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Participatory Epidemiological Assessment of Priority Livestock Diseases, Their Seasonal Occurrence and Impact on Livelihood in Mandera West Sub-County, Mandera County, Kenya

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Abstract

Participatory epidemiology (PE) is a valuable technique for mapping livestock diseases, as it recognizes the indigenous knowledge held by pastoral communities regarding diseases that impact their livelihood and acknowledges the creative capacity of these communities, which can be harnessed to complement scientific disease control and prevention measures. The study aimed to evaluate the priority livestock diseases, their seasonal occurrence, and their impact on the livelihood of communities in Mandera West Sub-County, Mandera County, Kenya. A Cross-sectional study using participatory epidemiological (PE) methods and approaches was conducted with livestock keepers in Mandera west Sub-county from December 2021 to January 2022. Forty group discussions of 10-15 informants involving both men and women were held in 40 randomly selected villages in five administrative wards (Gither, Dandu, Lagsure, Didkuro and Takaba). Data collection tools used in PE study consisted of semi-structured interviews, simple ranking, pair-wise ranking, proportional piling, matrix scoring, disease impact matrix scoring (DIMs) and seasonal calendars. Livestock species were ranked by informants based on economic value to their livelihood.

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The order was camel, goats, cattle, sheep, donkey, and poultry. The top five priority livestock diseases were Camel Pox, Contagious Caprine Pleuropneumonia (CCPP), Peste des Petits Ruminants (PPR), Contagious Bovine Pleuropneumonia (CBPP), and Enterotoxaemia. Disease Impact Matrix Scoring (DIMs) revealed CCPP as having the highest livelihood impact at 35.4%, followed by PPR (32.8%), CBPP (30.6%), and trypanosomiasis (28.1%). Proportional pilling indicated Black Quarter (BQ), Enterotoxaemia, CCPP, and Camel Pox had highest case fatalities (CF) of 69.8%, 55.9%, 45.5%, and 37.2% respectively. Informants identified four main seasons: Bira (January to March, dry season), Gan (April to June, long rain), Atholes (July to September, cold season), and Agay (October to December, short rain). Trypanosomiasis and mange were prevalent during the dry season, while CBPP, PPR, and CCPP were high in the cold season. Foot and Mouth Disease (FMD) and Sheep and Goat Pox (SGP) occurred frequently during the long rain, while Camel Pox and Haemorrhagic Septicemia (H.S) tended to occur during the short rain. In conclusion, the PE study identified a strong consensus among key informants in ranking priority livestock diseases, such as Camel Pox, CCPP, PPR, CBPP, and Enterotoxaemia. CCPP, PPR, CBPP, and trypanosomiasis had the most significant impact on community livelihoods. The study underscores the value of community involvement in disease control, utilizing indigenous knowledge.

Keywords: Participatory epidemiology; Livelihood; Mandera West.

1. Introduction

About 80% of Kenya is characterized as arid and semi-arid lands (ASAL) with pastoralism as the main source of livelihood to millions of people residing in these lands [1]. There is a general consensus that pastoralism contributes between 10% to 44% of the gross domestic product (GDP) of African countries with approximately 1.3 billion people benefiting from the livestock value chain [2]. Pastoralism makes significant contribution to Kenya's economy with livestock production accounting for 50% of agricultural GDP, which is 20–30% of the total GDP [3]. Mandera County is predominantly semi-arid, with most of the county receiving average annual rainfall of below 250mm. Despite the unfavorable climatic conditions, agriculture is the major livelihood in the county, employing over 90% of the population. Livestock production is the predominant sub-sector, employing over 84% of the population, and contributing approximately 72% to household incomes [4]. Animals provide food and other critical resources to most of the global population. As such, diseases of animals, especially those with high morbidity or mortality can cause dire consequences to the livelihoods and economy. Of great significance is Transboundary animal diseases (TADs) which are highly contagious or transmissible epidemic diseases, with the potential to spread rapidly across the globe and the potential to cause substantial socioeconomic and public health consequences[5]. Mandera County borders Ethiopia to the North and Somalia Republic to the East and due to the porous border, there is livestock migrations in to the county resulting into sporadic outbreak of TADs which often degenerate into emergency situations and loss of livelihoods. Therefore, the embodied effects of animal diseases thus often markedly increase livelihood vulnerability [6]. Despite the importance of livestock in the county, there is little information from systematic studies regarding common livestock diseases. Local knowledge of pastoralists about the relative importance of common livestock diseases, husbandry, and control practices is not fully exploited. The conventional Sero-surveillance techniques to detect and measure levels of livestock diseases in pastoral areas are expensive and often constrained by chronic lack of

funding and limited human resource [7].Participatory epidemiology (PE) methods have been adapted by animal health practitioners and researchers to explore and document this indigenous knowledge held by the communities so as to better understand local livestock disease situations[8]. Therefore, the study was undertaken to assess priority livestock diseases, their seasonal occurrence and impact on livelihood in Mandera West Sub-County, Mandera County, Kenya, using PE methods. This information will assist in the design of appropriate animal health programs that aim to reduce impact of diseases on livelihood and enhance livestock productivity.

2. Materials and Methods

2.1 Study area

Mandera County is one of the 47 counties in Kenya, located in the North Eastern part of Kenya and it borders Ethiopia to the North, Somalia Republic to the East and Wajir County to the South. It lies between latitudes 20 11` North, and 40 17`South, and longitudes 390 47` East and 410 4.8` West. The County covers an area of 25,991.5 km^2 and has an estimated human population of 867,457 persons (KNBS, 2019). Administratively the county is subdivided into six sub counties; Mandera West, Mandera South, Banisa, Mandera North, Mandera East and Lafey. The study was conducted in Mandera West Sub-county, Mandera County, Kenya, which is an arid and semi-arid region and receives an average level of 368mm of precipitation annually. The average day temperature is 29.65 C^0 and rainfall is 250-350mm. The Sub-County has a population of 98,296 and covers an area of about 4,778.5km^2. The livestock population in the sub-county is cattle: 235,308; Camels: 294,333; Goats: 632,985; Sheep: 257,130; Chicken: 18,732 and Donkeys: 64,953 [9]. Administratively, the sub-county has 5 wards: Gither, Dandu, Lagsure, Didkuro and Takaba wards which were selected to participate in the study.

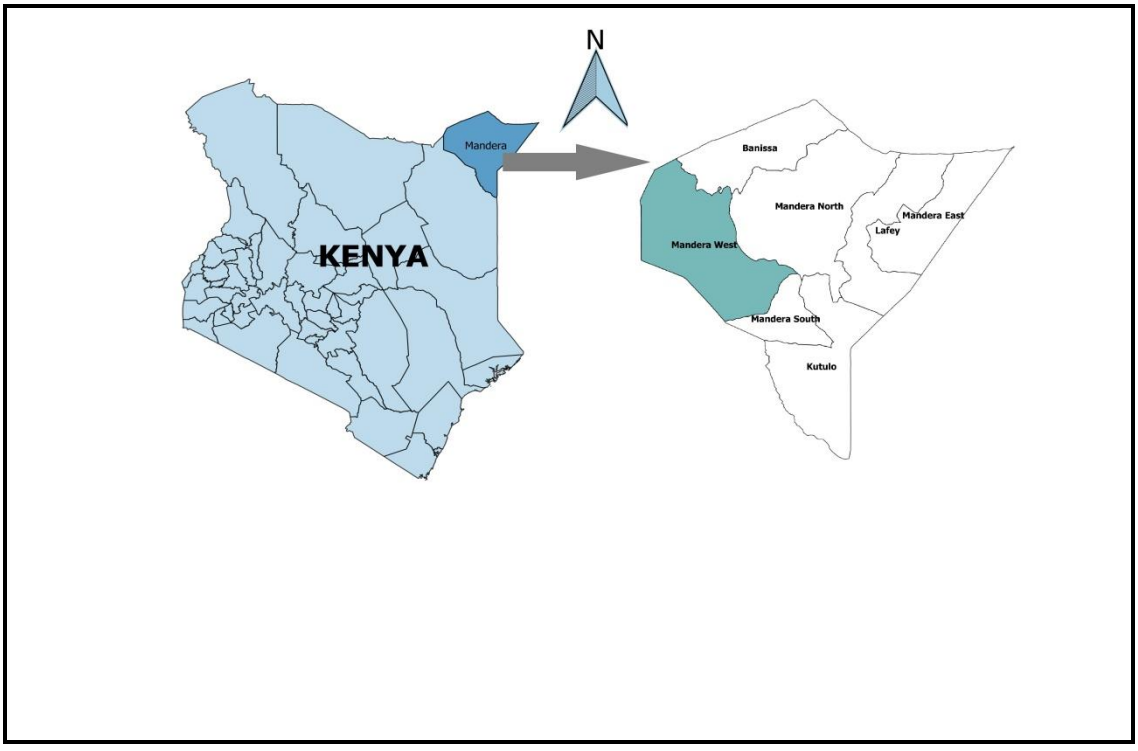

Figure 1: Map of Kenya showing relative location of Mandera County and study area.

2.2 Study design

A cross-sectional study using participatory epidemiology (PE) was conducted to map priority livestock diseases in Goat, Sheep, Cattle, and Camels. All Wards in Mandera West Sub-County were included, and eight villages per Ward were randomly selected. The study involved four teams, each working in two villages per Ward. Purposive sampling was used to select household and key informants based on their willingness to participate and their experience in livestock rearing. Forty group discussions, including 10-15 informants of both genders, were conducted in each selected village and included in the study.

2.3 Data Collection

The study was conducted in Mandera West Sub-county from December 2021 to January 2022. Forty group discussions comprising 10-15 informants, including both men and women, were held in selected villages and included in the study. Participatory epidemiology tools, such as simple ranking, pairwise ranking, proportional piling, matrix scoring, disease impact matrix scoring (DIMS), and seasonal calendar methods, were employed using a prepared checklist. The participants, who were livestock keepers, engaged in discussions that lasted for approximately an hour. The discussions were guided by a team of four individuals, including two facilitators who led and posed most of the questions, a recorder responsible for documenting the proceedings, and an interpreter when necessary. The facilitators received prior training on the application of participatory epidemiology methods and approaches from a researcher experienced in participatory disease surveillance (PDS).

2.3.1 Semi-structured interviews (SSI)

The investigation teams conducted semi-structured interviews with the respondents using a checklist specifically developed to address the study objectives. In each village, semi-structured interviews were conducted to gather information on the livestock species kept, grazing patterns, and livestock diseases observed in the local language over the past year.

2.3.2 Simple ranking of livestock species and diseases

The group members were asked to rank and compare the livestock species they kept based on the importance to community livelihood and their level of resilience to drought. Ranking on the given criteria was done one after another. They were also asked to list and rank common livestock diseases in the area.

2.3.3 Pairwise ranking of common livestock diseases

The ranking method used was a pairwise comparison, where each disease was individually compared to every other disease. Disease names were written on cards, and participants were asked to compare two diseases at a time in terms of importance. Probing questions were posed to understand the reasons behind their choices and how they distinguished between the two diseases. The diseases were subsequently ranked from first to fifth based on their scores in the pairwise comparisons, with the disease receiving the highest score ranked first and

the one with the lowest score ranked last.

2.3.4 Matrix Scoring

Local vernacular characterization of major endemic livestock disease problems was assessed by scoring within the informants' knowledge scope. This involved using counters, such as beans, to score the diseases based on their corresponding indicators, specifically the clinical signs.

2.3.5 Proportional Pilling

Proportional piling[10] was employed to estimate the morbidity, mortality, recovery, and case fatality rates of the five most significant diseases for each livestock species (Camel, Cattle, Goats, and Sheep) within the past year. Participants were provided with a pile of 100 counters to represent the number of animals in their herd for each species. They then divided the pile into two, representing the proportions of sick and healthy animals. The pile representing sick animals was further subdivided to represent the proportions of animals affected by each of the top five identified diseases, as well as a group labeled as "other diseases." Subsequently, participants divided the pile representing each disease to indicate the proportions of animals that recovered and those that died from that specific disease during the past year. Through discussion and consensus, pastoralists provided reasons for their choices and agreed upon the scores for each disease. This activity was repeated across all forty group discussions.

2.3.6 Disease Impact Matrix Scoring (DIMS)

Semi-structured interviews were conducted to generate a list of benefits associated with common livestock species. To determine the relative importance of these benefits, proportional scoring was performed along the Y-axis using 100 counters. The priority livestock diseases for each species were listed on the x-axis. Locally available materials, such as leaves and sticks, were used to represent the priority livestock diseases. A progressive scoring approach was employed to establish correlations between the benefits and diseases, with counters added one at a time. Lines were drawn on the ground to create a matrix, demarcating the relationships. This activity was repeated with all 40 groups of informants who participated in the study.

2.3.7 Seasonal Calendar

Seasonal calendars were employed to depict the occurrence of priority livestock diseases throughout a calendar year. Semi-structured interviews were conducted to elucidate the various seasons using the local language in the study area. Objects representing local seasons were positioned on the x-axis, while diseases, written on cards, were placed on the y-axis. Scoring the relationship between seasons and livestock diseases involved using 30 bean seeds as counters. After placing the counters for a specific disease against the corresponding season, participants were given the opportunity to thoroughly review the scores. If desired, they could rearrange the scores until they were satisfied with the results, which were then recorded as the agreed-upon outcomes. This process was repeated for each disease, resulting in the progressive expansion of the matrix.

2.4 Data Management and analysis

Data collected from all villages was entered into an Excel spreadsheet. The data was subsequently summarized and analyzed by consolidating information from different villages to provide a Sub-county perspective.

3. Results

3.1 Common livestock species kept

Livestock species in the Sub-County included cattle, goat, sheep, camel, donkey, and poultry. Table 1 shows their importance to community livelihood. The main livestock were camel, goat, cattle, and sheep, in that order.

Table 1: Livestock ranked based on economic importance.

No.	Livestock species	Gither ward	Dandu ward	Lagsure ward	Didkuro ward	Takaba ward	Mode
1.	Goat	2	2	1	2	2	2
2.	Sheep	4	4	3	4	4	4
3.	Cattle	3	3	2	3	3	3
4.	Donkey	5	5	4	5	6	5
5.	Camel	1	1	1	1	1	1
6.	Poultry	6	6	6	6	5	6

3.2 Common livestock diseases

3.2.1 Simple Ranking

Semi-structured interviews identified common livestock diseases/conditions observed in the last one year. The local names were then identified with their corresponding scientific diseases names using matrix scoring tool, as shown in Table 2:

Table 2: Common livestock diseases in Mandera West-Sub-County.

Species	Local Name	Disease/Condition
Camel	*Lesser/idi*	Plant poisoning
	Baga	Camel Pox
	Qandich	Haemorrhagic septicemia
	Dula	Skin necrosis
	Chito	Mange
	Gorian	Helminthiasis
	Dugut	Camel Pneumonia
	Furi	Camel Flu
	Shimpir	Wry neck
Goat	*Sombes*	Contagious Caprine Pleuropneumonia
	Birte	Plant Poisoning
	Furuq	Sheep and Goat Pox
	Qandol/Qalal	Heartwater
	Furi	Peste des petitis ruminants
	Mini/Gorian	Helminthiasis

	Saldes	Brucellosis
	Kolkole	Ringworm
Cattle	*Hoyale*	Foot and Mouth Disease
	Sombes	Contagious bovine Pleuropneumonia
	Garabgoy	Blackquarter
	Butal	Three-day sickness
	Adda	Plant poisoning
	Tukma	Salmonelosis in calves
	Luta	Trypanosomiasis
	Dadi	Bovine Viral Diarrhea
	Kuskusow	Lymphodenitis
Sheep	*Furi*	Peste des petitis ruminants
	Marjagas	Enterotoxaemia
	Chito	Mange
	Furuq	Sheep and Goat Pox
	Kathidig	Babesiosis
	Qalal	Heartwater
	Gorian	Helminthiasis
	Oyale	Footrot
	Diis	Brucellosis
	Robi	Ringworm

3.2.2 Pairwise ranking

Table 3: Priority livestock diseases in Mandera West Sub-county.

Main species kept	Common diseases	Local Name	Rank
Camel	Camel pox	*Baga*	1
	Trypanosomiasis	*Dukan*	2
	Haemorrhagic septicaemia	*Qandich*	3
	Helminths	*Gorian*	4
	Mange	*Chito*	5
Goats	CCPP	*Sombes ree*	1
	PPR	*Furi*	2
	SGP	*Baga*	3
	Mange	*Chito*	4
	Helminths	*Gorian*	5
Cattle	CBPP	*Sombes*	1
	LSD	*Baga*	2
	BQ	*Garbgoy*	3
	FMD	*Hoyale*	4
	Trypanosomiasis	*Dukan*	5
Sheep	Enterotoxaemia	*Marchaqis*	1
	PPR	*Furi*	2
	Mange	*Chito*	3
	Helminths	*Gorian*	4
	Ringworm	*Robi*	5

Informants in Mandera West Sub-County ranked common livestock diseases based on impact on livelihood, frequency of occurrence, morbidity, and mortality rates.

Pairwise ranking was done for the top five diseases in each species. The overall priority disease was determined

by calculating frequency responses from 40 group discussions. The diseases with the highest mention were sequentially ranked from 1 to 5.

Table 2 shows the pairwise ranking results from the group discussions.

3.2.3 Proportional piling for morbidity and mortality

Based on the impact of diseases on the morbidity and mortality, the results of proportional pilling showed that BQ, Enterotoxaemia, CCPP and Camel Pox had a case fatality (CF) of 69.8%, 55.9%, 45.5% and 37.2% respectively as shown in table 4.

Table 4: Overall livestock disease rate, Mandera West Sub-County.

Species	Disease	Specific Case Morbidity (%)	Specific Case Mortality (%)	Specific Case fatality rate (%)
Camel	Trypanosomiasis	5.3	2.5	36.9
	Helminthiasis	1.7	0.0	2
	Camel pox	5.8	3	37.2
	H.S	0.7	0.2	5.8
	Mange	1.8	0.0	0.0
	Others	2.4	1.1	32.3
Goat	CCPP	27.2	12.4	45.5
	PPR	6.7	3.8	6.5
	SGP	3.6	1.2	33.4
	Mange	5.4	2	14.8
	Helminths	2.3	0.5	10.6
	Others	2.9	1.2	40.7
Cattle	CBPP	5.5	3.7	44.2
	LSD	3.2	1.3	29.3
	BQ	5.4	4.3	69.8
	Trypanosomiasis	1.3	0.6	19
	FMD	4.2	1.2	28.6
	Others	1.9	0.7	28.3
Sheep	PPR	7.7	3.4	37.7
	Enterotoxaemia	8.1	5.3	55.9
	Mange	2.9	0.4	8.7
	Helminths	1.9	0.0	2.5
	Ringworm	1.4	0.3	4.0
	Others	2.5	0.3	11.4

3.2.4 Disease impact matrix scoring (DIMS)

Livestock benefits included milk, meat, cash, transport, Zakat, dowry, and prestige.

The correlation between diseases and benefits was scored.

CCPP had the highest impact on livelihood at 35.4%, followed by PPR (32.8%), CBPP (30.6%), and trypanosomiasis (28.1) in Mandera West Sub-county (Table 3).

Table 5: Estimated Impact of Livestock diseases on livelihood in Mandera West Sub-County.

Species	Disease	Overall Score (%)	Rank
Camel	Trypanosomiasis	28.1	1
	Helminthiasis	27.7	2
	Camel pox	23.3	3
	H.S	16.3	4
	Mange	8.3	5
Goat	CCPP	35.4	1
	PPR	30.2	2
	SGP	17.5	3
	Mange	8.5	4
	Helminths	3.9	5
Cattle	CBPP	30.6	1
	LSD	27.8	2
	BQ	24.2	3
	Trypanosomiasis	17.5	4
	FMD	17.2	5
Sheep	PPR	32.8	1
	Enterotoxaemia	24.9	2
	Mange	15.1	3
	Helminths	13.8	4
	Ringworm	13.0	5

3.2.5 Seasonal calendar

Informants identified four main seasons in a year: Bira (dry season from January to March), Gan (long rain from April to June), Atholes (cold season from July to September), and Agay (short rain from October to December). Trypanosomiasis and mange occur in the dry season, while CBPP, PPR, CCPP are high in the cold season. FMD and SGP occur frequently in long rains, and Camel pox and H.S tend to occur during short rains (Table 5)

Table 6: Seasonal Calendar for livestock diseases in Mandera West Sub-County.

Indicators	Bira (Dry season) Jan- March	Gan (Long rain) April-June	Adholes(Cold season) (July-Sep)	Agay (short rain) (Oct-Dec)
CBPP	1(0,3)	6.5 (0,8)	16.5 (0,20)	4 (0,7)
BQ	2 (0,15)	8 (0,18)	13.5 (0,23)	4.5 (0,13)
FMD	0 (0,2)	11.5 (4,17)	8.5 (3,23)	8.5 (3,14)
CCPP	3(2,3)	9.5 (8,13)	11 (1,13)	7 (4,8)
PPR	3 (1,5)	9 (7,14)	11(4,14)	7 (5,10)
SGP	4 (2,9)	10 (7,13)	8.5 (5,13)	7 (3,10)
Trypanosomiasis	10.5 (0,19)	3 (0,12)	9 (0,12)	3.5 (0,18)
Camel Pox	3.5 (1,6)	8.5 (0,22)	3 (0,23)	9 (1,18)
Enterotoxaemia	6.5 (6,12)	7.5 (5,12)	7 (5,13)	7 (4,8)
LSD	0 (0,5)	8.5 (0,16)	7.5 (0,20)	7 (0,14)
Mange	5 (0,9)	4 (0,8)	8 (0,18)	5 (0,9)
H.S	4.5 (0,12)	9.5 (0,11)	6 (0,14)	10.5 (0,20)

** Values in parenthesis are minimum and maximum median scores*

4. Discussion

This study utilized participatory epidemiological techniques (PE) tool to prioritize common livestock diseases, assess their seasonal occurrence, and evaluate their impact on livelihood in Mandera West Sub-County. PE tools have been widely employed by researchers to investigate animal health- related issues in resource - constrained regions [11]. The main criterion that Mandera West community used to determine the importance of livestock kept was the effect they had on their livelihoods. To some extent, they also considered resilience of livestock species to drought. The order of ranking was camel, goat, cattle, sheep, donkey and poultry. This pattern was repeated in all the Wards in Mandera West Sub-county except for Lagsure where goat surpassed camel. This preference for camels and goats can be attributed to the diverse resources they provide, such as milk, meat, and hides. Sheep, on the other hand, were less common and offered fewer economic benefits, which diminished their standing in the community's evaluation. Poultry was not historically raised by the Somali community in this region. Our findings indicated that camels were most highly ranked livestock species in Mandera West Sub-county. The preference can be attributed to their resilience against drought, disease resistance and high productivity in terms of milk and meat, and nutritional value. These results align with the findings of [12], who reported that camels exhibit prolonged and superior milk production of high nutritional quality compared to other species, despite the challenging environmental conditions characterized by extreme temperatures ,drought and limited pasture availability.

The study identified endemic diseases and conditions experienced by the communities in the Sub-county. Livestock owners later ordered these diseases using pairwise ranking with subsequent selection of five common diseases that were taken through participatory epidemiology methods. The criteria used by the community to determine the relative importance of these diseases were impact on community livelihood, frequency of occurrence of the disease in a population, mortality and morbidly rate. The five priority livestock diseases in Mandera West were Camel Pox, Contagious Caprine Pleuropneumonia (CCPP), Peste des Petits Ruminants (PPR), Contagious Bovine Pleuropneumonia (CBPP), and Enterotoxaemia. The pastoral community in Mandera West Sub-county demonstrated a profound understanding of livestock diseases, utilizing a diagnostic framework that considers factors like the season, vector presence, and the targeted animal species. This study's findings are consistent with prior research, highlighting the common occurrence of livestock diseases such as foot-and-mouth disease, tick-borne diseases, Peste des Petits Ruminants (PPR), and Contagious Caprine Pleuropneumonia (CCPP) within pastoral areas [13].

Keeping livestock offers numerous benefits, including the provision of essential resources such as milk, meat, and cash income. Livestock also hold cultural significance by contributing to practices like dowries and zakat (charitable giving). These positive outcomes are consistent with previous research findings [14]. However, Disease Matrix Scoring (DIMS) results have revealed that the presence of diseases, particularly contagious Caprine pleuropneumonia (CCPP), peste des petits ruminants (PPR), contagious bovine pleuropneumonia (CBPP), and trypanosomiasis, poses a significant threat to the livelihoods of livestock owners in Mandera West Sub-county. These findings are in line with previous research findings [11] , which emphasized that livestock diseases and drought pose a continuous threat to the livelihoods of pastoral communities. These diseases have broad-ranging adverse effects on animal products, resulting in reduced milk production, decreased meat quality,

devaluation of livestock, financial losses, and restricted market access. To address these challenges, the implementation of effective disease control and management strategies is crucial. Vaccination programs, adoption of biosecurity measures, and regular disease surveillance play pivotal roles in minimizing the impacts of these diseases. To ensure the long-term effectiveness and viability of disease control efforts within pastoral settings, it is imperative to carefully incorporate the cultural norms, livelihood strategies, and ecological dynamics of these communities into the planning and implementation of such initiatives [15].

Seasonality of livestock diseases and risk factors was determined in the Sub-county by creating seasonal calendars with the community. Seasonal calendars help in planning together with the community on the appropriate time to prevent and control diseases. The informants identified four main seasons that occur throughout the year: Bira (dry season from January to March), Gan (long rain from April to June), Atholes (cold season from July to September), and Agay (short rain from October to December). Each season has specific characteristics that influence the prevalence and transmission of livestock diseases. The outlook of the Sub-county revealed that Trypanosomiasis and mange tend to occur during the dry season (Bira). During this period, animals congregate around watering points and grazing areas, creating favorable conditions for the transmission of these diseases. Most diseases occurred in Gan and Adholes because of the cold weather. Migration of livestock and increase in vector population was widespread during Gan and Adholes aggravating disease outbreaks. These findings are in line with a study conducted by [16]. Pastoralists are well aware of livestock diseases and appropriate control strategies in their context thus should be included in disease control strategies [17].The study limitation is the variability in farmers' perspectives when defining the most critical diseases in their area. This variability can originate from differences in how farmers perceive disease significance, with some prioritizing diseases based on their persistent impact on herds and others focusing on economic losses, particularly for diseases with high treatment costs and fatal consequences. This subjectivity can introduce potential bias into the prioritization process, potentially affecting the accuracy of disease rankings. Additionally, the study's timing coincided with the occurrence of certain diseases, which may have inflated their perceived importance in the community, potentially influencing the disease prioritization results. Finally, the utilization of Focus Group Discussions (FGD) encountered resistance from some farmers due to time constraints, which could have limited the diversity of perspectives gathered during the study. These limitations should be taken into account when interpreting the study's findings and their practical implications for livestock health management in the region.

5. Conclusion

The participatory epidemiological tool employed in this study successfully identified the prevailing livestock diseases in Mandera West Sub-County. Through the active involvement of the pastoral community, diseases such as Camel Pox, Contagious Caprine Pleuropneumonia (CCPP), Peste des Petits Ruminants (PPR), Contagious Bovine Pleuropneumonia (CBPP), and Enterotoxaemia were classified as priority diseases in the study area. These diseases, which are endemic to the region, can be effectively prevented and managed through vaccination, treatment, and vector control measures. Temporal analysis revealed that the occurrence of most diseases was concentrated during the rainy season and cold season. The cold weather and the increased migration of livestock during these periods contribute to the higher prevalence of diseases. These findings are

likely representative of other sub-counties within Mandera County where pastoralism is practiced, indicating the broader relevance of the study's results.

Based on these findings, the results serve as a valuable foundation for the development of comprehensive prevention and control strategies for the identified priority diseases. By leveraging this information, policymakers, veterinary authorities, and stakeholders can plan and implement targeted interventions to mitigate the impact of these diseases on livestock health and the livelihoods of the pastoral communities. Ultimately, these efforts will contribute to improved disease management and the overall sustainability of livestock production in the region.

6.Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] D. M. Nyariki and D. A. Amwata, “The value of pastoralism in Kenya: Application of total economic value approach,” *Pastoralism*, vol. 9, no. 1, Dec. 2019, doi: 10.1186/s13570-019-0144-x.

[2] E. O. Omollo, O. V. Wasonga, M. Y. Elhadi, and W. N. Mnene, “Determinants of pastoral and agro-pastoral households’ participation in fodder production in Makueni and Kajiado Counties, Kenya,” *Pastoralism*, vol. 8, no. 1, Dec. 2018, doi: 10.1186/s13570-018-0113-9.

[3] J. Omiti and P. Irungu, “INSTITUTIONAL AND POLICY ISSUES RELEVANT TO PASTORAL DEVELOPMENT IN KENYA,” 2002.

[4] MoALF, “Kenya County Climate Risk Profile Series Highlights Climate Risk Profile Mandera County,” 2017, [Online]. Available: https://www.standardmedia.co.ke/article/2000223147/government-to-use-sh600-million-to-buy-livestock-from-mandera-pastoralists

[5] E. A. Clemmons, K. J. Alfson, and J. W. Dutton, “Transboundary animal diseases, an overview of 17 diseases with potential for global spread and serious consequences,” *Animals*, vol. 11, no. 7, Jul. 2021, doi: 10.3390/ani11072039.

[6] T. F. Randolph *et al.*, “Invited Review: Role of livestock in human nutrition and health for poverty

reduction in developing countries," in *Journal of Animal Science*, Nov. 2007, pp. 2788–2800. doi: 10.2527/jas.2007-0467.

[7] C. Byaruhanga, M. C. Oosthuizen, N. E. Collins, and D. Knobel, "Using participatory epidemiology to investigate management options and relative importance of tick-borne diseases amongst transhumant zebu cattle in Karamoja Region, Uganda," *Prev. Vet. Med.*, vol. 122, no. 3, pp. 287–297, 2015, doi: 10.1016/j.prevetmed.2015.10.011.

[8] R. G. Alders *et al.*, "Participatory Epidemiology: Principles, Practice, Utility, and Lessons Learnt," *Frontiers in Veterinary Science*, vol. 7. Frontiers Media S.A., Nov. 04, 2020. doi: 10.3389/fvets.2020.532763.

[9] *2019 Kenya Population and Housing Census: Volume II i*, vol. II. 2019.

[10] A. Catley, B. Admassu, G. Bekele, and D. Abebe, "Livestock mortality in pastoralist herds in Ethiopia and implications for drought response," vol. 38, no. 3, pp. 500–516, 2014.

[11] D. Nthiwa, "A participatory epidemiological study of major cattle diseases amongst Maasai pastoralists living in wildlife-livestock interfaces in Maasai Mara , Kenya," pp. 1097–1103, 2019.

[12] A. Abrhaley and S. Leta, "Medicinal value of camel milk and meat," vol. 2119, 2018, doi: 10.1080/09712119.2017.1357562.

[13] M. H. Abdilatif, J. O. Onono, and F. K. Mutua, "Analysis of pastoralists' perception on challenges and opportunities for sheep and goat production in Northern Kenya," *Trop. Anim. Health Prod.*, vol. 50, no. 7, pp. 1701–1710, 2018, doi: 10.1007/s11250-018-1613-8.

[14] T. Jibat, B. Admassu, T. Rufael, M. P. O. Baumann, and C. J. Pötzsch, "Impacts of foot-and-mouth disease on livelihoods in the Borena Plateau of Ethiopia," pp. 1–11, 2013.

[15] B. Perry and D. Grace, "The impacts of livestock diseases and their control on growth and development processes that are pro-poor," *Philos. Trans. R. Soc. B Biol. Sci.*, vol. 364, no. 1530, pp. 2643–2655, 2009, doi: 10.1098/rstb.2009.0097.

[16] P. Krishnamoorthy, G. Govindaraj, B. Shome, and H. Rahman, "Spatio-Temporal Epidemiological Analysis of Livestock Diseases - A Case of Tamil Nadu State in India," *Int. J. Livest. Res.*, vol. 6, no. 8, p. 27, 2016, doi: 10.5455/ijlr.20160804055652.

[17] S. W. Kairu-Wanyoike *et al.*, "Control of contagious bovine pleuropneumonia: Knowledge, attitudes, perceptions and practices in Narok district of Kenya," *Prev. Vet. Med.*, vol. 115, no. 3–4, pp. 143–156, 2014, doi: 10.1016/j.prevetmed.2014.03.029.