Levels and Predictors of Mortalities in Cattle Beef in Kenyan Rangelands: Kaplan–Meier Method Approach

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ABSTRACT

High health-related mortality has frequently been reported as the major impediment to cattle production. This article aims at investigating the vital infectious diseases and non-infectious factors that account for the majority of deaths, which is crucial in determining mortality control strategies. The study applies the Kaplan–Meier method in estimation mortality rate and truncated regression analysis to illuminate the influencing factors using eight-year retrospective data spanning from 2014 to 2022. The results indicate infectious diseases as the most important cause of cattle mortality. The mean annual mortality rates are higher and the pre-weaning cattle mortality appeared to be one of the major constraints hampering the development of replacement herds. The risk factors considered for high mortality were the age and sex of the calves. The infectious diseases identified as the important predictors of cattle mortality included bacterial, parasitic, and non-specific, while the non-infectious conditions included malnutrition, predation, shock, and traumatic injuries. The analysis provided an improved insight into animal-health-related factors, which once addressed could reduce mortality and hence optimize animal husbandry performance. Interventions in cattle health, and husbandry are recommended to control pre-weaning calve mortality. A comprehensive approaches integrating animal health with other aspects of cattle farming, such as proper feeding for a holistic and sustainable system is recommended.

Keywords: Kaplan–Meier method, truncated model, infectious diseases, non-infectious disease, mortality rate, Cattle, Kenya

INTRODUCTION

The livestock sector in Kenya is a major economic driver, contributing significantly to the national gross domestic product (GDP) and supporting the livelihoods of millions. It contributes approximately 12% to the national GDP and 42% to the agricultural GDP, and employs nearly half of the agricultural labor force (Farmer and Mbwika 2016). The sector is also a crucial source of food and income for many Kenyans, especially in the Arid and Semi-Arid Lands (ASALs). However, the sector faces significant challenges despite its substantial contribution to the economy and livelihoods, particularly in ASALs regions. These challenges include low productivity, disease outbreaks, climate change impacts, inadequate infrastructure, and limited investment. Despite these challenges, the sector remains vital for food security, income generation, and employment for many Kenyans.

In Kenya, cattle, goats, sheep, and camels are important livestock animals. Cattle are culturally the main important breed to the communities living in the ASALs of Kenya. The main cattle breeds kept in the rangelands are the Zebu and Boran, which together contribute to a national market supply of 70% of the total beef meat production (Huho, 2011; GoK, 2012). However, desirable results are yet to be observed in cattle production, and this can partly be attributed to the problems of herd health and adaptability which somewhat associated to the persistent exposure to multiple stresses of low quality and quantity feed, heat stress, high disease, and parasitic incidences, poor husbandry and breeding practices (Njarui et al., 2011; Ngila et al., 2016). The combined effect of these factors is high cattle mortality. However, high health-related mortality forms the major impediment to cattle production (Interbull, 2015). Since the dynamic of an animal population results from the balance between mortality and replacement, an appropriate understanding of mortality patterns is one of the keys to cattle genetic evaluation for the reason of fundamental goals, and this forms the premise of this study.

Retrospective studies addressing the causes of death in cattle in Kenya are scarcely making it hard in decision-making for control strategies. Neither assumption made in the previous studies under similar terrain (Perrin et al., 2012; Rumor et al., 2015; Struchen et al., 2015; Molossi et al., 2021; Credille, 2022) can be expected to hold in the more tropical regions of Kenyan rangelands, where cattle are routinely subjected to long periods of nutritional stress and high disease incidences. Therefore, there is a need to document the causes of these mortalities and put in place measures to control deaths, since cattle form a considerable prospective opportunity for smallholder farming and income generation and may contribute significantly to poverty alleviation, food and nutrition security for communities living in ASALs of Kenya. Consequently, this study proposed an econometric relationship that specifically address this gap of information by estimating the cattle mortality rates as well as identifying the infectious and non-infectious factors associated with mortality, which would be a target for determining mortality mitigation strategies.

Livestock Disease Theories

The causes and consequences of livestock diseases, whether infectious or non-infectious, are understood through epidemiological principles centered on the interaction of the host, agent, and environment**. T**hese principles form the basis of modern animal health theories, guiding the identification, management, and prevention of diseases. Livestock disease theories explain how diseases originate, spread, and affect livestock production. They encompass various factors including pathogens, environmental influences and animal health management practices. Understanding these theories is critical for designing an effective disease prevention, control, and treatment programmes. However, the scope of this study is limited to the etiology theories with specify the infectious and non-infectious factors that causes mortality in cattle production with special reference to arid and range lands of Kenya.

The primary theory explaining livestock infectious diseases is the germ theory, which posits that diseases caused by microorganisms like bacteria, viruses, and other pathogens. This theory was developed and refined by scientists like Pasteur, Koch, and Lister in the late 19th and early 20th centuries (Pasteur, 1996, Fredericks and Relman, 1996; Michaleas, 2022). The germ theory was also reinforced by the epidemiological triad theory (John and Kompithra 2023), which consider the interaction between the pathogen, the host, and the environment. Recently, modern theories have integrated insights from microbiological, ecological, immunological, and genetic factors to explain the diverse clinical presentations of infectious diseases (e.g Schmid-Hempel, 2021). The distinct commonality of these theories is that infectious disease is one produced by living organisms and that ability of an organism to cause disease in a host as its virulence or pathogenicity. The infectious diseases common in ASALs of Kenya are viral such as Foot and Mouth Disease (FMD) affecting cattle, pigs, and other ruminants, causing blisters on the mouth and feet, and Bovine Viral Diarrhea affecting cattle, causing diarrhea, fever, and respiratory problems. Bacterial diseases such as brucellosis that affect cattle, sheep, goats, and other livestock, causing abortions and reproductive problems and anthrax affecting cattle, sheep, goats, and other livestock, causing fever, swellings, and bleeding. Parasitic diseases such as East Coast Fever (Theileriosis) that affect cattle, causing fever, anemia, and wasting and Liver Fluke that affect ruminants, causing liver damage and blood loss.

Non-Infectious Diseases (NIDs), (also known as chronic diseases), are complex and multifactorial, meaning they are influenced by a mixture of genetic, physiological, environmental, and behavioral factors. Theories that attempt to explain the causes and development of NIDs, can be traced back to the "pathological convergence theory" and the "germ-organ theory" (Byndloss and Bäumler, 2018; Padrón-Monedero, 2023). The Germ-Organ theory suggests that the gut microbiome acts as a crucial organ influencing host health and disease, particularly non-communicable diseases whereas Pathological Convergence theory postulate that many NIDs share common pathways, particularly inflammation and oxidative stress, and that these pathways are influenced by the same risk factors. These diseases can affect various systems like the digestive, reproductive, or musculoskeletal systems. The NIDs can be categorized as those causing metabolic disorder (hypocalcemia – milk fever), nutritional disorder (white muscle, rickets, gout), toxicities (plant poisoning), gastrointestinal disorder (bloat), dystocia and heat stress.

MATERIALS AND METHODS

Study Areas and Animals

The longitudinal study was conducted at the Arid and Range Lands Research Institute, Kiboko, that lies between latitude 2° 10' and 2° South and longitude 37° 40' and 37° 55' East. The institute's mandates include generation of livestock related research, adapting, and up-scaling scientific research innovations, information, and knowledge geared towards sustainably managing the livelihoods of communities living in the arid and semi-arid lands of Kenya. Climatically, ASALs of Kenya are characterized by low, unreliable, and poorly distributed rainfall. They are in agro-climatic zones IV-VII and have an average rainfall ranging from 300-800mm per year, which is not ideal for arable agriculture but suitable for livestock production (Parry et al. 2012). The area receives a bimodal rainfall pattern, and the vegetation is mainly bushed grassland with scattered acacia and commiphora trees. The study animals comprises of Small East African Zebu and Boran crosses which were collected and in the entire ASALs region Kenya for breeding through selection.

The ASALs cover nearly 80% of the country's landmass and hold majorly of the national livestock herd and, therefore, deemed representative of many livestock production zones in Kenya (Elmi and Birch 2013).

Data collection

A retrospective longitudinal approach was used in extracting mortality data from the cattle registry. This register compiles information on cattle herds (identification number, sex, age, date of death/birth, and autopsy findings conducted by a qualified veterinary surgeon. The records were initially entered on paper by animal health technicians on daily basis and later digitized to the excel sheet for storage and further analysis. The study used this database to categorize the daily number of live and dead cattle between the years 2014 and 2022.

Infectious factors were categorized as bacterial (pneumonia, enteritis, septicemia/toxemia, enterotoxaemia, scours, anemia, CBPP, metritis, pyometra, sinusitis, myocarditis, etc.), parasitic (haemonchosis, ECF and haemonchus, anaplasmosis, babesiosis, , trypanosomosis), Rickettsial diseases (heartwater/cowdriosis) and other conditions (such as bloat, calculi, uremia, hardware disease, hepatitis, senescence, percadisise, trauma and viral conditions like rabies), and non-specified disease causes. Non-infectious causes included shock (hypothermic and cardiogenic), traumatic injuries, predation, plant poisoning, malnutrition, dystocia, premature birth (abortions and stillbirth), and postnatal/congenital defects. The sample comprises a multidimensional data of 120 observation points, with minimal outliers which were omitted during analysis and exploration of various infectious and non-infectious factors and their interactions simultaneously.

Data analysis

Data analysis was twofold; using the Kaplan-Meier method and econometric model approach employing STATA 2015 statistical software. Under the Kaplan-Meier method, the study involved computing the probabilities of cattle mortality at a certain point in time using the widely and commonly used Kaplan-Meier nonparametric method (Kaplan and Meier, 1958; Adelöf, et al., 2021). This Kaplan-Meier nonparametric method is recommended especially when dealing with incomplete observations or censored data and is commonly used for analyzing survival times, disease progression, and other events. Recent research highlights its widely application in understanding calf mortality, dairy cow survival, and identifying predictors of death in specific regions. For instance, Alemu, et al. (2022) used Kaplan-Meier analysis to assess the cumulative incidence and identify predictors of calf morbidity and mortality from birth to 6 months of age in urban and peri-urban dairy farms of Northwest Ethiopia providing valuable insights into the impact of different factors on survival. Similar study by Grzesiak, et al. (2022) employed the same method to estimate the survival of 347,939 Holstein-Friesian dairy cows between 2017 and 2018 in Poland, particularly in their first three lactations, and identified the reasons for culling. Other researchers such as D'Arrigo, et al. (2021) applied Kaplan-Meier curves to visualize the time-to-event of death (mortality) in different groups of cattle, allowing them to identify potential predictors of mortality based on various characteristic. The synthesized literature suggests that the Kaplan-Meier method, still remains a powerful statistical tool for analyzing survival data and for this reason it is applied in in this study to investigates the determinants and predators for cattle mortality at any particular period (C_p), specified as;

$$C_p = \frac{Number\ of\ cattle\ living\ at\ the\ start + Birth - Number\ of\ cattle\ that\ died}{Number\ of\ cattle\ living\ at\ the\ start + Birth}, \quad (1)$$

Since the herd size is dynamic and usually births are experienced at any time, this means that any births become a part of the study later. In some cases, there is often a shorter observation period and those cattle may or may not experience death in that short stipulated time. However, we cannot exclude those cattle since otherwise; the sample size of the study may become small. The Kaplan-Meier method allows us to compute survival over time despite such difficulties associated with situations (Goel et al., 2010; Grzesiak et al., 2022). The total probability of survival till that time period was calculated by multiplying all the probabilities of survival at all-time intervals preceding that time (by applying the law of multiplication of probability to calculate cumulative probability) (Kaplan and Meier,1958; Grzesiak et al., 2022). Then, the probability of cattle dying (cumulative mortality) is 1 (one) minus the probability of cattle survival (cumulative survival). Cattle who have been sold out are not counted as “at risk”, hence are considered “censored” and are not counted in the denominator.

$$\text{Annual mortality} = \frac{Deaths}{Total\ heard\ at\ start + births}, \quad (2)$$

The second phase of analysis involved the determination of the effect in terms of direction and magnitude; the various causes have on cattle mortality. Since econometric models offer estimates of actual values for forecasted variables and indicate both the direction and magnitude of change, then it was found appropriate to determine the effect of infectious and non-infectious factors on cattle mortality for uncensored data. In this paper, the outcome measure of interest was mortality, defined as any death of a study animal occurring during the period of observation and attributed to an infectious and non-infectious disease cause. The independent variables included infectious factors being the parasitic bacterial, rickettsial diseases and other conditions, and non-infectious factors categorized as shock, traumatic injury, predation, plant poisoning, malnutrition, dystocia, premature birth, congenital/postnatal defects, and non-specified causes. Truncated regression of the normal distribution was employed to identify risk factors for cattle mortality. This model type was selected because sample truncation is a pervasive issue in quantitative animal sciences, particularly when using observational data (Abot 2020; Ouédraogo et al., 2022). Its primary advantage over a censored model (such as a Tobit model, which the users likely refers to as a "consensor") is its ability to provide accurate and unbiased estimates for the original, underlying population in this specific scenario. Truncation reduces the variance compared with the variance in the untruncated (Heckman, 1979; Dongfang et al., 2017). A truncated regression is one in which the values of the explanatory variables are observed only if the value of the dependent variable is observed and, thus following Greene (2010) and Reinhammar (2019), a truncated regression (at zero) was specified as;

$$y_i = X_i'\beta + \varepsilon_i, i = 1, \ldots, n\ ; \varepsilon_i \sim iidN\ (0, \sigma^2), \quad (3)$$

Where y_i and x_i are observed number of livestock death and risk factors causing mortality respectively, the truncated form below for $y_i > 0$. The factors related to infectious and non-infectious diseases were considered independent variables (x_i) and livestock death as a dependent variable (y_i). Term ε_i is the random error associated with random shocks, not under the control of economic agent *i,* and in this case capture weather changes or any economic adversity. The X-vector parameter estimate for mortality level ($\hat{y}_i$), is expected to have a positive sign, which implies the corresponding variable would increase the level of cattle mortality rate. The analyses were carried out using the maximum likelihood estimation (MLE) procedure. The use of the MLE technique makes sense because the error terms nested on these equations are assumed to follow a certain distribution, and our goal is to obtain the "most likely" estimate rather than one which minimizes the sum of squares as is the case with ordinary least squares.

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RESULTS AND DISCUSSIONS

Kaplan–Meier estimates

The Kaplan–Meier versus the commonly used method of estimation mortality are displayed in Table 1. Looking at Table 1, the cattle production cycle was taken as eight-year-round of twelve intervals, conforming to the times of death of the 339 cattle. The year-round average number of cattle was about 399, while a total of 876 cattle exited the herd through death or sale. Based on the Kaplan–Meier functions, the cumulative survival decline could be observed and this translates to an increase in the cumulative mortality for the entire period of about 50.2% against the reported 66.2% when the common method of annual mortality estimation is used. However, the average all-cause mortality rate estimated using the common method was 0.0735 (7.35%) per 100 animal risk years. The proportion surviving of cattle per year seems to be relatively high and ranges from 0.848 (84.8%) to 0.976 (97.6%). Comparable survival probability for cows culled for different reasons was observed in Grzesiak et al. (2022) study.

Table 1. Kaplan-Meier estimate for cattle

					Kaplan-Meier method			**Annual mortality***
Years	**Total Herd**	**Births**	**Sale**	**Deaths**	**Probability surviving on this day (p)**	**Cumulative survival ($p * p_{t-1}$)**	**Cumulative mortality (CM)**	
2014	462	70	1	51	0.9044	0.9041	0.0959	0.0959
2015	541	50	14	24	0.9594	0.8674	0.1326	0.0406
2016	552	105	103	84	0.8721	0.7565	0.2435	0.1279
2017	468	65	133	81	0.8481	0.6415	0.3585	0.1521
2018	321	53	67	9	0.9759	0.6261	0.3739	0.0241
2019	298	75	37	22	0.9411	0.5892	0.4108	0.0591
2020	305	81	50	17	0.9551	0.5632	0.4368	0.0441
2021	323	108	2	33	0.9234	0.5201	0.4799	0.0766
2022	386	39	70	18	0.9576	0.4981	0.5019	0.0424
Cumulative		**646**	**477**	**339**				**0.6623**

Note: CM = 1-cumulative survival; *Annual motility computed using the common method

Source: Authors' construction

Age-specific mortality rate

The statistical analysis of mortality rates recorded in cattle production between 2014 and 2022 was skewed and showed a clear influence of age and sex as shown in Table 2. A higher mortality rate was reported in the young ones (calves and weaners). Early mortality for calve during the first six-month of their lifetime accounted for 30% of the total mortalities and was particularly high in female calves.

The percentage proportion for the calve-to-weaning contributed to the highest mortality (about 55.1%). Similar

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high mortality of about 67% for calves within a week of their birth with the cause of death most frequently recorded as unspecific was reported by Bunter et al. (2013). However, there was no significant difference in the number of deaths after one year of cattle life up to about 5 years. The high mortality of calve during the first one year reported in the present study means the ranch cannot raise enough stock to replace the loss, let alone expand the herds, and, therefore, more attention to calve management is a critical concern. This is because a reduction in calves' mortality would translate into an increase in herd size and consequently the increase in male and culled offtake.

Overall, the result shows high female mortality which is also inversely related to age. Since the herd composition differed somewhat between the sexes (with more females being maintained for herd expansion while males are frequently selected for offtake), the high female mortality rates could thus reflect these differences. The low mortality observed in males might also be because the males are regularly culled upon attaining one year of age to keep the limited number of males for breeding purposes. A similar result was observed in the Mlimbe et al. (2020) study.

Table 2: Mortality prevalence by age categories

Age category	PP of the Total	Male (%)	Female (%)
Calve (≤6 months)	30.0381	45.5696	54.4304
Weaners (7 to 12 months)	25.0951	45.4546	54.5455
Heifers/bulls (1 to 2 years)	9.5057	72	28
Mature (2 to 3 years)	9.5057	68	32
Mature (3 to 5 years)	8.3651	72.7278	27.2727
Mature (5 to 8 years)	15.5894	97.5609	2.4391
Mature (8 years and above)	1.9011	80	20
Total proportion (in %)	100	38.7833	61.2167

Note: PP implies a percentage proportion

Source: Authors' construction

Econometric estimation of the Causes of Livestock Mortality

To investigate the direction and magnitude of the various infectious and non-infectious factors that cause cattle mortality, the truncated model was fitted. The truncated regression analyses examined all possible interactions among variables with death as the dependent variable (Table 3). The estimates of sigma square (σ^2) are significantly different from zero at a 1% level of significance, implying a good fit of the specified distribution assumptions of the error term and the Wald Chi-square value showed that statistical tests are highly significant (P < 0.000), suggesting that the model had strong explanatory power.

Regarding the various covariant variables included in the model, the results as indicated in Table 3 are robust and all assumed the expected positive sign. The disease-related factors were identified as the major cause of mortality in the cattle production of the study area. In the present study, the magnitude of cattle mortality attributed to diseases is 0.996 which is statistically significant (at a 1% level), and the contribution to the overall mortality is about 65%. The high risk associated with diseases indicates that the most important area of intervention in reducing cattle mortality should be health management.

Among the non-infectious conditions associated with cattle mortality, malnutrition tops the list followed by shock and predation. This finding concurred with that of Fentie (2016), who found malnutrition (which was presented as a feed shortage) as one of the major problems causing mortality in young stock across all species. Accordingly, the high disease-related mortality rate observed can be aggravated by the effect of malnutrition in terms of feed and milk shortages that could compromise the immunity of young ones and expose them to diseases. Exposure to predators and plant poisoning, and traumatic injuries that can be categorized as non-infectious condition had a relatively higher marginal effect on cattle mortality. Similar to Fentie's (2016) findings, the contribution of predators (hyena, cheetah, etc.) and injury (physical damage) in herds where young and adult animals share the same barns were reported as important causes of mortality.

Table 3. Predictors for cattle mortality and percentage contribution (proportion)

Variable	**Coeff.**	**Percent proportion**	**Ranking**
_cons	-0.00344 (0.0277)	-	-
Diseases	0.9965*** (0.0063)	64.7273	1
Dystocia	0.9831*** (0.0873)	0.7273	6
Premature birth	1.0016*** (0.03795)	2.9091	4
Postnatal defects	0.47057** (0.2331)	0.3636	7
Shock	1.00697*** (0.02439)	3.2727	3
Malnutrition	1.0475*** (0.01476)	20.3636	2
Injury	0.9543*** (0.0455)	2.1818	5
Predation	0.9815*** (0.0366)	3.2727	3
Plant poisoning	1.0139*** (0.0543)	2.1818	5
/sigma	0.1192*** (0.0111)	-	-
Wald chi2(9)	135324.28***	-	-

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Log-likelihood	41.0796	-	-
Notes: ***, **, * ==> Significance at 1%, 5%, 10% level Sources: Authors' construction			

Having confirmed that disease-related syndromes were the main cause of mortality, an attempt was made to identify which particular disease conditions proportionally contribute to cattle mortality. The results of this analysis are displayed in Table 4. The results show that bacteria majorly represented by pneumonia, enteritis, septicemia, enterotoxaemia, and calve scours were noted as the dominant disease problem of cattle, followed by parasitic related diseases mainly represented by anaplasmosis, ECF, babesiosis, and trypanosomosis. The percentage proportion mortality as a result of bacteria was 73% and 35% was related to parasite problems. Bacteria dominate motility due perhaps to its evolutionary advantage it provides for survival and adaptation in diverse and often nutrient-scarce environments. The bacteria to survive harsh conditions such the once experienced in ASAL of Kenya is a result of unique adaptations, manifested by forming resilient spores and having high metabolic versatility. Similarly, Parasites thrive in specific environmental conditions, with ASAL environments presenting unique factors that influence parasite transmission and prevalence. This observation concurred with an in-depth study by Kocho (2007) where parasites related conditions were also significant at P>0.05 across the different sites of Southern Ethiopia which indicate that it is a major cross-cutting impediment to the livestock production in the region, although role of parasitic diseases as causes of mortality in cattle in a high potential area of central Kenya cannot be undermined (Kanyari and Kagira, 2000). It is therefore challenging to the Veterinary Department of Kenya to examine the service delivery systems and other factors that may contribute to the persistent presence of these fatal bacterial and parasitic conditions to cattle health. In southern Brazil, infectious and/or parasitic diseases (60%) and toxic and toxicoinfectious diseases (25%) most commonly cause beef cattle deaths (Molossi et al., 2021). The same study observed other specific issues like hemoprotozoal infections, rabies, and plant intoxications from Senecio spp. and Pteridium arachnoideum as significant contributors to cattle mortality.

Rickettsia infections in cattle are generally transmitted by ticks, mites, fleas, or lice, and can cause various diseases Among the rickettsia infections majorly represented by heartwater (or cowdrosis) diseases investigated also had relatively contribution to cattle mortality which means its effects should not be underestimated but rather reduced to the bare minimum. Heartwater has been reported throughout sub-Saharan Africa (Uilenberg, 1983) and in Mozambique; Asselbergs et al. (1993) observed that the disease does occur throughout the country and mainly during the rainy season. Control strategy that reduce tick populations through acaricides (tick-killing chemicals) and other measures is crucial for preventing rickettsial infections in cattle.

In veterinary medicine terms, "non-specific" refer to something that is not clearly related to a single, definitive cause or diagnosis. It can describe a symptom, finding, or condition where multiple possibilities exist for its origin and further investigation is needed to determine the exact cause. The results in Table 4 indicates a relatively high contribution of this parameter to cattle mortality which means that the finding, while not specific to one particular cause, is still important enough to warrant further investigation. For this reason, animal health provider will need to consider a broader range of possible causes for the finding, rather than just focusing on one specific diagnosis.

Table 4: The main disease that causes cattle mortality

Variables	**Cases**	**Proportion**	**Rank**
Parasitic	35	19.663	3
Bacteria	73	41.011	1
Rickettsia diseases	26	14.607	4

Other diseases	6	3.371	5
Non specific	38	21.348	2
	178	100	
Sources: Authors' construction			

CONCLUSION AND RECOMMENDATION

This study has investigated levels and predictors of mortality in cattle production with an aim of identifying the main causes of death and the risk factors associated with infectious and non-infectious diseases. The all-cause mortality rate was estimated at 7.35% per 100 animal risk years with an annual cumulative mortality of 50%. The mortality contribution to infectious diseases was estimated at 65%. This study has also indicated that mortality in calves is likely to be above 54%. The risk factors considered for high mortality were the age and sex of the calves. The pre-weaning mortality of cattle appeared to be one of the major constraints hampering the development of replacement stock. The critical time for higher cattle mortality was during the first six months of life-extending up to 12 months of age. Therefore, for an efficient cattle production system, the survival of the female calve is required for herd expansion and breed improvement, while that of the male calves is important as a source of income from sales; so the mortality against pre-weaning, in general, should be reduced to the bare minimum.

Regarding infectious and non-infectious conditions influencing mortality, an econometric model was fitted and disease and malnutrition appeared to be the most important causes of cattle mortality. Infectious diseases in cattle are a major concern due to their potential to impact animal health, productivity, and even human health. The model displayed that, bacterial diseases, parasitic conditions, and non-specific diseases were the most common challenges of raising cattle in the rangelands of Kenya. Overall, infectious diseases contribute to high mortalities in cattle production and can pose and zoonotic risks. However, excellent early nutrition and management can control many of the health problems of cattle. Modest interventions, for example, minimizing herd loss through disease control and protection against predators and proper feeding to curb the effect of malnutrition could potentially boost to the flock's performance. The study recommend that veterinary service needs to provide comprehensive strategic disease prevention, control, and treatment measures. Future studies should investigate the effects of farm management practices and other contextual variables such as season patterns, nutritional and pasture variability on cattle mortality, which together with the insight provided by this study will help in constructing a conceptual comprehensive stock-and-flow model of a representative production system for Kenya rangelands.

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