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Adaptation Measures to Mitigate the Impacts of Climate Variability among Pastoralists in Kajiado, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author JAY designed methodology, did investigation and statistical analysis, prepared and wrote the first draft of the manuscript, reviewed, edited and wrote the final manuscript. Author JOO managed data analyses of the study, reviewed and edited the first draft and the final manuscripts. Author WOO reviewed and edited the first draft and the final manuscripts. Author GOO reviewed and edited the first draft and the final manuscripts. Author SOO reviewed and edited the first draft and final manuscripts. All authors read and approved the final manuscript.

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ABSTRACT

Climate change and variability has direct and indirect effects on pastoralism through its effect on natural resources including water and pastures that support livestock production in pastoral areas. This study was conducted in Kajiado County where pastoralism is the main source of livelihood. The objective was to identify challenges facing pastoralism and adaptation measures applied by Maasai pastoralists to mitigate impacts of adverse climate events including flooding and drought. A cross-sectional study design was used and primary data collected through focus group discussions (FGDs), key informant interviews (KIs) and expert opinion interviews (EOIs). A total of 10 FGDs

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(114 respondents within 10 wards, out of which 81 were men and 33 women), 25 KIIs (6 opinion leaders, 5 village elders, 6 chiefs, 6 government staff and 2 non-governmental organisation) and 12 EOIs (1 Department of Meteorological Services, 1 National Drought Management Authority (NDMA), 2 Department of Agriculture and 8 Departments of Veterinary Services and Livestock Production) were conducted during the data collection period. The findings showed that drought and flooding were the main climate related challenges that were often experienced by the pastoralists. The adaptation measure which were frequently implemented by pastoralist during flooding was livestock vaccination and mass treatment of sick livestock ($Z > 1.96$) while the most frequently implemented adaptation measures during drought periods included migration with livestock to search for water and pasture ($Z=1.51$) and livestock vaccination and treatment of sick livestock ($Z=1.08$). Other climate variability related-challenges included increased incidences of livestock diseases, increased livestock deaths, increased cases of community conflicts, unavailability of veterinary vaccines and medicines, high cost of livestock vaccines and drugs and inadequate number of technical staff within the county. The study has shown that climate variability has significant impact on sources of livelihood for pastoralists who in turn are implementing several adaptation measures to mitigate the effects of climate change and variability. The study recommends formulation and implementation of appropriate plans and policies that are focussed on supporting resilience of the vulnerable pastoral communities and that could further assist in fighting the negative impacts of climate change and variability.

Keywords: *Pastoralism; livestock production; climate change and variability; climate change impacts; adaptation strategies.*

1. INTRODUCTION

Pastoralism is a complex livelihood system that maintains an optimal balance between people, livestock and pastures in an environment that is variable and uncertain Okoti et al. [1]. Reportedly, an increase on average surface global temperature by the year 2100 is expected to have more effect on livestock production and by extension on pastoralism as a livelihood source for pastoral communities in the Arid and Semi-Arid Lands IPCC, [2]. Estimated human population of about 386 million within Sub-Saharan region of Africa comprises of pastoral communities that are dependent on climate-sensitive resources that support their livelihood source Adhikari et al. [3]; IPCC [4]; Conway [5]; Thornton et al. [6]. Recurrent droughts, flooding and stormy winds are further contributing to the current climate change impacts within Africa as a continent IPCC, [7] and IPCC, [2]. The increasing frequency of drought conditions, diminishing water sources and encroachment on the grazing land are presenting pastoralism with real threats Catley et al. [8].

An adaptation measure is considered successful if it reduces vulnerability of poor populations to existing climate variability and at the same time strengthening the potential to anticipate and react to further climatic changes factors UNDP, [9]. However, the most effective way of adapting to changes in climatic conditions in the

undeveloped countries is to rely on local institutions that have well-established and sustainable mechanisms to deal with extreme climatic conditions Agrawal, [10]. Pastoralists have used indigenous knowledge to guide them in the protection and exploitation of the frequently changing dry weather conditions to support their livelihood systems even before the advent of climate change Mohammed et al. [11]. But with climate change, there is need to rethink the adaptation strategies that would appropriately address the challenges associated with the changing climatic patterns Kelemework, [12].

In Kenya, some of the key challenges that pastoralists face in relation to climate change are inadequate pasture and water due to the recurrent and prolonged droughts and high incidences of livestock diseases caused by uncontrolled movement of livestock. Dependency of livestock production system on the availability of rain-fed natural resources in Kajiado County makes the system susceptible to changing climatic conditions according to the County Integrated Development Plan CIDP, [13]. This study examined challenges facing pastoralism as a production system and adaptation measures applied by Maasai pastoralists to mitigate the negative impacts of adverse climate variability in the County. The study findings are useful for policy making with regard to designing appropriate measures that would support

resilience of vulnerable Kajiado pastoralist community and other pastoral communities in the fight against negative impacts of climate change and variability.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Kajiado County which is located in the southern part of Kenya. It is situated between Latitude: $-1^{\circ} 51' 8.57''$ S and Longitude: $36^{\circ} 46' 36.59''$ E with an area coverage of $21,900.9\text{ Km}^2$. The County borders Nakuru and Kiambu counties to the North, Narok County to the West, Machakos and Makueni Counties to the East, Nairobi County to the North East, Taita Taveta County to the South East and the United Republic of Tanzania to the South West. The County is classified as semi-arid and high-altitude pastoral ecosystem suitable for animal husbandry CIDP, [13]. It has four livelihood zones: pastoral, agro-pastoral, marginal mixed farming and mixed farming,

distributed across the County's five sub-counties. Maasai pastoral community are the main inhabitants and they practice pastoralism as a source of livelihood. The County's seasonal rainfall calendar is bimodal (long and short rains), with long rains observed between the months of March-May with the peak season in April while short rains are between the months of October-December. Fig. 1 below shows the study area.

2.2 Study Design

The research study employed a cross-sectional design. All the county's five sub-counties were first purposively selected because pastoral farming is the major farming activity practiced in the area. The selection took into consideration the County's four livelihood zones. Random selection of wards from each of the five sub-counties was done through a lottery method. At the end of the lottery, two wards were randomly selected from each sub-county.

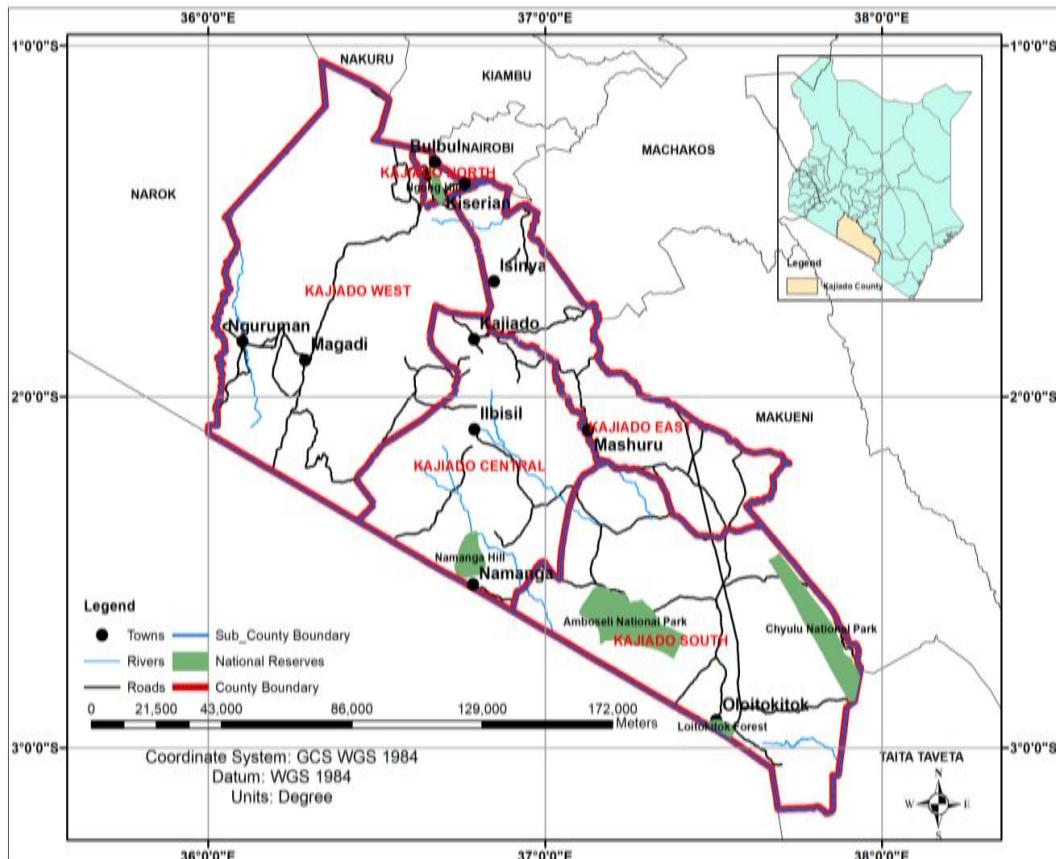


Fig. 1. The map of Kajiado County administrative units

2.3 Selection of the Study Subjects

The participants of focus group discussions were systematically selected within the selected wards. The mobilization of the study participants who took part in the focus group discussions was guided by the research team through the assistance of village elders, chiefs and extension workers familiar with the study area. The mobilized participants were people who had lived within these wards for several years and were therefore conversant with Maasai language, culture and their production systems. FGD guidelines guided the selection of participants (between 6-12) but in some groups the participants were between 6 and 16 comprising of both males and females. FGDs were held in homesteads, the community's makeshift structures of worship or schools that had been identified by the chiefs or village elders through consultation with research participants. A total 114 respondents participated in all the group discussions, out of which 81 were men and 33 women. The distribution of the respondents was as follows: Kajiado West sub-county 17 men and 7 women, Kajiado South 15 men and 8 women, Kajiado North 14 men and 3 women, Kajiado East 19 men and 4 women and Kajiado Central 16 men and 11 women.

Key informant Interview participants were selected from chiefs, opinion leaders, village elders and the staff from Non-Governmental Organization (NGO) and technical department. Expert opinion interview participants were drawn from the technical departments that were of relevance to the study. The participants for the group discussions and key informant interviews were people with deeper knowledge on what was going on in the community. They included community leaders, professionals and pastoralists themselves. Experts were people with specific knowledge on their professional field such as technical or social in relation to the study.

2.4 Data Collection

The focus group discussions, key informant interviews and expert opinion interviews were guided by open-ended questions using questionnaire guides. The FGDs, KIIs and EOIs were held through face-to-face interactions. The use of qualitative approaches gave an insight into the respondents' ideas, opinions and experiences on the problems being investigated Ali and Yusof, [14]. Focus group discussions

were conducted in two wards per sub-county giving a total of 10 FGDs across the five sub-counties. Participatory data collection methods that included listing, simple ranking and pairwise ranking and probing Catley et al. [15]; Catley et al. [16] were used during the data collection. The conducted twenty-five KIIs comprised of six from the community's opinion leaders, five from village elders, six from chiefs, six from the staff from the Department of Veterinary Services and two from the staff from a non-governmental organisation within the County. The twelve expert opinion interviews (EOIs) were conducted with experts drawn from technical departments, with one expert each from the Department of Meteorological Services and National Drought Management Authority (NDMA), two from the Department of Agriculture and eight from the Departments of Veterinary Services and Livestock Production. Other relevant data and information were obtained from published research papers, journals, books and other online publications.

2.5 Data Management and Analysis

Data collected through key informant interviews and expert opinion interviews on adaptation strategies were first recorded on note books and then entered on a database. The analysis was then done through content analysis. The data on challenges was analysed through thematic analysis where the discussants after listing the challenges, identified their causes and possible intervention measures. The ranking scores obtained on adaptation strategies during focus group discussions were analysed to determine whether the median ranks for scores for the strategies had any significant difference from zero.

3. RESULTS

3.1 Description of Adaptation Strategies to Adverse Climate Events Applied by Pastoralists

The respondents identified adaptation strategies which were commonly applied during drought related disasters (Table 1). Among them were migration with their livestock to other areas to look for pasture and water, vaccination of livestock which are at high risk for infectious diseases of livestock and mass treatment of livestock with antibiotics and anti-trypanosomiasis drugs as prophylaxis since livestock diseases including trypanosomiasis are

rampant in the areas where they always move their livestock to look for pasture and water. The other adaptation measures applied included purchase of hay, water tankering for livestock and human use, sending a team of herders to survey migration routes, purchase of commercial feeds and supplements and practice of destocking herds and flocks. The adaptation practices which were often applied by pastoralists during drought included migration with livestock to other areas and vaccination of susceptible livestock and mass treatment. However, there was no significant difference between the median ranks obtained for these adaptation measures by pastoralists when compared with the other adaptation measures which were practised. Similarly, the pastoralists were implementing other adaptation measures during rainy seasons to mitigate disasters associated with flooding events. The measures which were often applied included livestock vaccination and mass treatment as a prophylaxis for susceptible livestock, fencing and

paddocking, water harvesting, restocking, timed grazing, buying and stocking of hay, growing napier grass, mineral supplementation, zoning of livestock grazing areas, deworming of livestock, hay bailing, preservation of maize stock, and pasture conservation (Table 2). According to these pastoralists, the adaptation measures which were often practised during the rains included vaccinations of livestock against diseases and mass treatment, water preservations and paddocking and fencing off their farms. Water preservation was practiced as a measure to mitigate water shortages for use by livestock and households during droughts, while fencing and paddocking were practised to enable effective utilization of pasture and to practise rotational grazing during the time when pasture was in plenty. The adaptation measures which had a significant statistical difference from the other adaptation measures were vaccinations of livestock against common infectious diseases and mass treatment for prophylaxis ($Z > 1.96$).

Table 1. Adaptation strategies applied during drought related disasters by pastoralists

Adaptation strategy applied by pastoralists	Median	Average Rank	Z-score
Migration	0.27	24.4	1.51
Livestock vaccination and treatment	0.27	22.6	1.08
Purchase of hay	0.13	21.0	0.71
Water tankering	0.13	18.6	0.14
Survey of migration routes	0.00	17.0	-0.24
Purchase of commercial feeds and supplements	0.07	15.4	-0.61
Destocking	0.00	7.0	-2.59

$H = 9.97$ (adjusted for ties) with 6 df, Probability $> 9.97 = 0.1259$

Table 2. Adaptation strategies applied against flood related disasters by pastoralists

Adaptation strategy applied by pastoralists	Median	Average rank	Z-score
Livestock vaccination and treatment	0.17	64.2	2.78
Fencing and paddocking	0.20	51.4	1.42
Water harvesting	0.10	51.4	1.42
Restocking	0.00	42.5	0.48
Timed grazing	0.00	37.4	-0.09
Buying and stocking of hay	0.00	35.9	-0.22
Growing more Napier grass	0.00	35.1	-0.31
Mineral supplementation	0.00	35.1	-0.31
Zoning of grazing areas	0.00	34.4	-0.38
Deworming	0.00	33.9	-0.44
Hay bailing	0.00	31.8	-0.66
Preservation of maize stock	0.00	26.5	-1.22
Pasture conservation	0.00	26.5	-1.79

$H = 23.85$ (adjusted for ties) with 12 df, Probability $> 23.85 = 0.0213$

3.2 Description of Challenges to Pastoralism and Proposed Mitigation by Pastoralists

The challenges identified by pastoralists that affect livestock production system are listed in Table 3. Amongst these challenges are increased incidences of livestock disease which were either associated with occurrence of excessive rainfall or drought within the study areas, increased incidences of deaths of livestock during drought which were linked to the rampant livestock diseases or lack of sufficient feeding materials and pasture, conflicts (inter-community, livestock/wildlife and human/wildlife conflicts) which were associated with migration of livestock in search of pasture and water to areas occupied by other communities or the National parks and therefore resulting in conflicts with wildlife or settled communities who are practising crop agriculture. Challenges with accessibility to veterinary vaccines and drugs were also reported to results from products (vaccines and medicines) whose market prices were high and of poor quality and were also not affordable to pastoralists, lack of access to water sources for use by both livestock and humans especially during drought seasons. The pastoralists also identified low quality hay, poor quality commercial animal feeds and supplements which were available in the local markets. This challenge was attributed to lack of standardization for hay and other commercial feeds which are sold to pastoralists within the local markets. Furthermore, there was poor market prices for livestock in the local markets due to malnourished conditions for livestock which were being marketed, especially during drought seasons. The other production challenges were unacceptability of destocking as a measure against drought because of cultural barriers by most pastoralists households and increased insecurity for both livestock and herders especially when migrating with their livestock through the national parks where they encounter wildlife which may prey on livestock or attack and kill the herdsmen.

The respondents also proposed mitigation measures to the several challenges they currently faced. These included effective livestock disease control services by government public veterinary department, enhancement of livestock extension services, growing and conservation of pasture to ensure sufficient supply of fodder during times of scarcity and introduction of livestock insurance scheme to

mitigate the negative impacts through deaths of livestock that results during extended drought seasons. Furthermore they suggested provision of veterinary vaccines and drugs by county government for the prevention and control of livestock diseases since those that are supplied through the local markets were considered to be of poor quality and are sold at exorbitant prices that pastoralists could not afford. The proposal for the mitigation of drought and its negative effects on water supply included construction of boreholes, water pans and dams to address the persistent water scarcity, in addition to the harvesting of rain water through roof catchments or by channelling run-off waters to dams and water pans for use during drought seasons. In order to mitigate the challenges around livestock marketing, support for livestock market infrastructure development and enhanced government-supported livestock off take programmes were suggested. This was to enable pastoralists to access market for their livestock before the climate induced disasters such as drought sets in or easily sell their livestock during drought. The other mitigation measures which were increasingly being implemented by pastoralists included adoption of sedentary livestock keeping especially for the high producing dairy livestock by enlightened members of the pastoralist community instead of keeping large number of beef cattle and splitting cattle herds hence reducing herd sizes that could be supported by the available feeds and pasture. But other pastoralists also reported that they would often sell part of their herd and invest the sale proceeds in other investments such as housing.

4. DISCUSSION

This study has presented various adaptation measures applied by pastoralists to mitigate the effects of adverse climate associated with drought and flooding. Migration with livestock was the main adaptation measure applied during drought. Migration could occur within the County, to grazing areas outside the County and across the international boundary to the Republic of Tanzania. In addition to migration, pastoralists would often practice mass treatment of livestock with antibiotics to protect them from the rampant livestock diseases. Before pastoralists migrate with their livestock, it was mandatory that they survey the migration routes as an adaptation strategy. This was mandatory since animals were moved to new environment and they would be exposed to new disease challenges that needed

to be identified before they migrate. Livestock movement was also associated with increase in incidences of livestock diseases which created the need for livestock vaccination and treatment before or after movements to prevent any loses associated with diseases. Besides migration with livestock to mitigate drought, some pastoralists

have resorted to sedentary farming systems and they would stock pasture as dry hay and purchase other commercial feeds to supplement the inadequate supply of pasture during prolonged drought period besides ferrying of water (water tankering) along the livestock migration routes.

Table 3. Thematic analysis of production challenges facing pastoralism and suggested mitigation measures

Production challenges reported by pastoralists	Cause as reported by respondents	Suggested intervention to mitigate impact
Increased incidences of livestock diseases	Drought and rainfall related	Effective animal disease control services
Massive livestock deaths	Livestock diseases or inadequate livestock feeds	Effective animal disease control services, livestock extension services, pasture growing and conservation and introduction of livestock insurance scheme
High expenditure	Livestock migration necessitating purchase of animal feeds, hiring of grazing areas and herders and tankering of water	Increase pasture productivity and conservation to minimize migration
Conflicts (inter-community, livestock/wildlife and human/wildlife conflicts)	Migration of animals in such of pasture and water into areas occupied by other communities or into the National parks	Increase water sources and pasture productivity and conservation to minimize migration
Accessibility of veterinary vaccines and drugs	Unavailability of veterinary drugs and vaccines	Provision of veterinary vaccines and drugs by county government for prevention and control of livestock diseases
Expensive veterinary drugs and vaccine	Highly priced veterinary drugs and vaccines	Provision of affordable veterinary vaccines and drugs by county government for prevention and control of livestock diseases
Unavailability of technical staff	Inadequate technical staff	County government to recruit and deploy adequate technical staff for to advice on livestock diseases, treatment and feeding regimes through extension services
Shortages of water sources.	Lack of water sources from livestock and human beings especially during drought	Construction of boreholes, water pans and dams to address the water scarcity and harvesting of water during rain period through roof catchments or by channelling run-off waters to dams and water pans for use during drought
Unavailability of hay especially during drought	Low pasture productivity and high demand for hay during drought	Provision of pasture seeds, pasture planting equipment and hay harvesting equipment by the government to improve on the pasture productivity and conservation
Low quality hay, animal feeds and supplements	Non-standardization of hay, animal feeds and supplements	Pastoralists to buy hay, animal feeds and supplements from designated animal feed supply outlets

Production challenges reported by pastoralists	Cause as reported by respondents	Suggested intervention to mitigate impact
Low livestock prices	Poor livestock body conditions especially during drought	Provision of market infrastructure to enable pastoralists access market for their livestock before or during drought
Unacceptability of destocking by pastoralist	Destocking not culturally acceptable by most pastoralists.	Adopt sedentary livestock keeping system by keeping fewer but high producing dairy animals instead of the large number of beef cattle or reducing herd size by keeping herds that could be supported by the available feeds or selling part of the herd and putting the proceeds into other investments such as housing development
Insecurity to both animals and human beings	Migration through parks especially during drought	Increase pasture productivity and conservation to minimize migration
Lack of man-power (herders) to migrate and herd the migrated livestock	Most herders are school-going children	Increase pasture productivity and conservation to minimize migration
Lack of residence for herders (sleeping in the cold) during migration	No permanent residences in the areas of migration	Increase pasture productivity and conservation to minimize migration
Predation of wildlife on livestock	Migration through parks	Increase pasture productivity and conservation to minimize migration or avoid migration through parks
Low pasture productivity	Unreliable rainfall or weather conditions	Increasing pasture productivity through irrigation by using water from dams, pans, rivers or rain run-off waters
Destruction of water sources such as pans and dams	Wildlife especially by elephants	Protection of the available water sources through fencing

Enhancing immunity of their livestock through vaccination and mass treatment using vaccines and antibiotics was also done during the rainy seasons. This uncontrolled use of antibiotics by pastoralists has a potential to increase transmission of antimicrobial resistance genes across the connected systems and farms. Additionally, during rainy seasons, pastoralists would conserve pasture as standing hay through fencing and paddocking; zoning of grazing; timed gazing of livestock, or through bailing to secure animal feeds for the next anticipated drought period. However, capacity of individual pastoralist to conserve pasture is reportedly constrained by the limited supply of essential feed, water resources and capital.

These adaptation strategies were applied to mitigate effects of drought or flooding on pastoralism which is the main source of

livelihood for the majority of the population in the County. Due to its heavy dependence on rain fed conditions, pastoralism is highly vulnerable to climate change. According Bobadoye et al. [17], majority of farmers in Kajiado agreed that there are increased incidences of drought with reduced annual rainfall in each season rainfall. This has led to the adoption of various practices such as migration to cope with climate change aimed at ensuring their food security, livelihood and future well-being. Study carried by Omollo et al. [18], showed that pastoralists with large herds of cattle and who do not produce fodder tend to remain mobile with their livestock in search of pasture and water especially in the dry seasons as pasture scarcity greatly limits livestock production. Studies have shown that drought poses serious challenges for populations whose livelihoods depend principally on natural resources Below et al. [19]; Nicholson [20]. The

has made the pastoralists to adopt several strategies aimed at addressing the climate change effects

According to IPCC [5], changes in climate are expected to have negative impacts on livestock production and human settlements with major losses in life, social disruption and economic hardship. Furthermore, Speranza [21] reported that frequent droughts in ASALs are associated with increased incidence of livestock diseases, loss of livestock body condition and deaths while Adams et al. [22], reported that climate change tended to have adverse effect on livestock productivity. Indeed, the combined effects of climate change and variability and reduced vegetation cover/deforestation are argued to be the leading cause of loss of biodiversity and therefore putting biodiversity at risk within the affected systems Boko et al. [23]; Rotter and Geijn, [24], also argued that effects of climate change and variability on livestock production was manifested in rise in incidences of livestock diseases, their spread within systems and deterioration of quality of pasture, whose impacts are already being observed in the pastoralists' systems of Kajiado. In addition to this climate induced challenges, the pastoralists are also facing new challenges with changing market demands for livestock and livestock products with increase of insecurity and conflicts with wildlife, due to the inherent challenges with migration. Indeed, Kirimi et al. [25] in their recent publication have argued that pastoralists need to innovate new adaptation methods and rely less on the indigenous knowledge to cope with climate change and variability.

5. CONCLUSION AND RECOMMENDATION

In conclusion, the study has shown that climate variability is significantly impacting on sources of livelihood for pastoralists in Kajiado who in turn are implementing several adaptation measures to mitigate the effects of climate variability. The findings of the study are useful for policy making with regard to designing appropriate measures that would support resilience of vulnerable Kajiado pastoralist community and other pastoral communities in the fight against the negative impacts of climate variability. The study recommends formulation of appropriate plans and policies that are focussed on supporting resilience of the vulnerable pastoral communities and that could integrate the adaptation practices

currently being applied by pastoralists' community to cope with the adverse effects of climate variability hence assist in fighting the negative impacts of climate variability in other pastoral areas with similar environment.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

No non-human animals were involved in the study hence no ethical approval was required.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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