Vol. 5 (Iss. 2) 2024, pp. 843-858 African Journal of Empirical Research https://ajernet.net ISSN 2709-2607

Nexus between Indigenous Knowledge Systems and Adaptation to Climate Change Strategies by Farmers in Kajiado County, Kenya

Mudekhere, Stephen Muchaki[1]
Mugalavai, Edward Musungu[2]
Nabiswa, Ferdinand Makhanu[3]

[1]stevemuchaki2@yahoo.com (+447360876619, +254721200387)
[2]emugalavai@mmust.ac.ke (+254707705884)
[3]fnabiswa@mmust.ac.ke (+254710414943)

[1,2,3]Masinde Muliro University of Science and Technology, Kakamega, Kenya

…….….

ABSTRACT

Indigenous knowledge (IK) has played an important role in adaptation to climate change in traditional agricultural communities. These approaches have been shown to be more effective when integrated with scientifically developed strategies. In this study, a perception survey questionnaire was used to find out whether there is a nexus between IK systems and the uptake of modern Climate Change Adaptation Strategies (CCAS) among farmers in Kajiado County, Kenya. A mixed research approach that involved the use of household questionnaire surveys, key informant interviews, focus group discussions (FGD), and observations was used to obtain data. The two theories, namely the Situated Learning Theory (SLT) and the Theory of Planned Behavior (TPB), formed the basis for illustrating the relationship between variables, while the Model of Private Proactive Adaptation to Climate Change (MPPACC) was the key theoretical model employed. A total of 382 small-scale rural household representatives randomly selected from 3 Kajiado sub-counties were the principal respondents. The key informants included officers in the departments of agriculture, environment, meteorology, trade, and industry, as well as local administration and village elders. Statistical tools such as chi-square, correlation, and binary logistic regression analysis were used to determine associations. Thematic analysis of data collected from key informants and focus group discussions (FGD) was conducted to triangulate the survey results. Farmers' awareness of climate change, risk perceptions of impacts, existing locally developed approaches to climate change adaptation, and perceptions of CCAS were the main areas of investigation. The majority of farmers (85%) indicated that prolonged drought was the main extreme event that affected their farming activities. Of the indicators observed, drought (X2 = 13.861, p =.000) was perceived as the greatest risk associated with climate change to their agricultural productivity. Their IK adaptation strategies resulted from their interactions with the effects of drought on their livelihoods over the years. Farmers who were nomadic (IK practitioners) were not willing to apply for CCAS. For example, they were 72% less likely to increase their irrigated cropped area and 79% less likely to increase the number of better livestock breeds. Among the CCAS approaches, water resource management was the only preferred strategy. This particular finding shows that climate change policies can be easily adopted by indigenous farming communities if they are developed around an issue that matches their socio-ecological priorities. Without taking into account the prevailing social, cultural, and geo-environmental context of specific communities, the adoption of CCAS by farmers would be significantly affected. The study recommends that integrating indigenous agricultural knowledge into climate change adaptation policies would enhance community resilience. Aligning adaptation strategies with local responses enriches farmer knowledge and boosts resilience against climate change impacts. Effective climate change adaptation plans should incorporate local weather predictions, environmental conservation, and proven community-based strategies, especially in water resource management for arid and semi-arid pastoralist communities.

Keywords: Adaptation Strategies, Climate Change Impacts, Farming Practices, Indigenous Knowledge, Uptake

…….….

I. INTRODUCTION

Farmers in rural settings, particularly those without widespread use of advanced agricultural technologies, have reported the existence of significant adverse impacts of climate change (Aragón et al., 2021; Fahad & Wang, 2020; Malhi et al., 2021; Schlenker et al., 2010). Farmers primarily attribute reduced agricultural outputs to decreased rainfall, shorter rainy season durations, and rising temperatures (Fahad & Wang, 2020). The scarcity of water, a crucial resource in livestock farming and the degradation of natural pastures that leads to desertification have resulted into yearly increases in livestock deaths among pastoral communities in Africa (Uddin & Kebreab, 2020). According to Uddin and Kebreab (2020), farmers in most rural agricultural settings have consistently utilized their indigenous knowledge to adapt to climate variabilities that impacts their farming activities. They have naturally developed resilience from their long-term interactions with the natural environment (Chen and Cheng, 2020). The role that indigenous knowledge plays in local-level climate change adaptation responses can therefore no longer be overemphasized (Filho et al., 2022).

This study operationalized the term "indigenous management system" as collective community-level cultural management mechanisms for indigenous resources that include decision-making, collection, conceptualization, preservation, protection, and sharing of knowledge about these locally developed resources. This definition was adopted from the IK concept as advanced by Ngulube (2016) in the *Handbook of Research on Theoretical Perspectives on Indigenous Knowledge Systems in Developing Countries*. These concepts define how a particular community would manage not just their social and cultural systems but also their physical environments and, by extension, outline how they would manage agriculture, ecosystems, botany, and craft skills, among others (Chituu, 2022). In particular, indigenous knowledge management systems have now emerged as credible sources for effective local-based climate change adaptation approaches for rural communities, as adopted by the Intergovernmental Panel on Climate Change (IPCC) (Petzold et al., 2020). Indigenous agro-ecosystems within Kajiado County were examined to determine whether they have any influence on farmers' willingness to adopt scientifically developed climate change adaptation strategies.

Farmers' responses were assessed to determine if their existing indigenous practices affected their adaptation decisions. The perceptions of their existing traditional agricultural practices, such as intercropping, mulching, protection of certain plants and trees, use of cultivars in controlling pests, among others as well as indigenous weather trend observation methods, were observed to establish their efficacy in mitigating the effects of climate change on agricultural productivity. Similarly, farmers' views in regard to other approaches that they use to respond to adverse effects of climate change (e.g., droughts, floods, and the upsurge of livestock and crop diseases and pests) including migration (nomadism) and adjustment of their planting calendars were also assessed to determine whether these were more preferred compared to scientifically developed strategies. The scientifically developed Climate Change Adaptation Strategies (CCAS) included sedentary-oriented irrigation agriculture, keeping of more superior breeds of livestock, artificial insemination, modern water conservation technology, reseeding pastures, and farmers' active involvement in agricultural development initiatives.

Currently, no empirically conducted study has examined the role that these locally designed traditional practices play in the farmers' perceptions and subsequent uptake of scientific CCAS, in spite of numerous studies (Bobadoye et al., 2016; Center for Tropical Agriculture [CIAT], 2018; Chepkoech et al., 2018) done on indigenous knowledge in Kajiado County about climate change. This identified gap informs the significance of this study. It is important to note that an estimated 98% of the farmers in Kajiado County, which is located in an arid and semi-arid (ASAL) region, still apply IK in managing their farms (Manei et al., 2016), yet the county's profile prepared by the International Center for Tropical Agriculture (CIAT) shows that its agriculture sector has encountered persistent climatic challenges, especially drought (CIAT, 2018). This has led to massive crop failure and livestock losses and has subsequently occasioned severe food shortages for years.

The rationale of this study was therefore premised on the basis of these findings, which offer insights into the solutions to the hindrances related to the uptake of climate change adaptive practices by farmers. The subsequent recommendations are vital in Kajiado County, Kenya, in regard to enhancing farm productivity, addressing food insecurity concerns, and boosting the adaptive capacity of the community facing climate change-related hazards.

1.1 Statement of the Problem.

Through extensive research undertakings, stakeholders in agricultural production including agronomists, climatologists, hydrologists, agriculturalists among other scientists have developed strategies that farmers can employ in adapting to impacts of climate change. However, the recommended strategies have not been fully accepted by the farmers in ASAL areas in Kenya, and in particular, Kajiado County (Manei et al., 2016). This has hindered effective response and sustainability as manifested by the low levels of agricultural production and persistent food insecurity concerns (Bryan et al., 2013; Ng'ang'a et al., 2020). Response by farmers in adapting to new farming strategies is slow, hampering the implementation of climate change farming policies (Meijer et al., 2015). This study was therefore intended to determine the nexus between the farmers' indigenous knowledge practices and the uptake of climate change adaptation strategies in Kajiado County, Kenya.

1.2 Research Objective

To determine the influence of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

This study employed two theories and one theoretical model to illustrate how the identified variables under investigation related to each other. The two theories are the Situated Learning Theory (SLT), developed by Lave and Wengner (1991), and the Theory of Planned Behavior (TPB) by Ajzen (1991). The Model of Private Proactive

Adaptation to Climate Change (MPPACC) (Grothmann & Patt, 2005) was adopted to demonstrate how climate change characteristics interact with other proximal factors, including indigenous knowledge practices, in influencing an individual farmer's cognition and enabling him or her to adopt the CCAS.

Considering that indigenous knowledge is an epistemological body of facts and beliefs that are acquired by members of a community through a social-oriented mechanism from one generation to another, its acquisition by the succeeding generation is through an elaborate learning process. This study therefore used an instructional learning theory that is most relevant to exploring how indigenous knowledge can be so entrenched in a particular society. The situated learning theory (SLT), forwarded by Lave and Wengner (1991), is based on the assumption that a learning process takes place among social acquaintances in an environment of constant and ongoing interaction within contextual experience (Vygotsky, 1978; Theodory, 2016). Henning (2008) further posits that these kinds of learning interactions occur in a social relational environment, within a cultural context, specific artifacts, and physical dimensions of the learning setting. This theory was relevant for this study in the sense that it provided a framework within which to understand the learning processes among the local communities and how indigenous knowledge was created.

On the other hand, Theory of Planned Behavior (TPB) (Ajzen, 1991) deals with the aspect of perceived behavioral control, which predicts the behavioral intention in the decision-making process, subsequently leading to the performance itself (Ajzen, 1991; Meijer et al., 2015). At the center of this theory is attitude formation, which controls behavior and which may/may not eventually favor the uptake of climate change adaptation strategies by the farmers in Kajiado County. The theory illustrates how various socially constructed influences work together to achieve the desired behavior. Indigenous knowledge practices stem from socially learned processes, which can result in desired behaviors that may increase vulnerability to climate change-related hazards.

Indigenous knowledge practices exhibited by the farmers in Kajiado County were therefore analyzed based on the fact that they are psychological processes. As Dwyer et al. (2007) posit in their report on understanding and influencing positive behavior change in farmers and land managers, the patterns of behavior change studies in the agricultural field have mostly focused their work on attitudinal theories. Similarly, this particular study sought to determine if the attitudes of farmers towards new farming practices and technologies may have affected the uptake of the new concepts of agricultural production.

In the context of the uptake of climate change adaptation innovative practices, this theory offers an elaborate illustration on how the attitudes and perceptions of the farmers may only be modified positively if the social environment is set up in such a way that behavior, normative beliefs, and control beliefs are taken into consideration so that the intended behavior is acceptable.

In regard to the MPPACC, agricultural contextual factors, which consist of farmers' socio-economic, demographic, and regional farm characteristics, existing indigenous knowledge, as well as the farmer's knowledge, attitudes, and perceptions, all play a part in their climate change risks, opportunities, and adaptation appraisals. The key components that were examined to assess the likelihood of the farmers adapting to CCAS included their perceived adaptation efficacy, perceived self-efficacy, and perceived cost efficacy (Grothmann & Patt, 2005; Hailegiorgis et al., 2018).

In determining their perceived self-efficacy, the farmer's ability to effectively carry out climate change impact responses was assessed using this model by estimating their level of experience handling such interventions in the past through the process of learning. It is here that the learned IK over a period of time played a role in the farmers' way of responding to CC effects in Kajiado County. Since this model is so explicit in distinguishing between intention and actual behavioral adaptation, this study adopted it so as to clearly bring out the predictor variables that influence the willingness of the farmers in Kajiado County to adopt the CCAS.

2.2 Empirical Review

A review of the available study findings that explain the nature of the uptake of agricultural innovations reveals the critical role that intrinsic and extrinsic factors play on the attributes of the targeted adopter and the external environment within the course of decision-making (Meijer et al., 2015). Adaptation to climate change effects can be explained in terms of efforts that can be applied by communities at the local, national, regional, continental, and global levels, mainly in response to addressing vulnerabilities occasioned by compromised agricultural productivity as well as taking advantage of opportunities arising from the phenomenon (Kumar, 2014).

In their study on "The Extent of Adopting Climate Smart Agriculture Technologies in Addressing Household Food Security in Makueni County, Kenya," Nyale et al. (2019) found that although farmers were willing to adopt new agriculture technologies, cultural factors slowed this adoption. It was therefore imperative that the impact of these intrinsic factors (knowledge, attitudes, and perceptions) be empirically examined to establish if they affect the uptake of the CCAS.

In spite of what is viewed by the local farmers as a convenient basis for why they depend on indigenous knowledge practices rather than modern technologies in managing the effects of climate variability, persistent decreases in agricultural productivity as a result of drought emergencies have continued unabated (CIAT, 2018; Chepkoech et al., 2018; Nunow et al., 2019; Ombogo, 2013). However, a nexus between the adoption of new farming technologies by local farmers on the one hand and the nature of IK practices in terms of their geographical and socio-cultural characteristics on the other is manifestly lacking among the studies analyzed herein. In spite of the importance of farmers' perceptions in the implementation of climate change adaptation practices, considering all relevant literature reviews, only a few studies have applied the theory to climate change adaptation (Jellason et al., 2019; Lin & Lockwood, 2014; Masud et al., 2016), with almost no application in the context of Kenya and, in particular, Kajiado County.

Currently, there have been numerous studies (Bobadoye et al., 2016; CIAT, 2018; Chepkoech et al., 2018) that have analyzed indigenous knowledge practices as well as the perceptions of famers in Kajiado County about climate change, but which have not empirically examined the role that these practices and perceptions play in the uptake of new strategies, a gap that this study was aimed at addressing. The results are therefore considered to have contributed to the pool of knowledge on the need to address aspects of indigenous knowledge practices and perceptions among the farmers with the aim of enhancing the uptake of climate adaptation strategies, thereby reducing the food security vulnerabilities among the Kajiado County communities.

III. METHODOLOGY

3.1 Research Site

The study was conducted in Kajiado County, one of Kenya's 47 counties, situated in the country's southernmost region, bordering Tanzania. Kajiado County's location within the ASAL region informed our decision. Reporting on the deterioration of food security in this region, the International Center for Tropical Agriculture (CIAT) (2018) and the Famine Early Warning Systems Network (FEWS NET) (2019) stated that ecological conditions in these areas are rife with dwindling crop yields and increasing livestock deaths courtesy of the climate change phenomenon. The county's persistent increases in longer periods of drought are primarily responsible for the reported annual 90% crop failures and 70% livestock deaths.

The Intergovernmental Panel on Climate Change (IPCC) sixth assessment report with insights for African countries by Trisos et al. (2022) cites such regions as bearing the heaviest brunt of climate change with characteristic increases in temperature levels and diminishing amounts of precipitation. The majority of farmers in Kajiado County are pastoralists who have practiced nomadism, a livestock farming style that thrives under traditional tenets of indigenous knowledge. According to Karamesouti et al. (2018), local farmers have deeply ingrained IK practices that dictate the management of natural resources, particularly land; to the point where any attempts to introduce foreign practices have historically led to conflicts.

3.2 Target Population

The study focused on collecting responses from the representatives of households as principal respondents. The selection criteria were based on the household's major occupation or livelihood activity being farming (crop, livestock or both). The primary sampling units were sub-counties, sub-locations or villages in a multi-stage sampling process, as per the 2019 national census data. In stage 1, three sub-counties were purposively sampled namely Kajiado West, Kajiado Central and Loitokitok Sub-counties as shown in Table 1.

The study targeted representatives of national and county governments within relevant departments and parastatals under ministries such as agriculture, environment and natural resources, devolution, water and irrigation. Non-State Actors (NSA) such as NGOs and research organizations that have been involved in drought and food insecurity emergency responses as well as community's senior elders and opinion leaders as key informants. Three FGDs were conducted; two in Kajiado West and one in Loitokitok Sub-counties, each comprising of 8 participants. In Loitokitok the FGD was made up of the women farmers while the two in Kajiado West had village elders/leaders and youths participants respectively.

3.3 Sample Size

From the published statistics Kajiado County had an estimated 316,179 number of households in 2019 (KNBS, 2019). This is indicative that the sampling frame has a population of more than 100,000. Therefore, the researcher used the Cochran's (1977) formula for purposes of arriving at an appropriate sample size for continuous and categorical variables. The anticipated response rate in this study was pegged at 75%, hence the calculation to determine the sample size was:

$$n° = \frac{Z^2pq}{e^2}$$

Where;
n^0 = the anticipated sample size from a population that is more than 100,000
Z = Value for alpha level of .025 in each tail (i.e. 1.96)
p = (estimated) proportion of the population which has the attribute in question (estimate of variance) e = the desired level of precision (i.e. the margin of error).

Considering that the researcher will use a confidence level of 95% with a sampling error of 5%, the desired sample size for the households is;

$$\frac{(1.96)^2 * (0.5) * (0.5)}{(0.05)^2} = 384$$

The study focused on collecting responses from the representatives of households as principal respondents. The selection criteria were based on the household's major occupation or livelihood activity being farming (crop, livestock or both). The primary sampling units were sub-counties, sub-locations or villages in a multi-stage sampling process, as per the Kenya's 2019 national census data. In stage 1, three sub-counties were purposively sampled namely Kajiado West, Kajiado Central and Loitokitok Sub-counties as shown in Table 1.

Table 1
Sample Sizes per Sub-Location

Sub-County	Sub-Locations	Number of HH	Sample
Kajiado West	Emukutan	7,294	66
	Kipeto	4,973	45
Kajiado Central	Olepolos	6,853	62
	Oloyiankalani/Ilsilale	7,626	69
Loitokitok	Imbirikani	7,516	68
	Kimana	8,179	74
Totals		**42,441**	**384**

3.4 Sampling Procedure

The determination of the sample sizes in each sub-location was arrived at through proportionate sampling according to the Kenya population census of 2019 (GOK, 2019). The final sampling exercise involved determining six study locations, which were the sub-location administration units, from a total of 92 sub-locations in the three purposively sampled sub-counties. Random sampling was then done in each sub-location proportionately according to the population numbers. A total of 382 respondents participated in this study, representing a response rate of 99.5%. Table 1 above summarizes the methods used to analyze the data from the questionnaire and to interpret and present the results.

3.5 Data collection

3.5.1 Questionnaire

Under the requirement for validity and reliability of data collection instruments, the semi-structured questionnaire was a key tool that was used among the households' representatives. The other instruments were key-informant interview guides, Focus Group Discussion guides and observation checklists. The questionnaire was used to gather data concerning the farmers' socio-cultural and economic characteristics, sources of livelihoods, knowledge and practice of conventional climate change adaptation strategies, climate change risk perceptions and their existing indigenous knowledge practices in response to climate change. The data collection exercise was done using the locally recruited research assistants who had good command of local dialects, and were able to translate accurately the questions to respondents who could not understand English. They subsequently recorded the responses in English in the questionnaires. In addition, the instrument was also used to collect information on the farmers' perceptions and attitudes in regard to applying IK as compared with CCAS in responding to impacts of climate change.

3.5.2 Key Informant Interviews

Key informant interview schedules were developed and used to obtain data from government experts in the ministry of agriculture, livestock, departments of meteorology and professionals from non-governmental organizations who were specifically engaged in addressing the issues of climate change impacts on agricultural productivity within the county. The key questions focused on their perspectives/observations on what the indigenous knowledge adaptation practices applied by the local communities in their respective jurisdictions.

3.5.3 Focus Group Discussions (FGD)

This instrument was used by means of bringing together individuals that shared unique social characteristics and under an environment in which the group members had utmost liberty to give their views on the phenomenon under examination. The discussant groups were clustered under, youths, women, selected small scale farmers and pastoralists (mainly elders). The discussions focused on any observable climate changes (in precipitation, winds, droughts, floods) within their area in the last 10 years, how they could quantify that change and what they thought could be cause of these changes as well as their impacts. The discussants' knowledge regarding climate change adaptation in their community from both indigenous knowledge and from experts' CCAS perspectives were also covered. The discussion also extensively focused on challenges of applying IK and/or CCAS and whether there was a need to integrate the two sets of approaches.

3.5.4 Observation Checklists

The study also employed the use observation on farming activities so as to collect information in purposively selected sites in Kajiado County concerning climate change adaptation practices based on the specific diverse study themes. The study particularly focused on activities in specific consideration of existing ecological zones, noting and documenting prevailing livelihood activities as well as taking photographs for ease of reference.

3.6 Data Analysis

3.6.1 Survey Questionnaire

The quantitative data were analyzed using SPSS version 20, while thematic analysis was conducted to obtain results from the qualitative data. In the qualitative section, there were two areas that the survey questionnaire sought to obtain in-depth information about their existing IK-oriented approaches to climate change effects. First, the general IK approaches were enlisted by the respondents which came out clearly as farmers' ways of combatting pests and diseases, taboos on utilizing key forests, management of land and water resources. Secondly, the respondents gave their perspective on the "resigning to fate and do nothing" option in which a majority concurred that they would opt for the same because it correctly fitted with their indigenous belief that the harsh climatic events occurred as a result of gods' punishment to the community and that the phenomenon was meant to be obediently accepted, just as has been advanced in other studies (Rhoades *et al*., 2008). Table 2 below summarizes the design, variables, methods of analysis and presentation.

Table 2

Summary of Research Designs, Variables, Methods of Analysis and Presentation

Objective	Independent Variables	Dependent variables	Research Design	Methods of Data Analysis	Presentation
Determine the effect of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya.	Indigenous Knowledge Contextual factors Awareness of climate change impacts on agricultural productivity Existing IK Management of natural resources, livestock and crops Geographical farm characteristics Existing IK oriented CC response mechanisms (nomadism, other IK practices)	Levels of CCAS implemented irrigation, new breeds of cattle, involvement in Agricultural Development planning Artificial insemination, Growing drought resistant crops pastures management, Water resource management)	Descriptive, Correlational and Cross-sectional survey designs	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation, binomial logistic regression and Chi-square	Frequency Tables Pie-charts Graphs Narratives

Model 1: Relationship between variables using Chi-Square

$$x^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

O_i = Actual observed frequencies of IK contextual factor (variable)
E_i = Expected frequencies of IK contextual factor (variable)
In model 1, it was assumed that if the *p* (the square of the difference) value was less than .01 then the hypothesis that the farmers' willingness to adapt to CCAS was significantly dependent on their IK- oriented farming practices

Model 2: Test of association using Pearson Correlation Coefficient:

$$\boldsymbol{r} = \frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum(x_i-\bar{x})^2 \sum(y_i-\bar{y})^2}}$$

Where r = correlation coefficient x_2= values of IK contextual factor variable in sample
$\bar{x}$ = mean of the IK contextual factor variable, y_i = values of the CCAS variable
$\bar{y}$ = mean of the CCAS variable

In model 2, any association between an IK contextual factor variable (e.g. awareness of CC and its effects) and the CCAS variables that was $r > .200$ at $p <.01$ (99% Confidence Level) was considered significant. Where $r > .100$ at $p <.05$ (95% Confidence Level) was considered to have a weak significant association.

Model 3: Test of effect of IK on adaptation of CC strategies using Binomial logistic regression
The CCAS variables were measured categorically in terms of either "uptake" or "no uptake"

$Y = B_0 + B_1X_1 + . . . + B_KX_K$ where each X_i was any of IK contextual factor (predictor) variables and each B_i was the regression coefficient.

In this formula, the regression coefficient that denoted an inverse figure of more than 1 for any IK factor fitted into the model that the presence of IK systems within the community was a significant predictor of uptake of CCAS by the farmers.

IV. FINDINGS & DISCUSSIONS

4.1 Farmers' awareness about Climate Change

The findings as indicated in Table 3 below showed that there was a fair level of awareness of climate change attribute of increasing frequencies of extended periods of drought with 85% of respondents correctly demonstrating this knowledge. This result is mainly critical as the farmers viewed drought as the main climate related phenomenon that affected their farming activities.

Table 3
Farmers' Views on Climate Change as per Occurrence of Extreme Events

N=382	**Kajiado West**	**Kajiado Central**	**Loitokitok**	**Total**	**Percentage**
Occurrence of extreme events	Have you witnessed an increase of the following extreme events in your localities? ("yes" responses)				
Droughts	100(36%)	91(24%)	133(35%)	324	85
Very Heavy rains	102(27%)	77(20%)	136(35%)	315	82
Floods	66(17%)	49(13%)	70(18%)	185	48
Storms	5 (1%)	1(0.3%)	9(2%)	15	4
Very High Temperatures	28(7%)	23(%%)	84(22%)	135	35
Pest invasion on crops	23(6%)	14(4%)	123(32%)	160	42

A further test to determine any correlation between the knowledge about CC indicators and their CCAS adaptation intentions using Chi-square tests, the results indicate the farmers' apprehension about the increased incidences of prolonged periods of droughts that are characterized with hot temperatures as shown in Table 4 overleaf.

These results show that CC indicators such as increased heavy rain (CI=99%. X2 =26.869, p < .01), increased droughts (CI=99%. X2 =13.861, p < .01), increasingly high temperatures (CI=99%. X2 =24.155, p < .01) and flooding (CI=99%. X2=73.581, p < .01) are associated with farmers' willingness to either adopt or not to adopt CCAS. Interpretably, using model 1 used in the analysis, the farmers' CC risk perception concerning these adverse events are likely to influence them to make CC adaptation decisions. Therefore, for the farmers that are largely applying IK-based weather prediction methods in making adaptation choices, they are likely to favor those approaches that are traditionally developed locally.

Table 4

Relationship between CC Indicators and the Level of Uptake of Modern Agricultural Practices among Farmers

Extreme events	**index score; level of uptake of modern agricultural practices**			**Inferential statistics**		
	No uptake	**Uptake of**	**Difference**	**X2**	**P-value**	**Significance?**
1Very heavy rain, yes (%)	43.5	39	-4.5	26.869	0	Yes
1Storm, yes (%)	1	2.9	1.9	2.492	0.114	No
1Drought, yes (%)	42.9	41.9	-1	13.861	0	Yes
1Pest invasion on crops, yes (%)	17.3	24.6	7.3	3.163	0.075	No
1Very high temperatures, yes (%)	10.5	24.9	14.4	24.155	0	Yes
Wild fires, yes (%)	0.5	0.5	0	0.019	0.891	No
Floods, yes (%)	33.5	14.9	-18.6	73.581	0	Yes
Landslides, yes (%)	0.8	0.8	0	0.028	0.866	No
Thunder, yes (%)	1.8	4.5	2.7	3.127	0.077	Yes
Very low temperatures, yes (%)	1.3	1.6	0.3	0.006	0.939	No
Overall score climate change; extreme events						
Mean	49.44	49.9	0.464	t= -0.181	0.856	No
SD	19.51	28.87				
Std. Error Mean	1.46	2.02				

4.2 Farmers' Perceptions about Climate Change Impacts

In terms of their perceptions, the results shown in Table 5 below show that what the farmers experience as the main impact of climate change is the frequent episodes of drought (40%) which according to them, has occasioned lack of water and pasture for the livestock, threatening their principal livelihood assets. Since this question was open ended, all the suggested impacts came from the household representatives.

Table 5

Farmers' Perceptions about Impacts of Climate Change

What are the impacts of climate change in the community?	**Frequency**	**Percentage**
Drought, lack of water and pasture	149	39.0
Death of livestock	57	14.9
Pests and Diseases	38	9.9
Hunger	33	8.6
Migration of animal and human	19	5.0
population		
Destruction of property like schools and business premises	18	4.7
Poor agricultural production due low	18	4.7
income		
Floods	15	3.9
Increased food and livestock production	13	3.4
High cost of living	5	1.3

A closer scrutiny at these suggestions such as death of livestock (about 15%), hunger (about 9%), migration of animal and human population (5%) and poor agricultural production due low income are all closely related to the impacts of droughts (about 5%) - an aggregate of 74%. The increased incidences of longer periods of drought deplete water and pasture resources as well as being major cause of crop failures. It can therefore be deduced that extended period of droughts is the main effect of climate change that adversely affects farmers' livelihood and food security.

4.3 Knowledge of Modern Climate Change Adaptation Agricultural Technologies/Practices

A majority of farmers interviewed (74%) indicated that they had heard about the recommended modern farming approaches that would help mitigate the effects of climate change. However, Spearman Correlation analysis of the data collected on associations between farmers' knowledge about CCAS and their uptake thereof showed strong inverse relations. As shown in Table 6 below, the study indicates that although farmers' demonstrated knowledge on CCAS , they still did not favor the modern approaches. This is indicated by farmers' knowledge of CCAS having an inverse relation with their willingness to adopt some CCAS approaches such as increased acreage of land under irrigation farming (*rho*= -0.114, $P<0.05$) and increased numbers of animal breeds that include the superior breed among livestock farmers(*rho*= -0.130, $P<0.05$). However, these results show that farmers with CCAS knowledge were however willing to practice modern water conservation practices (rho= .227, $p<0.01$).

Table 6
Association between Farmers' CCAS Knowledge and its Uptake

Modern Agricultural Practices	Knowledge of modern agricultural technologies/practices	
N=382	Spearman Correlation	Sig. (2-tailed)
Increased acreage of land under irrigation farming.	-.114*	.026
Increased numbers of animal breeds that include the superior breed among livestock farmers	-.130*	.011
Involvement in agricultural development planning at village, ward or constituency committees	-.112*	.028
Practicing artificial insemination for livestock	-.091	.076
Fenced off and reseeded natural pasture	.233**	.000
Better pasture establishment by using more than one grass species to spread the risks	-.148**	.004
Increased cultivation of drought resistant crops	.021	.688
Water resource management practices (e.g. water harvesting)	.227**	.000

On the other hand, the findings indicated that farmers who have knowledge on CCAS were still sticking to the application of IK means of managing CC challenges as shown in Table 7 below. For instance, there was an inverse significant relation between farmers' CCAS knowledge and IK CC survival practices including practicing nomadism (migration).

Table 7
Association between Knowledge of Modern Agricultural Technologies/practices and Climatic Change Response Mechanism

Climatic Change Response Mechanism	Knowledge of Modern Agricultural Technologies/Practices	
N=382	Spearman Correlation	Sig. (2-tailed)
Resign to our fate and do nothing	-.027	.602
Appeal to government for help through local administration	-.045	.383
Wait for Humanitarian assistance from NGOs, civil societies etc.	-.160**	.002
Use traditional IK to survive	.192**	.000
Seek help within social networks; relatives, clan, neighbors	.014	.781
Migration	.286**	.000

The Spearman Correlation tests between farmers' knowledge about CCAS and some of the IK related response mechanisms is positively significant. The results show that in spite of their knowledge about the CCAS, the farmers would still prefer the use of traditional IK to survive (*rho*=0.192, $P<0.01$) and engage in migration/nomadism (*rho*=0.286, $P>0.01$). There was a significant negative correlation between CCAS knowledge and seeking humanitarian assistance (NGOs and civil societies), who in most cases are proponents of CCAS. However, there were no significant correlations between CCAS knowledge and seeking help from the government, social networks or resigning to their fate. Using Model 2 in analyzing the data, the findings therefore indicate that CC response mechanisms as IK contextual factors (e.g. migration nomadism) would have a significant influence on a farmer's decision to opt for CCAS.

4.4 Effect of IK Practices on Uptake of CCAS

Since the indigenous knowledge is socially acquired and passed on from generation to generation over a long period of time, the farmers who were found to have utilized the traditional practices in managing climate change challenges for a longer period of time were more reluctant to embrace CCAS. As shown in the pie-chart Figure 2 below, majority of the respondents (48.4%) indicated to have been using their IK practices for between 10-29 years in response to extreme climate variability. Only 2.1% of them were found to have applied IK in mitigating CC negative impacts on their agricultural activities.

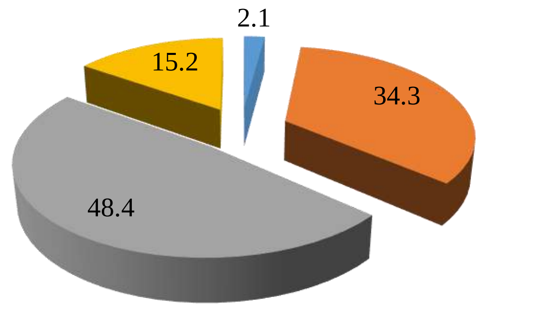

Figure 2
Period of Farmer's IK practice

Further, T-Test analysis was done to determine the mean differences between the duration of utilization of IK and the level uptake of modern agricultural practices. The results showed a higher level of utilization of IK knowledge among farmers who did not use modern agricultural practices than those farmers using modern agricultural practices by -3.316 mean margin of error. This means that the longer the period a farmer was found to have been applying IK in managing CC impacts, the more unlikely was he/she willing to adapt to modern CCAS.

The IK influence was further examined using Binary regression analysis to determine how existing farmers' IK response mechanisms to climate change effects affect the uptake of CCAS (Table 8).

Table 8
Binary Logistic Regression Analysis of Uptake of CCAs and Existing IK Response mechanism on Climate Change

Modern Farming Practices	IK Response Mechanism	B	S.E.	Wald	Df	Sig.	Exp (B)
irrigation farming.	Resign to fate	-1.034	.334	9.591	1	**.002**	.356
	Use of traditional IK	-.800	.399	3.615	1	**.047**	.449
	Migration	-1.715	.344	24.891	1	**.000**	.180
	Constant	-.084	.291	.084	1	.772	.919
Rearing superior breeds of livestock	Migration	-1.546	.338	20.888	1	**.000**	.213
	Constant	-.736	.288	6.516	1	**.011**	.479
agricultural development planning involvement	Resign to fate	-1.218	.454	7.190	1	**.007**	.296
	Migration	-2.251	.520	18.760	1	**.000**	.105
	Constant	-1.288	.360	12.781	1	**.000**	.276
Fenced off and reseeded natural pasture	Resign to fate	-2.022	.425	22.652	1	**.000**	.132
	Use traditional IK to survive	-2.039	.432	22.255	1	**.000**	.130
	social networks assistance	-2.582	.912	8.014	1	**.005**	.076
	Migration	-1.941	.412	22.163	1	**.000**	.144
	Constant	-1.548	.390	15.767	1	.000	.213
cultivation of drought resistant crops	Use traditional IK to survive	-1.385	.620	2.851	1	**.041**	.250
	social networks assistance	-2.107	.891	5.589	1	**.018**	.122
	Constant	-2.957	.413	51.231	1	.000	.052
Water resource management	Use traditional IK to survive	-2.933	.377	60.366	1	**.000**	.053
	social networks assistance	-3.471	.999	12.068	1	**.001**	.031
	Migration	-1.786	.319	31.430	1	**.000**	.168
	Constant	3.065	1.208	6.436	1	.011	21.445

The use of IK in carrying out main agricultural undertakings by farmers such as management of farming activities and natural resources, treatment of pests and diseases, climate predictions and preferences on key livelihood activities were considered in examining their influence on the uptake of the CCAS. The association was analyzed using Binary Logistic Regression Analysis and any IK practice parameter that had a significance statistic of less than 0.05 was considered to have fitted this model. Subtracting 1 from the odds ratio {Exp(B)} and multiplying it by 100, we got a percentage change in odds of the CCAS parameter (dependent variable) having a value of 1. For instance, as shown in Table 8 above, migration (nomadism) which had a significant association with irrigation farming (*p* =.000), with an odds ratio of 1 - 0.180= 0.82. This meant that the farmers who actively practiced nomadism (migration) were 82% less likely to increase acreage of land under irrigation farming. Any unit increase in nomadism practice is associated with odds of decrease in farmers doing irrigation farming.

The findings also indicate that farmers are 78.7% less likely to increase the numbers superior breeds that can be reared in a sedentary setting. The results equally indicate that those farmers who always practiced other IK practices in surviving the impacts of climate change were 55.1% less likely to increased acreage of land under irrigation farming,, 87.0% less likely to fenced off and reseed natural pasture, 75.0% less likely to increased cultivation of drought resistant crops and 94.7% less likely to involve themselves in water resource management practices (e.g. water harvesting). Other CC response mechanisms such as waiting for humanitarian or government assistance were found not to have any significant influence on CCAS uptake. Using Model 3 in this study, it can be deduced that since the coefficient for a number of IK-oriented CC response mechanisms denoted an inverse measurement and fitted into this model, presence IK systems within the community was a significant predictor of uptake of CCAS by the farmers.

4.5 Influence of the Type of Farming

A binomial logistic regression was also run to understand the effects of the type of main farming occupation of a farmer into two categories; either crop cultivation (which is largely sedentary and/or livestock farming (mainly practiced through pastoral nomadism) the type of farming formed the independent variables on one hand and type of IK-related CC response mechanism as dependent variables on the other. The results are shown in Table 9 below. The findings reveal that use of IK and migrations (nomadism) were two parameters that fitted this model as the Wald statistic was significant in both. Where the odds ratio {Exp(B)} was less than 1, increasing values of type of IK response mechanism corresponded to decreasing odds of either crop farming or pastoralism occurrence. When Exp(B) is greater than 1, the reverse was the case. This meant that every unit increase of either practice was associated a decrease in crop farming and increase in pastoral farming. Subtracting 1 from the Ex(B) would give a figure that when multiplied by 100 would provide the percentage by which the IK response mechanism is associated with type of farming.

Table 9

Binomial Logistic Regression Analysis between Climatic Change Response Mechanism and Type of Farming

Type of Farming	IK Response Mechanism	B	Wald	Df	Sig.	Exp (B)
Maize (crop) Farming	Resign to fate	0.099	0.225	1	0.635	1.105
	Use of traditional IK	-1.597	30.176	1	0	0.202
	social networks assistance	1.307	3.503	1	0.061	3.694
	Seek Government help	0.816	5.804	1	0.016	2.262
	Humanitarian assistance (NGOs)	1.172	24.088	1	0	3.228
	Migration	-1.627	51.537	1	0	0.197
	Constant	1.461	3.049	1	0.081	4.31
Pastoralism (keeping cattle)	Resign to fate	-0.345	1.366	1	0.242	0.708
	Use traditional IK to survive	1.066	6.358	1	0.012	2.903
	social networks assistance	-1.457	4.828	1	0.028	0.233
	Seek Government help	-0.65	2.503	1	0.114	0.522
	Humanitarian assistance (NGOs)	-0.357	1.286	1	0.257	0.7
	Migration	1.666	25.279	1	0	5.292
	Constant	0.993	1.467	1	0.226	2.699

The analysis therefore significantly differentiated livestock keepers and crop farmers in regards to how they opted for climatic change response mechanism. Maize farmers were 110.5% more likely to resign to their fate and do nothing as compared to livestock keepers although this effect was not significant. Further, maize farmers were 226.2% ([OR=2.262, 95 percent CI (1.164, 4.394), P= 0.0106) more likely to appeal to government for help through local administration. Similarly, maize farmers were 322.8% more likely to wait for humanitarian assistance from Non-governmental organizations (NGOs), civil societies etc. The two entities (government local administration and the humanitarian actors) are considered to be key institutions in disseminating the CCAS information to the local farmers through their assistance. However, maize farmers were 79.8% less likely use traditional IK to survive and 80.3% less likely to migrate and the likelihood was statistically significant ($p < .01$). These results also fitted in Model 3 of analyzing the data collected, showing that the existing IK practices have a significant influence on the farmers' uptake of CCAS.

4.6 Qualitative Analysis

4.6.1 Key Informant Interview Schedules with Agricultural Extension Officers and Community Elders

Among the 7 agricultural extension officers interviewed there was a unanimous response that they encountered resistance as they interacted with the local farmers, especially the older ones, to disseminate CCAS information. They averred that the farmers insisted that they had their own ways of predicting weather, respond to long extended droughts and had more effective ways of dealing with pests and diseases. This finding is in agreement with results obtained from the survey questionnaire in which the binary regression analysis indicated that the farmers who engaged in IK practices were more unlikely to adopt the CCAS approaches.

The community members readily embrace the tenets of this knowledge sometimes to an extent of attaching taboos on people that fail to adhere to them. For instance, the community prohibits the cutting of certain types of shrubs and trees that are considered sacred. To corroborate this fact, an officer working in the Kajiado County's Climate Smart Agriculture Project, stated during an in-depth key informant interview that:

"The locals largely believe in the set of traditional agriculture knowledge, especially on pastoralism, and rain prediction; which they use in challenging the modern knowledge proponents with. They even argue that much of the knowledge we purport to teach them, they either already have it or has been 'borrowed' from them!" He went ahead to explain that, during their field visits, they on several occasions, found the locals having dried and stored grass in a traditional manner, to be used to feed livestock during dry seasons. They also preserved certain paddocks from any grazing for some time to "replenish" them as well as protecting water pans and river banks".

This claim is illustrative of how the IK management system within the farming community can significantly influence the adaptation of other modern CC approaches. In addition, the findings also indicate that the farmers' belief in IK approaches of weather analysis is based on years of accurate predictions and subsequent development of effective traditional adaptation strategies. Considering that almost 50% of farmers who were interviewed in the survey stated that they had always applied IK practices in their agricultural activities for over 10 years, these findings are in consonant with the above statement; indicative of how strongly IK practices are deeply entrenched.

On how the farmers were able to determine the unusual weather trends, the study involved in-depth key informant interviews with elders that were viewed to be well informed about how to predict weather patterns within the community. All the three elders that were interviewed from the three sub-counties had their views concurring on the methodologies that they used to do weather prediction. One specific elder in Kajiado West stated:

> *Tuko na njia mingi ya kuangalia vile kunyesha ya mvua inaendelea, hali ya kiangazi na hata joto. Iko mimea na miti fulani sisi tunaangalia majani na maua yake kama mvua iko karibu, ama kama itaendelea kukuwa kiangazi. Na pia, hata tunaweza kuchinja mbuzi na kuangalia vile rangi ya matumbo yake iko. Saa ingine tunaangalia tu tabia ya ndege na wanyama hata kukauka ya nyasi na inasaidia kujua kama joto iko kiwango gani.* [We have so many ways which show us the rainfall patterns, drought trends and even temperature levels. There are certain plants and trees whose leaves and flowers clearly indicate to us if rain will soon fall or if the drought will persist. We can also slaughter a goat and observe the condition of its intestines. At times we just observe the behavior of birds and animals in addition to looking at drying of grass for us to determine levels of temperatures". He added that having used these indigenous knowledge, observatory tools have proved over the years that they are accurate, and therefore can be trusted].

Based on the MPPACC model (Figure 1) that was used in this study to determine the farmers' climate change as well as adaptation appraisals, it was observed that the above empirical findings are indicative of the general fact that an individual farmer's evaluation of climate change trends may lead him/her to form a risk avoidance decision. The results therefore indicate that these farmers' risk and opportunity appraisals which affect their socio-cognitive pathways can be positively associated with their adaptation intentions towards climate variations. This conclusion is informed by the fact that the farmer's appraisals based on their responses to questions concerning climate change parameters may influence their decisions to limit agriculturally related physical or monetary damages that emanate from extreme weather changes. Specifically, the majority 85% of the farmers interviewed who indicated that there has been an increasing trend of extended periods of drought (increased periods without rainfall using their traditional ways of weather monitoring), are obliged to adopt response mechanisms that will maintain and sustain the availability of pasture and water for the pastoral farmers.

4.6.2 Focus Group Discussions

Thematic analysis of discussants' responses clearly indicated that they were more aware and conversant with IK approaches of reading weather patterns. They stated that they have noticed changes in temperatures and more extended periods of droughts over the years. For instance, they explained that there are certain plants and trees whose leaves and flowers clearly indicated to them if rain will soon fall or if the drought will persist. At times they would just observe the behavior of birds and animals in addition to looking at drying of grass for them to determine levels of temperatures.

On how the farmers were able to determine the unusual weather trends, the study involved in-depth key informant interviews with elder discussants that were viewed to be well informed about how to predict weather patterns within the community. All the three elders that were interviewed from the three sub-counties had their views concurring on the methodologies that they used to do weather predictions. One specific elder in Kajiado West stated:

> Tuko na njia mingi ya kuangalia vile kunyesha ya mvua inaendelea, hali ya kiangazi na hata joto. Iko mimea na miti fulani sisi tunaangalia majani na maua yake kama mvua iko karibu, ama kama itaendelea kukuwa kiangazi. Na pia, hata tunaweza kuchinja mbuzi na kuangalia vile rangi ya matumbo yake iko. Saa ingine tunaangalia tu tabia ya ndege na wanyama hata kukauka ya nyasi na inasaidia kujua kama joto iko kiwango gani. "*We have so many ways which show us the rainfall patterns, drought trends and even temperature levels. There are certain plants and trees whose leaves and flowers clearly indicate to us if rain will soon fall or if the drought will persist. We can also slaughter a goat and observe the condition of its intestines. At times we just observe the behavior of birds and animals in addition to looking at drying of grass for us to determine levels of temperatures*".

He added that having used this indigenous knowledge, observatory tools have proved over the years that they are accurate, and therefore can be trusted. The above assertion fits well with the illustration of the MPPACC model in regards to how the farmers' risk and opportunity appraisals are processed; which subsequently influences their socio-cognitive pathways positively associating this with their adaptation intentions towards climate variations.

One repeated response on their preferences on which adaptation approach showed that the local farmers found it hard to discard IK in their climate change adaptation because they have tested and proved these practices over many years. They insisted that their traditions of knowing weather patterns, farming and environmental management are preserved by the elders. They stated that the elders among them have knowledge including treating sick cattle and therefore they cannot use some other knowledge that is unproven.

4.7 Discussions

The findings from the survey questionnaires, key informant interviews and the FGDs all indicate that the local farmers in Kajiado County had embraced IK practices to mitigate the effects of climate change for many years, insisting that the approach has worked for them, and in this regard, found CCAS not to be relevant in their farming environment setting. The results are in consonant with other studies that there is slow uptake of new agricultural technologies among rural traditional farming communities globally, but more pronounced in the Sub-Saharan Africa (CIAT, 2018; Chepkoech et al., 2018; Meijer et al., 2015; Nunow et al., 2019; Ombogo, 2013).

On the assumption that the farmers would reflect on their ability to do climate change risk and opportunity appraisal as suggested in the MPPACC illustrated by diagram (Figure 1), majority opted to apply IK practices rather than CCAS. The existing agriculturally related IK practices were regarded in this model as a key proximal contextual factor that would modify farmer's individual cognition towards avoidance or acceptance of CCAS.

The study also concluded in its findings that the way of carrying out of farming activities among local small scale farmers in Kajiado County is largely traditional and that the main livelihood activity is nomadic pastoralism; an indigenous practice among majority of farmers in the county. The inferential statistical analysis on migration as the main indigenous knowledge livestock management practice in nomadic pastoralism as it relates to the uptake of CCAS shows an inverse correlation, with 60 % affirming that it is a preferred practice in responding to CC effects. This result is further buttressed by another finding that the main observable CC related extreme event within the study area were increased incidences of prolonged droughts characterized hotter temperatures that have occasioned food and livelihood related vulnerabilities. In addition, the results show that the local farmers prefer the use of traditional herbs in treating their livestock against diseases and pests, a traditional practice that has made the local farmers to be averse to adopting the CCAS.

It can be deduced that, even with the knowledge about these weather changes, the farmers were not able to relate these grave CC impacts with the need to adapt to new ways of farming; similar to the findings from a study by Tripathi and Mishra (2017). Categorizing the main activity of a farmer into either agrarian, which mainly deals with cultivation of land and livestock pastoralism, has clearly manifested a dichotomy of the form of response to CC adverse effects. While crop farmers are not likely to opt for IK-related response practices, the pastoralists will likely opt for these practices, especially migration (nomadism). By extension, the pastoralists clearly favor the use of IK practices when managing climate change impacts while crop farmers are more willing to adopt the CCAS.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

This study was grounded on the Model of Private Proactive Adaptation to Climate Change to illustrate the process through which a farmer would arrive at his/her decision to uptake modern, scientifically developed climate change adaptation technologies. The study query was on the current slow adaptation by farmers and this could have well been as a result of existing alternative IK practices, a supposition that this study sought to establish. The findings clearly indicated that the farmers were fully knowledgeable about climate change, clearly demonstrating that the key observable phenomena were a trend of increasing lengths of periods of drought over the recent years. It was further established that these practices had significant influence on the uptake of CCAS.

Based on the farmers' perceptions about climate change impacts, management of farming activities, natural resource management, treatment of pests and diseases and weather predictions; these farmers still favor existing IK practices to CCAS. This outcome is especially expected because based on their perceived CC risk and opportunity appraisals using IK systems, they would most likely opt for avoidance to any concepts they view would increase risks to their livelihoods.

Among the CCAS approaches, water resource management was the only preferred strategy. The findings clearly indicate that specific programs that guarantee water supply and managing water sources of any agricultural activity as the most acceptable among the CCAS options to the farmers. The introduction of CCAS concepts that lean toward a sedentary lifestyle for this farming community would definitely be met with fervent resistance, especially if the process of internalizing these "foreign" technologies would be complex, thereby failing to achieve the perceived adaptation efficacy.

5.2 Recommendations

The integration of the agricultural related IK into conventional climate change adaptation policy frameworks would enhance the uptake and develop a more CC resilient community. Furthermore, designing CC adaptation approaches that mirror the locally developed response mechanisms would not only enhance adaptation rates but also enrich the farmers' knowledge about other more robust strategies and subsequently increase community resilience to CC adverse impacts. Development of CCAS needs to include the IK management concepts of weather prediction, environmental conservation and proven locally based CC response mechanisms into adaptation plans. Moreover, the CCAS approach would be more effective if the development experts can utilize that option and upscale the CC related water resources management programs within the ASAL pastoralist farming community as an entry strategy

Data Availability

Data will be made available on request.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. Academic Press.

Aragón, F. M., Oteiza, F., & Rud, J. P. (2021). Climate change and agriculture: Subsistence farmers' response to extreme heat. *American Economic Journal: Economic Policy, 13*(1), 1-35.

Bobadoye, A. O., Ogara, W. O., Ouma, G. O., & Onono, J. O. (2016). Pastoralist perceptions on climate change and variability in Kajiado in relation to meteorology. *Academic Journal of Interdisciplinary Studies, 5*(1), 37-46.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M. (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management*, *114*, 26–35. https://doi.org/10.1016/j.jenvman.2012.10.036

Chen, T. L., & Cheng, H. W. (2020). Applying traditional knowledge to resilience in coastal rural villages. *International Journal of Disaster Risk Reduction, 47* (August 2020), 101564. https://doi.org/10.1016/j.ijdrr.2020.101564

Chepkoech, W., Mungai, N. W., Stöber, S., Bett, H. K., & Lotze-Campen, H. (2018). Farmers' perspectives: Impact of climate change on African indigenous vegetable production in Kenya. *International Journal of Climate Change Strategies and Management, 10*(4), 551-579. https://doi.org/10.1108/IJCCSM-07-2017-0160

Chituu, B. (2022). Indigenous knowledge systems and the environment. *Green Business Gazette*. https://www.gbg.co.zw/2022/01/19/indigenous-knowledge-systems-and-the-environment/

CIAT. (2018). *Climate risk profile Kajiado County. Kenya County Climate Risk Profile Series*. International Center for Tropical Agriculture. https://reliefweb.int/sites/reliefweb.int/files/resources/Kajiado_Climate_Risk_Profile_Final.pdf

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.

Dwyer, J., Mills, J., Ingram, J., Taylor, J., Burton, R., Blackstock, K., Slee, B., Brown, K., Schwarz, G., Matthews, K., & Dilley, R. (2007). *Understanding and influencing positive behaviour change in farmers and land managers - A project for Defra.* Gloucester: CCRI, Macaulay Institute

Fahad, S., & Wang, J. (2020). Climate change, vulnerability and its impacts in rural Pakistan: A review. *Environmental Science and Pollution Research, 27*, 1334-1338.

Filho, W. L., Barbir, J., Gwenzi, J., Ayal, D., Simpson, N. P., Adeleke, L., Tilahun, B., Chirisa, I., Gbedemah, S. F., Nzengya, D. M., Sharifi, A., Theodory, T., & Yaffa, S. (2022). The role of indigenous knowledge in climate change adaptation in Africa. *Environmental Science & Policy, 136*, 250-260.

GOK. (2019). *Kenya population and housing census 2019: Distribution of Population by Administrative Units* Volume II. Kenya National Bureau of Statistics.

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change, 15*, 199–213. https://doi.org/10.1016/j.gloenvcha.2005.01.002

Hailegiorgis, A., Crooks, A., & Cioffi-Revilla, C. (2018). An agent-based model of rural households' adaptation to climate change. *Journal of Artificial Societies and Social Simulation, 21*(4), 4. https://doi.org/10.18564/jasss.3812

Jellason, N. P., Baines, R. N., Conway, J. S., & Ogbaga, C. C. (2019). Climate change perceptions and attitudes to smallholder adaptation in northwestern Nigerian drylands. *Social Sciences, 8*(2), 31. https://doi.org/10.3390/socsci8020031

Karamesouti, M., Schultz, C., Chipofya, M., Jan, S., Galeano, C. E. M., Schwering, A., & Timm, C. (2018). The Maasai of southern Kenya domain model of land use. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* IV-4. https://doi.org/10.5194/isprs-annals-IV-4-45-2018

KNBS. (2019). *2019 Kenya population and housing census* (Volume I). Kenya National Bureau of Statistics.

Kumar, V. (2014). Role of indigenous knowledge in climate change adaptation strategies: A study with special reference to north-western India. *Journal of Geography & Natural Disasters, 5,* 131. https://doi.org/10.4172/2167-0587.1000131

Lave, J., & Wengner, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lin, C. C., & Lockwood, M. (2014). Assessing sense of place in natural settings: A mixed-method approach. *Journal of Environmental Planning and Management, 57*(10), 1441–1464. https://doi.org/10.1080/09640568.2013.811401

Malhi, G. S., Kaur, M., & Kaushik, P. (2021). Impact of climate change on agriculture and its mitigation strategies. *Sustainability, 13*(3), 1318. http://doi.org/10.3390/su13031318

Manei, N., MacOpiyo, L., & Kironchi, G. (2016). Integration of indigenous knowledge with ICTs in managing effects of climate change and variability in Kajiado County, Kenya. *RUFORUM Working Document Series, 14*(2), 231-236.

Masud, M. M., Al-Amin, A. Q., Junsheng, H., Ahmed, F., Yahaya, S. R., Akhtar, R., & Banna, H. (2016). Climate change issue and theory of planned behaviour: Relationship by empirical evidence. *Journal of Cleaner Production, 113*, 613-623.

Meijer, S. S., Catacutan, D., Ajayi, O. C., Sileshi, G. W., & Nieuwenhuis, M. (2015). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International Journal of Agricultural Sustainability, 13*(1), 40-54. https://doi.org/10.1080/14735903.2014.912493

Ng'ang'a, T. W., Coulibaly, J. Y., Crane, T. A., Gachene, C. K., & Kironchi, G. (2020). Propensity to adapt to climate change: Insights from pastoralist and agro-pastoralist households of Laikipia County, Kenya. *Climatic Change, 161*, 393–413. https://doi.org/10.1007/s10584-020-02696-4

Ngulube, P. (Ed.). (2016). *Handbook of research on theoretical perspectives on indigenous knowledge systems in developing countries*. IGI Global.

Nunow, A., Nzioka, J. M., Ininda, J. M., & Kinama, J. M. (2019). The effects of climate change on household food security in Kajiado and Kiambu County, Kenya. *International Journal of Innovative Research and Knowledge, 4*(4). http://www.ijirk.com/issue_image/IJIRK-4.04.01.pdf

Nyale, E. H., China, S. S., & Nabiswa, F. (2019). The extent of adopting climate smart agriculture technologies in addressing household food security in Makueni County, Kenya. *International Journal of Scientific and Research Publications, 9*(11), 578-591. http://doi.org/10.29322/IJSRP.9.11.2019.p9579

Ombogo, M. O. (2013). *The impact of climate variability on pastoralism: Forage dynamics and trends of cattle population in Kajiado County, Kenya* (Master's thesis, University of Nairobi, University of Nairobi).

Petzold, J., Andrews, N., Ford, J. D., Hedemann, C., & Postigo, J. C. (2020). Indigenous knowledge on climate change adaptation: A global evidence map of academic literature. *Environmental Research Letters*, *15*(11), 113007. https://doi.org/10.1088/1748-9326/abb330

Rhoades, R. E., Zapata Ríos, X., & Aragundy Ochoa, J. (2008). Mama Cotacachi - History, local perceptions, and social impacts of climate change and glacier retreat in the Ecuadorian Andes. In B. Orlove, E. Wiegandt, & B. H. Luckman (Eds.), *Darkening peaks: Glacier retreat, science, and society* (pp. 216–225). University of California Press.

Schlenker, W., & Lobell, D. B. (2010). Robust negative impacts of climate change on African agriculture. *Environmental Research Letters*, *5*(1), 014010.

Tripathi, A., & Mishra, A. K. (2017). Knowledge and passive adaptation to climate change: An example from Indian farmers. *Climate Risk Management, 16*, 195-207.

Trisos, C. H., Adelekan, I. O., Totin, E., Ayanlade, A., Efitre, J., Gemeda, A., Kalaba, K., Lennard, C., Masao, C., Mgaya, Y., Ngaruiya, G., Olago, D., Simpson, N. P., & Zakieldeen, S. (2022). Africa. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1285–1455). Cambridge University Press. https://doi.org/10.1017/9781009325844.011

Uddin, M. E., & Kebreab, E. (2020). Review: Impact of food and climate change on pastoral industries. *Frontiers in Sustainable Food Systems*, *4*, 543403. https://doi.org/10.3389/fsufs.2020.543403