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Original Article

Assessment of the Level of Awareness of Climate-Smart Agricultural Practices among Smallholder Farmers in Mwingi West Sub-county, Kitui County, Kenya

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Climate-Smart Agriculture, Climate change, Awareness Level, Adoption Determinants, Kitui County-Kenya.

ABSTRACT

Smallholder farmers in Mwingi West Sub-county, Kitui County, rely heavily on rainfed agriculture, making them highly vulnerable to climate change. Although Climate-Smart Agriculture (CSA) provides a sustainable approach to enhance productivity, resilience, and reduce emissions, its adoption in the region remains limited. This study assessed the level of awareness of Climate-Smart Agricultural (CSA) practices among smallholder farmers in Mwingi West Sub-county. The CSA practices considered included conservation agriculture (CA), mulching, water harvesting, irrigation technologies, integrated pest management (IPM), agroforestry, weather-based agro-advisories, inorganic fertiliser use, zai pits, and soil conservation structures. A cross-sectional design was employed, involving 393 randomly selected smallholder farmers, with the sample size determined using Yamane's formula. In addition, purposive sampling was used to select seven agricultural extension officers and eight farmer groups for key informant interviews and focus group discussions. Data were analysed using chi-square tests and binary logistic regression in SPSS v26. The results showed that 83.2% of farmers were aware of CSA, yet significant disparities existed in sources of information, training participation, and knowledge of specific practices. These variables were statistically associated with CSA adoption at $p < 0.05$. To enhance CSA adoption, the study recommended strengthening extension services and baraza platforms to deliver regular, practical training; improving the use of digital tools such as radio, TV, SMS, and WhatsApp for timely information dissemination; and encouraging the formation of farmer groups to support peer learning and localised knowledge exchange.

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INTRODUCTION

Agriculture remains the backbone of rural livelihoods and national economies in many developing countries, particularly in Sub-Saharan Africa, where smallholder farmers account for more than 70% of agricultural production (World Bank, 2021; Jayne & Sanchez, 2021). In Kenya, the agricultural sector contributes approximately 20% to the gross domestic product and supports over 70% of rural households (Central Bank of Kenya, 2024). However, the sector's dependence on rain-fed systems makes it highly vulnerable to climate change impacts such as erratic rainfall, prolonged droughts, and land degradation (Kogo et al., 2022; Mogeni, 2024). These climatic shocks have significantly undermined agricultural productivity, food security, and rural livelihoods, particularly in arid and semi-arid lands (ASALs) (Waiyaki et al., 2012).

According to the Food and Agriculture Organization (FAO, 2013), the climate-smart agriculture (CSA) framework was introduced as an integrated approach aimed at improving agricultural productivity, enhancing food security, and increasing resilience to climate variability and change. In addition, CSA seeks to mitigate greenhouse gas emissions while simultaneously promoting sustainable agricultural development. This approach integrates sustainable farming practices with advanced technologies to boost productivity, promote efficient and sustainable resource use, and enhance farmers' capacity to mitigate the effects of climate-related risks (Matteoli et al., 2020; FAO, 2020). Globally, CSA has demonstrated considerable potential, particularly in climate-vulnerable regions such as Sub-Saharan Africa, where agriculture remains highly sensitive to the adverse effects of climate change (Akinsemolu et al., 2024).

In response, Kenya has developed national strategies like the Kenya Climate-Smart Agriculture Strategy (KCSAS) and implemented projects such as KCEP-CRAL and ASDSP to promote CSA practices across the country, including in Mwingi West Sub-County. Despite these efforts, adoption of CSA remains low in many regions, particularly in Kitui County (Waaswa et al., 2024; Muriithi et al., 2021). A critical barrier to uptake is limited awareness, which significantly influences whether farmers recognise, understand, or apply CSA practices. Although some smallholders are aware of individual techniques such as drought-tolerant crop varieties or intercropping, a comprehensive understanding of CSA as a holistic approach remains limited (Nyasimi et al., 2017; Kurgat et al., 2020)

This study focused on the awareness and adoption of Climate-Smart Agriculture (CSA) practices in Mwingi West Sub-county, Kitui County, a semi-arid region that is highly vulnerable to climate shocks. By examining farmers' familiarity with

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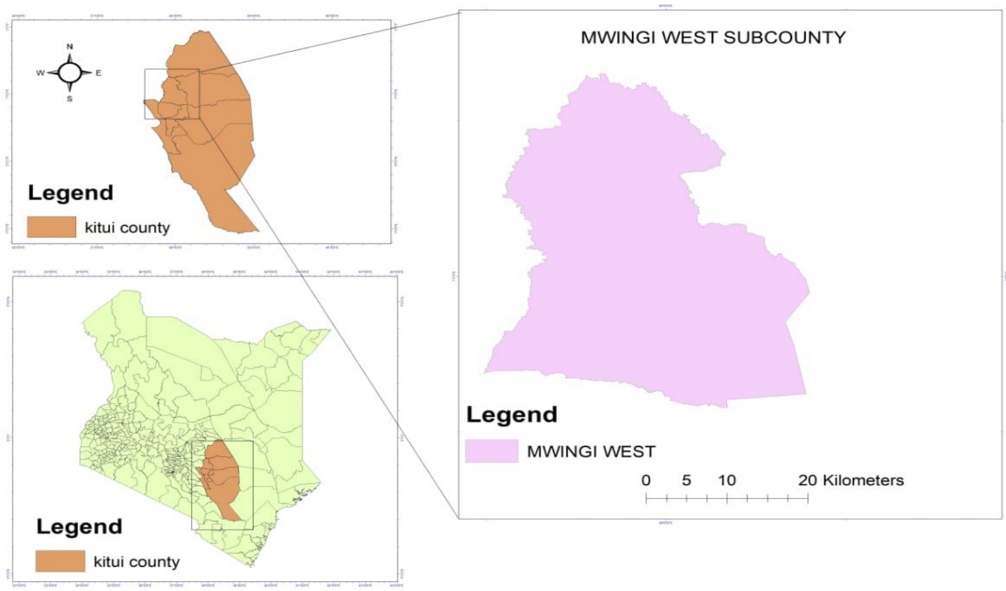
CSA and identifying key barriers to adoption, the research aimed to provide empirical evidence to guide policy formulation, agricultural programming, and extension services for enhancing climate resilience in Kenya's arid and semi-arid lands (ASALs).

MATERIALS AND METHODS

Description of the Study Area

This study was conducted in Mwingi West Sub-county (figure 1), Kitui County, Kenya, covering approximately 1,090 km² with a population of 115,816 (KNBS, 2019). The sub-county comprises four administrative wards: Migwani, Nguutani, Kyome/Thaana, and Kiomo/Kyethani. Agro-ecologically, it falls within Upper Midland (UM 3–4), Lower Midland (LM 4–5), and Inner Lowland (IL 5) zones, with elevations ranging from 400 to 1,830 meters above sea level (KCIDP, 2018). The area experiences a bimodal rainfall pattern (400–760 mm annually) and temperatures ranging from 14°C to 35°C (Kenya Meteorological Department, 2022), supporting two cropping seasons per year. Agriculture is the dominant livelihood activity, contributing approximately 87% of rural household income (Kenya County Climate Risk Profile: Kitui County, n.d).

Figure 1: Map of the Study Area



Research Design

This study adopted a cross-sectional survey design, enabling data to be gathered at a given time (Maier et al., 2023)

Target Population and Sample Size Determination

The study targeted a population of 22,705 smallholder farmers in Mwingi West Sub-county, Kitui County (Ministry of Agriculture and Livestock Development, 2024). In addition, agricultural extension officers and leaders of farmer groups were included to provide broader insights into the factors influencing the adoption of climate-smart agricultural practices**.**

The sample size was calculated using Yamane's (1967) formula:

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{22{,}705}{1+22{,}705\,(0.05)^2}$$

n=393

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Sampling Techniques

The study adopted a multi-stage sampling approach. Mwingi West Sub-county was purposively selected due to its low CSA adoption and high climate vulnerability (Campbell et al., 2020). Stratified sampling divided the area into four wards for geographic and ecological representation (Iliyasu & Etikan, 2021), followed by simple random sampling to select smallholder farmers (Noor et al., 2022). Agricultural extension officers and farmer groups were purposively sampled for their CSA-related knowledge.

Data Analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 26, employing chi-square tests and binary logistic regression analysis.

Binary logistic regression was used to examine the effect of farmer characteristics on the likelihood of adopting climate-smart agriculture (CSA) practices. The model is specified as: $\text{Logit}(P)=\text{In}\left(\frac{P}{1-P}\right)=\beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5$

Where:

P is the probability of CSA adoption, and X_1–X_5 represent key independent variables: education level, age, gender and income level

RESULTS

Demographic Information

The demographic characteristics of the respondents, as presented in Table 1, provide a comprehensive overview of the population involved in the study on the adoption of climate-smart agriculture (CSA). Gender distribution shows a higher participation of female respondents, accounting for 59.3%, compared to 40.7% male respondents. This indicates that women play a dominant role in smallholder farming activities in the study area, possibly reflecting their active involvement in agricultural production and household food security.

Regarding the age of household heads, the majority of respondents (28.8%) were between 50 and 59 years, followed by those aged 60–69 years (22.4%) and those above 69 years (19.8%). Respondents aged 40–49 years constituted 20.9%, while the youngest group (below 40 years) represented only 8.1%. These findings suggest that most farming households are headed by older individuals, indicating a possible generational gap in agricultural participation and decision-making, which may influence the adoption of modern CSA practices.

In terms of education levels, the highest proportion of respondents had attained primary education (44.0%), followed by tertiary education (26.0%) and secondary education (21.9%). A small portion (8.1%) had no formal education. This distribution highlights a relatively literate farming population, which may be advantageous for the dissemination and understanding of CSA technologies and practices.

When analysing family size, the majority of households (51.4%) had between 4 to 7 members, followed by 26.0% with 8 to 11 members, and 22.6% with fewer than 4 members. Notably, no household reported having more than 11 members. Larger family sizes may contribute positively to labour availability for agricultural activities, including the implementation of CSA practices.

The data on farming experience indicates that a significant number of respondents (36.1%) had over 20 years of experience in farming, followed by 25.7% with 30–39 years of experience. However, a surprisingly low 9.1% reported 20–29 years of experience, which may reflect either a data recording error or a demographic transition.

Finally, in terms of technology use, 52.2% of respondents reported owning a smartphone, while 47.8% did not. This near-equal distribution indicates a growing level of digital connectivity among farmers, which can be leveraged for the dissemination of CSA-related information, market access, weather updates, and training.

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Table 1: Demographic Information

Demographic data	Responses	F (%)
Gender	Male	160 (40.7)
	Female	233 (59.3)
Age of house head	<40	32(8.1)
	40-49	82(20.9)
	50-59	113 (28.8)
	60-69	88(22.4)
	>69	78 (19.8)
Academic level	None	32(8.1)
	Primary	173(44.0)
	Secondary	86(21.9)
	Tertiary	102(26.0)
Family size	<4	89(22.6)
	4-7	202(51.4)
	8-11	102(26.0)
	>11	0(0.0)
Farming experience in years	>20	53(36.1)
	20-29	142(9.1)
	30-39	101(25.7)
Own smart phone	Yes	205(52.2)
	No	188(47.8)

Level of Awareness of Climate-Smart Agricultural (CSA) Practices among Smallholder Farmers

The results in Table 2 indicate that a significant majority of farmers, 83.2%, have heard about climate-smart agriculture (CSA), while only 16.8% have not. The chi-square test yielded a p-value of 0.000, indicating a statistically significant difference in awareness levels among the respondents. This implies that CSA is relatively well-known among the farming community.

When asked about the sources of information on CSA, the most frequently cited sources were farmer groups (30.3%), fellow farmers (20.9%), and local non-governmental organisations (17.3%). Other sources, such as extension officers and barazas, each accounted for 8.7%, while radio/TV stations (5.6%), print media (4.3%), and social media (4.3%) were less commonly mentioned. The chi-square analysis for these responses revealed a p-value of 0.022, showing a statistically significant variation in the sources of CSA information. This highlights the important role that informal networks and community-based organisations play in disseminating CSA knowledge, more so than mass media or official government sources.

Regarding training attendance, 56.7% of the respondents reported that they had not attended any CSA training, while 43.3% had participated in some form of training. The p-value of 0.000 confirms a statistically significant difference, emphasising the gap in access to CSA training opportunities among farmers. Among those who had received training, the majority indicated that the workshops were organised by farmer groups (52.4%), followed by government agricultural extension officers (38.9%) and local NGOs (8.7%). The chi-square test produced a p-value of 0.001, indicating a significant difference in the sources of training, with farmer groups emerging as the most influential actors in CSA training efforts.

When analysing the number of training sessions attended, the data show that most farmers attended between three and five sessions 22.1%, while only 21.6% attended less than three sessions, and a small proportion (4.3%) had attended six or more.

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The p-value of 0.003 indicates that the differences in the number of sessions attended were statistically significant, pointing to inconsistent levels of training exposure among farmers.

In terms of awareness of specific CSA practices, conservation agriculture was the most widely known (21.6%), followed by the use of drought-resistant crop varieties (17.3%), both water harvesting techniques and agroforestry at (13.0%). Lesser-known practices included mulching, zai pits, instilled irrigation technologies, and soil conservation structures, each reported by only 1.3% of respondents. The chi-square value and corresponding p-value of 0.001 reflect significant differences in awareness levels of various CSA practices, suggesting that certain practices are more widely promoted or understood than others.

Finally, when respondents were asked to rate their understanding of CSA practices, nearly half (47.6%) rated their understanding as very low, 26.0% rated it as low, 15.5% as moderate, and only 10.9% rated it as high. Notably, none of the respondents rated their understanding as very high. The p-value of 0.000 confirms that these differences are statistically significant. These results underscore a general lack of in-depth understanding of CSA practices among smallholder farmers, even though overall awareness may be relatively high.

These results indicate that a good number of farmers' awareness and related variables showed a significant association with the adoption of CSA at $p < 0.05$.

Table 2: Level of Awareness of Climate-Smart Agricultural (CSA) Practices among Smallholder Farmers

		F (%)	Chi-square (χ^2)	p-value
Heard about CSA	Yes	327(83.2)	0.531	0.000
	No	66(16.8)		
Source of Information	Extension officers	34(8.7)	0.921	0.022
	Local NGOs	68(17.3)		
	Farmer groups	119(30.3)		
	Print media	17(4.3)		
	Radio/TV stations	22(5.6)		
	Social media	17(4.3)		
	Barazas	34(8.7)		
	Fellow farmers	82(20.9)		
Attended any training on CSA	Yes	170(43.3)	0.835	0.000
	No	223(56.7)		
Organisers of training/workshops	Government agricultural extension officers	153(38.9)	0.464	0.001
	Local NGOs	34(8.7)		
	Farmer groups	206(52.4)		
Number of training sessions	<3	289(21.6)	0.243	003
	3-5	87(22.1)		
	6 and above	17(4.3)		
CSA practices farmers are aware of	Conservation agriculture	85(21.6)	0.853	0.001
	Use of drought-resistant crop varieties	68(17.3)		
	Water harvesting techniques	51(13.0)		
	Use of inorganic fertilisers	34(8.7)		

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	Agroforestry	51(13.0)		
	Weather-based agro-advisories	34(8.7)		
	Use of organic manure	34(8.7)		
	Intercropping	17(4.3)		
	Mulching	5(1.3)		
	Zai pits	5(1.3)		
	Instilled irrigation technologies	5(1.3)		
	Soil conservation structures	5(1.3)		
Rating understanding of CSA practices	Very low	187(47.6)	0.475	0.000
	Low	102(26.0)		
	Moderate	61(15.5)		
	High	43(10.9)		
	Very High	0(0.0)		

Demographic Determinants of CSA Adoption

Further, a binary logistic regression analysis was conducted to determine the influence of various farmer characteristics on the likelihood of adopting climate-smart agricultural (CSA) practices. The results in Table 3 indicate that education level significantly predicts CSA adoption. The odds of adoption among educated farmers were 4.36 times higher than among uneducated farmers (B = 1.473, $p < 0.001$). Similarly, farmers with higher income levels were significantly more likely to adopt CSA, with odds nearly 4.6 times greater than those with lower income (B = 1.523, $p < 0.001$).

Gender also played a significant role, with male farmers being 2.34 times more likely to adopt CSA than female farmers (B = 0.852, p = 0.024), likely due to differences in access to resources and decision-making power.

Conversely, farm size had a negative influence on adoption. Farmers with larger farms were 75% less likely to adopt CSA practices compared to those with smaller farms (B = -1.403, $p < 0.001$), suggesting that implementation over large areas may be more resource-intensive or harder to manage.

In addition, younger farmers were significantly less likely to adopt CSA than older farmers. The odds ratio of 0.18 (B = -1.739, $p < 0.001$) implies that older farmers are more likely to implement CSA, possibly due to more experience, access to land, or engagement with agricultural programs.

Table 3. Logistic Regression Output on the Adoption of CSA Practices

Predictor	B (Coefficient)	S.E.	Wald	(p-value)	Exp(B) (Odds Ratio)
Education	1.473	0.411	12.84	0.000	4.36
Gender (Male)	0.852	0.378	5.08	0.024	2.34
Income (High)	1.523	0.428	12.63	0.000	4.58
Farm Size (Large)	-1.403	0.381	13.57	0.000	0.25
Age (Young)	-1.739	0.412	17.83	0.000	0.18
Constant	0.456	0.198	5.3	0.021	1.58

DISCUSSION

Level of Awareness of Climate-Smart Agricultural (CSA) Practices among Amallholder Farmers

The study findings indicated that there was a statistically significant difference in awareness levels among the respondents. The cited sources were farmer groups, fellow farmers and local non-governmental organisations. The chi-square analysis for these responses revealed a p-value of less than 0.05, showing a statistically significant variation in the sources of CSA information. This highlights the important role that informal

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networks and community-based organisations play in disseminating CSA knowledge, more so than mass media or official government sources. These results agree with Macharia et al. (2020), who noted that exposure to CSA awareness campaigns through non-governmental organisations (NGOs) and government programs contributed to increased recognition of these practices. However, there remains a considerable gap in awareness in remote areas where farmers lack information and training. According to Kamau et al. (2018), many smallholders have limited awareness of climate-smart options due to insufficient outreach programs and resource constraints.

Regarding training attendance, there was a statistically significant difference, emphasising the gap in access to CSA training opportunities among farmers. Among those who had received training, the majority indicated that the workshops were organised by farmer groups, government agricultural extension officers and local NGOs. The chi-square test produced a p-value less than 0.05, indicating a significant difference in the sources of training, with farmer groups emerging as the most influential actors in CSA training efforts. This agrees with Autio et al. (2021), who argued that the lack of awareness hinders the adoption of CSA practices, even when they have the potential to improve productivity and resilience. This is because awareness plays a crucial role in the adoption of climate-smart agriculture (CSA) practices. Without adequate understanding of CSA benefits and techniques, smallholder farmers may be reluctant to implement such practices, limiting their ability to adapt to climate variability and improve agricultural resilience.

The findings of this study, supported by related literature, affirm that awareness of Climate-Smart Agriculture (CSA) practices is a pivotal factor influencing their adoption among smallholder farmers, especially in arid and semi-arid lands (ASALs). As demonstrated by Akuja and Kandagor (2024), limited awareness has contributed to persistent gaps and implementation barriers within CSA policy frameworks. Similarly, Ndungu and Mwangi (2023) observed that inadequate knowledge and insufficient extension training have constrained farmers' capacity to adapt to climate change effectively. These insights collectively highlight that low levels of CSA awareness remain a significant constraint to adoption, reinforcing the need to address informational and institutional limitations in future interventions.

CONCLUSIONS

Level of Awareness of Climate-Smart Agricultural (CSA) Practices among Smallholder Farmers

While most farmers have heard about CSA and receive information primarily through peer networks and farmer groups, the majority have not received adequate training, and their understanding of CSA practices remains limited. The study findings indicated that there was a statistically significant difference in awareness levels among the respondents. The cited sources were farmer groups, fellow farmers and local non-governmental organisations.

Regarding training attendance, there was a statistically significant difference, emphasising the gap in access to CSA training opportunities among farmers. Among those who had received training, the majority indicated that the workshops were organised by farmer groups, government agricultural extension officers and local NGOs. The study concluded that limited awareness and unequal access to training significantly hinder the adoption of climate-smart agriculture (CSA) practices among smallholder farmers, particularly in remote areas. Informal networks and community-based organisations play a critical role in disseminating CSA knowledge.

RECOMMENDATIONS

To enhance awareness and adoption of climate-smart agricultural (CSA) practices, the study recommends strengthening the role of extension officers and community forums by increasing their frequency and coverage to provide consistent, hands-on CSA training. Additionally, mass media and mobile-based platforms such as radio, TV,

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SMS, and WhatsApp should be more strategically utilised to disseminate timely agro-advisories, particularly given the widespread ownership of smartphones among farmers. Finally, the formation of farmer groups should be actively encouraged to promote peer-to-peer learning, as farmers are more likely to adopt CSA practices demonstrated and endorsed by fellow community members.

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