

EFFICACY OF FARMERS' INDIGENOUS KNOWLEDGE IN CLIMATE CHANGE ADAPTATION IN THARAKA SOUTH SUB COUNTY, KENYA

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ABSTRACT

Purpose of the study: The study evaluated the efficacy of farmers' indigenous knowledge practices in climate change adaptation in Tharaka South Sub-County, Kenya.

Statement of the problem: Limited integration of indigenous knowledge into formal climate change adaptation strategies continues to constrain agricultural resilience among smallholder farmers in Kenya, especially in semi-arid areas. Although farmers use formal adaptation strategies, many also rely on time-tested indigenous knowledge systems developed through local experience. However, the extent to which these practices effectively support climate change adaptation in Tharaka South Sub-County remains insufficiently established.

Research methodology: The study was guided by Resilience Theory and Decolonial Theory and adopted a correlational research design. From a target population of 10,968 farming households, a sample of 386 respondents was determined using Slovin's formula at a 95% confidence level and

a 0.05 margin of error. Data were collected using researcher-administered and self-administered questionnaires, complemented by key informant interviews with representatives from ICE, SwedBio, agricultural officials, and community opinion leaders. Quantitative data were analyzed using Spearman's rank-order correlation coefficient at $\alpha = 0.05$.

Findings: Strong positive correlations were observed between several indigenous practices and perceived climate adaptation efficacy. Biological weather forecasting was positively correlated with forecast accuracy ($r_s = .568$, $p < .001$), while cultivation of drought-tolerant crops was associated with food security ($r_s = .555$, $p < .001$) and traditional soil and water conservation was associated with reduced crop failure ($r_s = .544$, $p < .001$). Consultation with indigenous knowledge experts was not significantly associated with yield stability ($r_s = -.042$, $p = .416$) or soil conservation ($r_s = -.064$, $p = .218$).

Conclusion: The study concludes that practical indigenous knowledge practices remain effective, affordable, and sustainable approaches to strengthening rural climate resilience. Their efficacy is strongest where farmers directly apply field-based practices rather than relying solely on advisory consultation.

Recommendations: The study recommends that the Tharaka-Nithi County Government should support access to traditional drought-tolerant seeds, including sorghum, cowpeas, green grams, and millet. The county should also integrate indigenous weather indicators with scientific meteorological forecasts to improve local farming calendars. Farmer training should prioritize practical indigenous soil, water, crop, and pest management practices.

Keywords: *Indigenous knowledge, climate change, climate change adaptation, agricultural planning, agricultural resilience, smallholder farmers*

INTRODUCTION

The existing climate change adaptation measures have not eliminated the agricultural sector's significant vulnerability to climate variability and change (Arora, 2019), making local knowledge systems vital for building resilience in rural agricultural settings. Although agricultural production has improved, climate change has slowed this growth over the past 50 years globally, with adverse impacts concentrated mainly in mid- and low-latitude regions (Calvin et al., 2023). A report by the Integrated Food Security Phase Classification (2022) classified 53% of Yemen's population as experiencing crisis-level acute food insecurity or worse between October and December 2022. Despite contributing the least to climate change, Africa experiences some of its greatest impacts (Mushy & Mbonile, 2021). Ayanlade et al. (2022), for instance, highlighted that climate change has prolonged and intensified droughts across many parts of sub-Saharan Africa, increasing crop failure, hunger, and habitat destruction.

In East Africa, farming is dominated by small-scale farmers who rely on rain-fed agriculture (Palmer et al., 2023). Failure of seasonal rains results in agricultural droughts, which have intensified from about once every decade in the early 1900s to once every three years since 2005. Kenya's economy depends substantially on tourism and rain-fed agriculture, both of which are susceptible to climate change and extreme weather events (Odhiambo, 2022). Drought, for instance, severely affected crop yields and the livestock subsector in the first half of 2022, contributing to poor performance in Kenya's key commodity exports, including tea and horticulture (Ochieng & Ogeyo, 2023).

Kenya's northern frontier counties have also experienced substantial impacts of climate change. Severe and extreme droughts have disrupted livelihoods through high livestock mortality and crop failure, forcing farmers to rely on relief aid from the Government of Kenya (Lekapana, 2013). In

Tharaka South, climate variability and change have contributed to low crop yields, crop failure, increased pests and diseases, and the drying of water sources (Mwenda & Nzeve, 2025). In particular, green gram yield in Tharaka South remains low at 560 kg/ha, far below the estimated national potential of 1,500 kg/ha and below the global and national averages of 730 kg/ha and 670 kg/ha, respectively (Mugure et al., 2023).

To address the impacts of climate change, the Kenyan Government, in partnership with Plan International and Kenya Agricultural Research and Livestock Organization (KARLO), has improved seed quality to withstand climate change and provided early warning systems, extension services, training, credit, storage facilities, and market information to strengthen farmers' climate adaptive capacity (Ministry of Agriculture, Livestock and Fisheries [MoALF], 2017). To cope with climate-related shocks, many farming households also reduce food consumption, while others diversify their income sources (World Bank, 2023).

Although farmers in different communities rely on formal climate change adaptation strategies, many small-scale farmers in semi-arid regions also resort to approaches rooted in local experience to cope with escalating ecological shifts (Jiri et al., 2016; Theodory, 2025). This knowledge encompasses climate-resilient practices that are closely tied to local ecosystems, thereby fostering community ownership and active participation (Burgos-Ayala et al., 2020). Integrating indigenous knowledge with modern techniques therefore enables farmers to adapt to changing weather patterns, reduce greenhouse gas emissions, and improve food security (Munawar & Khalid, 2025). The integration of indigenous knowledge as a natural farm management strategy is also reflected in Kenya's National Climate Change Response Strategy 2010, Sustainable Development Goal 13 on climate action, and the Paris Agreement 2015.

In Vihiga County, animal behaviors such as the movement of safari ants, loud croaking of frogs, and singing of certain birds signify an impending storm (Kwanya et al., 2024). Farmers in Makueni predict rainfall by observing the behavior of certain plants, including flowering and fruit ripening, and astronomical signals such as changes in the moon's position and the position of the setting sun relative to the Chyulu Hills (Musembi & Cheruiyot, 2016). According to Salma (2023), farmers possess indigenous knowledge of crop varieties, planting decisions, and soil management, all of which are tailored to changing climatic conditions. To cope with climate change, farmers in Kitui County employ diverse indigenous practices, including soil and water conservation techniques and the use of ash and smoke to repel insecticide-resistant insects (Mwatu et al., 2020).

In Tharaka South Sub-County, smallholder farmers operate within a fragile, semi-arid agro-ecological setting that is highly exposed to recurrent droughts and variable seasonal rainfall (Njoka et al., 2016). Despite clear evidence of the agricultural sector's baseline susceptibility to climatic anomalies (Arora, 2019), rural communities are not entirely passive. Instead, they draw on inherited knowledge and indigenous practices to buffer environmental shocks (Global Center on Adaptation [GCA], 2025). Therefore, as climate change increasingly disrupts agricultural livelihoods, there is a growing need to investigate locally embedded solutions that align with community values, lived experiences, and ecological understanding. Despite the rich indigenous knowledge systems in Tharaka South, empirical gaps remain regarding the extent to which these adaptation measures offset climate variability across different stages of the farming cycle. Against this background, the study sought to evaluate the perceived efficacy of indigenous practices in supporting climate change adaptation in Tharaka South Sub-County.

RESEARCH METHODOLOGY

Description of the Study Area

The study was conducted in Tharaka South Sub-County, which has an estimated area of 384.5 km² according to the Kenya National Bureau of Statistics (KNBS, 2019). The area is situated in lower Eastern Kenya and forms part of the larger Tharaka-Nithi County. It lies between latitudes 0°05' South and 1°15' South and longitudes 37°52' East and 38°00' East. It borders Chiakariaga Sub-County to the east and Tharaka North Sub-County to the west. Administratively, the sub-county is divided into two wards, Marimanti and Nkondi, as shown in Figure 1.

According to Jaetzold et al. (2007), Tharaka South Sub-County has two agro-ecological zones, namely Intermediate Lowland (IL5) and Lower Midland (LM4). It has a semi-arid climate with a bimodal rainfall pattern, comprising short rains between October and December and long rains between March and May. Like other semi-arid regions, annual rainfall in Tharaka South Sub-County ranges from 200 mm to 800 mm (Shumsky et al., 2014), while temperatures range from 24 °C to 37 °C and may reach 40 °C. This climatic vulnerability makes the area suitable for examining the resilience and adaptation strategies that local farmers have developed over time to cope with droughts and unpredictable rainfall.

Agriculture is the major economic activity in the area, where residents largely depend on mixed farming for their livelihoods, with indigenous breeds of cattle, sheep, and goats dominating livestock production (Recha et al., 2017). The major crops grown are millet, green grams, sorghum, and cowpeas. Owing to inadequate rainfall and high temperatures, agricultural productivity in Tharaka South Sub-County remains low. For instance, green gram production, which is perceived as the 'cash crop' of the Tharaka community, remains low at 560 kg/ha, far

below the estimated national potential of 1,500 kg/ha and below the global and national averages of 730 kg/ha and 670 kg/ha, respectively (Mugure et al., 2023).

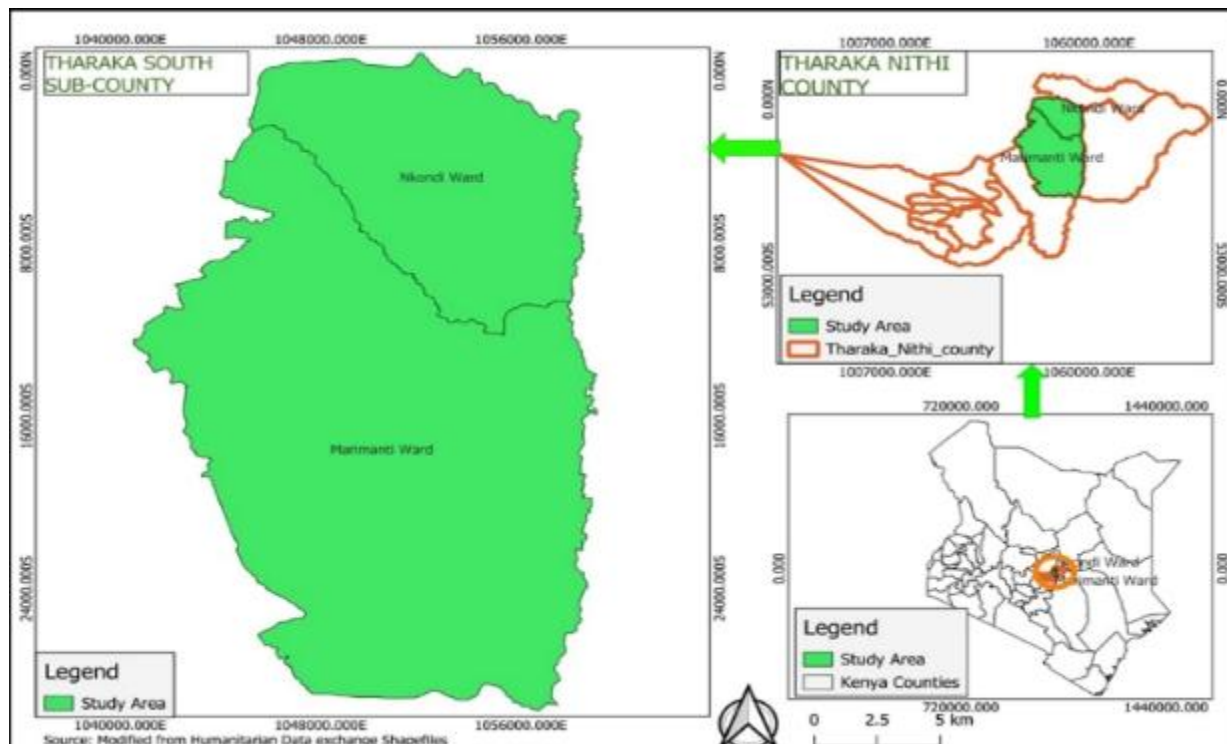


Figure 1: Map of Tharaka South Sub-County

Source: Researcher's modification of Humanitarian Data Exchange shapefiles (2026)

Research Design

The study adopted a correlational research design. The design was used to determine whether relationships existed between the identified indigenous climate change adaptation mechanisms and perceived adaptation efficacy.

Sampling and Sample Size

The study adopted a multistage sampling technique to select respondents and study sites. In the first stage, proportionate random sampling was used to select respondents for the household survey. According to the KNBS (2019) report, Tharaka South Sub-County has 10,968 farming households. To obtain proportional representation for the household survey, the study used Slovin's formula (1960) at a 95% confidence level. Of the 386 questionnaires administered to farming households, 376 were successfully completed, representing a response rate of 97.4%.

In the second stage, purposive sampling was used to select respondents for the key informant interviews. Following the reasoning of Lowe et al. (2018), 14 key informants were purposively

selected for the study. They were drawn from extension officers in the County Government of Tharaka-Nithi, the Institute for Culture and Ecology (ICE), SwedBio, and community opinion leaders perceived to have a deep understanding of the subject.

Data Collection and Analysis

A questionnaire was used to collect the quantitative data. The instrument employed a dual-mode delivery approach to enhance sample representativeness and reduce bias associated with varying literacy levels in the sub-county. Where respondents were unable to read or interpret the questions because of limited formal education, the researcher administered the questionnaire by reading the questions in Kitharaka and recording the responses without leading the participants. Where a response was unclear or subjective, the researcher immediately sought clarification. This approach was consistent with Grothmann and Patt (2005) and helped minimize data loss while ensuring the inclusion of marginalized and less formally educated farmers in climate change adaptation research.

Conversely, self-administered questionnaires were distributed to literate farmers in Tharaka South Sub-County for independent completion. This approach provided respondents with privacy and adequate time to report their socio-economic characteristics and farming practices. Questionnaire items used five-point rating scales to assess the effectiveness of indigenous practices in mitigating climate-induced shocks. Farming household heads rated these practices in relation to crop yield stability, household food security, and long-term socio-ecological resilience, providing quantitative data for assessing the viability of local adaptation options. Because efficacy levels and adaptation success were measured using ordinal Likert scales, a non-parametric statistical test was appropriate. Consequently, Spearman's rank-order correlation coefficient was computed to assess the strength and direction of the relationship between utilization of indigenous practices and perceived adaptation efficacy.

The statistical significance of the correlations was tested at the 95% confidence level ($\alpha = .05$) using the standard mathematical formula advanced by Spearman (1904).

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

Where d_i represented the difference between the ranks of each pair of observations and n denoted the total number of responding farmers.

RESULTS

General Description of the Relationship between Indigenous Knowledge Utilization and Climate Change Adaptation Efficacy

A structured five-point Likert scale was used to convert qualitative farmer experiences into quantifiable ordinal measures and operationalize the study variables. The level of utilization of indigenous knowledge practices was measured using a frequency-based scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, and 5 = Always. Lower scores (1 and 2) reflected non-adoption or infrequent use, whereas higher scores (4 and 5) indicated consistent use of indigenous agricultural methods. Perceived efficacy of climate change adaptation measures was assessed using an agreement-based scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. Lower scores (1 and 2) indicated limited perceived efficacy, whereas higher scores (4 and 5) reflected stronger perceived success of the adaptation strategies.

Table 1: Percentage Distribution of Responses to Likert Items

Item Code	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Total (%)
Practice Utilization	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Often</i>	<i>Always</i>	
Observing Vegetation Bio-indicators	4.3	6.1	18.4	43.1	28.1	100.0
Local Weather / Wind Forecasting	5.1	8.2	22.3	41.2	23.2	100.0
Cultivating Drought-Tolerant Crops	2.1	3.5	11.2	48.4	34.8	100.0
Traditional Crop Diversification	3.2	4.8	14.9	50.3	26.8	100.0
Traditional Water & Soil Conservation	2.4	5.3	12.8	46.5	33.0	100.0
Consultation of indigenous knowledge expert	11.7	13.8	48.9	15.2	10.4	100.0
Traditional Pest & Disease Control	6.4	9.0	20.2	44.1	20.3	100.0
Perceived Adaptation Efficacy	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Strongly Agree</i>	
Forecasts Accurately Prepared Farm	5.6	7.4	19.1	42.6	25.3	100.0
Resilient Crops Resulted in Reliable Yields	1.9	4.0	10.6	51.1	32.4	100.0
Conservation Reduced Crop Failures	2.7	4.5	13.3	47.9	31.6	100.0
Indigenous Methods are Cheaper/Accessible	1.6	3.7	9.8	39.4	45.5	100.0
Practices Significantly Increased Food Security	3.5	5.1	14.1	48.7	28.6	100.0
Organic Pest Measures Protected Crops	5.9	8.5	22.1	44.4	19.1	100.0
Total Reliance on Indigenous Systems	12.2	24.5	34.3	19.7	9.3	100.0

As shown in Table 1, smallholder farmers reported substantial reliance on practical field adjustments such as planting drought-tolerant crops and using manure, while showing comparatively limited consultation with indigenous knowledge experts. The results indicate

widespread use of hands-on adaptation practices. For instance, 83.2% of respondents reported planting drought-tolerant crops often or always. This corresponds with 83.5% of respondents who agreed or strongly agreed that resilient crops resulted in reliable yields. In addition, 79.5% frequently used traditional water and soil conservation practices, which corresponds with the 79.5% who agreed or strongly agreed that conservation reduced crop failures.

Consultation with indigenous knowledge experts showed a more varied response pattern than practical field-based strategies. Only 25.6% of respondents reported consulting experts often or always, while 48.9% reported doing so sometimes. In contrast, positive agreement on efficacy outcomes such as yield reliability and food security was close to 80%. These patterns suggest that farmers may achieve adaptation benefits primarily through direct field practices, such as manure application and altered cropping patterns, regardless of the frequency with which they consult indigenous knowledge experts.

Relationship between Indigenous Knowledge Utilization and Perceived Climate Change Adaptation Efficacy

Spearman's rank-order correlation coefficient was used to evaluate this relationship. According to Mugenda and Mugenda (2019), this non-parametric statistic is appropriate for assessing the strength and direction of relationships between ordinal variables. Testing was conducted at a 95% confidence level ($\alpha = .05$), with $p < .05$ indicating a statistically significant relationship.

The findings showed that most indigenous practice indicators had positive and statistically significant relationships with perceived adaptation efficacy, as presented in Table 2. The use of biological indicators showed a strong positive correlation with perceived forecast accuracy ($r_s = .568$, $p < .001$) and reliable crop yields ($r_s = .604$, $p < .001$). Similarly, cultivation of drought-tolerant crops was positively correlated with enhanced food security ($r_s = .555$, $p < .001$). These findings indicate that greater utilization of practical indigenous farming strategies was associated with higher perceived adaptation efficacy. Table 2 presents the cross-correlation matrix between the seven indigenous knowledge utilization items and the seven perceived efficacy items.

Table 2: Spearman Rank Correlation Matrix

Items	Forecast accurately	Reliable yields	Reduce crop failure	Cheaper	Enhance food security	Protect crops	Highly Reliable
Vegetation Indicators	($r_s = .568^{**}$) (p = .000)	($r_s = .604^{**}$) (p = .000)	($r_s = .557^{**}$) (p = .000)	($r_s = .512^{**}$) (p = .000)	($r_s = .530^{**}$) (p = .000)	($r_s = .576^{**}$) (p = .000)	($r_s = .541^{**}$) (p = .000)
Weather Forecasts	($r_s = .505^{**}$) (p = .000)	($r_s = .533^{**}$) (p = .000)	($r_s = .498^{**}$) (p = .000)	($r_s = .476^{**}$) (p = .000)	($r_s = .489^{**}$) (p = .000)	($r_s = .550^{**}$) (p = .000)	($r_s = .511^{**}$) (p = .000)
Drought-tolerant Crops	($r_s = .534^{**}$) (p = .000)	($r_s = .584^{**}$) (p = .000)	($r_s = .570^{**}$) (p = .000)	($r_s = .521^{**}$) (p = .000)	($r_s = .555^{**}$) (p = .000)	($r_s = .587^{**}$) (p = .000)	($r_s = .539^{**}$) (p = .000)
Crop Diversification	($r_s = .520^{**}$) (p = .000)	($r_s = .514^{**}$) (p = .000)	($r_s = .485^{**}$) (p = .000)	($r_s = .469^{**}$) (p = .000)	($r_s = .502^{**}$) (p = .000)	($r_s = .557^{**}$) (p = .000)	($r_s = .495^{**}$) (p = .000)
Water/Soil Conservation	($r_s = .551^{**}$) (p = .000)	($r_s = .594^{**}$) (p = .000)	($r_s = .544^{**}$) (p = .000)	($r_s = .510^{**}$) (p = .000)	($r_s = .548^{**}$) (p = .000)	($r_s = .587^{**}$) (p = .000)	($r_s = .532^{**}$) (p = .000)
Expert Consultation	($r_s = -.064$) (p = .239)	($r_s = -.042$) (p = .416)	($r_s = -.064$) (p = .218)	($r_s = -.033$) (p = .524)	($r_s = -.015$) (p = .772)	($r_s = -.052$) (p = .311)	($r_s = -.048$) (p = .354)
Traditional pest management	($r_s = .515^{**}$) (p = .000)	($r_s = .538^{**}$) (p = .000)	($r_s = .546^{**}$) (p = .000)	($r_s = .488^{**}$) (p = .000)	($r_s = .519^{**}$) (p = .000)	($r_s = .578^{**}$) (p = .000)	($r_s = .525^{**}$) (p = .000)

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

However, consultation with indigenous knowledge experts for agricultural planning produced a distinct result. The practice was not statistically significant across the perceived efficacy outcomes. Specifically, expert consultation showed weak negative correlations with forecast accuracy ($r_s = -.064$, $p = .239$), reliable yields ($r_s = -.042$, $p = .416$), and reduced crop failure ($r_s = -.064$, $p = .218$). Because these p-values exceeded the 0.05 significance threshold, the null hypothesis was not rejected for these relationships. The statistical findings indicate that consultation with indigenous knowledge experts, by itself, was not measurably associated with perceived adaptation efficacy on modern farms. Household survey responses further suggested that some generalized historical advice may have become less applicable because of rapid shifts in regional microclimates within Tharaka South. Consequently, reliance on consultation without corresponding field interventions, such as mulching or the use of animal manure, was not associated with statistically observable improvements in crop protection or food security.

DISCUSSION OF THE FINDINGS

The findings reveal contrasting patterns in how indigenous knowledge functions under contemporary climate stress. The strong positive correlations between tangible field practices, such as cultivation of drought-tolerant crop varieties and traditional soil conservation practices such as manure application, and adaptation efficacy align with established agro-ecological research. These results corroborate Mugambi and Njeru (2021), who observed that smallholder farmers in the semi-arid lands of Eastern Kenya mitigate erratic rainfall by returning to resilient traditional staples such as sorghum and pearl millet.

Furthermore, the statistically significant relationship between natural bio-indicators and seasonal preparedness echoes the conclusions of Speranza et al. (2014). Their work in similar semi-arid landscapes indicated that local phenological knowledge, including observations of tree budding and insect migration, provides high-resolution localized climate forecasts that broad meteorological forecasts may not capture at the sub-county level. The field-level application of these practices may therefore strengthen farm resilience by creating direct experiential feedback between farmers and their local ecosystems.

Although farmers still consult indigenous knowledge experts for agricultural planning, expert consultation was not significantly correlated with outcomes such as forecast accuracy and soil conservation efficacy. This result points to a possible decoupling between consultation and measurable adaptation outcomes. The direct use of expert consultation as a driver of agricultural efficacy may therefore be weakening even though the practice remains socially embedded. Similarly, Mafongoya et al. (2023) argue that increasing climate change severity has shifted historical weather baselines. As rainfall patterns and droughts in regions such as Tharaka South Sub-County change faster than traditional oral frameworks can adjust, some historical timelines preserved by community elders may become less applicable.

According to Tambu et al. (2024), a calendar system or astronomical marker that was effective thirty years ago may mislead farmers under severe microclimatic shifts. This possible decoupling also points to an intergenerational knowledge transmission gap, a phenomenon documented by Nyong et al. (2019). As younger farmers navigate changing socio-economic conditions and volatile climates, they may rely less on verbal consultation and more on visible, immediate interventions such as multi-cropping, manure application, and organic pest management.

Consequently, elder consultation may increasingly function as a mechanism for community cohesion and historical identity rather than as a standalone predictive tool for climate risk management.

SUMMARY OF FINDINGS

The study revealed strong, statistically significant positive relationships between practical indigenous practices and adaptation outcomes. Specifically, biological weather forecasting, planting drought-tolerant crops, and indigenous soil and water conservation techniques were positively correlated with seasonal preparedness, yield reliability, and food security. These findings are consistent with Mugambi and Njeru (2021), who observed that smallholder farmers in the semi-arid lands of Eastern Kenya mitigate erratic rainfall by adopting resilient traditional practices. However, consultation with indigenous knowledge experts for agricultural planning was not significantly correlated with adaptation efficacy. It showed weak, non-significant negative relationships with core efficacy measures such as yield reliability and crop-failure reduction. This suggests that consultation alone may not predict practical climate resilience on local farms. The finding is consistent with the argument advanced by Mafongoya et al. (2023) that increasing climate change severity has shifted historical weather baselines.

CONCLUSION

Based on the empirical findings, the study indicates that indigenous environmental knowledge remains an important resource that farmers use in day-to-day farm decision-making (Mugi-Ngenga et al., 2016). However, the non-significant relationships involving expert consultation suggest that historical oral guidance may not always align with current microclimatic conditions. Advice on planting dates or weather trends may therefore require continual validation against changing climatic patterns. For smallholder farmers in semi-arid areas, the findings emphasize the importance of active, field-based adaptation practices alongside, rather than solely depending on, localized traditional advisory structures.

RECOMMENDATIONS

Policy and Practice Recommendations

To enhance climate resilience among smallholder farmers in Tharaka South Sub-County, the County Government should prioritize farmer-led training on practical indigenous interventions

such as multi-cropping, soil conservation, and traditional pest-control practices. Policymakers should also establish community-led indigenous seed banks to preserve and subsidize high-performing drought-tolerant crop varieties, including local sorghum, millet, and green grams, which showed positive relationships with household food security. In addition, ICE and SwedBio should support low-cost improvements to traditional soil and water conservation structures to strengthen their capacity to reduce crop failure. Advisory forums with community elders should be integrated with practical field-based support and current scientific climate information.

Recommendations for Future Research

The study recommends comparative research between Tharaka South and neighboring arid and semi-arid (ASAL) sub-counties to determine whether the observed weak relationship between elder consultation and climate adaptation efficacy is consistent across Eastern Kenya.

DECLARATION OF CONFLICT OF INTEREST

The author declares that there is no conflict of interest, financial or otherwise, that could be perceived as influencing the design, execution, analysis or reporting of this research.

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DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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