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Indigenous knowledge factors influencing farmers' uptake of climate change adaptation strategies in Kajiado County, Kenya

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ABSTRACT

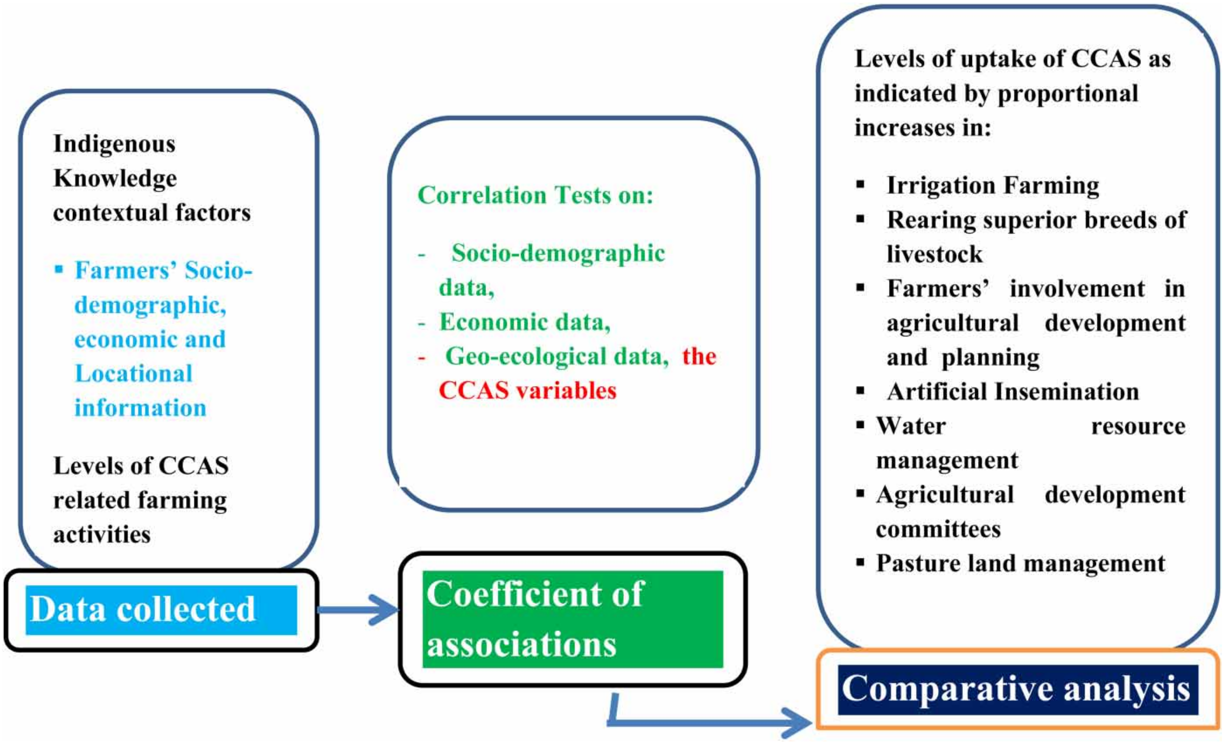
Due to the effects of climate change, farmers in Kajiado County have embraced different climate change adaptation strategies including the use of indigenous knowledge (IK) and scientific approaches. The objective of this study was to assess the determinants of farmers' IK practices influencing the uptake of Climate Change Adaptation Strategies (CCAS) in Kajiado County, Kenya. Using the Model of Private Proactive Adaptation to Climate Change (MPPACC), IK-related contextual factors that constituted the socio-demographic, economic, and geo-ecological variables were tested against the CCAS variable on Pearson Coefficient Correlation in determining associations. Multi-stage sampling was done and data were collected using questionnaires, key informant interviews, focus group discussions (FGDs), and observation checklists while data analysis involved the use of both descriptive and inferential statistics. The findings show CCAS were likely to be adapted to by those with higher levels of education and those with higher levels of monthly income while those unwilling were more likely males, older, with larger household sizes. and those who owned land. The findings also showed that effective approaches including IK climate change adaptation practices and the CCAS can be applied in a complimentary manner to achieve the desired results in regions that possess diverse climatic and geophysical conditions.

Key words: adaptation strategies, climate change, farming practices, indigenous knowledge, uptake

HIGHLIGHTS

- IK adherence depends on the farmer's individual socio-demographic factors.
- IK is entrenched among farmers as it is learned through a social-oriented mechanism.
- Type of farming determines IK applications hence influencing CCAS uptake differently.
- Geo-ecological factors influence the types of locally developed agricultural technologies.
- Integration of local farming techniques with CCAS can enhance the latter's uptake.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Effects of climate change on agricultural productivity globally have elicited significant responses from agronomists, hydrologists, and agriculturalists among other scientists who have collaborated with the aim of coming out with mitigation measures to alleviate the resultant adverse effects (Piontek *et al.* 2014). However, despite all these efforts, there is a growing concern since previous studies indicate that only limited adoption of climate-smart agricultural (CSA) practices by farmers is realized (Sain *et al.* 2018).

Studies conducted on farmers' climate change adaptation approaches reveal that there are contextual factors that determine the practices that local small-scale farmers would prefer (Grothmann & Patt 2005; Hailegiorgis *et al.* 2018). These factors go a long way in shaping the farmers' climate change risk perceptions, subsequently influencing their adaptation efficacy, perceived self-efficacy, and perceived cost efficacy. The relevant literature that was reviewed showed that IK practiced by local farmers in relation to their socio-demographic profiles as well as the peoples' knowledge attitudes and perceptions either slowed or enhanced their uptake of new farming technologies (Dhanush *et al.* 2015; Meijer *et al.* 2015; Nyale *et al.* 2019). Socio-demographic and economic characteristics such as age, sex, household size, level of education, poverty indices, and sources of income were considered as key in determining the perceived adaptation efficacy – a farmer's evaluated effectiveness of his/her adaptation measures to avert climate change risks.

Globally, farmers, especially in developed economies have been encouraged to adopt new farming technologies not just for purposes of increasing productivity, but more recently, for their products to be competitive in the international markets (Macfadyen *et al.* 2018; Heeb *et al.* 2019). Agricultural production has a myriad of objectives including operating at optimal levels of production while meeting the current stipulated millennium sustainability goals (OECD 2001). For example, within Western Europe countries, there has been a purposive initiative facilitated and sponsored by the European Union to adopt active management of agricultural practices by the farmers, focusing on applying appropriate technologies and practices, such as 'Precision Agriculture', that decrease greenhouse gas (GHG) emissions while increasing agriculture productivity and income (European Union 2019).

There is no gainsaying by stating that a critical body with a mandate to devise mitigation and response mechanisms toward addressing adverse effects of the escalating global warming trends still grapples with sharp contradictions created by different perceptions from researchers on scientifically designed approaches to dealing with climate change. In its recent report the Intergovernmental Panel on Climate Change (IPCC) in regard to Bio-energy with Carbon Capture Storage (BECCS), is believed to keep the global temperature low, yet other insights from the same body believe that the concept can easily surpass the sustainable levels in the land domain-land being the key resource for agricultural production (Creutzig *et al.* 2021).

In Sub-Saharan Africa, most of the local farmers tend to stick to their traditional coping mechanisms for climate variability, rather than taking up the recommended strategies developed by the experts. Response by farmers in adapting to new farming strategies is rather slow (Ndjeunga & Bantilan 2005), hampering the implementation of climate change farming policies. It has been observed that even in the cases where these agricultural innovations have been implemented by the farmers, they are soon abandoned particularly in Sub-Saharan Africa (Dahlquist *et al.* 2007; Kiptot *et al.* 2007; Meijer *et al.* 2015). Moreover, many traditional communities especially in Africa find the transferability of indigenous agricultural knowledge easier than trying out more conventional scientific farming techniques (Tanyanyiwa 2019). Other studies have also indicated that there are underlying socio-cultural factors that could be hindering the adoption of CSA technologies by local rural farmers (Jellason *et al.* 2021).

In Kenya, and more specifically, Kajiado County, a recent and relevant study carried out in the county on the indigenous knowledge (IK) practices being utilized by farmers to cope with and adapt to adverse climate change impacts revealed in its findings that 98% of the respondents still apply IK in managing their farms (Manei *et al.* 2016). In full appreciation of the importance of the adverse effects of climate change on agriculture, the Kenya Government, through the Ministry of Environment and Mineral Resources (MoEMR), developed the 2010 National Climate Change Response Strategy (NCCRS). The Kajiado 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 indigenous practices employed in agriculture by local communities in affected areas are deeply rooted and the successful introduction of new technologies requires sufficient training and sensitization. The current study examined certain characteristic factors that embody the IK among several local communities which may influence the adoption of scientific climate change farming strategies. Additionally, IK most commonly has an accepted assertion from its proponents, that the term is associated with a particular place (Tatira 2000; Aryal *et al.* 2018; Tanyanyiwa 2019). This assertion is buttressed by general consensus among scientists on which Studley (1998) avers that this knowledge 'is linked to a specific place, culture or society; is dynamic in nature; belongs to groups of people who live in close contact with natural systems and contrasts with "modern" or western formal scientific knowledge.'

Equally, the socio-cognitive progression within which farming-oriented climate change adaptation occurs tends to take place in a localized socio-ecological environment. Moreover, it is argued by Mitter *et al.* (2019) that farm and regional characteristics can also significantly modify the way a farmer will appraise climate change-related risks, hence seeking to apply the knowledge that is 'locally' understood in response to the adverse effects of climate change. This study, therefore, focused on examining the nature of these IK-oriented socio-cultural, economic, and ecological characteristics that may influence the local farmers' uptake of CCAS in Kajiado County, Kenya.

2. CONCEPTUAL FRAMEWORK

The research question was to establish what determinants of farmers' IK practices influenced the uptake of climate change adaptive strategies. The theoretical Model of Private Proactive Adaptation to Climate Change (MPPACC) was utilized in this study to determine how these variables correlated. This model is diagrammatically illustrated in Figure 1 and was first developed by Grothmann & Patt (2005), but modified herein to capture the key variables that are unique to the study population.

It is used to demonstrate how climate change characteristics relate to other proximal factors that influence an individual farmer's cognition enabling him/her willingness to adopt the CCAS. The agricultural contextual factors which consist of farmers' socio-economic, demographic, and regional farm characteristics, existing IK as well as the farmer's knowledge, attitudes, and perceptions all play a part in their climate change risks, opportunities, and adaptation appraisals. This model was therefore used to illustrate succinctly how these predictor variables influenced the willingness of the farmers in Kajiado County to adopt the CCAS.

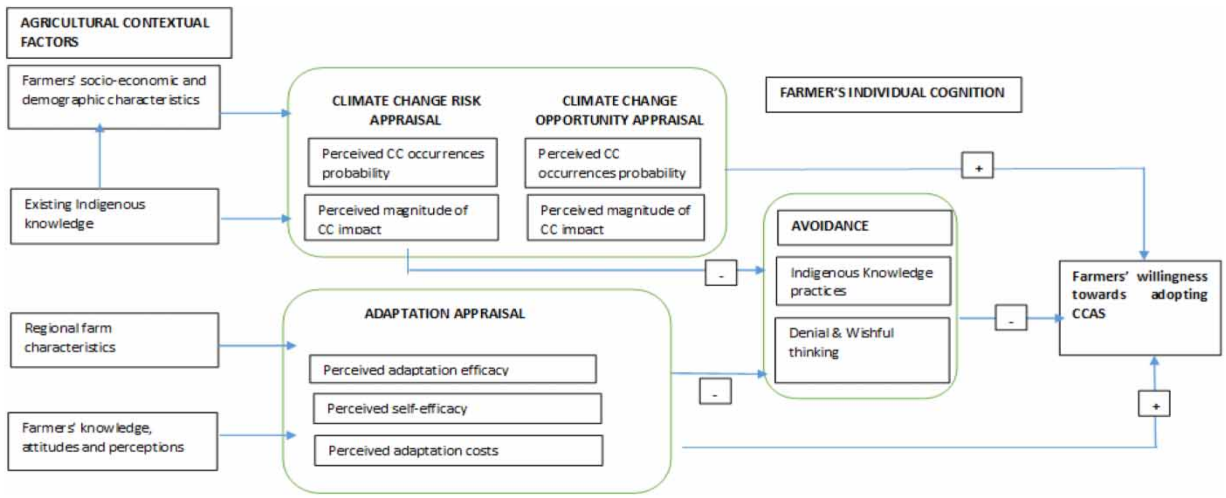


Figure 1 | Model of Private Proactive Adaptation to Climate Change (*Source:* Grothmann & Patt 2005).

3. MATERIALS AND METHODS

3.1. Study area

This study was conducted within Kajiado County which is among the 47 Counties in Kenya. The County is located between Longitudes 36° 5′ and 37° 5′ East and between Latitudes 1° 0′ and 3° 0′ South, covering an approximated area of 21,900.9 km^2. Demarcated according to the 2019 Kenya population census administrative units, Kajiado County consists of six sub-counties, namely Kajiado Central, Kajiado West, Kajiado North, Loitokitok, Isinya and Mashuuru as per the Kenya National Bureau of Statistics (KNBS 2019). Bordering the Capital City of Kenya, Nairobi on the north, the County also neighbors Machakos, Makueni, Narok, Taita Taveta, and Kiambu Counties. The County's physical features are characterized by beautiful plains, valleys, volcanic hills, scarce vegetation in low altitude areas which increases with altitude and rain. The rainfall pattern in the county is erratic and the rains are infrequent, causing dry spells which subject the inhabitants and their livestock to water scarcity. Kajiado County is located in the southern part of Kenya as shown in Figure 2.

3.2. Research design

This study adopted a mixed methods research approach in which both qualitative and quantitative methods were used, highlighting and examining the subjectivity and objectivity aspects of matters under investigation. The descriptive research design was therefore used to determine the nature of farmers' IK practices influencing the uptake of climate change adaptation strategies in Kajiado County, Kenya.

3.3. Sampling strategy

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. The choice of Loitokitok is informed by the fact that it is the region with much of the crop farming that is rain-fed. On the other hand, Kajiado West is largely arid and semi-arid with pastoralism being the major livelihood activity. Kajiado Central has a bit of crop farming but is extensively inhabited by pastoralists who live in large semi-arid areas that constitute the sub-county (County Government of Kajiado 2019).

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

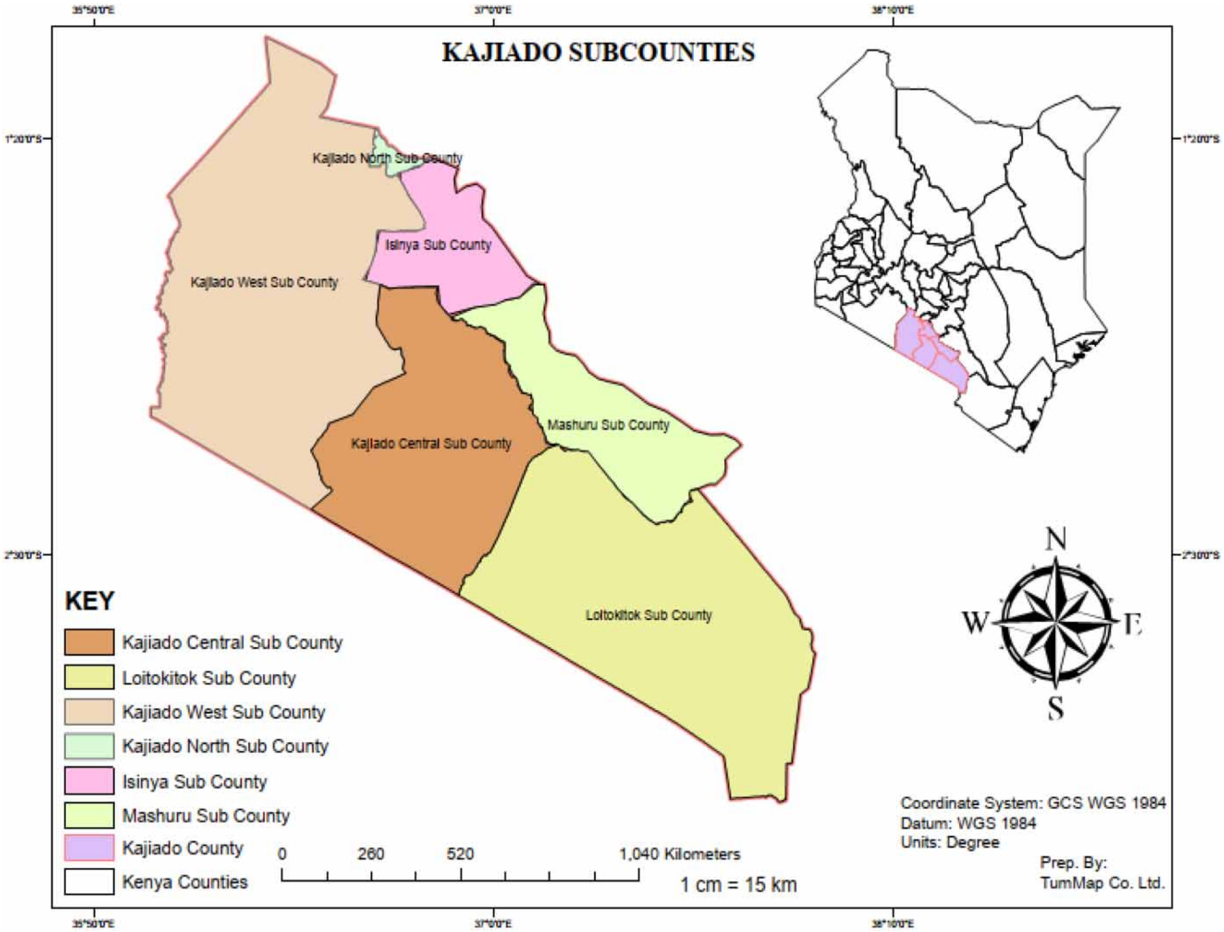


Figure 2 | Location of Kajiado County showing the study sites (*Source:* GOK 2019).

in this study was pegged at 75%, hence the calculation to determine the sample size was:

$$n^\circ = \frac{Z^2pq}{e^2}$$

where n^o indicates the anticipated sample size from a population that is more than 100,000; Z indicates the value for alpha level of 0.025 in each tail (i.e. 1.96); p indicates (estimated) proportion of the population which has the attribute in question (estimate of variance); e indicates 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 382 respondents participated in this study, representing a response rate of 99.5%, as shown in Table 1 overleaf.

3.4. Data collection

The determination of data collection instruments was done to illustrate the methodology and the data types that were utilized in this study. Both quantitative and qualitative data were required for the purposes of obtaining the desired information in Kajiado County. A questionnaire survey was used to capture data on the farmers' level of awareness of climate change adaptation strategies, their familiarity with the adaptation practices and Knowledge of climate change-related risks. 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 the impacts of climate change.

Table 1 | Summary of sampling methods and sample size for the study population

Sub-counties	Sampling method	No. of households (KNBS)	Sample size
Kajiado West	Multi-stage Random, Simple random and Proportionate	42,774	110
Kajiado Central	Multi-stage Random, Simple random and Proportionate	37, 238	131
Loitokitok	Multi-stage Random, Simple random and Proportionate	47,058	141
TOTAL		**127,070**	**382**

Source: Researcher, 2019.

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. In regard to the FGD, there were three discussant groups which were each made up of eight participants and were clustered under youths, women and selected small-scale farmers and pastoralists (mainly elders). The discussion guides were predetermined and semi-structured to avoid digression hence safeguarding the quality of data collected.

3.5. Data analysis and presentation techniques

This study mainly queried the uptake of climate change adaptation strategies by local farmers as influenced by IK practices, the latter being the independent variable and the former, the dependent variable. The independent variables were examined through the prism of the nature of these practices, defined by farmers' socio-demographic, economic and geo-ecological factors. The analysis and presentation techniques are summarized in Table 2.

Table 2 | Summary of methods of data analysis and presentation techniques

Objective	Independent Variables	Dependent variables	Research Design	Methods of Data Analysis	Presentation
Assess the determinants of farmers' indigenous knowledge practices influencing the uptake of climate change adaptation strategies in Kajiado County, Kenya..	Farmers' socio-demographic and economic characteristics Geographic and ecological factors Management of natural resources, livestock and crops Existing IK-oriented CC response mechanisms (nomadism, other IK practices)	Levels of CCAS implemented 1. irrigation, 2. new breeds of cattle, 3. involvement in Agricultural Development planning 4. Artificia insemination, 5. Growing drought-resistant crops 6. pastures management, 7. Water resource management	Descriptive, Correlational and Cross-sectional survey designs	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation and Chi-square	Frequency Tables Pie-charts Graphs Narratives

FORMULA: Test of association using Pearson Correlation Coefficient

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

where r represents correlation coefficient; x_2 represents values of the socio-demographics or economic variable in sample; $\bar{x}$ represents mean of the socio-demographics or economic variable, y_i represents values of the CCAS variable; $\bar{y}$ represents mean of the CCAS variable.

The frequency tables, charts, graphs, and narratives have been used to present the findings of this study. Inferential statistics were done through the Likert scale, Spearman rank order correlation, and Chi-square calculations using SPSS version 20.

4. RESULTS AND DISCUSSIONS

4.1. Socio-demographic and economic characteristics of the farmers

In the study, the most dominant age group among the farmers who participated was 35–49 years that accounted for 34.6% (132), while the age group of 18–24 years had the least number of respondents at 7.9% (30) as shown in Figure 3. Although the age group 18–34 years would be considered as the youth doing farming, it was assumed in this study to categorize this group further to classify 18–24 years as the youths who are engaged in institutions of learning hence doing farming on a part-time basis. Subsequently, those youths in the 25–34 years were those that were through with schooling and expected to be engaged in farming fully. Age has a bearing on the acceptance and use of the different practices and hence is perceived differently based on the age group. The elderly, for example, are more biased toward IK as compared to the educated youth who easily embrace technology. As will be discussed later in regard to education levels, these results show that the younger generation in the community and who are well informed by having been more exposed academically are not keen on agriculture as an occupation. On the other hand, the majority of the farmers are older and who are not well endowed academically may not find new farming technologies that help in responding to climate change impact as useful- opting instead for traditional approaches.

Of the farmers that were interviewed, 198 which accounted for the biggest proportion (51.9%) belonged to households with between 4 and 7 persons as illustrated in Figure 4. Because these are mainly small-scale farmers who do subsistence agriculture, it is the same members of the households that also participate in the farming activities. The farming technologies applied especially in response to climate change effects can only be assumed to be adaptable by these farmers if they will not be overly labor intensive. Over time, these farmers have adapted to farming methods that are convenient to their 'labor force' and in which individual responsibilities are culturally and socially defined for each member of the household.

As it was found in this study, the unanimous response from women in one of the FGDs is that women are the ones who mainly work on farms. One of them stated:

> 'Sisi wanawake ndio tunafanya kazi shambani. Wazee wetu wamezoea kupeleka mifugo malishoni mbali. Watoto wetu siku hizi wanaenda shuleni, na wale walimaliza shule wameenda mjini kutafuta vibarua *It is we women who work on farms. Our husbands focus on taking livestock for grazing in far places. Our children go to school, while those that are through with school, migrate to urban areas to look for employment.*'

The above assertion underscores the importance of household size as a measure of labor in carrying out farming activities at a household level. The narrative supports an argument that IK-related farming practices being highly labor intensive (Altieri

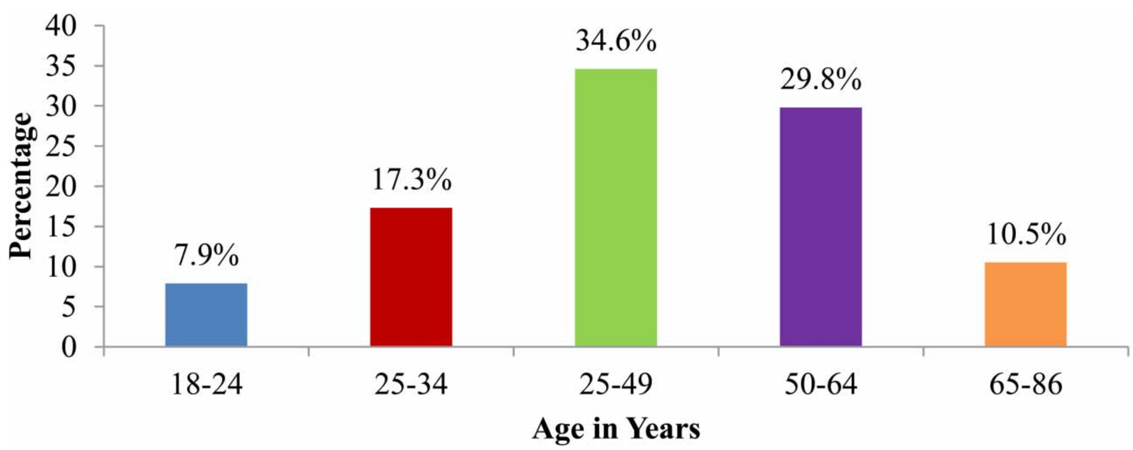


Figure 3 | Age distribution of the respondents (Field data, 2020).

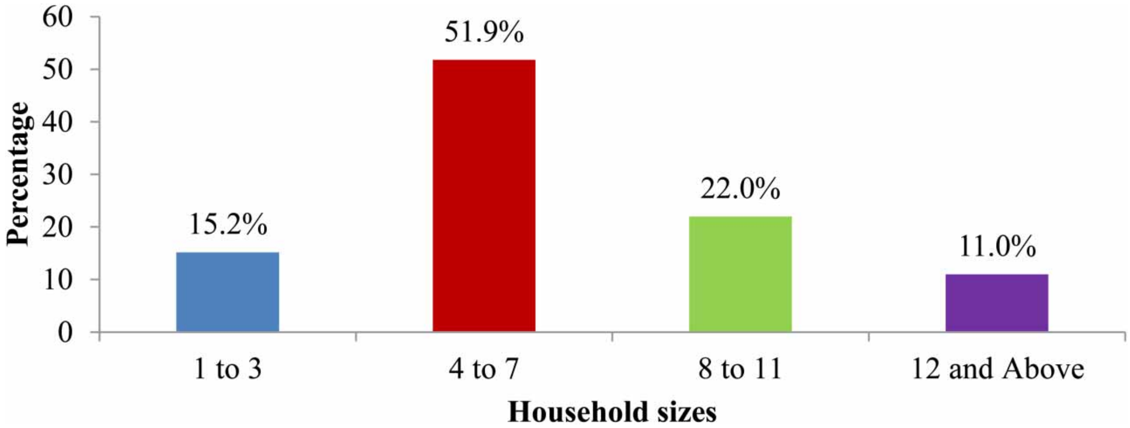


Figure 4 | Household sizes of the respondents (Field data, 2020).

et al. 2012), they are easier facilitated by larger household sizes which have more individuals available to ease the constraints on either the grazing work or on the overworked women in the farms. Larger families are therefore likely to find it easier to carry out IK-oriented agricultural activities.

On their level of education, 145 (38%) which were the majority of the participants were illiterate as shown in the pie-chart of Figure 5 overleaf. It was a strong assumption in this study that the willingness of farmers to adapt to the CCAS could be enhanced by their ability to understand and internalize the concepts. With no formal education, their level of comprehension the CCAS would really be compromised while on the other hand, it is easier to apply and utilize the IK practices that are relevant to responding to the effects of climate change as correctly in the Situation Learning Theory (Lave & Wengner 1991). The assumption that the majority of these farmers in Kajiado County who are illiterate would stick to a concept that they have learnt among social acquaintances, in an environment of constant and ongoing interaction within contextual experience is largely relevant in this case.

This study also sought to determine the influence of the household's farm size on the farmer's willingness to adapt to climate change agricultural technologies. The responses were grouped categorically into six; those with land under 5 ha, 5–9, 10–19, 20–49, 50–100, and those with over 100 ha. The farm sizes according to those who responded in the affirmative to the

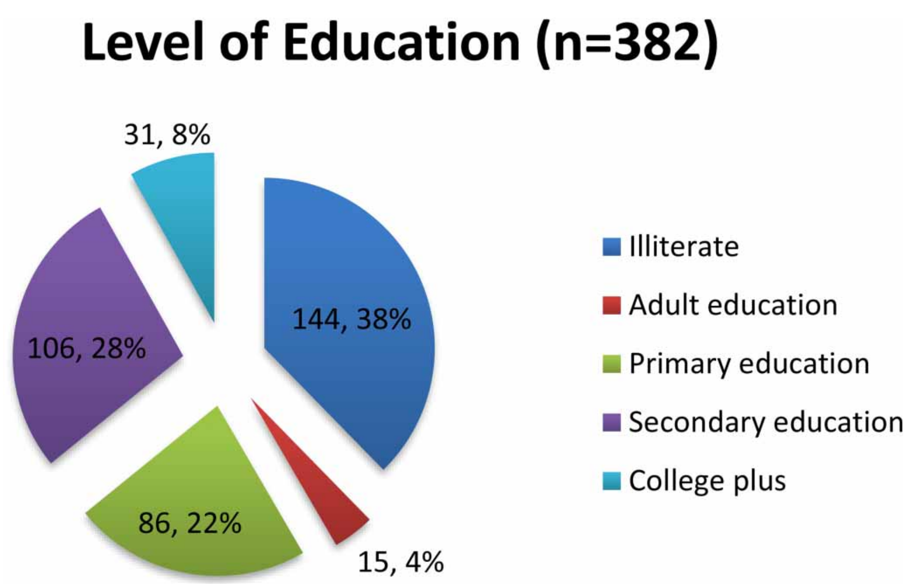


Figure 5 | Level of education of household heads (Field data, 2020).

question as to whether they own land and who were 269 in number, is illustrated by results in Table 3 overleaf. Although a majority of those who owned land were those with farms of between <1 and 5 ha (45%), and were found in more wet areas of Loitokitok where crop farming is most common, the farmers with bigger lands (51–100 ha) were found in the more arid areas of Kajiado West where livestock pastoralism was the most common form of agriculture. As shown in Table 3, the majority of the respondents had land of <5 ha at 45.8% yet those with land between 10 and 19 ha represented only 4.8%.

These results indicate that the majority of participants in this study were small-scale farmers. Their farming technologies are largely traditional and characterized by what they have socially learned over the years as IK.

4.2. Farmers' socio-demographic influences

The findings of this study show that the socio-demographic characteristics of a farmer can determine how his/her IK practices influence the uptake of modern CC adaptation technologies as shown in Table 4 overleaf. The results indicate that the majority of the socio-demographic variables, namely, level of income, level of education, type of livelihood activity /source of income household size, size of land owned, age, land ownership and type of land ownership all have a significant relationship with the uptake of CCAS. In the MPPAC model (Figure 1) that was used in this study, these socio-demographic and economic characteristics were the contextual factors that were able to predict the adaptation intentions of farmers in Kajiado County.

A more succinct interpretation from these findings is that on a reducing scale level of income, level of education and type of land ownership were significant factors that influenced a farmer who practices IK in their farming activities to adopt new climate change-oriented technologies. It can be deduced that a farmer with a high income, may easily opt to adopt new technology, should this have any cost implications. On the other hand, a farmer's low level of education may hinder him/her to internalize quickly the benefits of scientific-developed adaptation strategies. Lastly, the type of land ownership is a critical component, especially for the nomadic pastoralists who own huge tracks of land and consider migration as the best option during extended droughts.

To answer the question as to what degree and direction the relationships between these factors and the CCAS approaches exhibited, Pearson Correlation tests were conducted, and the results are summarized in Table 5. A comparative analysis was done on the socio-demographic and economic characteristics of the participant farmers; results show that these factors have low degree correlations with most of the CCASs except for the age which had a moderate degree relationship ($r = -0.337$). Compared to the farmers who were willing to do irrigation, those that were unwilling were more likely males, more likely older, more likely with larger household sizes, and more likely those who own land.

Similarly, those that were unwilling to rear other cattle breeds were more likely males, more likely older, more likely those with larger household sizes, and more likely those who own land. On the other hand, farmers willing to embrace irrigation were more likely to be those with higher levels of education and more likely those with higher monthly incomes.

Although the custodianship of IK farming practices in most of the African traditional settings is collectively exercised among the older members of the society (both men and women) (Barigye & Siraje 2019), this study found that among the Maasai community, this knowledge is mainly exercised at the goodwill of men. One of the focus group participants among the eight selected women commented on this:

> 'Our customs and traditions concerning what should be done on the land as well as our cattle is mainly decided by our husbands or male elders. As women, we are mainly mandated to implement the decisions already made. For example,

Table 3 | Households' farm sizes

	Kajiado West ($n = 67$)	Kajiado Central ($n = 91$)	Loitokitok ($n = 111$)	Total ($n = 269$)
Below 5 h	4.5	16.5	92.8	45.0
5–9 ha	6.0	16.5	4.5	8.9
10–19 ha	6.0	7.7	1.8	4.8
20–49 ha	19.4	24.2	0.9	13.4
51–100 ha	31.3	19.8	0.0	14.5
Over 100 ha	32.8	15.4	0.0	13.4

Field data, 2020.

Table 4 | The relationship between background factors and level of uptake of modern agricultural practices index score

	No uptake of modern agricultural practices ($n = 178$)	Uptake of modern agricultural practices ($n = 204$)	Spearman *rho*	*p*-value
Sub-county				
Kajiado West	14.1	14.7	0.163**	0.002
Kajiado Central	13.6	20.7		
Loitokitok	18.8	18.1		
Sex of the respondents				
Male	28.8	31.9	0.057	0.271
Female	17.8	21.5		
Age group of the respondents				
18–24	6.0	1.8	0.340**	0.006
25–34	9.2	8.1		
35–49	11.8	22.8		
50–64	14.9	14.9		
65–86	4.7	5.8		
Household size				
1–3 members	9.2	6.0	0.519**	0.000
4–7 members	22.3	29.6		
8–11 members	8.6	13.4		
11 and above	6.5	4.5		
Household farm in hectares recorded ($n = 269$)				
Below 5 ha	21.2	23.8	0.451**	0.000
5–9 ha	1.9	7.1		
10–19 ha	1.1	3.7		
20–49 hactares	4.1	9.3		
51–100 ha	8.6	5.9		
Over 100 ha	2.6	10.8		
Household average monthly income				
<3,000	19.4	2.6	0.581**	0.000
3,000 – <10,000	14.9	14.4		
10,000 – <20,000	6.0	14.7		
20,000 – <30,000	4.2	8.1		
>30,000	2.1	13.6		
Education level of the respondents				
Illiterate	25.4	12.3	0.562**	0.000
Adult education	2.6	1.3		
Primary education	11.3	11.3		
Secondary education	7.3	20.4		
College plus	0.0	8.1		
PPI Index				
Poorest	4.5	1.0	0.314**	0.000
Poor	18.6	17.8		
Medium	23.0	31.2		

(*Continued.*)

Table 4 | Continued

	No uptake of modern agricultural practices ($n = 178$)	Uptake of modern agricultural practices ($n = 204$)	Spearman *rho*	*p*-value
High	0.5	3.4		
Are you originally from this village?, No (migrated)	6.8	10.2	0.136**	0.000
The reason for your movement ($n = 65$)				
Marriage	26.2	41.5	0.164	0.191
Search for pasture	13.8	10.8		
Due to land	3.1	4.6		
Land ownership (Do you own land?), yes	27.7	42.7	0.309**	0.000
Type of land ownership? ($n = 269$)				
Private	19.7	46.1	0.290**	0.000
Communal	13.8	10.0		
Public	4.1	0.7		
Leased	1.9	3.7		
Source of income				
Livestock and agricultural products and produce	34.8	31.7	0.555**	0.000
Employment salary	2.1	8.6		
Remittances	2.1	4.5		
Other sources of income	7.6	8.6		

Field data, 2020.

whatever is going to be planted on the land in one given season, the size of the land to be utilized, which animals to be sold are all decisions that are made by the man of the house – my husband.'

The above assertion therefore still underscores the decision-making aspect of gender in adapting to new farming technologies among farmers. However, as the findings further reveal in this study, the more rural and traditional Kajiado West sub-county, farming communities have their decision-making processes influenced by these socio-demographic factors.'

Socio-demographic profiles have been proven to considerably predict the uptake of new agricultural technologies by farmers that operate within traditional rural settings (Badu *et al.* 2018; Melesse 2018; Sunny *et al.* 2018). Similar to documented study findings, these results tend to affirm that socio-demographic profiles have been proven to considerably predict the uptake of new agricultural technologies by farmers that operate within traditional rural settings (Badu *et al.* 2018; Melesse 2018; Sunny *et al.* 2018).

4.3. Geo-ecological influences

The findings show in regard to regional variances of prevailing ecological and climatic conditions that communities tend to adapt to climate change effects differently; each region using unique IK practices. When asked about what their likely response mechanisms would be in cases of adverse effects of climate change, 95, 82, and 10% of the respondents in Kajiado West, Kajiado Central and Loitokitok, respectively, opted for migration in search for water and pastures. Overall, 56% of the respondents in Kajiado County opted for migration in search of water and pastures illustrated in Table 6.

These same variations in response were noted when they were asked about composite IK practices as an option, with Kajiado West, Kajiado Central, and Loitokitok posting 53, 39, and 6%, respectively. Overall, 39% of the respondents in Kajiado County opted for IK practices. The results therefore confirm that; based on the regional variances of prevailing ecological and climatic conditions, communities tend to adapt to climate change effects differently. The cooler temperatures and

Table 5 | Summary of correlation between socio-demographic factors and CCAS approaches

	Tests	Increased acreage of land under irrigation farming	Increased numbers of superior cattle breeds	Farmer's involvement in agricultural development planning	Practicing artificial insemination for livestock	Fenced off and reseeded natural pasture	Better pasture establishments	Increased cultivation of drought resistant crops	Water resource management practices (e.g. water harvesting)
Sex of the respondent In favor of male	Pearson Correlation	−0.160	−0.102	0.038	−0.154	−0.161	−0.143	0.008	0.072
	Sig. (two-tailed)	0.000	0.041	0.458	0.001	0.000	0.005	0.869	0.162
Age	Pearson Correlation	−0.161	−0.337	0.008	−0.218	−0.095	−0.168	0.021	−0.143
	Sig. (two-tailed)	0.002	0.000	0.871	0.000	0.063	0.002	0.685	0.005
Household size	Pearson Correlation	−0.113	−0.187	−0.052	−0.028	−0.046	−0.042	−0.006	−0.056
	Sig. (two-tailed)	0.028	0.001	0.312	0.584	0.367	0.414	0.904	0.278
Education level	Pearson Correlation	0.284	0.196	0.074	0.172	0.355	0.061	0.125*	0.458
	Sig. (two-tailed)	0.000	0.000	0.147	0.001	0.000	0.235	0.015	0.000
Land ownership (Do you own land?) in Favor of yes	Pearson Correlation	−0.192	−0.198	−0.039	−0.101	−0.144	−0.038	−0.084	−0.208
	Sig. (two-tailed)	0.003	0.000	0.453	0.049	0.005	0.458	0.100	0.000
Type of land ownership? In Favor of communal	Pearson Correlation	−0.121	−0.149	−0.069	−0.188	−0.315	−0.054	0.049	−0.214
	Sig. (two-tailed)	0.017	0.002	0.257	0.000	0.000	0.379	0.428	0.000
What is your farm size in acres?	Pearson Correlation	−0.254	−0.272	−0.240	−0.008	−0.141	−0.227	−0.030	0.129
	Sig. (two-tailed)	0.000	0.000	0.000	0.900	0.021	0.000	0.623	0.034
Household average monthly income	Pearson Correlation	0.218	0.145	0.028	0.250	0.394	0.199	0.075	0.474
	Sig. (two-tailed)	0.000	0.004	0.581	0.000	0.000	0.000	0.142	0.000

Field data, 2020.

Table 6 | Farmers' response mechanisms to climate change effects per sub-county

Response mechanism to CC effects		Migration % Yes	No	Totals
Sub-county	Kajiado West	95	5	100
	Kajiado Central	82	18	100
	Loitokitok	10	90	100
	Overall	**56**	**44**	**100**
Response mechanism to CC effects		**Indigenous Knowledge practices % Yes**	**No**	**Totals**
	Kajiado West	53	47	100
	Kajiado Central	39	61	100
	Loitokitok	6	94	100
Sub-county	**Overall**	**29**	**71**	**100**
Response mechanism to CC effects		**Wait for Humanitarian assistance from NGOs, civil societies, etc. (%) Yes**	**No**	**Totals**
	Kajiado West	5	95	100
	Kajiado Central	11	89	100
	Loitokitok	58	42	100
Sub-county	**Overall**	**29**	**71**	**100**

Field Data, 2020.

Table 7 | Crosstabs showing relationship between farmer's sub-county and climate change response mechanisms

Independent variable	Dependent variable	Pearson Chi-Square	df	Asymp. Sig. (2-sided)	Significance
Farmer's location of residence (Sub-county)	Climate change response				
	Resign to our fate and do nothing	79.467	2	0.000**	Significant
	Appeal to government for help through local administration	9.887	2	0.007**	Significant
	Wait for Humanitarian assistance from NGOs, civil societies etc.	111.514	2	0.000**	Significant
	Use traditional IK to survive	66.604	2	0.000**	Significant
	Seek help within social networks; relatives, clan, neighbors	6.908	2	0.032	
	Migration	231.267	2	0.000**	Significant

Field Data, 2020.

relatively heavy amounts of rainfall that aRe(and adequately predictable) experienced in Loitokitok sub-county; which also has rich volcanic soils, has its farmers adopting a largely sedentary form of agriculture which is mainly characterized by crop and dairy farming technologies.

This can be demonstrated from the study findings shown in Table 6, where 58% of the farmers in Loitokitok sub-county would likely look up to expert assistance from NGOs, civil societies, and research institutions among others, to address the effects of climate change as compared to only 5% of the respondents in more arid Kajiado West sub-county. Overall, 29% of the respondents in Kajiado County waited for humanitarian assistance from NGOs, and civil societies.

These findings therefore reinforce the applicability and significance of the credence that, the socio-cognitive progression within which farming-oriented climate change adaptation occurs, tends to take place in a localized socio-ecological environment. Such an environment as Mitter *et al.* (2019) avers is characterized by 'social and institutional support, cultural values and norms, regional characteristics, and climate-related trigger events'.

Crosstab tests done between the existing likely climate change response approaches from farmers and the farmer's current location, the pro-IK practice of migration was the most preferred option that was influenced by where a farmer resided (CI = 99%, $\chi^2 = 231.27$, $p < 0.000$). Similarly, dependence on humanitarian assistance from an organization that more often offers development programs that are CCAS-oriented is an option that is significantly associated with the location of a farmer.

The type of farming is regionally unique to the prevailing climatic and geophysical conditions and is a likely determinant of which climate change adaptation approach a farmer would prefer; whether IK practice or conventional CCAS.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

This study investigated the extent to which socio-demographic, economic, and geo-ecological factors influence farmers to either favor applying IK practices or the conventional CCAS in their agricultural activities in Kajiado County in Kenya. On socio-demographic characteristics of farmers, the level of education played a key role in the CC adaptation approach revealing a slower uptake among less learned farmers which could be attributed to a gap in terms of inadequate CCAS sensitization and awareness efforts considering that the majority of them were illiterate. Based on the findings on the gender and age of a farmer, it was manifestly clear that adaptation programs that would target the youth and women by increasing their involvement in agriculture would boost CCAS uptake.

The IK practices that are largely labor intensive, are more sustained by traditional families that have larger numbers of members. Economically, the study results show that farmers view the adoption of CCAS as having some financial implications on their incomes. It would therefore mean that CCAS programs that reflect envisaged improved returns for new technologies are more likely to be received well by farmers as revealed by increased uptake among those with higher incomes. As shown in the study results, farmers that resided in a particular location with a unique climatic and geophysical profile are involved in a specific type of farming that can thrive in the prevailing conditions. This is an indication that an effective approach that includes the IK climate change adaptation practices and the CCAS can be applied in a complimentary manner to achieve the desired results in a region that possesses diverse climatic and geophysical conditions.

The socio-demographic and economic characteristics of farmers in determining the farmer's tendency to practice IK ranked differently in terms of their significance. These factors therefore correctly fitted in the MPPACC model as contextual factors that played a significant role in influencing a farmer's appraisals, subsequently shaping his/her decision to either adapt to new agricultural CCAS or stick to their IK practices.

5.2. Recommendations

There is a need to prioritize the development of climate change adaptation and development plans that conform to the geo-ecological and socio-cultural characteristics through the direct involvement of all stakeholders, including the local farmers of Kajiado County.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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