ABSTRACT

The continued rise in global temperature, increasing rainfall intensity and frequency of droughts would have severe impacts on pastoralists' livelihoods. The pastoralist communities manage resources unpredictable through regular herd movement and dividing their grazing areas for utilization into dry and wet season. However, little attention has been paid to the information on which pastoralists base their methods for managing resources and how they view major problems that affect herd mobility. This study examined how key informants perceived climate variability and livestock disease effects on pastoralists' livelihoods, their coping strategies and the institutional support systems available. Interviews with key informants were used. A total of twenty-two (22) key informants were purposively selected to be interviewed. These included veterinary officers, livestock officers, veterinary drugs outlet merchants and other key stakeholders from each of the three sub-counties of Samburu County. Themes and sub-themes were developed through qualitative analysis of key informant data. The respondents observed that there has been climatic variations that has continued to affect pastoralists. The effects of the changes included increase of livestock mortality, disease occurrences, and frequent herd migrations. The study suggests controlled herd mobility and grazing management, and continuous vaccination of livestock to reduce disease recurrence. The development of grazing management committees, drug provision, additional livestock treatment centres, and vaccination of livestock before entry into disease infested areas are also recommended.

Keywords: Rangelands, pastoralism, veterinary, grazing, interviews

INTRODUCTION

The rangelands that the pastoralists relied on for thousands of years have continued to be affected by climate variability and changes in availability of pasture and water resources (GoK, 2017; Fer et al., 2017; Lelenguyah et al., 2014; Wasonga et al., 2011; Mcsweeney et al., 2010). Because of this, pastoralists and their herds have been in constant movement pursuit of these rare supplies (Ellis and Galvin, 1994, Adriansen, 1999). Pastoralists from many ethnic groups have always found themselves converging and competing for the same resources since the availability of these resources determines their migration patterns (Lengoiboni, 2011; Mulianga, 2009).

Pastoralism is reliant on a complex interaction of natural resources, vibrant management through well-established local institutions, and livestock that has adapted to the environment. Pastoralism's three main pillars are natural resources, institutions, and the herd, all of which are significantly influenced by seasonal weather patterns (McCabe, 2010), whose function is constantly impacted by the changing climate.

To manage their pasture, pastoralist communities divide their rangeland into dry and wet grazing zones (Lengoiboni, 2011; Lesorogol, 2008). During the rainy season, they graze in drier portions of the rangeland, then shift to wetter areas during the dry season, when the pasture and water resources are depleted (Meza-Morales, 2010). During these periods, pastoralists maintain their seasonal routes dictated by livestock feed and water presence. As the pastoralists move, they face various challenges such as competition for resources leading to resource-based conflicts, livestock diseases and predation from wild cats.
For generations, this nomadic movement has maintained pastoral life, but today their livelihoods are at risk due to climate change. Climate change in dryland areas manifests itself in floodstorms and cyclic droughts, which damage livelihoods by causing high livestock mortality, compromising peoples’ adaptive capacity and resilience in Kenya’s drylands.

In Kenya, regular mobility usually occurs mainly as the dry seasons sets in. Livestock disease cases are usually presumably higher due to the fact that veterinary services in the dry season grazing areas are limited or not available at all. The risk of spread of diseases increases when livestock from other pastoral communities converge for water and pasture resources. Despite the recurrent epidemics and loss of livestock, little attention has been paid to finding solutions to pastoralism-related livestock disease outbreaks and their control. A disease-specific control strategy has not been developed for these harsh pastoral environments. The relationship between climate variability and herd mobility, and the resulting disease incidences has not been examined.

In order to control livestock diseases resulting from herd mobility and to adapt pastoralists to the changing climate, this study sought to get information from key informants who are work in various organizations in the three sub-counties of Samburu County. The information obtained was on the various changes in climate and disease patterns, its effects on pastoralists, their coping strategies and the assistance provided by these organizations. The study then suggested disease control strategies and interventions for pastoralists in northern Kenya to ensure that climate variability and herd mobility do not constrain livestock disease control. This study aimed at answering three key research questions; (1) What are the perceptions, impacts and coping strategies to climate variability in the Samburu pastoral production system? (2) What is the relationship between seasonal rainfall variability and herd mobility patterns in Northern Kenya? (3) What are the livestock diseases hotspots and the effects of seasons on disease incidences in the study area?

MATERIAL AND METHODS

Study Area

The size of Samburu County is roughly 21,022.01 km² (Samburu County Government, 2018). It is a semi-arid rangeland located between the latitudes 0°30’N and 2°45’N and longitudes 36°15’E and 38°10’E, with an average elevation of around 900m above sea level (Samburu County Government, 2018). Baringo and Turkana counties to the west, Marsabit County to the north, Isiolo County to the east, and Laikipia County to the south are its neighbours. The county’s climate varies with altitude. In the lowlands, the average annual rainfall can be as low as 400 mm and as high as 1250 mm (SCG and WFP, 2015). Eight percent of the county has high rainfall and sufficient moisture to enable arable farming, while the rest is classified as rangeland.

Research design and sampling procedure

The study utilized a non-probability sampling technique. To determine a sample for the institutional survey, purposive sampling was used. This non-probability sampling technique allows the investigator to choose representative samples using his/her expert judgment. A total of twenty-two (22) key informants from the public and private sectors were interviewed for this study at the county and sub-county levels between March and June 2021. Veterinary (3), livestock (3), Agriculture (3), National Drought Management Authority (NDMA) (1), Special Programs (3), County Livestock Marketing Council (CLMC) (1), Food Agricultural Organization (FAO) (1), CARITAS (1), Veterinary drug outlets (3), and sub-county administration (3) were the organizations chosen for key informant interviews. The selection of the institutions and the key informants, however, was purposive and primarily based on the significance of the institution and the key informant’s position in the community under investigation. The results of this study was used to triangulate information that had already been collected from local pastoralists. The respondents from the selected organization were asked questions with regard to trends in climate variability, livestock diseases occurrences, coping strategies of the local pastoralists community and organizational support provided to assist them in coping with these changes. The interviews were administered with the assistance of trained enumerators.

Statistical Methods and Analysis

Themes and sub-themes were used to qualitatively analyze key informant data, according to Maguire and Delahunt (2017). Each interview was transcribed and in a qualitative analysis of the transcriptions, keywords and
themes were found, allocated to a specific coding subject (such as decreasing rainfall), and then tallied to assess how frequently respondents made remarks about that theme. The transcribed interviews were analyzed using an inductive coding method to identify patterns in behavior and thought (Bernard 2002).

RESULTS

The findings of this study have been presented as sub-themes, as described by Maguire and Delahunt (2017). The presented results have focused on the key informant interview questions that were asked during the research process. The summary of results of this investigation are as described in Table I. The results indicate a decreasing trend of rainfall, increasing temperatures and increasing incidences of Pestes des Petits Ruminants (PPR), Contagious Caprine Pleuropneumonia (CCPP) and Foot and Mouth Disease (FMD). In addition, increasing trend of ticks and mosquitoes populations was also perceived by the key informants.

TABLE I - KEY INFORMANT RESPONSES ON THE TREND OF VARIOUS VARIABLES OVER 20 YEARS (2000 - 2020) IN SAMBURU COUNTY

<table>
<thead>
<tr>
<th>Selected Sub-themes</th>
<th>Percentage of respondents n=22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing rainfall amount</td>
<td>86.4%</td>
</tr>
<tr>
<td>Increasing temperature</td>
<td>77.3%</td>
</tr>
<tr>
<td>Normal trend of floods</td>
<td>59.1%</td>
</tr>
<tr>
<td>More severe droughts</td>
<td>77.3%</td>
</tr>
<tr>
<td>Fewer water sources</td>
<td>54.5%</td>
</tr>
<tr>
<td>Less vegetation cover</td>
<td>59.1%</td>
</tr>
<tr>
<td>Increasing trend of mosquitoes</td>
<td>63.6%</td>
</tr>
<tr>
<td>Increasing trend of ticks</td>
<td>68.2%</td>
</tr>
<tr>
<td>Constant trend of tsetse flies</td>
<td>54.5%</td>
</tr>
<tr>
<td>Increasing cases of PPR</td>
<td>77.3%</td>
</tr>
<tr>
<td>Increasing cases of CCPP</td>
<td>81.8%</td>
</tr>
<tr>
<td>Increasing cases of FMD</td>
<td>72.7%</td>
</tr>
<tr>
<td>Declining cases of Trypanosomiasis</td>
<td>59.1%</td>
</tr>
<tr>
<td>Declining cases of Camel pox</td>
<td>54.5%</td>
</tr>
</tbody>
</table>

Changes in the trend of the climatic variables over the last 20 years

Temperature

More than seventy-seven percent (77.3%) of the respondents said they had observed a rise in temperatures. There was more heat throughout the day and fewer chilly nights than experienced before. It was reported that 2016 was the hottest year ever. And that temperatures rose to extremely high levels during the dry season and decreased during the wet season. Analysis of the January to March temperature data from meteorological department from 2001 to 2020 shows that 2016 had the highest average maximum temperature at 32.8 °C while the lowest average temperatures were recorded in 2020 at 29.3 °C. According to one of the respondents, extremely high temperatures were recorded in 2002 and 2007, with an oscillation of the cold seasons getting colder and the typically considered warmer seasons of the year getting hotter. Average maximum temperatures for January to March for 2002 and 2007 were 31.2 and 31.6 respectively. A greater diurnal range, or high temperatures during the day and very low temperatures at night, was reported by 46.5% of the respondents. Highland areas like Maralal were said to have been very cold in the past but warmer at the time of the survey.

Rainfall

With a significant change in the onset of rains from March being noted since early 2000, the sub-county agricultural officer for Samburu Central reported that the rains had become highly irregular. Furthermore, frequency of rains had decreased, with little or no reduction attributed to climate variability and change. Rainfall that was
Changes in rainfall patterns were noted as being inconsistent and occasionally being either insufficient or excessive, resulting in decreased pasture supply. Over three-quarters (86.4%) of the key informants observed that rainfall decreased between 1999 and 2019 and does not follow the historical March-April-May and October-November-December rain seasons pattern. An analysis of the annual trends of the rainfall between 1981 to 2020 showed a general decline in rainfall amounts in Samburu north (Lonyangaten and Arsim) and an increase in the rainfall amounts received in Samburu central (Longewan) and Samburu East (Swari, Lpus and Ngutuk Engiron) areas.

**Drought**

Over half (55.5%) of the respondents noted an increase in the frequency of drought, while 32% claimed that droughts occurred every one to two years. Most respondents (60%) noted that, in contrast to the past, when droughts only happened once every ten years, the intervals between them had reduced to just one or two years. Due to insufficient precipitation, it was noted that severe droughts occurred in 2002 and 2007. Other years with droughts were 1999–2000, 2005–2006, 2008–2009, 2016–2017, and the intervening years with insufficient precipitation. It was also reported that several dry seasons have been observed within the study period and the most notables ones were in 2013 and 2014. Meteorological data shows that the year 2000 had the lowest annual rainfall at 345 mm, this was followed by 2009 (380 mm), 2005 (400 mm), 2016 (435 mm) and 2004 (462 mm). In general, the frequency of droughts had increased throughout time, and incidents of extended droughts brought on by the absence of two successive wet seasons resulted in acute drought.

**Floods**

Five respondents (22.7%) reported that land degradation have led to an increase in floods. Respondents from livestock and veterinary departments indicated that flash floods occurred during El Nino and prolonged lengthy rains, resulting in property and livestock losses. Floods were reported in several areas of Samburu County in 2010, 2013, and 2016 even though they were claimed to be infrequent there. The average annual rainfall amounts received in these years over the last 20 years were 622 mm, 662 mm and 435 mm respectively. Flooding was observed to have dramatically increased in frequency, which is aggravated by land degradation. However, only less than 10% of Samburu County was reported by the department of special programmes to be affected by flooding, mainly around the major rivers of Ewaso Nyiro, Seyia, Nagor-Oworu, Barsilinga, Arsim and Lengusaka.

**Effects of the changes on pastoralists’ livelihoods**

The key informants noted an increase of disease occurrences, poverty levels, and susceptibility as resource conflicts. Stated the Sub-County Agriculture Officer (Samburu Central, Kenya); “Recurrence of community conflicts had increased over pasture due to reduced grazing land and pasture supply. Conflicts had increased as people compete for limited resources, and the livestocks are forced to migrate in search of pasture and water to far places resulting in increased pests and diseases occurrences. Poor harvests and losses due to untimely rain seasons lead to food insecurity, loss of livestock, crops and properties as a result of floods”.

Drought-related livestock losses led to increased poverty levels. More livestock deaths were reported as a result of increased diseases occurrences, including Rift Valley fever (RVF) and blue tongue (BT) brought on by above-average rains. For instance, according to veterinary department, during the 1997 and 2007 above-average rainfall, outbreaks of both RVF and BT were reported. There was increased frequency of livestock movement between locations in search of grass and water resources. The livelihood structure of pastoralists was also observed to have changed because they frequently moved in search of pastures and water for their livestock with a negative impact on their social and economic welfare.

According to respondents from the department of Agriculture and NDMA, there is a decrease in vegetation cover caused soil erosion in the area. The loss of livestock during drought and loss of human life and property due to
floods were also cited as contributing factors to pastoral dropouts, resulting in household poverty. Many households were said to have abandoned pastoralism for new business opportunities, such as petty trade, charcoal burning, and casual employment. Insufficient pasture regeneration, resulted in reduced livestock feed availability which was attributed to increased land degradation. The observed changes were also responsible for decreased purchasing power and food security, engagement in alternative livelihoods like charcoal burning, and increased school dropout rates. Malnutrition was also reported among vulnerable groups of young and aged. Reduction in pasture and water supply also caused resource-based conflicts that resulted in the death of people and livestock. Increased instances of drought have also contributed to the depletion of natural resources (such as water and pastures), resulting in low livestock productivity and, increased livestock mortality due to excessive movement.

Climate variability and outbreaks of livestock diseases

The respondents from veterinary and livestock departments as well as NDMA and special programmes outlined some of the major diseases that have occurred over the last 20 years in Samburu County (Table II). Although most livestock diseases were not directly related to climatic change, frequent livestock migrations caused increased disease incidences.

According to the respondents from veterinary department, when livestock move from one location to another in search of pasture, FMD is spread mechanically by the movement of livestock, persons, vehicles and other things which have been contaminated by the virus as such can be easily transmitted from one herd to another. Equally, PPR is a novel disease linked to recent developments in climate change. While CCPP and foot rot were said to predominantly occur during the rainy season, blue tongue and Rift Valley Fever (RVF) were noted to occur following above-average rains that resulted in flooding. Records from the veterinary department shows that RVF outbreaks were mainly experienced in 2007 and 2017/2018 following heavy rains.

Factors that affect the herd's seasonal mobility

The amount of rainfall in a particular location was considered critical in determining the herd’s movement. For instance, there was more migration of households and herds following insufficient rains. Typically, availability of pastures and water determines the herd’s migratory patterns according to the respondents from livestock department.

Livestock disease challenges during herd movement

The key informants from veterinary and livestock departments stated that livestock diseases had become a serious problem during herds movements and when livestock from various

<table>
<thead>
<tr>
<th>Year</th>
<th>Livestock Disease</th>
<th>Year</th>
<th>Livestock Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>East Coast Fever</td>
<td>2016/2017</td>
<td>Lumpy Skin Disease (LSD)</td>
</tr>
<tr>
<td>2004</td>
<td>Foot and Mouth Disease (FMD)</td>
<td>2016/2017</td>
<td>SGP</td>
</tr>
<tr>
<td>2006/2007</td>
<td>PPR</td>
<td>2017/2018</td>
<td>Foot rot</td>
</tr>
<tr>
<td>2007</td>
<td>Rift Valley Fever (RVF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>FMD</td>
<td>2018</td>
<td>FMD</td>
</tr>
<tr>
<td>2009</td>
<td>PPR in Goats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010-2011</td>
<td>FMD</td>
<td>2018</td>
<td>Pestes des Petits Ruminants (PPR)</td>
</tr>
<tr>
<td></td>
<td>Contagious Caprine Pleuropneumonia (CCPP)</td>
<td>2018</td>
<td>Blue Tongue</td>
</tr>
<tr>
<td>2013</td>
<td>FMD</td>
<td>2019</td>
<td>Haemorrhagic Septicaemia (HS)</td>
</tr>
<tr>
<td>2013</td>
<td>Sheep and Goat Pox (SGP)</td>
<td>2019/2020</td>
<td>FMD</td>
</tr>
<tr>
<td>2017</td>
<td>PPR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016/2017</td>
<td>FMD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE II- MAJOR DISEASE OUTBREAKS OVER A 20 YEAR PERIOD ACCORDING TO KEY INFORMANTS IN SAMBURU COUNTY
locations converged in the dry season grazing areas. The converging livestock populations from various regions raised the risk of disease outbreaks. Instances of the sick and healthy herds spreading infections to one another, particularly near water sources had been noted. Reduced demands for veterinary drugs and for veterinary services were reported during these times, despite the increasing rates of livestock diseases during herd mobility. This could imply that when livestock move to distant areas from the homesteads there is less attention paid to their health since household purchasing power is lower.

Disease challenges experienced during herd mobility, negatively impacts on their health and market value. As a spill over effect, such livestock diseases results to food insecurity at the household level. Resource-based conflicts between communities was perceived to negatively impact on the pastoral production system since they make pastoralists not to move to the affected areas hence such areas remains unutilized due to insecurity reasons. The key informants from the veterinary department noted that while the risk of disease transmission increases in the dry season grazing areas, managing the livestock infections during these times presented a significant problem. This was particularly true given the vastness of the area, the difficulty in accessing the areas where livestock graze and the problems with insecurity. Stated the Sub-County Veterinary officer (Samburu North), “It is a big challenge controlling diseases during herd mobility considering the inter-County nature of migrations. Also, some areas are hard to reach, and veterinary service provision becomes a challenge”.

Major disease outbreaks always follow major migrations. Such epidemics during such times result in market closures and imposition of quarantine measures to stop further spread. In addition to livestock diseases, other issues raised by the key informants included increased cases of thefts in local markets, decreased household income, and livestock grazing on pastures and crops on private farms resulting in conflicts with crop farmers. Households were unable to purchase farm inputs for crop production and pay for cultivation costs when the livestock were not at home. Low market prices were also cited as arising from the influx of livestock from other areas.

Community coping mechanisms for livestock diseases and other challenges

The respondents highlighted various coping mechanisms pastoralists used to deal with diseases and other difficulties such as selling their livestock and purchasing medications, requesting assistance from the government, culling weak livestock, and informing local authorities like chiefs or community disease reporters trained by the livestock department. The key respondents also highlighted quarantining particular grazing areas and watering spots, treating livestock with medications from veterinary drug stores, using ethnoveterinary medicine, and vaccinating their livestock before and after outbreaks as coping mechanisms. Remarked the Sub-County Special Programs Officer (Samburu East), “The community cope through self-administration of veterinary drugs without seeking professional services and, in most cases, let these diseases take a natural course”. The veterinary staff are not readily available in most of the pastoral areas to provide treatment to livestock when need arises during these migrations. This forces the pastoralists to use readily available options including using herbal treatments and, in some instances using already expired drugs. Despite the fact that pastoralists strived to cope with the effects of livestock diseases they were constrained by limited knowledge on livestock diseases, poor infrastructure, lack of drugs and vaccines, insecurity and lack of disease control facilities.

Another coping mechanism during herd mobility was herd splitting to make them more manageable. The key informants also mentioned using acacia pods, fencing off the land, moving to safer regions, deferring movement to grazing areas, controlling grazing patterns, and monitoring the weather patterns and climatic trends as other coping mechanisms. In general, the respondents found that communities had become more resilient in response to these challenges. The improved resilience has been brought about by the coping strategies adopted by the pastoralists including livelihood diversification, venturing into pasture production and keeping of goats and camels in the lowlands of Samburu County which are more resistant to drought.

Organizations’ interventions during disease outbreaks

The key informants, being organizations’ representatives, indicated a number of interventions they offer when disease epidemics occur. These interventions included giving the veterinary department logistical support, such as funding for mass vaccinations, quarantines, and livestock movement control, providing advice to livestock owners, making necessary medications available to livestock keepers, setting
up outreach programs, and distributing emergency food to the locals. Additionally, the NDMA has created an early warning system to advise pastoralists in risk mitigation. The veterinary directorate has also enhanced village-level disease surveillance, diagnosis, and treatment capability. “Other partners have been facilitating the procurement of vaccines to support the veterinary department while others offer logistical support. The veterinary department has also been intervening through ring vaccinations, advising herders on the right drugs to be administered to various diseases, mass vaccinations supported by county government or other development partners, and advising farmers through offering extension services”. Said the County Director of Veterinary Services (Samburu County, Kenya). Partners including FAO and CARITAS cooperated with the veterinary department to control livestock diseases by raising community awareness, facilitating grazing plans, providing water, facilitating community dialogues and peace meetings, encouraging livestock off-take, and providing supportive treatments and supplemental feeds during dry spells.

Factors that influence organizations’ interventions in disease control

The key informants mentioned several elements as the primary determinants of the organization’s initiatives. Some of these factors include length of the dry season, whether or not the situation necessitates emergency action, accessibility of funds, collaboration with appropriate personnel during the onset of disease, the scope of the organization’s budget allocation, and delays in the procurement process. Other considerations included the availability of transportation, availability of resources (which include vaccines, facilitation allowances for the staff, vehicles and fuels, and adequate cold chain facilities), farmers’ willingness to allow their livestock to be vaccinated, and how effectively the communities and farmers had been organized to increase vaccine uptake and coverage. Additionally, the area’s road accessibility, weather patterns (which was a challenge to carry out operations during the rainy seasons), migration patterns, reported cases of disease outbreaks, the stage of the drought (termed as either normal, alert, alarm, or emergency stage), the area’s security situation, and the availability of partners for disease control interventions are all factors.

DISCUSSIONS

All the key informants agreed that there had been sporadic instances of extremely heavy rain with an irregular rainfall trend. The UNDP’s climate change profile for Kenya made a similar observation, noting that rainfall observations since 1960 have not revealed any statistically significant difference. In addition, this analysis revealed no statistically significant trend in the increase in heavy rainfall occurrences (McSweeney et al., 2010). Generally, the two studies agree on the fact that the rainfall have become irregular and inconsistent in its occurrences.

The respondents indicated that heavy rainfall occurrences had persisted in the Arsim area since 2011, leading to flooding. The key informants indicated that among the several factors that led to the displacement of households in Arsim, the effects of floods predominated. Most homes in the Arsim area were located along the rivers that originate in the Ndoto Mountains (personal observation) and flood during periods of heavy rainfall. Floods inevitably cause population displacement, fatalities, and increased incidences of water-borne diseases in the afflicted areas.

According to the respondents, temperatures got hotter and droughts increased during the research period. Vegetation cover have also been increasing especially in areas around Samburu Central where crops cultivation has increased. However, of all the climatic factors, only rainfall was anticipated to decrease in the future, but respondents also indicated that temperature rise, frequency of droughts and floods might probably increase. By 2100, it is anticipated that temperatures will have increased globally by 1.0 to 3.5 degrees Celsius (Githeko et al., 2000).

Most respondents believed that the trend for ticks and mosquitoes was upward. On the other hand, tsetse flies were claimed to have a consistent trend, while other biting flies were said to be on the decline. Githeko et al. (2000) and Wilcox et al. (2019) found that variations in temperature, precipitation, and humidity impact the ecology and biology of vectors, which may result in an increase or decrease in the number of vectors.

However, the respondents’ perception of a drop in the prevalence of other biting flies in these areas may have been influenced by changes in land use. They claim that increased bush clearing in Ngutuk Engiron, Lonyangaten,
The respondents listed several coping mechanisms to lessen the effects of livestock diseases, including purchasing medications for prophylaxis and treatment of sick livestock, moving the livestock to locations free of disease, killing sick livestocks to prevent disease spread, vaccination and reporting disease outbreaks. Other coping mechanisms included restricted movement, herbal treatment, quarantining sick livestocks, and controlling livestock movement. According to Chengula et al. (2013) and Montavon et al. (2013), pastoralists have become adapted to the arid and semi-arid rangelands where service provision is deficient and veterinary personnel and services are inaccessible. They, therefore, go to the extent of treating the sick livestocks themselves, controlling the movements of the herds thereby controlling the spread of livestock diseases.

Ways that livestock diseases can be controlled/treated during mobility

Several recommendations were made regarding the best methods for managing or treating livestock diseases during mobility. These included reducing migration, creating disease-free zones, routine dipping, directing herders to move in particular directions to reduce conflicts, launching awareness campaigns on disease surveillance during mobility, and forming grazing management committees. “I strongly advocate for provision of veterinary drugs and creating more livestock treatment stations, vaccination before entry into affected areas or preventive antibiotic therapy, weekly spraying to control ticks, providing prophylaxis drugs during herd mobility, isolating the sick livestock from the rest of the herd and mass vaccinations. This will ensure reaching out to large numbers of livestock”, declared the Sub-County Veterinary Officer (Samburu East, Kenya)

It was recommended limiting herd movement through zoning grazing areas, notifying authorities in advance of migrations, routine vaccinations, inter-county disease control collaboration, understanding livestock movement patterns and treating/vaccinating them at specific sites, avoiding concentration of livestock in one area, supportive treatments, encouraging the use of ethnomedicine, and ensuring the herders move to accessible areas during disease control.

and Longewan for farming, pasture production, or simply for other economic activities like charcoal burning may also have led to changes in the abundance of these vectors. The population of flies is reduced by destroying the vectors’ habitat through cultivation and bush clearing (Yatich, 1995; Lelenguyah et al., 2014).

Among the veterinary diseases under review, only trypanosomiasis and camel pox were found to have decreased over the study period. All other diseases, such as FMD, CCPP, and PPR, were perceived to have worsened. According to Githeko et al. (2000) and Wilcox et al. (2019), changes in the biology and ecology of disease-carrying vectors enhance the likelihood of disease transmission, which may be a major reason for the rising trend of diseases over the research period.

When dealing with disease outbreaks, the weather factor also comes into play because it is known that weather conditions impact both the timing and the severity of epidemics (Wilcox et al., 2019; Kshirsagar et al., 2013; Lelenguyah et al., 2014; Githeko et al., 2000; Nguku et al. 2010). This is especially true concerning CCPP. Managing livestock diseases is difficult during herd mobility (Akilul and Wekesa, 2001; Bouslikhane, 2015). Heartwater, sheep and goat pox, anaemia, black quarter, diarrhoea, Lumpy Skin Disease (LSD), and East Coast Fever (ECF) are some diseases that respondents mentioned were challenging during herd migration. Other diseases were Redwater (Babesiosis), Camel Pox, Trypanosomiasis (Nagana), PPR, FMD, Enterotoxaemia, Anaplasmosis, Worms, 3-Day Fever, and Foot Rot.

Regarding how diseases affect livestock and the household during herd mobility, there are several effects on the herder or the pastoralists, the livestock and the livestock products (Egeru, 2016; Ayanda, 2013; Bailey, 2012; Onono et al., 2010; Bayissa et al., 2009; Catley et al., 2005). The respondents highlighted some implications, including the impact on household food supply and security, limited mobility, the effect on livestock reproduction, and weight loss. They also mentioned the effects on livestock health and mortality including limited reproduction, reduced number of livestocks, low-quality and quantity of products (meat, milk), the transmission of diseases to humans as well as weak and unhealthy livestocks
CONCLUSIONS AND RECOMMENDATIONS

This study aimed at investigating; (1) the perceptions, impacts and coping strategies to climate variability in the Samburu pastoral production system (2) the relationship between seasonal rainfall variability and herd mobility patterns in Northern Kenya (3) the livestock diseases hotspots and the effects of seasons on disease incidences in the study area. The key informants’ perception indicated a general decline in rainfall and an increase in temperature and drought and flood incidences in Samburu County. The study also revealed a number of issues including the upward trend of ticks and mosquitoes and declining trends of other biting flies. The observed changes have had negative impacts on the pastoralists’ livelihoods including livestock deaths resulting to poverty and destitution, reduction in pasture and water availability as well as reduction of livestock productivity and market value. Concerted efforts amongst all the stakeholders is required to ensure that the pastoralists and their livelihoods are secured against climatic change effects. The measures should include improvement of veterinary services, infrastructure development and enhancing information dissemination mechanism to suit the pastoral areas. Diversification of livelihood sources will help the pastoralists to cushion themselves against the effects of climate variability. More research is needed on the herd mobility patterns in various Counties or cluster of Counties. This study only focused on Samburu County. Such study will inform various interventions including inter-County rangeland planning, grazing management as well as disease control.

ACKNOWLEDGEMENTS

The authors take this opportunity to thank everyone who contributed to or helped with this research in any way, shape, or form. Our gratitude and appreciation to the key informants and the research assistants who helped with this study. The Kenya Climate Smart Agriculture Project (KCSAP), an initiative of the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives, provided funding for this study.

REFERENCES


