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CONSTRAINTS LIMITING EFFECTIVE COPING AND ADAPTATION TO CLIMATE IMPACTS BY SMALL-SCALE FARMERS IN KATUK AREA, KISUMU KENYA

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ABSTRACT

Climate change provides a difficult challenge to agricultural productivity and food security in developing nations, necessitating the implementation of environmentally benign and scientifically sound adaptation strategies. In Kenya, more research has been done on climate impact adaptation at the national or regional levels, but less focus has been directed to community levels. This study utilizes knowledge from small-scale farmers in Katuk Odeyo area, Kisumu, to tackle the issue of climate impact adaptation and more particularly the constraints to effective coping and adaptation to climate impacts in the community. The study uses questionnaires, interviews, Focus Group Discussions, desk research, and observations to gather data relevant to the study phenomenon. The gathered data was analyzed using both quantitative and qualitative approaches. The quantitative data was processed to determine frequency counts, means, and percentages. The results were then presented as frequency tables. The chi-square test was used to determine the relationships between adaptation approaches and background factors such as age, education level, and awareness of climate change. The results of the focus group discussions were transcribed, translated, and qualitatively evaluated to find categories, themes, correlations, and patterns, and draw conclusions in line with the study's objectives. The findings indicate that small-scale farmers in Katuk utilize on-farm and off-farm coping and adaptation strategies. These strategies are utilized before, during, and after farming seasons. The findings further indicated that constraints and barriers to effective coping and adaptation are related to factors such as limited access or absence of climate data, insufficient support from critical government institutions, declining quality and quantity of productive labour and/or knowledge, and limited access to feasible and affordable financial resources. The study demonstrated that a complex structure of land ownership and tenure, limited land sizes, and gender hierarchy are significant barriers to implementing long-term climate adaptation solutions. Respondents also mentioned lack of farm implements and machinery, high cost of and limited access to improved crop varieties, socio-cultural barriers, poor access to climate information and institutional support, and loss of productive labour and knowledge as major barriers to adaptation. The findings are significant because they will provide decision-makers, researchers, and practitioners with useful insights into how various socioeconomic variables may influence the viability of a certain community climate response plan. It underlines the significance of thoroughly analyzing the local situation to identify priority activities for prompt climate response and risk reduction.

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1. Introduction

Climate change is a major worry for farmers worldwide, affecting all types of farmers (Kom *et al*., 2022). Climate change provides a difficult challenge to agricultural productivity and food security in developing nations, necessitating the implementation of environmentally benign and scientifically sound adaptation strategies. Agricultural productivity in Africa is vulnerable to climate fluctuation and change (Kom *et al.,* 2022). Multiple studies have found that this phenomenon is caused by climate shocks such as erratic rainfall, rising temperatures, prolonged drought, heat waves, and humidity (IPCC, 2018). Water scarcity is a serious challenge for agricultural output and long-term progress (Kahinda and Taigbenu, 2011). These variables have had an influence on small-scale farmers in Sub-Saharan Africa, whose agricultural output relied on rain-fed systems for survival (Alemayehu and Bewket, 2017). Food insecurity is primarily caused by rainfall changes and rising temperatures, which result in prolonged droughts and climate-related issues for agricultural systems (Domenech, 2015).

Small-scale agriculture is critical for food production and sustaining livelihoods in many African countries (Abegunde & Sibanda, 2018). Fields (2011) underlines the significance of small-scale agriculture in many emerging economies. Small-scale farming is the principal source of food and income for the vast majority of sub-Saharan African households (Gollin, 2014). According to Abegunde *et al*. (2019), majority of African farmers operate on a modest scale. Small-scale farmers produce agricultural products on fragmented land, yet they play an important role in food supply (Chamberlin, 2015). Climate change poses a significant threat to small-scale farmers (Bryan *et al.,* 2010). Climate change, notably rising temperatures, and precipitation patterns, hurts biodiversity, exacerbates current water resource pressures, and increases the vulnerability of small-scale farming systems (Change 2014). Climate adaptation is one of the important options for small-scale farmers to continue prospering. Several constraints prevent the application of adaptation strategies, leaving small-scale farmers vulnerable to the effects of climate change (Abegunde *et al.,* 2019).

Adaptation is an unceasing and dynamic process that addresses climate change impacts (Walker 2019). According to Howden *et al.,* (2007), significant climate disruptions demand continual adaptation methods aimed at mitigating their effects. Adaptation is a set of approaches aimed at mitigating the severe and long-term consequences of current and future large environmental changes (Zilberman *et al.,* 2012). Adaptation in small-scale systems is the consequence of a complex interaction of capabilities and susceptibilities within larger socio-ecological settings (Wilk *et al.* 2013). As indicated in the wider adaptation strategy (Zilberman *et al.,* 2012), the adoption of informed decisions should guide the selection of appropriate adaptation methods. Thus, the application of adaptation techniques by individual farmers is critical to the overall success of adaptation in small-scale farming settings. Adoption is a complex process in which farmers use adaptation tactics to varying degrees to optimize benefits (Wilk *et al.,* 2013). When presented with multiple options, small-scale farmers frequently use a variety of adaptation approaches to satisfy individual demands (Islam *et al.,* 2014). Composite indices have been established to assess the acceptability of various adaptation approaches, but there has been little study into quantifying adoption in smallholder farmer settings. This inability to access appropriate information that is

context specific, has therefore undermined efforts for elaborating smallholder farmers' climate change adaptation actions (Wilk *et al.,* 2013).

Barriers are challenges that arise within a certain setting and can be addressed with the necessary adaptation efforts (Moser and Ekstrom, 2010). According to Wilk *et al.* (2013), the primary barriers to implementing climate change adaptation methods have been qualitatively discussed. Moser and Ekstrom (2010) contend that impediments arise from the interaction between persons, the environment, and the relevant systems. According to Jones and Boyd (2011), social barriers to adaptation have cognitive, normative, and institutional components. Islam *et al.* (2014) identified several interrelated hurdles in Bangladesh's farming community, including ecological, technological, social, economic, and institutional issues that influenced adaptation strategies. Barriers are caused by a lack of human, financial, natural, and social capital (Islam *et al.,* 2014). Researching adaptation barriers can aid in reducing climatic risks, selecting suitable adaptation procedures, and developing policies that promote effective adaptation (Wilk *et al.*, 2013). Efforts to measure adaptation barriers have been limited, despite the critical need to thoroughly guide adaptation programs in small-scale agriculture in developing countries.

In Kenya, scholars and policymakers have debated how to effectively adapt to climate impacts among small-scale farmers. More research has been done on climate impact adaptation at the national or regional level, but less focus has been directed to community levels like the Katuk area. Lack of knowledge impedes the development of appropriate and efficient adaptation strategies tailored to the needs and vulnerabilities of Katuk Odeyo's local communities. Policymakers, local governments, and community stakeholders must understand the specific barriers to adaptation in this environment to implement contextually appropriate interventions that promote resilience and sustainability in response to the consequences of climate change. By addressing this research gap, we can develop better adaptation approaches to improve the resilience and well-being of small-scale farmers in Katuk Odeyo, Kisumu, and other communities facing comparable challenges around the world. This paper aims to assess response strategies to climate impact, and barriers to adaptation and offer recommendations and opportunities for small-scale farmers in Katuk Odeyo - Kisumu, Kenya. The main objective is to assess the constraints that limit farmers' ability to effectively adapt to climate impacts. The paper more specifically addresses:

1. Climate adaptation perceptions and response strategies by small-scale farmers,
2. Community adaptation strategies,
3. Barriers influencing effective adaptation and,
4. Policy implications of the study findings.

1.1 Climate Adaptation Perceptions and Response Strategies by Small-Scale Farmers

According to Ludi *et al.* (2012), effective adaptation mechanisms rely on long-term efforts to build resilience in unexpected environments. Adger *et al*. (2011) assert that the failure of developmental approaches to properly address current climate threats has resulted in an adaptation deficit. It is critical to underline the importance of strengthening the link between mitigation and low-regret

adaptation alternatives. According to the IPCC (2018), no single adaptation approach can fully address the needs of a community or landscape. Recognizing the importance of socioeconomic perspectives, strategies that previously focused on technological solutions for dealing with climate effects are shifting to more comprehensive approaches that prioritize enhancing resilience by strengthening institutional structures for policy frameworks and providing social services, climate knowledge, and information (Chambwera and Anderson, 2011). This viewpoint seeks to encourage programs that focus on embracing local social norms and cultural practices, as well as recognizing the links between diverse adaptation techniques and the multiple hazards that are threatening the well-being of individuals and communities across Africa.

Adaptation measures in the Nyando subcounty are primarily concerned with the immediate hazards provided by floods, limited and/or inadequate water resources, protracted droughts, and increased incidences of plant diseases (Onyango *et al.,* 2012). No significant research has been undertaken in Nyando sub-county to examine the efficacy of the several adaptation initiatives supported by stakeholders. Despite efforts to highlight indigenous solutions and behavioral changes, uncertainties remain within the community. (Onyango *et al*., 2012).

There has recently been an emphasis on using flexible and iterative learning methods to improve adaptability (Panthi *et al*., 2015). According to (Moser and Ekström, 2010), because of the everchanging and intricate nature of the interconnections amongst economic, environmental, and social elements, adaptation is being seen as a multifaceted process encompassing many phases at numerous intersections instead of a sequence of intentional technical interventions. Efforts to increase adaptation should center on using participatory procedures to maximize learning possibilities for all stakeholders. This will eventually assist communities in taking proactive or predictive actions to lessen the risk of relying on reactive tactics based on unexpected shocks (Tschakert and Dietrich, 2010). Experiential learning gives elasticity to adaptation scheduling by incorporating a variety of climate factors (Koelle & Annecke, 2011). Various researchers emphasize the necessity of controlling ambiguity by encouraging participatory research, and social learning through experiments, and creating platforms and conditions that allow for multi-stakeholder conversation networks and engagements (Moser and Ekström, 2010). Scholars like Faysse *et al.* (2013) have underlined the need to foster initiatives to assist the behavioural and social alterations required for adaptation. Technical and financial resources, such as skill and time, needed by both domestic and international stakeholders, have been recognized as barriers to seeing adaptation as a participating process of learning and knowledge sharing (Shankland and Chambote, 2011). Inadequate tools and resources for multidisciplinary research, political issues surrounding stakeholder involvement, gender power imbalances, and the importance of considering consensus-building methods and conflict resolution are all obstacles to the use of participatory approaches (Beardon and Newman, 2011).

2. Methodology

2.1 The Study Area

The study area also known as Katuk Odeyo is semi-arid and is in Nyakach Kisumu County, Kenya on the plains of Lake Victoria as shown in map of the study area in Fig. 2.1 below. Katuk Odeyo experiences environmental challenges coupled with food insecurity and complex socioeconomic

challenges, low farm labour productivity, and population pressure (Raburu *et al.,* 2012). Further, land fragmentation and erosion-related land degradation have undermined food security (Recha *et al.,* 2017). According to CCAF, 2017, The average annual rainfall is 1507mm while the average rainfall during the main rainy season of March, April, and May is 542mm respectively. The area has average temperatures ranging between 25 and 29°C. Katuk Odeyo's population density is mainly affected by water availability and land productivity.

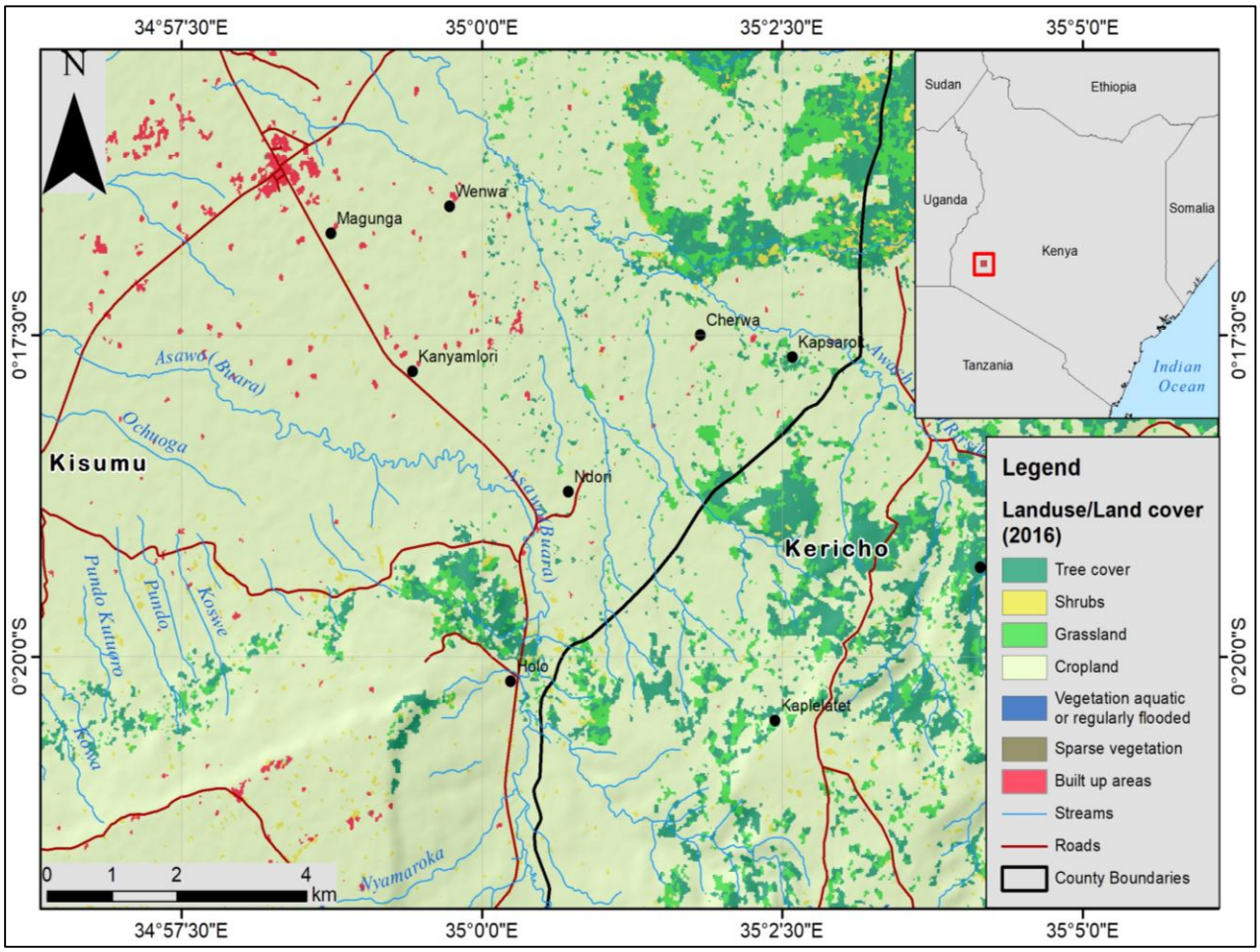

Figure 2.1. Map of the Study Area

2.2 Sampling, Data Collection, and Analysis

A stratified random sampling approach was adopted for equal distribution of 315 households within 5 clans. The village `population` register complimented transect walks and participatory resource mapping as shown in the map in Fig 2.1. The study employed the use of interviews, questionnaires, desk research, focus group discussions (FGDs), and observations to gather data. The interviews were conducted in an open and semi-structured approach, allowing participants to explore deeper into interesting issues. Farmers with higher education provided more detailed responses than farmers with lower education, who provided shorter responses. The questions focused on the most prevalent and distinctive challenges that communities face, such as general and climate-related difficulties. They also looked at how families dealt with various climate shocks in both good and bad years. The study also asked about farmers' planning strategies for addressing present and future

climate-related challenges, as well as the factors that hampered or aided their capacity to adopt successful adaptation measures.

The gathered data was analyzed using both qualitative and quantitative approaches. The quantitative data was processed to determine percentages, means, and frequency counts. The results were then presented as frequency tables. The chi-square test was used to examine the linkage between adaption approaches and background factors such as age, education level, and awareness of climate change. The results of the FGDs were transcribed, translated, and qualitatively evaluated to find categories, themes, correlations, and patterns, and draw conclusions by the study's objectives.

3. Findings

3.1 Community's Adaptation Strategies

Adaptation methods are long-term solutions that include management decisions and household production to manage and mitigate adverse climate impacts (Kelly and Adger, 2000; Smith *et al.,* 2000). Coping strategies are immediate actions taken to reduce short-term unfavourable climate risks such as drought (Yohe and Tol, 2002; Campbell *et al*., 2011). The climate responses outlined below are divided into on-farm and off-farm strategies (Table 3.1). The first relates to community-implemented on-farm management approaches, whilst the latter refers to alternative activities carried out away from the farm.

3.1.1 On-farm adaptation strategies and coping mechanisms

The study results showed that the adaptation responses under this category mostly entailed changing agronomic practices to deal with lower precipitation while increasing crop output. The findings showed that changing planting time is an important community response tactic to mitigating and reducing climatic variability. Furthermore, the study findings revealed that numerous households produce early maturing crop varieties and change their cropping patterns in response to climate effects. Poor seed selection and the inability to predict optimal cropping patterns were directly responsible for approximately 53.9% of the reported outcomes (39.9% experiencing reduced or no crop output and 14% facing crops and seedlings drying out). Some households reported that they were already producing early maturing millet, sorghum, and maize varieties that are drought-resistant and mature in 70-90 days, as opposed to typical varieties that take 120-140 days. Farmers interviewed said that this increased their produce by allowing their crops to flourish. They claimed that this strategy enabled their drought-resistant crops to continue through critical growth phases such as flowering, which generally requires more water, before the start of the dry season. These early-maturing crop kinds assist the community in mitigating the risks associated with climate variability. These findings show that households changed their farming practices to adapt to climate change. However, recession, economic stress, and decreased land ownership may have influenced their adaptation techniques. This validates the findings of Mertz *et al*. (2010), Thomas *et al*. (2007), and Reid and Vogel (2006), who found that households in arid locations routinely modify their farming techniques in response to climate fluctuations, as well as other non-climatic elements and complexity.

Households prefer to diversify crops as a main adaptation approach to capitalize on opportunities to reduce output losses, as demonstrated by the findings. Diversification is commonly employed to mitigate the effects of unpredictable rainfall and deteriorating soil fertility. According to Gliessman (2007), various crops have distinct physiological characteristics that influence their reactions to changes in temperature and rainfall. The results challenge those of Mac Oloo and others (2013), who found that only 32% and 37% of households in the research area have incorporated the above three new varieties of crops into their farming practices. Bryan *et al*. (2013) backed up these findings, noting that farmers in Sub-Saharan Africa are adjusting to climate variability by diversifying their crops to avoid crop failure.

Transect walks made it easier to observe farms that mostly grew maize, millet, and sorghum. Crops were planted between rows of *Grevillea robusta* and *Gliricidia sepium* trees to help stabilize and enhance soil. The primary reasons for using this practice, particularly among female respondents, were to improve farm microclimate and increase economic benefits from the sale of agroforestry products such as seedlings and firewood. The findings confirm the findings of Kebebew and Urgessa (2011) and Jama *et al*. (2006), who discovered that agroforestry has the potential to offer opportunities for low-income farmers by allowing them to sell wood products such as medications, small timber, and food. According to the study, the adoption of this strategy is determined by individual farmers' land holding size. Small-scale farmers expressed concern about competing goals for growing trees and food. Antwi-Agyei (2012) supports this result, indicating that farmers' capability to engage in agro-forestry as an adaptation strategy is connected to their land ownership system.

The study findings further indicated that the adoption of irrigation techniques was not a common coping strategy for managing climate impacts within the community. Small-scale farmers can lower the risk of crop loss due to drought by using irrigation techniques (Laube *et al*., 2012). However, just about 4% of respondents reported engaging in any form of irrigation. The restricted use of irrigation for adaptation may be related to the availability of financing for the initial expenditure. According to the research findings, the majority of study participants do not have a consistent income and rely on financial assistance from relatives who live outside the area.

The community has adopted the essential adaptation practice of planting drought-tolerant crops for a variety of reasons. Drought-resistant crops such as cassava, sorghum, and millet were identified as an important adaptation strategy. This technique is consistent with Campbell *et al*. (2011) findings, which imply that cassava, millet, and sorghum are useful crops in dry and semi-arid locations. The households used this strategy because they noticed that maize and other cereals were more vulnerable to climate change, mainly drought and sickness. Farmers said that applying this response strategy, together with conventional post-harvest management measures, increased yields and food security. Nonetheless, this technique was still in its early stages and was only being used by a few farmers who received assistance from the Kenya Agricultural Research Institute (KARI).

Also, the findings from this study indicated that crop rotation is a fundamental approach utilized to capitalize on opportunities for diversification while preserving soil fertility. Rotating crops improves yields more than a constant monoculture system. It enables the assimilation of plant residues into the soil, which promotes a variety of microorganism biological activities. Crop rotation provides transitory diversity, which may interrupt disease and insect life cycles, resulting in increased crop growth and yield (Altieri and Nicholls, 2005). Some farmers assisted by the Vi agroforestry project prefer to implement soil management methods, like prolonged fallow seasons and manure production, to preserve soil quality on their properties. The focus group meetings also included themes including composting and implementing agricultural strategies such as using organic or green manure, mulching, crop rotation, cover crops, residue retention, and so on. The soil conservation strategies described above are critical in ecological agriculture and are known as efficient methods for raising crop output while mitigating drought-related consequences (Niggli *et al*., 2009). Farmers can enhance drought management by applying methods that increase organic matter and improve water retention in the soil (Borron, 2006). Viewing soil management as an adaptation approach can assist in preserving soil veracity, enhancing yields, and preventing crop deaths.

3.1.2 Off-farm responses by the community

These approaches included temporary migration, social capital dependence, livelihood diversification information sharing about imminent droughts, the use of non-governmental and governmental organizations, dietary changes, reduced food consumption, and early warning systems. Livelihood diversification was reported as a response strategy in the community. Diversifying livelihoods is a frequent technique in Africa to manage climate risks, particularly in locations where agriculture is strongly dependent on rainfall (Paavola, 2008). Tables 3.1, 3.2, and Figure 3.1 show that households have engaged in a variety of non-arable farming activities because of changes in both rainfall and temperature. Households said that this is currently a more common practice than in prior years. The findings confirmed that when a community experiences food poverty and stress, households are more likely to participate in a variety of non-farm activities. Female traders frequently engage in small-scale business at the Ahero, Sondu, and Katito marketplaces. Similarly, males engage in livestock sales despite the significant initial investment necessary. Furthermore, numerous households reported making charcoal for extra income. It is worth noting that this non-agricultural coping method was implemented despite a statewide ban on deforestation induced by charcoal burning. Furthermore, sand extraction and motorcycle taxi services, known as boda boda, have grown into substantial and financially rewarding businesses, especially among young men in the community.

The findings from this study show that a respondent's gender, family education, and socioeconomic level all have a substantial impact on the type of non-farm livelihood activity they prefer. Livelihood activities within the study area were divided into three categories: activities mostly carried out by women, activities primarily carried out by men, and gender-neutral activities involving both women and men as shown in Table 3.1. According to research findings, women trade a wide range of things, including food, household items, agricultural equipment and tools, and prepared meals. Men, on the other hand, are more likely to handle tangible assets like land and animals, as well as agricultural

investments like irrigation and greenhouse systems. Diversifying livelihood is a strategy used to address low or inadequate household income. Petty trade, cattle sales, temporal migration, and charcoal burning were suggested as additional activities to help minimize the consequences of poor weather and economic crises. As a result, smallholder farmers can mitigate risks such as crop failure or low yields by diversifying their sources of income and livelihood. Men found that selling animals was a more effective adaptation technique than selling crops because it allowed them to quickly make cash and gain capital. This conclusion is consistent with Maconachie's (2011) research, which found that rearing cattle represents stability in rural African households. This livelihood option is critical for providing security and serving as a quick source of emergency income for the family. The emergency funds were mostly used to purchase farm inputs, maintain the family during a drought, provide medical care, and cover costs associated with enrolling and supporting children in school.

Table 3.1: Household coping and adapting strategies

Response strategies	Specific activities	Gender cluster
On-farm adaptation and coping mechanisms	• Changing the timing of planting	Both
	• Planting early maturing varieties	Both
	• Crop diversification/staggered cropping	Both
		Male
	• Practising agroforestry	Both
	• Crop rotation/intercropping	Both
	• Planting drought tolerant crops	Male
	• Using drip irrigation facilities	Male
	• Using green houses	Both
	• Composting	Men
	• Water harvesting and storage	Both
	• Fodder conservation	Both
	• Zero grazing	Both
	• Drought tolerant feeds	Both
	• Pest control (crush pens, vaccination)	Both
	• Climate resilient breeds	
Off-farm responses and coping mechanisms	• Livelihood diversification	Both
	• Rely on family, friends and church	Both
	• Selling livestock	Male
	• Selling fish	Female
	• Charcoal production	Male
	• Changing diets	Male
	• Temporary migration	Male
	• Sand harvesting	Male
	• Government/NGO assistance	Both
	• Early warning systems	Both

Several households depend on remittances from family and friends as a coping technique during climate-related issues. Social networks such as farmer-based associations and non-governmental organizations (NGOs) provide aid during emergencies. Clan type and education level can have a considerable impact on the structure and extent of social networks, particularly in terms of access to numerous benefits such as merry-go-round groups, exchanging information about future droughts, farm supplies, and opportunities for temporary job relocation. Rural agricultural communities rely heavily on social networks to maintain their livelihoods (Antwi-Agyei, 2012).

According to the findings from this study, certain farmers, particularly those participating in the "Climate Smart Village" (CSV) project led by the Consultative Group on International Agricultural Research (CGIAR) focusing on agriculture, climate change, and food security, received weather data

from the Kenya Meteorological Department via text messages on their mobile devices. Notably, some households continued to rely on social networks to exchange indigenous agro-ecological knowledge on early warning signs for climate forecasting. The findings show that farmers have established intricate mental climate models founded on agro-ecological occurrences in their surroundings. Conventional climate models are used to create seasonal calendars that aid in the planning of agricultural activities such as crop planting and harvesting. This is critical in rain-fed agricultural systems because crop yields can be dramatically influenced if farmers ignore key events in the seasonal cycle. Small-scale farmers in Africa have a strong awareness of how to manage their local agro-ecological systems. Local knowledge is detailed, with intricate systems for gathering information, anticipating threats, and making critical agricultural decisions (Orlove *et al*., 2010).

Further, the study findings indicate that many of the households have a member who has relocated due to climate change, bad environmental circumstances, or socioeconomic pressures (Table 3.1). This behavior is common, particularly among young people who tend to relocate to urban areas, such as Nairobi and Kisumu. Individuals with limited education and abilities may have difficulty finding formal and profitable employment, even while seeking food assistance from older farmers during the dry season. The study findings also indicate the presence of power dynamics and gender stratification in temporary migration. Men are more likely to migrate than women. Married women indicated that they must obtain permission from their husbands or the head of their immediate family before leaving the community. The findings confirm Rademacher-Schulz and Mahama's (2012) observation that cultural and social norms limit female migration in certain African countries. McLeman and Smit (2006), as well as Gemenne (2011), supported the premise that farmers in poor countries migrate to cope with difficult climate conditions and environmental changes, such as shifting seasons (Van der Geest, 2011). This movement pattern, known as circular migration or transient migration lasting fewer than six months, involves people returning to their homes at the onset of the rainy season (Findley, 1994). Table 3.1 show that the community relies on non-governmental organizations (NGOs) for assistance because government aid and extension services are intermittent.

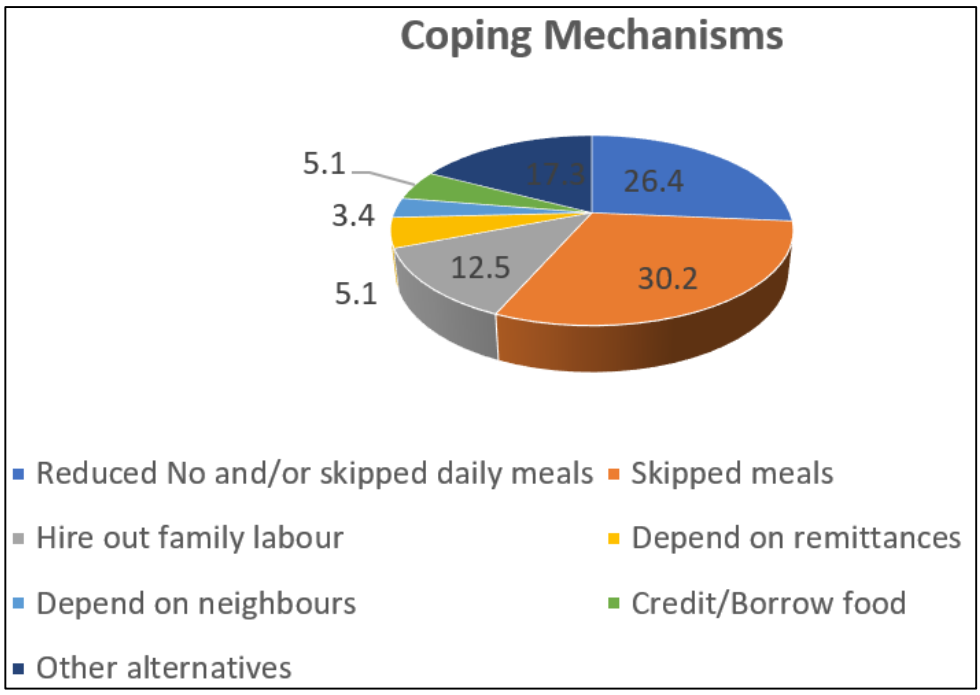

Figure 3.1: Coping Mechanisms for Food Unavailability

According to specific findings, the majority of participating non-governmental organizations (NGOs) prioritize increasing food security and managing natural resources over responding to food emergencies during disasters. This has an impact on existing government activities targeted at increasing community resilience in dealing with climate-related issues. Some government and NGO actions focused on reducing community vulnerability were shown to be beneficial in addressing community needs. For example, Friends of Katuk Odeyo (FOKO) has established cereal banks to shield farmers from potential post-harvest losses caused by poor grain handling. Kenya Commercial Bank (KCB), Equity Bank, and other partners have created climate risk insurance schemes for fisheries, livestock, and crop failures. The Agricultural Finance Corporation (AFC) provides loans and credits for the horticultural, livestock, and beekeeping value chains. The study did not look into the suitability, accessibility, or performance of risk management amenities. Some respondents reported difficulty due to the high initial expenditures of receiving these services. According to the study findings, reducing food intake or foregoing meals was an important strategy for dealing with drought-induced food insecurity (see Figure 3.1). However, this strategy must be carefully evaluated because it may result in a variety of disorders and health-related effects (Heltberg *et al*. 2009).

The general findings of the non-farm climate response approach are consistent with previous research by Paavola (2008) and Barrett *et al*. (2001), which show that households may engage in non-farm livelihood activities to offset climate risks, particularly those linked with crop failure. According to Osbahr *et al*. (2010), diversifying livelihoods can play an important role in increasing farmer households' asset base and, as a result, boosting their resilience. It is important to note that, while the response strategies mentioned above are comprehensive, there is limited evidence to suggest that incentivizing behavioral changes to promote efforts to reduce water use, shift away from chemical fertilizers, and transition to climate-resilient crops has been successfully replicated. This emphasizes the cautionary advice of other experts on solutions that prioritize growing supply

(such as more water and fertilizers) over meeting needs, as noted by Singh (2018). According to Singh *et al*. (2016), changes in rural lives, farming practices, ecosystems, and social structures all have an impact on generic techniques.

3.2 Socio-economic drivers that influence adaptation responses.

Climate adaptation can be done before, during, and after farming seasons as shown in Table 3.2. Two noteworthy discoveries are made after reviewing the climate response mechanisms described in Tables 3.1 and Figure 3.1.

Table 3.2: Scale of Strategies Implementation

Time frame for climate adaptation		
Before farming season	**During farming season**	**After farming season**
Livelihood diversification	Planting drought-tolerant crops	Buying food or changing diet
Relying on social networks	Changing the timing of planting	Selling livestock
Selling livestock	Crop diversification	Temporary migration
Selling fish/fishing	Planting early maturing crops	Selling fish/fishing
Reducing food consumption	Using irrigation facilities	Livelihood diversification
Sand harvesting		Using irrigation facilities/greenhouse
		Sand harvesting

The findings mention that socioeconomic characteristics such as gender, household head age, land tenure system, education level, perceived wealth in the local community, and agroecological environment (proximity to water sources or gullies) may influence response plan selection (Tables 3.2 and 3.3). The findings support the conclusions of Deressa *et al*. (2009), Below *et al*. (2012), and Bryan *et al*. (2013), who found that socioeconomic characteristics have an important influence in influencing a household's response approach. The study findings indicate that household farm size may not have a huge influence on the choice of an adaptation strategy (Table 3.3). Droughts, limited market access, low education, and adverse economic growth are all common difficulties for households in Africa's desert regions. Climate events can influence adaptation, but it is crucial to understand that other factors, such as economic, political, and socio-environmental variations, might make it difficult to identify a specific adaptation approach that is exclusively due to climate change.

Table 3.3: Socio-economic drivers influencing the response strategies

S. No	Socio-economic factor	Potential influence of adaptation strategy	
1.	Gender orientation of the family head	✔	
2.	The maturity (age) of the leader of the household	✔	
3.	The size of the household		x
4.	Land tenure system	✔	
5.	Land holding	✔	
6.	Education level of household head	✔	
7.	Wealth status	✔	
8.	Agro ecological setting	✔	

Where:

✔ implies Yes and x implies No

3.3 Barriers and constraints limiting adaptation in the community.

The study findings indicate that barriers and constraints are related to factors such as limited access or absence of climate data, insufficient support from critical government institutions, declining quality and quantity of productive labor and/or knowledge, and limited access to feasible and affordable financial resources (refer to Table 3.4). According to Bewket *et al*. (2013), these characteristics include poverty, social networks, technical capacity, and no access to critical resources like land, information, and innovative solutions. The study demonstrates that an intricate structure of land tenure and ownership, limited land sizes, and gender hierarchy are significant barriers to implementing long-term climate adaptation solutions. Gender hierarchy persisted, leaving women missing the "political capital" required to access and efficiently manage family assets and investments. For example, the majority of women were either barred or hesitant to transfer cows or other animals, even when they needed money for non-agricultural income-generating activities. Furthermore, women might use the family land for profitable operations, but they needed their husbands' permission to mortgage it for loan or credit purposes. Gender roles are distinct, with men anticipated to defend and provide for the family and women to handle domestic activities like fetching water, cleaning, cooking, and washing. This frequently resulted in uneven power dynamics that favoured men. This discovery undermines prior efforts to include women as key contributors in environmental and ecosystem-based management. According to Denton (2002), important hurdles to the implementation of effective adaptation measures include limiting women's access to critical resources, denying them socioeconomic rights, and silencing their voices and participation in decision-making processes.

Table 3.4: Important barriers to climate response within Katuk Odeyo

Specific barrier to adaptation	Example of adaptation strategies influenced
Limited access to financial resources	• Development of nurseries and planting trees • Engaging in climate smart agriculture • Diversification of livelihood activities • Changing diets
Loss of productive labour and knowledge	• Soil and water conservation i.e. mulching, terracing, composting, water harvesting etc. • Livelihood diversification • Practising traditional and inherited knowledge i.e. early warning systems
Poor access to climate information and institutional support	• Changing the time for planting • Planting early maturing varieties
Complex land tenure system and gender issues	• Planting trees • Engaging in climate smart agriculture • Crop rotation/intercropping • Water harvesting
Socio-cultural barriers	• Temporary migration • Livelihood diversification • Changing the timing for planting • Integrated animal husbandry
Inadequate ready markets	• Planting drought tolerant crops • Diversification of livelihoods • Crops diversification
High cost of and limited access to improved crop varieties	• Planting early maturing varieties • Planting drought tolerant crops
Lack of farm implements and machinery	• Planting early maturing varieties • Changing the timing for planting • Initiating climate smart agriculture (mainly green houses, drip irrigation and organic fertilisers)

The study findings further indicate that inadequate access to low-cost financial services and appropriate local solutions for improving adaptation efforts are important barriers to community members' well-being. Some respondents claimed that limited extension and outreach services stopped them from experimenting with climate-friendly farming techniques such as greenhouses and drip irrigation. Respondents stated that a lack of technical expertise limited their ability to implement innovative ways to increase soil productivity, reduce post-harvest losses, and explore

renewable energy possibilities. Financial constraints may prohibit governments from taking an important role in climate adaptation (Techoro, 2013). Government agencies are typically underfunded in comparison to the expectations and demands placed on them (Adger, 2010). Because of inadequate local administrative systems, a lack of accountability, and corruption, government agencies typically confront problems and fail to effectively prioritize climate adaptation efforts.

According to Table 3.4, the scarcity of competent agricultural workers is a substantial barrier to using advanced adaptation approaches. Some farmers may have been forced to reduce the quantity of land they cultivated. Some participants stated that they were very weak as a result of anger and illness to work in the fields for more than a few hours at a time. The moderately high prevalence of HIV/AIDS, as discussed by Obiero in 2017, may have hampered farm labor availability, as has the added obligation of caring for orphans and extended family members.

Additional challenges to successful community climate adaptation include insufficient or no localized climatic data, as well as a lack of awareness and comprehension of appropriate adaptation measures adapted to the specific local setting. While some farmers were familiar with traditional coping strategies for dealing with droughts and other issues, their adoption of modern technologies was restricted. This might be linked to insufficient education levels, insufficient extension facilities, and climate-related capacity building. Farmers with limited knowledge or no formal schooling are hesitant to experiment with novel solutions, particularly those critical for adaptation and mitigation. Forecast data was rare and, when available, was frequently inefficiently distributed (Mougou *et al*., 2007). Furthermore, the data is typically offered in complex formats and released just before the expected dates, making it difficult to use for planning. Inadequate weather data for disaster prediction is a significant source of food insecurity and a major impediment to successful adaptation.

4. Conclusions and Policy Implications

Overall findings from this study demonstrated that a variety of constraints, including a lack of expertise, agricultural resources, financial services, climate information, water shortages, and poverty, impede successful community-based adaptation. The findings are consistent with those of Bewket *et al*. (2013) and Ziervogel *et al*. (2006), which found that wealthier households in subsistence farming areas can mobilize resources more quickly to handle climate challenges than poorer households. The findings also showed that household size has no substantial impact on a climate response plan as a socioeconomic determinant. Gender, age, education level of family head, land ownership, tenure system, wealth position, and agroecological environment are all important elements influencing community-based adaptation.

Food production in the study area has transitioned from indigenous varieties to drought-resistant crops with higher-than-average yields. Although there was a risk of resource depletion and excessive use of community resources, some farmers, particularly those who were well-informed and supported by government extension services, demonstrated a thorough awareness of the benefits and drawbacks of the many crop varieties planted. Furthermore, potential maladaptive reactions were seen during the transect walk. Maladaptive reactions mostly included practices that

impair ecological and water resources while reducing land productivity, such as unsustainable sand mining, charcoal burning, and soil extraction for brick making, also known as "matafari." To avoid undesirable outcomes, the community must comprehend the important ramifications and trade-offs involved with each response option. The findings confirm that responses are dynamic, alternating between different types (away from agricultural livelihoods) and nature (non-agriculture activities). These advancements show how livelihood portfolios are evolving to become more modern and move away from traditional techniques. The changes in livelihood are complex and reflect shifting objectives and desires, particularly among rural women and youth.

The findings are significant because they will provide decision-makers, researchers, and practitioners with useful insights into how various socioeconomic variables may influence the viability of a certain community climate response plan. It underlines the significance of thoroughly analyzing the local situation to identify priority activities for prompt climate response and risk reduction.

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