Impacts of Climate Change on Pastoralist Livestock Production System in West Pokot County, Kenya

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Abstract

In Kenya ASAL counties such as West Pokot are among those adversely affected by extreme climatic conditions, given that a larger section of the population is pastoralist who mainly depends on livestock production as the main source of food security. The main objective of the study was to examine the impacts of climate change on livestock production. Respondents were selected through random sampling methods and questionnaires were used to collect primary data from 384 households from different strata in the study area. Interview schedules were used during key informant interviews and focus group discussions. Quantitative data obtained were analyzed using SPSS version 25. The results obtained from the analysis indicated that the livestock body condition during climate extreme events shows that 71.4% are in deteriorating condition, 26.8% are in fair category and 1.8% are in good condition. The study indicated that livestock is threatened by livestock diseases due to low immune systems because of body emaciation. While FGDs confirm that drought and livestock diseases are the most common challenges that affect the livestock production system. Pastoralists adapt to climate change by practising pasture establishment, conservation of livestock feeds and designating seasonal grazing areas. The findings revealed that climate change adversely impacted livestock pastures by 39.1%, while 38.3% of respondents indicated complete drying up of pasture. Community opinions on climate change as a threat to pastoral livelihoods showed that 49.2% agreed, 45.6% strongly agreed, 3.6% disagreed and 1.6% partially agreed. This confirms that pastoralists are aware of climate change as a great threat to livestock production. These results will be further used in developing an effective, sustainable pastoral adaptation mechanism, such as the rangeland management system and policies that reduce the risk posed by weather-related hazards that compromise pastoralist livelihoods and food insecurity in ASAL counties. There is need to strengthen pastoralist community capacity on embracing adaptation practices that promote resilience to climate change impacts.

Key Word: *Pastoral community, livestock production, community resilience, drought risk reduction and livelihood*

Introduction

Increased global warming has devastating effects on developing countries that lack the technical and financial resources to adapt and withstand the effects of climate change on the productivity of pastoralist livelihood, (Hulme *et al*, 2001). East Africa is home to many pastoralists and agro-pastoralists, climate data show that East Africa is getting warmer and drier, by between 0.9°C and 1.2°C, with rainfall declining at an average rate of 20–100 millimetres every 10 years. This is accompanied by high inter-seasonal rainfall variability, especially in marginal agricultural areas, (IPCC, 2014).

Livestock productivity may be lowered by 50% in the 2050s compared to without a climate change scenario. Climate change increases the number of people in need of food aid, due to the impacts of climate on the

source of their food production and there is an increased drought expense by 72% in the 2050s, (FDRE, 2015).

The impacts of climate change exacerbated the vulnerability of livestock systems and reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food/livestock feeds, and products, and increased conflict over scarce resources, (IFAD, 2011). Climate extremes, particularly droughts in West Pokot County, strongly affect pastoralists' production; the impacts are higher on the pastoralists because they constitute the majority in the fragile ASALs area, where there is a greater probability of drought occurrences. For instance, drought contingency planning is often non-existent, particularly concerning the provision of veterinary services and initiatives for drought risk reduction measures (NDMA, 2017). Climate change results in a fall in productivity, and livestock productivity may be lowered by 50% in 2050s compared to without a climate change scenario. Climate change is also expected to increase the number of people looking for food aid by 30% (World Bank, 2010). As prioritized by pastoralists, the four major effects of climate change on livestock production include feed shortage, shortage of water, reduced productivity, and decreased mature weight, (Zelalem *et al*., 2009). Reduction in vegetation cover and increases land surface temperature that consequently triggers drought and leads to land degradation. Therefore, the evaluation of drought effects on vegetation cover and its relationship with land surface temperature is very important. (Rafiei *et al.,* 2021).

Materials and Methods

Study area

The study was carried out in West Pokot County which is one of the 14 counties in the Rift Valley region. It is situated in the North Rift along Kenya's Western boundary with Uganda. It borders Turkana County to the North and Northeast, Trans-Nzoia County to the South; Elgeyo Marakwet County and Baringo County to the Southeast and east respectively. The County lies within Longitudes 34^0 47'and 35^0 49' East and Latitude 10^0 and 20^0 North. The County covers an area of approximately 9,169.4 km^2 stretching 132 km from North to South (Figure 2.1). The county has four constituencies namely Kacheliba, Kapenguria, Lelan and Sigor. The population of the county is estimated at 621,240 persons, consisting of 307,013 (49.7%) males and 314,213 (50.3%) females, (KNBS, 2019). West Pokot County is characterized by a variety of topographic features. On the northern and northeastern parts are the dry plains, with an altitude of less than 900 m above sea level. The county depends more on the long rains than the short rains for crop production, regeneration of pasture, browsing and recharge of water sources. The county experiences a bimodal type of rainfall with the long rains falling between March and June while the short rains fall between September and November**.** The lowlands receive 600 mm per annum while the highlands receive 1,600 mm per annum. The County also experiences great variations in temperature with the lowlands experiencing temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C.

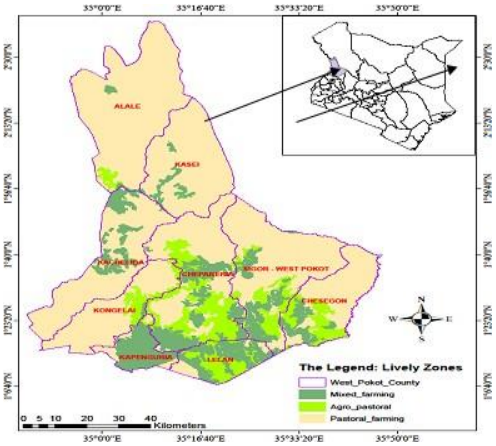

Figure 2.1: Location of West Pokot County in Kenya
Source: Researcher 2020

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Research Design

The study used a mixed research approach, the qualitative method dealt mainly with the pastoralists' perceptions of the climate situation and its effect on the livestock system, water and pasture availability. In this study, the quantitative method focused on in-depth data collection on livestock and its effect on livestock production systems and diseases outbreak. Triangulation of results was done to increase the validity and reliability of the results. A descriptive and survey design was relevant in this study because it employs both qualitative and quantitative approaches. The quantitative method dealt mainly with vegetation index cover, standard precipitation index and pastoralists' community perceptions on the effect of climate change on the livestock production system. A survey obtained information from a sample of people using self-report, that is, the people who responded to a series of questions posed by the researcher. This study adopted stratified random sampling in determining the sample size for different wards. This study used various methods of data collection which include questionnaires surveys, observations, focus group discussions, transect walk and key informant interviews.

Target population

The study population consisted of the local community in the sampled nine Wards in West Pokot County, the department of agriculture and livestock at the County level, the national drought management authority branch office in West Pokot County, the Regional Resilience programme, the County meteorological department, Kenya Smart Agriculture West Pokot County, non-governmental organizations that operate within West Pokot County, UN agencies that work in west Pokot County and some selected key informants in west Pokot County.

Sampling Strategy

The sample size of the study was 384, and this was determined using the formula of Fisher *et al.*, (1991).

$$n= z^2pq/d^2$$

Where-:

n – The desired sample size (assuming the population is greater than 10,000)

z – The standard normal deviation, set at 1.96, corresponds to 95% confidence level.

p – The proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate, then use 50 per cent (the study used0.50).

q=1.0–p

d = the degree of accuracy desired, here set at 0.05 corresponding to 1.96.

In substitution, $n= \mathbf{1.96^2 \times 0.5(1-0.5)/0.5^2} = \mathbf{384}$ It was necessary to tabulate the

Table 2.1: Sample Frame

Sub-County	Target Ward	Wards	Target Households	Sampled Household
North Pokot	3	Suam	30100	39
		Kodich	12363	16
		Kapchok	13631	18
West Pokot	2	Riwo	50239	65
		Siyoi	20904	27
Pokot South	2	Chepareri	5a7787	74
		Batei	44846	58
Pokot Central	2	Sekerr	27544	35
		Weiwei	40446	52
Total	**9**		**297,860**	**384**

Source: Filed Data 2020

Data Collection Methods and Techniques

This study used various methods of data collection which include Questionnaires, Surveys. Observations, 4 Focus Groups discussion, transect walk and 8 Key informant interviews, the researcher collected both primary and secondary data for data collection and analysis.

Data Analysis

The data analysis used descriptive statistics of the spectrum. The data mainly compose impacts of climate change on a livestock production system. Cross tabulation was also used to compare the relationship among the variables, to give inferences; the data were analyzed using bi-variances analysis to certain the association and level of significance between the variables and Quantitative data obtained were analyzed using SPSS version 25.

Results and Discussions

Introduction

The study evaluated the impacts of climate change on pastoralists' livestock production system, the study further examined how climate change affects pastoralist support systems, livestock body condition, impacts of climate change on pasture and invasive plant species that hinder pasture development.

Impacts of climate change on a livestock production system

The study investigated the impacts of climate change on pastoral livelihood. The study revealed that the pastoral production system is highly susceptible to climate variability and different animals are impacted differently by climate change, (Table 3.1). The study indicated that pastoralism was the most affected with 71.4% of the respondents indicating very high, while mixed farming was less affected with 12.2 % of the respondents indicating very high because pastoralist depends on one source of livelihood compared to mixed farming which has multiple choices of livelihood.

In terms of animals affected by climate change, it was found that sheep and cows are the most vulnerable

animals to the effects of climate change with 57% and 48% respectively, this was due to their feeding habits, and they are mainly grazers. This implied that cows and sheep breed reared in West Pokot are more susceptible to climate extremes, compared to other animals such as camels, goats and donkeys which were perceived to be more resilient to harsh climatic conditions associated with climate change and feed on forage, camels access forage from top of the tree, while goat being browser, can climb trees, as their adaptive strategies. The study is consistent with Jones *et al*., (2009) who stated that West Pokot County has a diversity of ecological zones, all affected differently by climate variability impacts. This means those who practice pure pastoralists are more exposed to climate variability compared to agro-pastoralist and mixed farming. This study implies that different ecological (livelihood) zones are affected differently and their vulnerability differs with pastoral zone being the most vulnerable, then agro-pastoral and mixed farming zone. Pastoral zone depends on one livelihood (livestock) that is more exposed to the effects of climate extremes, thus making communities that depend on livestock as their main source of livelihood more susceptible to climate shocks. This means that livelihood diversification was noted be to the more sustainable strategy for climate change adaptation among the pastoralist communities.

Table 3.1: Livelihoods and animals affected mostly by climate change as per the respondents

	Ecological zones and livestock species	Very high	High	Moderate	low	Very low	Not affected	Don't know
Which ecological zone is mostly affected by climate change?	Pastoral	71.4	17.4	6.3	0.5	1.3	0.3	2.9
	Agro-pastoral	14.8	50	22.1	1.8	1.6	1	8.6
	Mixed	12.2	12.8	57.8	7.8	1.8	1.6	6
Which ecological zone is least affected by climate change?	Pastoral	39.1	17.4	18.5	7.8	13.8		3.4
	Agro-pastoral	10.9	38.3	27.3	11.5	2.1	1.3	8.6
	Mixed	18	16.7	45.8	7.6	2.6	2.6	6.8
Which animals are mostly affected by climate change?	Cow	48.2	30.2	12.8	4.9	3.6	0.3	
	Goat	7	21.6	50.8	5.5	2.9	10.4	1.8
	Sheep	57.8	20.6	11.7	6.3	1	0.8	1.8
	Camel	1.6	3.4	16.1	8.9	22.7	20.1	27.3
	Donkey	14.3	12	12	6.8	8.9	9.1	37
Which animals are least affected by climate change?	Cow	37.5	27.6	8.9	8.6	17.2		0.3
	Goat	14.8	21.9	44	5.2	2.6	9.1	2.3
	Sheep	35.2	22.4	15.4	8.3	16.9	0.3	1.6
	Camel	15.1	3.1	13.8	7	13.3	19.5	28.1
	Donkey	12.2	5.5	12.5	12	12	8.6	37.2

Source: Field Data, 2020

Standard Precipitation Index (SPI)

Standard Precipitation Index is the standardized anomaly, equivalent to the statistical Z-score, representing the precipitation deficit over a specific time scale, such as 3, 6, 9, or 12 months, relative to climatology (McKee *et al*., 1993). It shows that rainfall patterns have been fluctuating across the categories (Table 3.2). This study shows how to determine and classify the SPI, their threshold and the magnitude of the drought.

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This finding from NDMA SPI data analysis reveals that drought in West Pokot County keeps on fluctuating from one phase to another as indicated by SPI (Table 3.2). Key informants reported that West Pokot County reports every year one-two phases of drought. It can be alert, alarm or emergency phase. This implies that drought is the most chronic climate extreme in West Pokot County; it further revealed that poor rainfall performance is attributed to poor pasture growth and availability of water, which are critical natural resources to the livestock sector. The study revealed that drought has direct effects on livestock production, due to the sensitivity of pasture and water to climate extremes. During FGD, it was reported that drought and livestock diseases are intertwined because during drought periods livestock immunity goes down and livestock are exposed to the disease on migratory routes and water points where animals concentrate from many parts of the county.

Table: 3.2 Drought classifications by SPI-3month values and their thresholds

Colour	SPI Values	Rainfall Category
	> +1.5 or more	Strongly above normal
	1 to +1.5	Above normal
	-1 to 1	Normal
	-1.5 to -1	Below normal
	<-1.5	Strongly below normal

Source: NDMA, 2020

Climate change and livestock body health system

The study evaluated the impacts of climate change on livestock body condition, the results show that 71.4% are in deteriorating condition, 26.8% are in fair and 1.8% are in good condition, as shown in Figure 3.1. These results showed that many livestock having deteriorating body conditions during drought periods are deteriorating due to inadequate pasture and water crises. This finding was justified by the key informants who indicated that the livestock body conditions are usually deteriorating during the drought period, which always poses food insecurity threats due to reduced livestock production, as many households in West Pokot depend mainly on livestock as a source of food security.

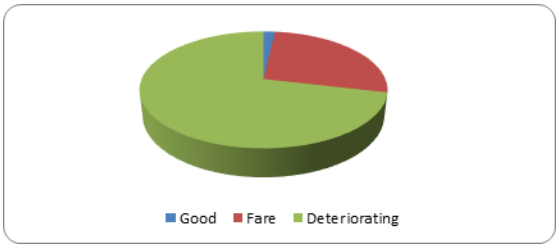

Figure 3.1: Livestock body condition during drought **Source:** Field Data, 2020

The key informant reported that *"most livestock in Pokot North and Pokot Central. The two sub-counties practice pure pastoralist, where community source of food security is from livestock product".* From field transect, it was noted that most parts of Pokot North, Pokot Central and part of West Pokot had bare ground with no pasture, while Agro-pastoral and mixed farming which mainly covers Pokot South and part of West Pokot sub-counties was noted to have good-fair vegetation condition. The key informant further indicated that "*breed diversification and livestock off-take was the best measure for drought risk reduction, but it was found to be interfered with by cultural beliefs and pastoralist perception, such as cross-breeding of livestock cultural unacceptable and livestock off-take is associated with someone who prays for calamity to strike a community, such people are considered deviant in the community".* This implies that during the drought

period livestock body condition is deteriorating condition with a few animals being in good condition, the study found that browse and pasture are sensitive to drought. This study was in agreement with NDMA, (2018) stated that the most threatening effect of drought is the drying up of pasture, vegetation and water sources that directly affect livestock body conditions in arid areas. It was observed that recurrent drought in West Pokot undermines the re-germination of pasture in a pure arid part of West Pokot County, with Pokot North and Pokot Central being the most affected. Therefore investment in pasture management and water harvesting is a key drought adaptation measure. This means that among the direct impacts of climate extremes is drying up of water sources, drying of pasture and

Climate change impacts on dry land ecosystem

The study analyzed land use cover change detection through GIS, and it was noted that vegetation cover in the early 1980s was thick and green, but as approach 2000 onward the forest covers drastically reduced, due to the destruction of forests for crop farming and settlement due to population increased, the respondents indicated charcoal burning and cultivation as the main threat to vegetation covers. The study analyzed vegetation cover through the use of GIS and it was indicated forest cover has rapidly decreased in the entire county as shown in (table 3.3), the study found that in 1995 forest cover was at 14.13%, 2015, it was at 7.07% and 2019 it was at 5.11%, as forest reduced cropland increased, this means that deforestation is being practised at expense of expansion of cropland or farming activities. This finding agrees with key informants who revealed that; "*all the area that our animals use to graze is now plantation, people nowadays preferred to have huge plantation under crop farming that takes more space than grazing area".* The study observed that many human activities pose more threat to the environment and ecosystem at large; activities are practised without understanding its implication, thus exacerbating climate change extreme events. During fieldwork, it was observed that charcoal burning and opening of new land for settlement and crop farming widespread was noted, especially in North Pokot and Pokot Central.

Table: 3.3: vegetation covers status in face of climate change

No	***VegetationCover***	***Area in Hectares***			***Percentage of Vegetation Cover***		
		1995	***2015***	***2019***	***1995***	***2015***	***2019***
1	Forest	49108.3 Ha	24651.9 Ha	17818.2 Ha	14.13	7.07	5.11
2	Closed Scrubland	93131.1 Ha	187976 Ha	172053 Ha	26.79	53.91	49.34
3	Open Scrubland	126793 Ha	110251 Ha	104127 Ha	36.47	31.62	29.86
4	Cropland	78589.3 Ha	25804.9 Ha	54685.1 Ha	22.61	7.4	15.68
	Total	347621.7 Ha	348683.8 Ha	348683.3 Ha	100	100	100

Source: Field, 2020

This study showed that enforcement of environmental conservation and management is the key to promoting dryland ecosystems. It was further noted that an increase in negative adaptation measures such as charcoal burning, illegal logging of timber from forests and expansion of agricultural land compromise environmental conservation and ecosystem sustainability.

Impacts of climate change on pasture

The finding indicated that climate change adversely impacts livestock pasture by 39.1% of the respondents indicating completely drying up, 38.3% deteriorating, 21.1% in fair and 1.6%. These results indicated that most parts of West Pokot experienced serious pasture scarcity during the drought period, Figure 3.2.

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This result is evident when most respondents indicated to have experienced completely dried pasture. The findings mean that pasture is very sensitive and more exposed to the effects of climate change. When there is severe drought pasture dried up completely. This shows how pasture is susceptible to climate variability.

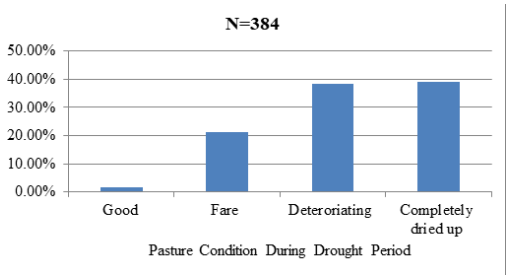

Figure 3.2: Pasture condition during the drought period
Source: Field Data, 2020

The finding from key informants' interview indicated that pastoralist area was noted to experience completely dried up of pasture when drought persist for more than three months, whereas only agro-pastoral area where pasture was reported to be in deteriorating condition and mixed farming was in fair condition with the support of community climate change mitigation and adaptation measure measures, such as hey establishment and conservation of crop residues.

Invasive plants that threaten pasture development

The study indicated that some invasive plant species have been on increase, which hinders increase, which hinders pasture germination in West Pokot County. For example, sansevieria and acacia plants were found to be a great threat to pasture in ASAL area. The finding shows that sansevieria and acacia are on the increase because they grow faster than pasture and suppress pasture development, this was attributed to climatic variability. During fieldwork, these plants were noted to cover a large part of the grazing land in North Pokot, the lower part of West Pokot and Pokot Central Sub-County; these are areas that practice pure livestock rearing as their many sources of livelihood. A key informant from the regional pastoral resilience project reported that *"our focus on livestock, help in pasture reseeding and clearing invasive plants that have hinder pasture growth example sansevieria plants, we have the budget for bush clearing targeting these notorious plants that affect pasture development in pastoral zones".*

As shown from plate 3.1, pastures are not seen in the ground, this, therefore, indicates that no pasture can grow or germinate under these plant species, and an increase in these plants poses a serious threat to pasture development and pastoralism in general. It was further reported that this plant is an evergreen event during severe drought, because of its adaptive nature to harsh climatic conditions; the respondents indicated that this plant has given rise to an increase in shrubs instead of pasture. It was further revealed that even hills that used to be grazing area with good pasture, it is full of shrubs and other invasive plants spices that never use to be and cannot be browsed by animals.

Plate 3.1: Sansevieria plants
Source: Field Data, 2020

Desert plant species such as acacia, and sansevieria and other invasive such as Prosopis juliflora are becoming a threat to pasture and shrubs developments in West Pokot. The study was supported by Perrings, *et al*,(2005), who found that invasive and emerging desert plants have a range of impacts including, interference with crop and pasture production through competition for light, water and displacement of crops and pasture species through the production of toxins that inhibit the growth of other plants. Smith and Smith, (2009) further indicated that invasive species colonise, expand and out-compete native plant species and become a major threat to our habitats, terrestrial and aquatic species, and biodiversity.

Impacts of climate change on different animal species

The finding shows how various animals are affected by climate change. The results categorize these findings into high and low. The cows were noted to be highly affected by climate change at 43%, sheep 28%, goats 13%, camel 10%. And donkey 11% and The respondents indicated that cows and sheep are the most vulnerable animals to impacts of climatic variability. It was further indicated that goats were noted to be moderately less affected by climate change, while camels and donkeys were indicated by respondents to be less affected by climate extremes. As indicated in Figure 3.3, from key informant interviews, it was unanimously agreed that the cow was the most vulnerable animal to climate change simply because cows feed only on pasture, which is sensitive to climate extremes such as drought. Camels were reported to be more resilient because they depend on forage that is less affected by drought more so forage on top of trees that other animals cannot access, this study was supported by Lesnoff *et al*., (2012). The study observed that cattle are generally the livestock species most sensitive to adverse effects of climate change since they have slow recovery after severe droughts, averaging 10 to 15 years. Recovery can be further prolonged if interrupted by other climatic shocks, which are most likely to occur under scenarios of more frequent droughts that demonstrated the highest vulnerability to climate variability in arid environments. It was indicated that in Pokot North camel rearing is being embraced by the local community because of its resilience to drought. Goats are the most reared livestock in Pokot North and Pokot Central compared to sheep, this is because of their ability to adapt and cope with the effects of drought. This implies that camels, goats, and donkeys are the most preferred livestock in ASAL areas that is prone to drought because of their ability to withstand harsh climatic condition.

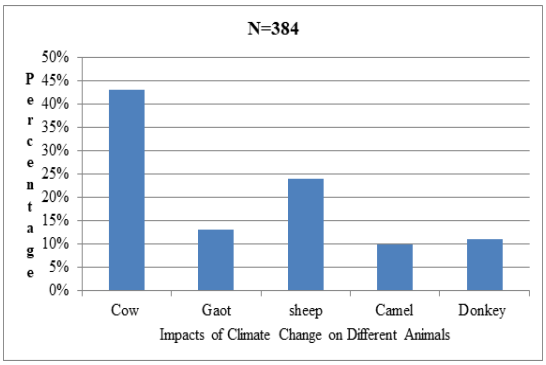

Figure 3.3: Effects of climate change on animals in West Pokot County
Source: Field Data, 2020

Community perception of effects of climate on livestock production

Climate change impacts negatively livestock production. During the key informant interview and focus group discussion, respondents indicated the various factors that affect livestock production. The respondents further ranked the factors based on the most threatening factor to livestock production. Livestock disease was ranked the most threatening factor as shown in table 3.5. Other factors that influence livestock production are pasture and water shortage, increased conflicts, and increased livestock mortality. Conflicts resulted in the loss of animals to cattle rustlers

and deaths, thus compromising livestock production and pastoralist food security. It was also found that animal trucks for long distances in search of pasture andwater coupled with high heat intensity increased livestock stress in arid and semi-arid areas of West Pokot County thus compromising productivity. During FGD it was indicated that livestock production is directly affected by climatic variability such as lack of pasture, water crisis, and outbreak of diseases, all these leadto livestock body conditions to deteriorate, thus resulting in massive livestock deaths and complete failure of livestock production.

Table 5.4: Effects of climate on livestock production

Effects	Percentage %	Rank
Livestock Diseases	40	1st
Shortage of pasture	28	2nd
Water shortage	15	2nd
Increased Conflicts	9	4th
Increased livestock mortality	8	5th

Source: Field Data, 2020

Respondents indicated that water and pasture scarcity affected the livestock body condition, which influences livestock production. The study indicated further that scarcity of pasture and water increased violent conflicts that triggered cattle rustling among the neighbouring communities due to competition/scramble over pasture and water. Climate extremes increased pastoralists' vulnerability to the effects of climate change-related hazards. According to the study by Nardone *et al.,* (2010) it was found that high milk-producing cattle were kept in hot climatic zones, where metabolic heat production was intensified increasing respiratory rate, consequently, decreasing the milk production, it was further noted that direct impacts are related to the morbidity and mortality of animals caused by thermal stresses and extreme weather events.

Variations of milk production in West Pokot

Climate change results in the reduction and fluctuation of milk production. The respondents indicated that milk production varies with season and ecological zone and it was observed to be influenced by theavailability of pasture and water. The focus group and key informant interviews indicated that milk increases during the wet season because there is plenty of pasture and water that directly influence milk production, as shown in Table 3.5. This means that milk production increases with increased rainfall, which influences pasture germination and increases livestock access to water. This study greed with Sprott *et al.*, (2001) who found that heat stress is a major source of production loss in the dairy and beef industry and whereas new knowledge about animal responses to the environment continues to be developed, managing animals to reduce the impact of the climate remains a challenge. *NejashAbdela and Kula Jilo,* (2016) further found that high environmental temperatures compromise the reproductive efficiency of farm animals in both sexes and hence negatively affect milk and meat. Consequently, Magita, (2017) also found that the lower milk yield was associated with inadequate feed in quantity and nutritional quality leading to general weakness and lower production in their cattle, it further impacts milk production and livestock body condition as was reported in other semi-arid areas of Tanzania

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.Table 3.4: Variations of milk production as per the respondents

Predictor variable	N	Mean	Std. Deviation	Range	Minimum	Maximum
How many litters of milk do your cows produce per day during the dry season?	384	2.2	2.5	18	0	18
How many litters of milk do your cows produce per day during the wet season?	384	6.3	4.7	30	0	30

Source: Field Data, 2020

As indicated by the mean values, production systems are adversely affected by climatic variability. The pastoralist' livelihoods are therefore greatly influenced by climate extreme events. The sustainability of pastoral livelihood was found to be directly affected by climate variation. The study found that the reduction in milk yield was due to the sensitivity of animals to thermal stress. This means that climate variability has a direct impact on the growth of palatable grass and the regeneration of fodder. Pasture and vegetation have been decreasing because of less rainfall or fluctuating rainfall. The study further found that high temperature resulting from climate change increases the rate of development of certain pathogens or parasites that have one or more life cycle stages outside their animal host.

Impact of climate change on animal's reproduction

The study found that livestock reproduction has been adversely affected by climate extremes, during focus group discussions one of the respondents reported that*: "some time back animals use to give birth every year because there was plenty of pasture and water. When animals are healthy with good pasture they take few months before they are on heat and ready for mating and male animals ready to mate every female animal on heat, but due to frequent occurrences of drought, this has reduced the multiplication of animal because animals take almost two-three year before being on heat, since they take longer to recover from impacts of drought and disease, thus affecting their reproduction".*

It was further observed that heat stress resulting from temperature increases causes infertility that adversely affects the reproductive performance of livestock. One of the key informants from the veterinary department revealed that reproductive processes in the male animal are very sensitive to disruption by hyperthermia with the most pronounced consequences being reduced quantity and quality of sperm production thus reducing fertility. Amundson *et al., (*2006), indicated that the reproductive functions of livestock are vulnerable to climatic changes and both females and males are affected adversely by heat stress which negatively affects the reproductive function of animals. This indicates that climate extremes such as drought and livestock disease affect livestock reproduction, therefore drastically reducing the reproduction rate of the animals directly impacting on livestock population.

Conclusion

Climate variability impacts negatively livestock production, especially in arid areas which prone to climate-related shocks. The study revealed that drought and livestock diseases are some of the common factors that compromise livestock production in West Pokot County. Emerging of invasive plant species that suppress the germination of pasture, coupled with severe drought that triggers water and pasture crisis in West Pokot County exacerbated the situation. Some animal species were noted to be resilient to climate extremes and can adapt to the effects of climate change, but livestock reproduction was found to be adversely affected by

climate extremes.

Recommendations

There is a need for pastoralist communities to embrace the rearing of camel, goats and donkey that were found to be resilient to climate extremes and more adaptive to climate shocks

The rangeland system and practising seasonal grazing shifts and management, to enhance pasture management and guarantee pasture availability need to be supported by county stakeholders and the pastoralist community themselves

The need for stakeholders in West Pokot County to capacity build of pastoralists on livestock breeds diversification and livestock off-take as an adaptation measure to enhance community resilience to climate extremes. Stakeholders should be involved in policy development to enhance climate change adaptation and promote pastoralists' resilience during a period of climate extremes

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