients ranging from $\beta = 0.69$ (Cooking Stoves, at $p < 0.05$) to $\beta = 0.79$ (Ox-Drain Tillage, at $p < 0.05$). This suggests that ease of implementation supports sustainability, though its impact is less pronounced than Self-Efficacy and Perceived Image. Abera and Tesema (2019) reported similar findings, noting that usability enhances farmers' adaptive behaviour. Alsyof *et al.* (2023) also emphasized that ease of use increases the likelihood of long-term adoption and sustainability of climate adaptation practices.

Table 6

Results of the Multivariate Ordered Probit Regression model for Relative User Satisfaction on Sustainable Climate change Adaptation Practices

Variables	Ox-Drawn Tillage	Tree Planting	Cooking Stoves	Manure Application	Soil Water Conservation
Self-Efficacy	0.92 (0.27) ***	1.02 (0.29) ***	0.84 (0.28) **	0.99 (0.30) ***	1.07 (0.31) ***
Subjective Norms	0.75 (0.24) ***	0.71 (0.27) **	0.66 (0.26) **	0.74 (0.29) **	0.68 (0.28) **
Usage Experience	0.63 (0.30) *	0.55 (0.32)	0.49 (0.31)	0.52 (0.33)	0.50 (0.33)
Output Quality	0.47 (0.28)	0.48 (0.29)	0.45 (0.30)	0.43 (0.31)	0.41 (0.32)
Results Demonstrability	0.58 (0.31)	0.61 (0.32) *	0.56 (0.29) *	0.60 (0.31) *	0.58 (0.30) *
Perceived Image	1.05 (0.29) ***	1.14 (0.31) ***	1.08 (0.32) ***	1.12 (0.34) ***	1.20 (0.35) ***
Usability	0.79 (0.26) **	0.76 (0.28) **	0.69 (0.27) **	0.71 (0.29) **	0.73 (0.29) **
Constant	-1.24 (0.50) **	-1.18 (0.52) **	-1.30 (0.53) **	-1.35 (0.55) **	-1.40 (0.57) **
Wald χ^2 (70)	348.52*	362.18*	331.74*	345.61*	359.02*
n	295	295	295	295	295

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, Robust standard errors in parentheses.

The results underscore that Perceived Image and Self-Efficacy were the most critical determinants of sustainability in climate adaptation practices. Subjective Norms also played a crucial role, particularly in practices reliant on social validation. These insights provide valuable guidance for policymakers and practitioners in designing user-friendly interventions that consider user confidence, Leverage social influence and reputational benefits

4.4 Chances of sustainability of CCA practices influenced by Relative User Satisfaction

The probability of sustaining the implementation of CCA practices after funding with influence of RUS was determined using Marginal analysis. Findings from the results identified perceived image to have highest marginal effect across all the practices, but strongest on Soil Water Conservation with Marginal effect of ($dy/dx=0.170$, $p<0.001$), and the lowest marginal effect on Energy-Efficient Cooking Stoves ($dy/dx=0.130$, $p<0.001$). This explain that individual are more likely to adopt and continue adoption when the practices enhances their social recognition or aligns with what they need to feel. Significant marginal effect was also observed on Self-efficacy to practices such as Soil Water Conservation ($dy/dx=0.150$, $p<0.001$) and Tree Planting ($dy/dx=0.140$, $p<0.001$). These findings tells that for one unit increase of self-efficacy there is 15% and 14% chances of sustainability of Soil water conservation and Trees planting in future signifying the importance of confidence through continuous training and technical support (Ajzen, 1991; Bandura, 2006). High Chances of sustainability by Subjective norms were also observed on Ox-Drawn Tillage with ($dy/dx=0.1$, $p<0.01$), Energy-Efficient Cooking Stoves ($dy/dx=0.08$, $p<0.01$), and Farm Yard Manure ($dy/dx=0.1$, $p<0.01$). The findings reveal the contribution of peer and community norms on sustaining the adoption through motivation by elder people around them and norms which bind them. Results Demonstrability expressed high chances in sustainability of Tree Planting with ($dy/dx=0.09$, $p < 0.01$) followed by Ox-Drawn Tillage at ($dy/dx=0.080$, $p < 0.01$) and the use of farm yard manure at ($dy/dx=0.080$, $p < 0.01$). The findings complement the idea that individuals are happy and willing to continue implementing the practices when they are able to make results visible to others. Usability showed moderate significant marginal effects practices particularly in Ox-drain tillage ($dy/dx=0.090$, $p < 0.01$), Tree Planting ($dy/dx=0.018$, $p < 0.01$), and Soil water conservation ($dy/dx=0.049$, $p < 0.01$), demonstrating that ease of use and practicality enhance long-term engagement. Prior research supports this assertion, emphasizing that user-friendly and adaptable technologies encourage continued adoption among smallholder farmers (Nyanga et al., 2011; Kassie *et al.*, 2013).

The Wald chi-square values (χ^2) and pseudo R^2 results confirmed the robustness of the model, with a pseudo R^2 range between 0.108 and 0.163, suggesting a moderate model fit (Greene, 2012). The findings emphasize the need for targeted strategies that enhance self-efficacy, leverage social norms, ensure usability, and demonstrate observable benefits. These elements are critical for the sustainability of climate adaptation interventions in agro-ecological zones.

Table 7*Marginal effect (dy/dx) for RUS across Climate Change Adaptation practices*

Variables	Ox-Drawn Tillage	Tree Planting	Cooking Stoves	Manure Application	Soil Water Conservation
Self-Efficacy	0.120 (0.025)***	0.140 (0.045)***	0.110 (0.017)**	0.130 (0.016)***	0.150 (0.034)***
Subjective Norms	0.100 (0.048)**	0.090 (0.034)*	0.080 (0.017)**	0.100 (0.022)**	0.110 (0.012)*
Usage Experience	0.060 (0.039)*	0.050 (0.038)*	0.040 (0.022)	0.050 (0.025)*	0.060 (0.034)
Output Quality	0.040 (0.034)	0.030 (0.011)*	0.030 (0.031)	0.040 (0.028)	0.050 (0.017)*
Results Demonstrability	0.080 (0.016)**	0.090 (0.049)**	0.070 (0.027)*	0.080 (0.041)**	0.100 (0.013)*
Perceived Image	0.140 (0.016)***	0.160 (0.043)***	0.130 (0.022)***	0.150 (0.018)***	0.170 (0.048)***
Usability	0.090 (0.012)**	0.110 (0.018)**	0.100 (0.034)*	0.100 (0.031)	0.120 (0.049)**
Wald χ^2 (70)	349.19*	372.71*	362.52*	352.27*	360.15*
Pseudo R ²	0.149	0.108	0.112	0.163	0.124

These findings underscore the need for strategies that enhance self-efficacy, leverage social norms, and ensure practices are user-friendly and deliver observable benefits.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study examined the influence of relative user satisfaction on the sustainability of climate change adaptation (CCA) practices after funding period in Chamwino and Igunga agro-ecological zones. The findings revealed variation in sustainability of CCA practices, with highest prevalence of trees planting and the use of farmyard manure practices across the zones, indicating strong post-funding sustainability. Practices such as Ox-drain tillage demonstrated moderate prevalence, while soil water conservation and energy-efficient cooking stoves had lower prevalence rates. These findings inform that the sustainability of the CCA practices after funding period depends on community awareness, practicality in implementation and expected benefits. Practices expressed high adoption was due to their simplicity in implementation, immediate benefits and alignment with local knowledge, while practices scored lowest adoption was to labor demands, technical barriers, and socio-economic factors. Therefore, for sustainable adoption, future programs should prioritize community engagement, simplify implementation, and address socio-cultural and economic barriers during project design. In line with the Technology Acceptance Model (TAM), self-efficacy and perceived image emerged as the most influential determinants across the practices, with Subjective norms also playing a vital role. Usage experience and Usability had moderate effect while Output quality had a relatively weak impact, and Results demonstrability found significant for specific practices. The findings inform that human-centered factors through individual's confidence and the social recognition are important in driving the adoption and sustained use of Climate adaptation practices. Individuals are more likely to engage with the interventions when they believe in their own capability to successfully use them and when the practice positively contributes to leveraging their social networks

5.2 Recommendations

Study findings recommends that, for sustainability of the climate adaptation interventions, government through ministries should design future policies, programs and projects with consideration of community engagement, practicability, and socio-cultural and economic factors. Targeted training programmes incorporating practical demonstrations and hands-on experiences should also be developed by local government authorities and non-government organizations with interest on Climate change adaptations to strengthen individual capacity and motivation. Such training would equip users with the necessary skills and confidence to continue implementing CCA practices beyond external funding support. Promoting role models who have successfully adopted and sustained CCA practices through arrangements developed and monitored by village-level administrations is also important to enhance social influence. Additionally, introducing incentive systems is necessary by the local government authorities and other stakeholders to reward those who are doing well so as to enhance perceived image that boost the social status of individuals resulting to sustainability.

The Vice President's Office (Environment Division), in collaboration with LGAs and community-based organizations (CBOs) should develop community-based Monitoring and Evaluation (M&E) frameworks for ensuring and reinforcing long-term implementation after fund termination. Developing User friendly-guidelines for labour-

intensive practices such as ox-drain tillage and energy-efficient cooking stoves should also be given priority so as to improve usability

Henceforth, by integrating the influence of relative user satisfaction into climate adaptation strategies, policymakers and practitioners should design more effective and sustainable interventions. Policies should focus on strengthening self-efficacy and perceived image while leveraging social influence, promoting showcase platforms, and simplifying the implementation of CCA practices. Addressing these factors could create an enabling environment that fosters long-term adoption, ensuring the continued effectiveness of climate adaptation efforts in the targeted agro-ecological zones.

REFERENCES

- Abera, N., & Tesema, D. (2019). Perceptions and practices of climate change adaptation and mitigation strategies among farmers in the Konta Special District, Ethiopia. *Environmental & Socio-economic Studies*, 7(4), 1–16.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Alharbi, S., & Drew, S. (2019). The role of self-efficacy in technology acceptance. In *Proceedings of the Future Technologies Conference (FTC) 2018: Volume 1* (pp. 1142–1150). Springer International Publishing.
- Alsyouf, A., Lutfi, A., Alsubahi, N., Alhazmi, F. N., Al-Mugheed, K., Anshasi, R. J., Alharbi, N. I., & Albugami, M. (2023). The use of a technology acceptance model (TAM) to predict patients' usage of a personal health record system: The role of security, privacy, and usability. *International Journal of Environmental Research and Public Health*, 20(2), 1347.
- Bailey, D. K. (1998). *Methods of social research*. The Free Press.
- Bandura, A. (2006). Toward a psychology of human agency. *Perspectives on Psychological Science*, 1(4), 164–180. <http://dx.doi.org/10.1111/j.1745-6916.2006.00011.x>
- Breidenich, C., Magraw, D., Rowley, A., & Rubin, R. (1998). The Kyoto Protocol to the United Nations Framework Convention on Climate Change. *American Journal of International Law*, 92(2), 315–331.
- Candelon, B., Dumitrescu, E. I., Hurlin, C., & Palm, F. C. (2013). Multivariate dynamic probit models: An application to financial crises mutation. In *VAR models in macroeconomics—New developments and applications: Essays in honor of Christopher A. Sims* (pp. 395–427). Emerald Group Publishing Limited.
- Chismar, W. G., & Wiley-Patton, S. (2003). Does the extended technology acceptance model apply to physicians? *36th Annual Hawaii International Conference on System Sciences*.
- Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.
- Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., Friel, S., Groce, N., Johnson, A., Kett, M., Lee, M., Levy, C., Maslin, M., McCoy, D., McGuire, B., Montgomery, H., Napier, D., Pagel, C., & Patel, J. (2009). Managing the health effects of climate change. *The Lancet*, 373(9676), 1693–1733.
- Dalcher, I., & Shine, J. (2003). Extending the new technology acceptance model to measure the end-user information systems satisfaction in a mandatory environment: A bank's treasury. *Technology Analysis & Strategic Management*, 15(4), 441–455.
- Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results. *Sloan School of Management, Massachusetts Institute of Technology*.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340.
- Doll, W. J., Deng, X., Raghunathan, T., Torkzadeh, G., & Xia, W. (2004). The meaning and measurement of user satisfaction: A multigroup invariance analysis of the end-user computing satisfaction instrument. *Journal of Management Information Systems*, 21(1), 227–262.
- Faqih, K. M., & Jaradat, M. I. R. M. (2015). Assessing the moderating effect of gender differences and individualism-collectivism at individual level on the adoption of mobile commerce technology: TAM3 perspective. *Journal of Retailing and Consumer Services*, 22(1), 37–52.
- Füssel, H., & Klein, R. J. T. (2006). Climate change vulnerability assessments: An evolution of conceptual thinking. *Climatic Change*, 75(3), 301–329.
- Gebreegziabher, Z., Mekonnen, A., Kassie, M., & Köhlin, G. (2018). Household tree planting in Tigray, northern Ethiopia: Tree species, purposes, and determinants. *Resources, Conservation and Recycling*, 133, 139–150.
- Gifford, R., Kormos, C., & McIntyre, A. (2011). Behavioral dimensions of climate change: Drivers, responses, barriers, and interventions. *Wiley Interdisciplinary Reviews: Climate Change*, 2(6), 801–827.
- Greene, W. H. (2012). *Econometric analysis* (7th ed.). Pearson.
- Guillen-Royo, M. (2015). *Sustainability and well-being: Human-scale development in practice*. Routledge.

- Hofisi, C., & Chizimba, M. (2013). The sustainability of donor-funded projects in Malawi. *Mediterranean Journal of Social Sciences*, 4(6), 705–714.
- Hong, S., Thong, J. Y., & Tam, K. Y. (2006). Understanding continued information technology usage behavior: A comparison of three models in the context of mobile internet. *Decision Support Systems*, 42(3), 1819–1834.
- Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological Forecasting and Social Change*, 80(3), 525–540.
- Khoza, S., De Beer, L. T., Van Niekerk, D., & Nemaconde, L. (2020). A gender-differentiated analysis of climate-smart agriculture adoption by smallholder farmers: Application of the extended technology acceptance model. *Gender, Technology and Development*, 25(1), 1–21.
- Kimbowa, R., Mwayafu, D. M., & Mugenyi, O. (2011). REDD+ negotiations: Insights from Africa. *International Institute for Environment and Development (IIED)*.
- Komalawati, D. S. (2008). *Participation and project sustainability: Participatory integrated development in rain-fed areas project in East Java, Indonesia* (Unpublished MSc thesis). Massey University.
- Kothari, C. R. (2014). *Research methodology: Methods and techniques* (2nd ed.). New Age International.
- Kunze, I., & Avelino, F. (2015). Social innovation and the global ecovillage movement. *Ecological Economics*, 114, 243–253.
- Ma, Q., & Liu, L. (2004). The technology acceptance model. *Journal of Organizational and End User Computing*, 16(1), 59–72.
- Makate, M., Makate, C., Mango, N., & Siziba, S. (2018). Increasing resilience of smallholder farmers to climate change through multiple adoption of proven climate-smart agriculture innovations: Lessons from Southern Africa. *Journal of Environmental Management*, 231, 858–868. <https://doi.org/10.1016/j.jenvman.2018.10.069>
- Masera, O. R., Bailis, R., Drigo, R., Ghilardi, A., & Ruiz-Mercado, I. (2015). Environmental burden of traditional bioenergy use. *Annual Review of Environment and Resources*, 40(1), 121–150.
- McCarthy, N., Lipper, L., & Branca, G. (2011). Climate-smart agriculture: Smallholder adoption and implications for climate change adaptation and mitigation (Vol. 3). FAO.
- McMichael, A. J., Powles, J. W., Butler, C. D., & Uauy, R. (2007). Food, livestock production, energy, climate change, and health. *The Lancet*, 370(9594), 1253–1263.
- Mdoe, S. Y., & Kilawi, C. J. (2014). Enhancing climate change adaptation and ecosystems of the Uluguru Mountains: Final project evaluation report. Sokoine University of Agriculture.
- Mngomezulu, N., Challenor, M., Munapo, E., Mashau, P., & Chikandiwa, C. (2015). The impact of recognition on retention of good talent in the workforce. *Journal of Governance and Regulation*, 4(4), 372–379.
- Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing workforce. *Personnel Psychology*, 53(2), 375–403.
- Mswima, F. S., & Kaswamila, A. (2022). Role of eco-village initiatives in mitigating desertification in semi-arid areas of Tanzania. In *IntechOpen* (pp. 1–13). IntechOpen.
- Mtwanga, J., Haule, T., & Fundisha, E. (2022). Sustainability of adaptation strategies in rainfed agriculture to climate change and variability in Nyang'oro Ward, Iringa district, Tanzania. *Journal of the Geographical Association of Tanzania*, 42(1), 129–144.
- Muthee, K., Macharia, M., & Mwangi, W. (2021). Sustainable land management practices and their impact on soil fertility: Case study from semi-arid regions of Kenya. *Journal of Sustainable Agriculture and Environment*, 10(1), 45–60.
- Myles, K., Olesen, G. B., Tamilselvam, D., & Poonia, A. (2015). Evidence-based advocacy for low-carbon, pro-poor sustainable eco-village development in South Asia. www.ideassrilanka.org.
- Narayan-Parker, D. (Ed.). (2005). *Measuring empowerment: Cross-disciplinary perspectives*. World Bank Publications.
- Njau, F. B. (2014a). Achievements and challenges of climate change adaptation: A case of semi-arid areas – Chololo project in central Tanzania. Presented at the National Conference, November 12, 2014. Retrieved from <http://chololoecovillage.wordpress.com>
- Njau, F. B. (2014b). The final evaluation of the Chololo Ecovillage project on empowering vulnerable rural communities to adapt and mitigate the impacts of climate change in central Tanzania. Retrieved from <https://reliefweb.int/report/united-republic-tanzania/Chololo-ecovillage-model-good-practice-climate-change-adaptation>
- Nugraha, R., Muhaimin, A. W., Maulidah, S., Putri, R. W., & Maulidah, D. L. (2024). Fostering food security through farmers' intentions to embrace climate-smart agriculture: Unraveling the impact of attitude, subjective norms, and behavioral control. *IOP Conference Series: Earth and Environmental Science*, 1323(1), 012018.
- Nyanga, P. H., Johnsen, F. H., Aune, J. B., & Kalinda, T. H. (2011). Smallholder farmers' perceptions of climate change and conservation agriculture: Evidence from Zambia. *Journal of Sustainable Development*, 4(4), 73.

- Nyong, A., Adesina, F., & Osman-Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12(5), 787–797.
- Oguntuase, O. J., Adu, O. B., & Obayori, O. S. (2023). How do individual-level factors influence the adoption of low-carbon technology? Proposing and validating the bioeconomy technology acceptance model in the context of Africa. *Frontiers in Sustainability*, 4, 1148001.
- Olivier, T. (2015). The Senegalese ecovillage network: The past, present, and future. Retrieved from https://ecovillage.org/sites/default/files/files/5report_senegalese_ecovillage
- Petter, S., DeLone, W., & McLean, E. R. (2013). Information systems success: The quest for the independent variables. *Journal of Management Information Systems*, 29(4), 7–62.
- Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S., & Milligan, A. (2009). Community-based adaptation: An overview. In H. Reid (Ed.), *Community-based adaptation to climate change* (pp. 11–38). International Institute for Environment and Development.
- Rockström, J., Kaumbutho, P., Mwalley, J., Nzabi, A., Temesgen, M., Mawenya, L., Barron, J., Mutua, J., & Damgaard-Larsen, S. (2008). Conservation farming strategies in East and Southern Africa: Yields and rainwater productivity from on-farm action research. *Soil and Tillage Research*, 103(1), 23–32.
- Sang, S., Lee, J. D., & Lee, J. (2009). E-government adoption in ASEAN: The case of Cambodia. *Internet Research*, 19(5), 517–534.
- Scheirer, M. A., Santos, S. L. Z., Tagai, E. K., Bowie, J., Slade, J., Carter, R., & Holt, C. (2017). Dimensions of sustainability for a health communication intervention in African American churches: A multi-methods study. *Implementation Science*, 12(1), 43.
- Sewando, P. T. (2023). Adoption of sustainable land management practices in Mbulu district, a semi-arid area in northern Tanzania. *Asian Journal of Environment & Ecology*, 20(3), 36–47.
- Sosa-Rubi, S. G., Galárraga, O., & Harris, J. E. (2009). Heterogeneous impact of the “Seguro Popular” program on the utilization of obstetrical services in Mexico, 2001–2006: A multinomial probit model with a discrete endogenous variable. *Journal of Health Economics*, 28(1), 20–34.
- Stern, N. (2006). *Stern review: The economics of climate change*. Cambridge University Press.
- Sun, P., Tsai, R. J., Finger, G., Chen, Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 50(4), 1183–1202.
- Tittonell, P., Muriuki, A., Shepherd, K., Mugendi, D., Kaizzi, K., Okeyo, J., Verchot, L., Coe, R., & Vanlauwe, B. (2009). The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa: A typology of smallholder farms. *Agricultural Systems*, 103(2), 83–97.
- UNDP. (2010). *Human development report 2010: The real wealth of nations: Pathways to human development*. Palgrave Macmillan.
- UNFCCC. (2007). *Impacts, vulnerabilities, and adaptation in developing countries*. Climate Change Secretariat.
- Ung, M., Luginaah, I., Chuenpagdee, R., & Campbell, G. (2015). Perceived self-efficacy and adaptation to climate change in coastal Cambodia. *Climate*, 4(1), 1.
- URT. (2012a). *Monitoring and evaluation framework for climate change adaptation in Tanzania*. Vice President’s Office, Environment.
- URT. (2013b). *The national climate change strategy*. Dar es Salaam, Tanzania: Vice President’s Office, Environment.
- URT. (2014b). *State of the environment report 2*. Dar es Salaam, Tanzania: Vice President’s Office, Environment.