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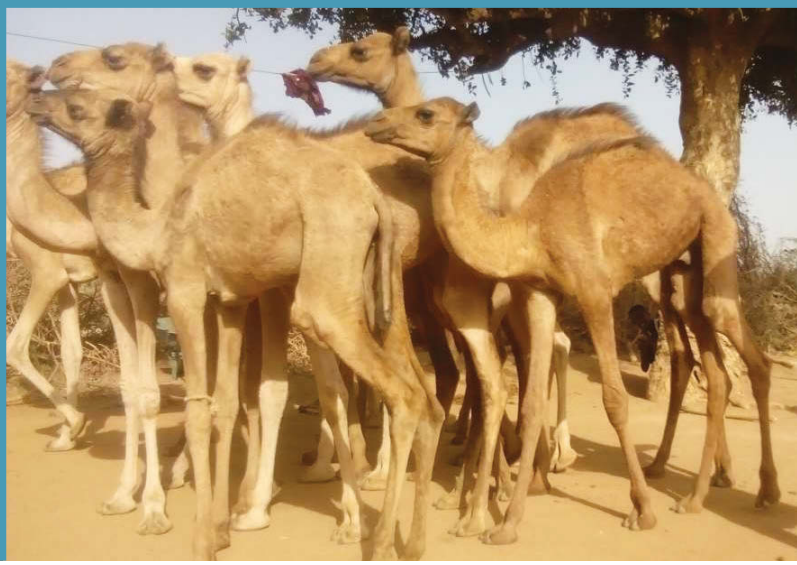

Feed the Future – Research Award

ASSESSMENT OF YOUNG STOCK MORTALITY IN MAJOR LIVESTOCK PRODUCTION SYSTEMS OF ETHIOPIA

February 2016

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Agricultural Knowledge, Learning, Documentation and Policy Project (AKLDP-Ethiopia)

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February 2016

Tsegaw Fentie
University of Gondar
Revised Research Report

RESEARCH TEAM
Lead researcher:
Dr. Tsegaw Fentie, University of Gondar

Collaborating researchers:
1. Dr. Wudu Temesgen, University of Gondar
2. Dr. Achenef Melaku, University of Gondar
3. Mr. Getachew Assefa, University of Gondar
4. Dr. Shimelis Tesfaye, University of Gondar
5. Dr. Feyissa Fufa, Jimma University
6. Mr. Zemene Adane, Jimma University
7. Dr. Ayalew Niguse, Jigjiga University
8. Mr. Bosenu Alemu, Jigjiga University
9. Dr. Fikre Zeru Wahild, Samara University
10. Dr. Birhanu Hailu, Samara University
11. Dr. Sentayehu Guta, National Animal Health Diagnostic and Investigation Center
12. Dr. Gebreyes Mekonen, Bahir Dar Regional Vet Laboratory

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EXECUTIVE SUMMARY

Livestock in Ethiopia has been recognized as one of the most important sectors in subsistence agriculture in the quest to attain human food security and good welfare. Though the country has the largest inventory of livestock in the continent, production is severely affected for various reasons. A single visit survey was undertaken in July and August 2015 with the purpose of determining the annual mortality during June 2014 to June 2015 and investigating the major causes of young stock mortality under different livestock production settings. The study was undertaken in herds from mixed crop-livestock (n = 747), pastoral (n = 452), and peri-urban and urban dairy (n = 332) production systems. One-year retrospective data were collected from livestock owners by interview using semi-structured questionnaires and direct observation of farm practices. Participatory investigation techniques were applied to identify and prioritize causes of young stock mortality. In mixed crop-livestock production systems, mean annual mortality (birth-to-weaning) was reported in the range of 9.2–14% in calves, 14.9–33.5% in lambs, and 17.6–24% in kids. The pre-parturient loss in terms of abortion and stillbirth was 3.0–8.7% in cattle, 7.5–8% in lambs, and 9.3–14.4% in kids. The annual calf mortality in the urban and peri-urban dairy production system was reported in the range of 15.3–25%. The premature loss in terms of stillbirth was 6.2–14.4%. In the pastoral production system, the annual birth-to-weaning mortality of young stock was reported in the range of 26–29.2% in cattle, 32.5–35% in camel calves, and 35–36% in lambs and kids. The premature death (abortion and stillbirth) was 17.4–21.2% in cattle, 23.4–48.8% in camels, and 25–41% in small ruminants. Age-specific mortality across the production systems declined with increased age, and the highest mortality was recorded during the first month of life extending up to the third month of age. Regardless of the production system, disease and malnutrition were the most important causes of mortality in young stock. Among the diseases, diarrhea and respiratory disorders were important causes of young stock mortality. Malpractices in young stock management were identified, including restricted colostrum and milk feeding, poor care and supplemental feeding, and poor health management. Livestock keepers appeared to be aware of the challenges of young stock, but seemed to have inadequate knowledge to deal with the challenges. Interventions in health and husbandry are recommended to control young stock mortality.

1. INTRODUCTION

Livestock is an integral part of agriculture in Ethiopia, and its contribution to the economy accounts for about 19% of GDP and 20% of export earnings (Behnke and Metaferia, 2011). The livestock sector is pertinent to sustainable food security and poverty reduction in the country. About 85–90% of mixed crop-livestock farmers, and 21.6 million agropastoralists and pastoralists, depend on livestock as a major economic activity for their livelihoods (NABC, 2010). The contribution of the livestock sector to the livelihoods of producers in particular and to the national economy in general can be explained in terms of food production, supply of inputs and services for crop production, raw material for agro-industry, cash income and export earning, savings and investment, and its role as a generator of employment (Behnke and Metaferia, 2011). Moreover, the livestock sector supports and sustains enterprises and groups linked and associated with the livestock value chains, such as the livestock traders, transporters, slaughter processors, feed manufacturers, and veterinary drug suppliers (Negassa et al., 2011; Aleme and Lemma, 2015).

Ethiopia has the largest livestock inventories in Africa, estimated at 53.99 million cattle, 25.5 million sheep, 24.1 million goats, 9.01 million equines, 0.92 million camels, and 50.4 million poultry (CSA, 2013). Despite the large number of livestock, productivity in general is low in the country, mainly due to the low genetic quality of local breeds, poor nutrition, and animal health problems. Similar to low-income African countries, per capita consumption of food from a livestock origin is low, mainly due to uncontrolled animal diseases, poor husbandry, and poor infrastructure (Ayele et al., 2003; Negassa et al., 2011).

The livestock is characterized by high mortality. The annual direct losses from ruminant mortality are generally estimated at about 8–10% of the cattle herd, 14–16% of the sheep flock, and 11–13% of the goat flock. Young stock mortalities constitute the larger share of constraints to herd expansion and genetic improvement. The few studies in Africa, including Ethiopia, in young stock morbidity and mortality indicate high calf, lamb, and kid mortalities both in the subsistence and market-oriented production systems. Studies of calf mortality on smallholder farms indicate pre-weaning and early post-weaning mortality rates in the range of 15% to 25%. In some African countries, for instance in Tanzania, calf mortality rates range from 9% to 45%

(Chenyambuga and Mseleko 2009; Changa et al., 2010), and in Mali the range is 10% to 25%

(Wymann et al., 2006). In Sudan, 4.9% mortality was reported in dairy farms in Khartoum

(Abdullatief et al., 2014). In Ethiopia, a 30% pre-weaning calf mortality rate was reported in mixed crop-livestock production systems in Amhara Region (Ferede et al., 2015) and an 18% mortality rate was found in market-oriented dairy farms in Central Ethiopia (Wudu et al., 2008). Neonatal calf mortality is the most important constraint in young stock and accounted for 8.7 to 84% of the total mortality (Inamdar, 2012).

Camels in Ethiopia contribute significantly to the livelihood of the pastoralists and agropastoralists living in low-rainfall environments. Camel husbandry is a profitable venture for utilizing the vast arid and semiarid areas of the country where other animals thrive with difficulty, especially due to the recurring drought conditions. Reports indicate that young camel calf mortality up to eight months of age is common due to malnutrition and diseases (Keskes et al., 2013).

One of the most important production factors that adversely affect small ruminant production is high pre-weaning mortality of young lambs and kids. Studies indicate that up to 50% of the lambs born can die, mainly due to diseases and other causes such as adaptation failure, dystocia, cold stress, starvation, and mis-mothering (Hinch et al., 1986; Tibbo, 2006). High-level neonatal lamb mortalities (46.3% on-station and 51.5% on-farm) were reported in the Ethiopian highlands (Bekele et al., 1992) and 46.8% pre-weaning kid mortality and 30.3% neonatal kid mortality up to one month of age in the Rift valley of Ethiopia (Petros et al., 2014). Factors such as the type of birth, sex and birth weight of lamb/kid, parity order and season of lambing/kidding, and age of the lamb/kid affect the mortality rate (Hailu et al., 2006).

Both infectious and non-infectious causes contributed to the morbidity and mortality of young stock. Young animal diseases that cause morbidity and mortality are the results of the complex interaction of the management practices, the environment, infectious agents, and the animal itself. Mortality of neonates of ruminants was mainly attributed to conditions like diarrhea and pneumonia associated with poor housing, hygiene, and nutrition (Lema et al., 2001). Different management and environmental factors such as colostral feeding, housing, calving assistance, production system, herd size, season, and hygiene of micro-environment were reported to affect significantly calf morbidity and mortality. It is estimated that 20% calf mortality resulted in a 38% reduction in the profit of a livestock farm (Shiferaw et al., 2002).

Proper nutrition is fundamental for the growth of young animals and for the general profitability of livestock-rearing enterprises. A good nutritional strategy in young stock optimizes the development and growth while minimizing stress and disease. Experience indicates that young animal losses can be significantly reduced by introducing new techniques of management, including proper feeding and nutrition, housing, and hygiene (Razzaque et al., 2009). Furthermore, herd replacement can be attained by improved management strategies that can reduce stillbirth and pre-weaned mortalities. Improved management strategies can increase the number of replacement stock in the herd from 15% to over 35%, and will allow farmers to increase their herd sizes (Inamdar, 2012).

The current Ethiopian livestock breeding policy emphasizes upgrading the genetic makeup of the local stock through crossing with high-grade exotic breeds of cattle, sheep, goats, and poultry. As a result, the proportion of crossbred young stock is gradually increasing in the smallholder farms, mainly in the highlands of the country, suggesting a susceptible population that will need improved health and proper management. One of the major health and management intervention areas recently proposed in the Livestock Development Master Plan is aimed at reducing young and adult stock mortality (MoA, 2014).

Efficient production and limited losses are important for the livestock producers to realize benefits from their livestock resource. In order to minimize losses, the causes of animal morbidity and mortality and the associated risk factors need to be identified and appropriate control measures implemented. A fuller understanding of the causes of young stock losses and mortality patterns will help in: identifying major management problems and hence areas for improvement; guiding further research efforts; and guiding policy makers and extension personnel to the important management and control problems in diverse production systems. Appropriate intervention to address these problems requires identification of major causes and estimating the level of young stock mortality, about which information is scarce in the country. This assessment was undertaken with the interests of the livestock ministry to generate information on young stock mortality for designing and implementing control strategies.

1.1 Aim and Objectives of the Project

The overall aim of this study was to investigate the major causes and degrees of young stock mortality hampering the potential productivity of livestock managed by smallholder producers and identify the management risk factors associated with stock mortality in different livestock production systems of the country. The research output aimed to fill the knowledge gaps pertaining to causes of young stock mortality and facilitate the development of effective control measures applicable in major livestock production systems of the country. Subsequent mitigation of those constraints could improve production and reproductive performance, with significant contribution to food security.

The specific objectives of the study were to:

- Quantify the level of mortality of young stock in different ruminant species and livestock production systems
- Determine the causes of young stock mortality in the major livestock production systems
- Assess the young stock management practices and knowledge gaps of livestock producers
- Identify potential animal- and management-related risk factors associated with young stock mortality.

2. STUDY METHODOLOGY

2.1 Study Area

This study was conducted on smallholder farms and pastoralist herds in selected livestock production systems of Ethiopia. Three major livestock production systems were considered in this study: the mixed crop-livestock system, the dominant production system that prevailed in the central highland parts of the country; the pastoral production system, which is practiced in the arid and semi-arid peripheral parts of the country; and the market-oriented dairy production system, which is a small but growing component of the sector found mainly in urban and peri-urban parts of the country. In the highlands of mixed production systems and agropastoralist areas, small-scale commercialization processes are underway, and so within a given area there can be a mix of subsistence livestock keepers and more market-orientated producers.

The study regions representing the major production systems were selected in consultation with livestock health extension expert team in the Ministry of Livestock and Fisheries Resources (MoLFR). In the mixed crop-livestock production system, four districts from Amhara Region, comprising both moisture-surplus and -deficit districts with unreliable moisture, and four districts from Western Oromia Region, including districts prone to tsetse fly and trypanosomiasis, were included in the study.

The western part of Amhara Region is considered a moisture-surplus area with mean annual rainfall ranging from 850–1,600 mm, while the eastern Amhara subregion included some districts in South Gondar, North and South Wollo, and Waghemra as moisture-deficit areas with mean annual rainfall ranging from 500–900 mm. The rainfall is usually unpredictable in distribution, affecting crop production and feed availability for livestock. For this study, four districts, Dembia (North Gondar), Sekela (West Gojjam) from the moisture-surplus area and Lasta (North Wollo) and Simada (South Gondar) from the moisture-deficit area were included in the study.

In Oromia Region, the study was conducted in four districts with surplus moisture; namely Chora Botor and Shebe Sombo of Jimma Zone and Didessa and Dabo Hana Districts of Illubabor Zone. Part of the districts in these zones is found within the tsetse belt. Study districts in Jimma Zone, Shebe Sombo and Chora Botor, include the Gojeb and Gibe river valleys, respectively. Didessa and Dabo Hana Districts of Illubabor Zone include the Didessa valley, which is usually inhabited by tsetse flies.

In the pastoral production system, the study was conducted in two selected districts of Afar and four districts of Somali Region. Pastoral livestock production is

Figure 1. Study sites.

the dominant land use in the arid and semi-arid areas of Ethiopia and provides a livelihood to millions of pastoralists. The arid lands of Ethiopia experience frequently recurring droughts that have significant effect on livestock and livelihoods of pastoral communities. This study was conducted in Afar and Somali pastoral districts during a drought year. The feed and water shortage was severe starting in March 2015 until the end of the study period in August 2015.

In the market-oriented urban and peri-urban dairy production system, a calf mortality study was conducted in milk sheds of Addis Ababa and surrounding districts of Oromia (i.e., Sebeta, Sululta, Holleta, Bishoftu, and Sendafa towns), and Amhara Regions (Chacha, Debre Birhan, and Bahir Dar).

Animal husbandry in the crop-livestock production system is characterized by a smallholder extensive management system. Cattle and sheep are the predominant animal species kept integrated with crop production. The pastoral production system of Afar and Somali Regions is characterized by seasonal mobility of livestock in the search for pasture and water. Cattle are the dominant animal species followed by goats, camels, and sheep. The market-oriented dairy production system is mainly located in urban and peri-urban areas of Addis Ababa, Oromia, and Amhara Regions. Dairy cattle of improved breeds are the dominant animals kept by smallholder and medium-scale farmers targeted mainly for milk production.

2.2 Study Design

A single visit survey (cross-sectional) was designed and employed during July and August 2015 in herds of cattle, camel, sheep, and goats. This was intended to collect a retrospective one-year data set (July 2014 to June 2015) of young stock mortality. The research utilized both conventional survey methods and participatory epidemiological tools and principles of data collection and interpretation. Animal owners, both men and women, participated in the identification of causes and assessment of young stock mortality and related constraints having negative impact on the productivity of livestock. In addition to information provision on problems, the local people were also involved in problem analysis, generation of ideas for control measures, and showed readiness to take part in control measures and in influencing the policy makers.

Young stock in the context of this study was defined as birth-to-weaning age; that is, up to one year of age for cattle, up to eight months for camel, and up to six months of age for sheep and goats. The study population was stratified by the major production systems: mixed crop-livestock, pastoral/agropastoral, and market-oriented urban and peri-urban dairy production.

2.3 Sample Size and Sampling Strategy

Sample size was determined for each production system considering each a separate population taking the highest possible variability of 50% in the response of farmers with regard to young stock death, 95% level of confidence, and 0.05 desired precision. The relevant sample size formula provided by Dohoo et al. (2009) was used:

$$n = \frac{Z_{\alpha^2} * pq}{L^2}$$

Where n = sample size, Z_α = the value of standard normal distribution for a chosen confidence level, p = expected proportion, q = 1– p, and L = the required absolute precision of the estimate. Accordingly, a sample of 384 farms/herds was determined for each system. The study population was stratified by production system. Attempts were made to select four representative districts judgmentally from Amhara and Oromia Regions and two from pastoral and agropastoral areas of Afar and Somali Regions. Five villages per district and fifteen herds per village were studied (see Table 1).

Both large and small ruminants in selected household farms/pastoral herds were taken as the sampling unit. The study *kebeles*/villages were selected randomly by constructing a list of villages in selected study districts, but with some restrictions on the selection imposed based on accessibility to villages by vehicle or proximity to road and distribution of study animal population. For the participatory study, two focus group discussions involving key informants of male and female farm or herd owners were conducted per village, with some restrictions in pastoral districts. In some villages, pastoral informants were inaccessible due to movements with their animals, and therefore few FGDs were conducted.

Table 1. Structure of farm selection in study livestock production system

Production System	Region	Districts	No. of villages	No. farms/ herds	No. of focus groups/FGD
Mixed crop-livestock farming	Amhara	Dembia (N. Gondar)	5	75	10
		Sekella (W. Gojam)	5	75	10
		Lasta (N. Wollo)	5	75	10
		Simada (S. Gondar)	5	75	10
	Oromia	Chora Botor and Shebe Sombo (Jimma Zone)	10	150	20
		Didessa and Dabo Hana (Illubabor Zone)	10	150	20
Pastoral and agropastoral	Somali	Gursum, Shinle, Dire Dawa, and Afdem	10	150	20
	Afar	Abe'ala, Ayssaita	10	150	20
Market-oriented dairy production	A. Ababa	Addis Ababa	-	110	-
	Oromia	Sebeta, Holeta, Sendafa, Sululta, and Bishoftu	-	110	-
	Amhara	Chacha, Debre Berhan, and Bahir Dar	-	110	-

2.3 Questionnaire Survey and Participatory Investigations

Quantitative and qualitative data regarding young stock mortality were generated through the questionnaire survey, farm/herd visits, and key informant discussions. Questionnaire formats and checklists were developed and standardized by experts. Training on data collection methods was given to experts involved in the field study. A semi-structured questionnaire was used to collect data on herd and individual animal reproductive performances and the fate of offspring born during the study year.

2.3.1 Young stock mortality

Young stock in the context of this study are young animals from birth-to-weaning age: up to 12 months of age for cattle, up to 8 months for camels, and up to 6 months of age for sheep and goats. One-year retrospective data (from July 1, 2014 to June 30, 2015) on young stock mortality experiences were collected from selected farmers/ pastoralists in the major production systems in order to determine the mortality rates. A semi-structured questionnaire format was developed, tested, and used to gather data. Each participant farmer/pastoralist was asked about the births and deaths (including abortions and stillbirths) of young stock in the preceding year (from July 2014 to June 2015). In addition to birth and death events, other relevant information related to causes of death, farm animal management practices, disease occurrences, and disease prevention and control practices was collected for each individual newborn: calves, lambs, and kids in all the production areas and camel calves in pastoral and agropastoral areas of Afar and Somali Regions.

2.3.2 Identification and prioritization of causes of young stock mortality

In addition to the questionnaire survey, a participatory investigation of young stock mortality was also carried out in focus group discussions using participatory tools and principles. Focus group discussions of key informants (5–10 informants/group) were used to identify and prioritize causes of mortality in young stock. Key informants selected were men or women herd owners with good herding experience who had rich indigenous knowledge related to animal husbandry and health care. Participants were selected purposively in consultation with local administrators and livestock development agents for focus group discussion to elicit and rank causes of mortality in young animals. The participatory investigation was undertaken with smallholder farmers and pastoral herders in mixed crop-livestock and pastoral production systems, respectively, to complement the questionnaire study. Proportional piling and pair-wise ranking techniques were employed to gather information.

Thus, information about causes of young stock mortality, prevailing diseases, management practices, veterinary services, and traditional knowledge and practices was collected. Important diseases with local vernacular names were listed and characterized for possible translation into veterinary terms or English names. The findings of

participatory discussions were compared with field observations/farm visits, and the validity of information was assessed.

2.3.3 Assessing young stock management practices

Along with the mortality inventory, young stock management practices of farmers were assessed by interviewing owners. The standard young stock management was used to assess the farmers' knowledge and practices. Farm visits were made to about 25% of participant farmers in all production systems, during which observational assessment of young stock management was performed. The farm visit involved recording young stock's health condition and management practices by clinical and body condition examination of animals and by observing feeding and housing conditions. A checklist of parameters for evaluation of young animal health and management status was completed by the investigators during observation.

2.4 Data Management and Analysis

Data were stored in Excel® spreadsheets. After initial validation of data and simple descriptive analyses, data were transferred to a statistical package, Stata (SE for Windows, version 12.0, Stata Corp, College Station, TX). Mean crude and specific annual mortalities were presented with 95% confidence intervals. For statistical inference, a regression approach was used, to compare means (linear regressions) and proportions (logistic regression) across predictor factors such as farm management practices.

2.4.1 Describing young stock mortality

2.4.1.1 Identifying causes of young stock mortality

Causes of young stock mortality (as described by the individual farmer/pastoralist interviewee) were compiled and percentage contribution (proportion) of each cause for young stock mortality was calculated and presented by species. The information collected from the questionnaire was complemented by focus group discussions and was used to list and rank the causes based on syndromes. Data from participatory investigations were presented as median ranks with range.

2.4.1.2 Estimating young stock mortality

Mean annual birth-to-weaning young stock mortality was determined for each species of livestock by dividing the number of deaths of young stock in the study for one year by the number of live births within that particular study year (number of deaths divided by live births). The overall annual mortality was calculated by dividing the total pre-parturient and birth-to-weaning deaths by expected births. Pre-parturient mortality in terms of abortion and stillbirth during the same study year was also calculated (number of abortions and stillbirths divided by expected births (number of abortions and stillbirths + live births)). Mean annual mortality was calculated at aggregated level with 95% confidence intervals assuming that the study population was normally distributed, sample size was large enough, and outliers were minimal and, if any, were omitted from the analysis.

Pre-parturient loss and birth-to-weaning mortality was calculated for different age groups for all species and production systems as:

- **Abortion and stillbirth:** refers to expulsion of dead fetus immediately before parturition or death during parturition
- **Perinatal mortality:** refers to death of live-born animals within 48 hours of life
- **Neonatal morality:** refers to deaths of newborn animals between 48 hours and 1 month of age
- **Early pre-weaning mortality:** refers to death of young stock within 1–3 months of age
- **Late pre-weaning mortality:** refers to death of young stock within 3–12 months of age in cattle and camel calves, from 3–6 months of age in lambs and kids.

2.4.2 Analyzing effects of management-related factors associated with young stock mortality

A multivariate logistic analysis was performed in order to identify the predictor variables associated with early young stock mortality. The logistic regression analyses examined all possible interactions among variables and death as the outcome variable. The end results of the analyses were final models including all variables (risk factors) significantly associated with early mortality. The models were described in terms of odds ratios, with 95% confidence intervals.

3. RESULTS

3.1 Young Stock Mortality in Mixed Crop-livestock Production System

3.1.1 Young stock mortality in Amhara Region

3.1.1.1 Herd structure and size

The study was undertaken in smallholder farms (n = 422) of Amhara Region consisting of 2,116 heads of cattle, 1,831 sheep, and 918 goats. The mean herd size of ruminants in the region was 5.3 (95% CI: 5.0–6.0) for cattle, 5.6 (95% CI: 5.3–6.0) for sheep, and 6.9 (95% CI: 6.1–7.6) for goats. Among the study farmer households, 14% (n = 61) keep both large and small ruminants, while 13.5% (n = 57) raise only cattle. There is more tendency of raising female breeding cattle (with a proportion of 47.2%) and male adults (27.4%) for milk production and draught power for cultivation of land for crop production, respectively. The proportion of young calves of pre-weaning age (<1 year) was 25.5%. In Amhara Region, the mean weaning age for calves was 10 months (with the range of 8–12 months), and 4.5 months (2–7months) for lambs and kids, which showed wide calving and lambing intervals in the herds.

All ruminant species in the study area were predominantly local indigenous types raised as integrated subsistence agriculture under an extensive management system. For 85% of the study farmers, livestock stands as the second source of family income and means of livelihood next to crop production. However, farmers said that herd size per household is declining owing to mortalities at an early age and scarce animal feed resources as a result of shrinkage of grazing lands.

3.1.1.2 Estimates of young stock mortality

The analysis of young stock mortality for the different species and age groups of ruminants from the questionnaire study is summarized in Table 2. The overall pre-parturient mortality in terms of stillbirth and post-parturient (birth-to-weaning) mortality showed significant variation among species, the highest being in small ruminants. Higher premature loss in terms of stillbirth was reported in goats, almost twofold compared to sheep and cattle. Farmers associated stillbirths with disease condition in dams and plant toxicity, particularly in goats. The mortality variation between moisture-surplus and -deficit districts was not statistically significant.

Mortality was inversely related with age and declined with increased age of animals across all species. High mortality was reported in neonates in the first one month of age in all species but dropped in the subsequent pre-weaning life. Of the total pre-weaning loss, mortality among live born up to one month of age was 44.6% for calves and 51% for lambs and kids.

3.1.1.3 Causes of young stock mortality

The causes of mortality in calves, lambs, and kids and their relative contribution to the mortalities based on the questionnaire study are presented in Table 3. Various causes were responsible for the mortality of newborn animals, both in large and small ruminants in the study districts of Amhara Region. Animal disease was the major problem causing mortality across all the species. The disease-related mortality was between 4–19.5% and accounted for 50–75% of the total mortality. Next to disease, malnutrition and poor mothering instinct (unable to support for suckling) were identified as important causes of loss.

Table 2. Mean annual mortality of young stock and distribution by age category in Amhara Region, 2014 to 2015

Age category	Calf mortality (%) (95% CI)	Lamb mortality (%) (95% CI)	Kid mortality (%) (95% CI)
Abortion and stillbirth	3.0 (1.4, 4.6)	8.0 (5.4, 10.6)	14.4 (7.2, 21.5)
Perinatal (<48 hrs.)	0.6 (0.2, 1.8)	1.0 (0.5, 1.9)	1.8 (0.8, 3.8)
Neonatal (48 hrs.–1 month)	3.5 (2.2, 5.5)	6.7 (5.2, 8.5)	10.3 (7.5, 14.1)
Early pre-weaning (1–3 months)	1.8 (1, 3.5)	3.8 (2.6, 5.1)	5.0 (3.2, 7.9)
Late pre-weaning (>3 months)	3.0 (1.9, 5.0)	3.0 (2.0, 4.3)	6.2 (4.1, 9.3)
Mean annual birth-to-weaning mortality*	9.2 (6.6, 11.9)	14.9 (12.2, 17.7)	24.0 (19.2, 28.7)
Overall annual mortality**	11.9 (9.1, 14.8)	21.7 (18.6, 24.8)	35.5 (29.8, 41.1)

* Mean birth-to-weaning mortality calculated related to total number of born live (calf = 488, lamb = 882, kid = 335)

** Overall mean mortality calculated related to total number of born live + stillborn (calf = 503, lamb = 959, kid = 392)

Mortality in young animals born weak at birth and small in size and that needed help with suckling was reported in calves, lambs, and kids. In small ruminants, predators like hyenas, cheetahs, and jackals/wolves were incriminated as important causes of loss in some study districts. Unknown reasons of mortality were reported at an early age in lambs and kids; farm owners were not able to remember or describe properly the cause of death.

Based on the individual interviews, an attempt was made to identify disease conditions that were observed in each morbid young animal prior to death. In most cases, farm owners were able to recognize and describe syndromes of diseases responsible for mortality of young animals as presented in Table 4. Diarrhea was the most frequently reported syndrome of disease that caused newborn mortality, especially in the first month of age. The contribution of diarrhea was wide in range, from 32.4% in calves to 61% in kids. All farmers appreciated the challenges, but many of them lack the knowledge and misconceived occurrence of diarrhea in neonates as excess consumption of colostrum. This is especially more common in the case of calves because of meconium coming out, and for this reason they deny suckling of calves with the first colostrum by fully or partially milking the first colostrum. Obviously this practice could have negative effects on the passive transfer of immunity and compromise the health status and growth of newborns at an early age.

Respiratory disorder, described by farmers as difficult breathing, coughing, and nasal discharge, was the second-most important disease syndrome recorded in the first three months, both in large and small ruminants. The contribution to mortality was between 15% and 26%. Sheep and goat poxes and mange mite infestations were recognized as important skin problems in lambs and kids. The large proportion reported as non-specific syndromes were cases of anorexia, shivering, depression, emaciation, and dehydration of young animals.

Table 3. Relative importance of causes of young stock mortality and cause-specific mortality in Amhara Region, 2014 to 2015

Cause of mortality	Relative contribution of each cause (%)[a]			Cause-specific mortality (%)[b]		
	Calves	Lambs	Kids	Calves	Lambs	Kids
Disease	75.6	50.4	50.6	7.0	19.5	4.6
Malnutrition	8.9	23.7	23.5	0.8	9.2	2.1
Poor mothering	11.1	6.9	0.0	1.0	2.7	0.0
Weak at birth	4.4	3.1	2.5	0.4	1.2	0.2
Predation	0	9.9	16.0	0.0	3.8	1.4
Unknown reason	0	6.1	7.4	0.0	2.4	0.7

[a] Each cause expressed as number of deaths due to the specific cause relative to the total number of deaths: calf (n = 45), lamb (n = 131), and kid (n = 81)

[b] Cause-specific mortality relative to the number of live born: calf (n = 487), lamb (n = 338), and kid (n = 898)

Table 4. Disease syndromes related to young stock mortality in Amhara Region

Disease /syndrome	Calf proportion (%)	Lamb proportion (%)	Kids proportion (%)
Diarrhea	32.4	33.3	61.0
Respiratory problem	14.7	25.8	19.5
Bloat	8.8	0.0	0.0
Navel ill	5.9	0.0	0.0
Skin diseases (pox, mange)	0.0	13.6	7.3
Non-specific syndromes	38.2	75.8	12.2

No. of deaths observed: calf (n = 34), lamb (n = 66), kid (n = 41)

3.1.1.4 Effect of farm management practices on young stock mortality

In the study districts of Amhara Region, the dam and offspring management practices of farmers were assessed through individual farmer interviews and farm visits. A significant proportion of the livestock owners separated dams for a few days immediately before and after parturition (see Table 5). This practice could to some extent contribute to a hygienic environment and minimize injuries that cause loss of young stock. In this study, the protective effect of the maternal facility on mortality of goat kids was statistically significant, but was not significant in cattle and lambs. High mortality of kids was reported on farms that did not use separate maternal facilities.

The effect of birth time on mortality of young stock was assessed, because all farmers in the study region attempt to assist difficult births. As presented in Table 6, the mortality was relatively lower in births in the daytime in cattle and goats compared to those births at night. However, the effect of time of parturition on mortality was statistically significant only in goats. During the daytime, the possibility of assisting difficult births and giving care to newborns would be optimal, which might contribute to the low risk of newborn deaths.

Farmers' colostrum feeding practice in newborn calves, lambs, and kids was assessed. Livestock owners provide considerable care to newborn animals during and after birth. Small proportions of respondent farmers (36%) were well aware of the importance of colostrum and allow free suckling of calves, while a large proportion of respondents (64%) restricted feeding, particularly of calves. They deny newborns the ability to suckle the first colostrum, and they milk the first colostrum, partially or fully thinking that it causes illnesses like diarrhea and alopecia and/or death of calves at an early age.

Almost all interviewed herd owners in the study districts of Amhara Region allowed calves to start suckling before six hours and even allow free milk suckling for about 1–4 weeks. Residual suckling is the main method of calf feeding commonly practiced twice per day. In the case of small ruminants, suckling of milk is free. As presented in Table 7, mortality of young stock was relatively lower in those farms that practiced free colostrum feeding on the first day. However, the mortality rate difference among farms that practiced partial colostrum feeding and those that allowed free suckling was not statistically significant across all species of ruminants. Navel treatment or disinfection was not practiced by smallholder farmers in the Amhara Region.

Table 5. Effect of maternal facility on young stock mortality in Amhara Region

Species	Maternal facility	Mortality rate (%) (95% CI)	Odds ratio (95% CI)	P-value
Cattle	Calving pen	9.5 (5.1, 17.0)	1.0	
	Same barn	9.1 (5.7, 14.1)	0.64 (0.33, 1.25)	0.188
Sheep	Lambing pen	10.3 (4.1, 23.8)	1.0	
	Same barn	17.4 (13.0, 23.0)	0.86 (0.47, 1.57)	0.619
Goat	Kidding pen	11.1 (3.1, 32.8)	1.0	
	Same barn	46.2 (36.5, 56.3)	3.5 (1.3, 8.5)	0.030

Observations: cattle (n = 282), sheep (n = 263), goat (n = 111).

Table 6. Effect of birth time on young stock mortality in Amhara Region

Young stock category	Birth time	Mortality rate (%)	Odds ratio (95%CI)	P-value
Calves	Day	9.2 (4.2, 14.2)	1.0	
	Night	10.8 (6.6, 15.0)	1.7 (0.8, 1.7)	0.208
Lambs	Day	17.4 (13.1, 21.8)	1.0	
	Night	14.6 (3.30, 25.9)	1.1 (0.4, 2.8)	0.821
Kids	Day	18.1 (12.1, 24.2)	1.0	
	Night	14.3 (10.2, 22.4)	0.9 (0.2, 1.4)	0.322

Observations: calf (n = 384), kid (n = 216), lamb (n = 160)

Table 7. Effect of colostrum feeding practice on young stock mortality in Amhara Region

Young stock category	1st day colostrum feeding	Mortality rate (%)	Odds ratio (95% CI)	P-value
Calves	Allow full suckling	10.0 (5.5, 17.4)	1.0	
	Restricted suckling	12.5 (8.7, 18.1)	1.14 (0.55, 2.35)	0.734
Lambs	Allow full suckling	13.8 (8.3, 22.2)	1.0	
	Restricted suckling	22.4 (17.4, 28.3)	1.12 (0.60, 2.07)	0.619
Kids	Allow full suckling	21.3 (13.6, 31.9)	1.0	
	Restricted suckling	32.5 (20.1, 48.0)	1.4 (0.6, 3.0)	0.430

Observations: calf (n = 297), kid (n = 115), lamb (n = 317)

3.1.1.5 Participatory investigation of causes of young stock mortality

In addition to the questionnaire survey, focus group discussions (FGD) of key informant herd owners were conducted for identification and prioritization of causes of young stock mortality using participatory tools. Twenty focus group discussions (one group per study village) were undertaken in Amhara Region. Health- and management-related causes of mortality of young animals were raised by species and prioritized according to their importance.

Local vernacular names of diseases and syndromes were used by key informants and then translated to the possible common English name or scientific name by consulting with the district animal health professionals.

The median rank for causes of mortality presented in Table 8 showed that diseases such as blackleg, anthrax, and lumpy skin disease (LSD) and disease syndromes like pneumonia, calf diarrhea, and bloody urine (possibly babesiosis) were among the major problems causing calf mortality in Amhara Region.

Table 8. Median rank for causes of young stock mortality in Amhara Region (FGD = 20)

Vernacular name	Common disease/syndrome name	Median rank (range)
Calves		
Kortim, worch wogi	Blackleg	1 (1–3)
Kurba	Anthrax	2 (1–2)
Mitch	Pneumonia	2 (1–4)
Yelam geta/Guribrib	Lumpy skin disease	2 (1–4)
Tekmat/Madadat	Diarrhea/Diarrhea	3 (1–5)
Yedem shint	Bloody urine	3 (1–4)
Berer/Kulkult	Fascioliasis	3.5 (2–4)
Aftegir/Afemaz	Foot-and-mouth disease	4 (3–6)
Kimajir	Lice and ticks	4 (2–7)
Lambs		
Tergib/Enqit	Respiratory problem/ Pneumonia	1 (1–2)
Tekmat/Madadat	Diarrhea	2 (1–4)
Fentata	Sheep pox	3 (1–5)
Berer/Kulkulit	Bottle jaw/Fascioliasis	3 (2–5)
Dafint/Girdosh	Infectious keratoconjunctivitis/Blindness	3 (2–5)
Mujele	Foot rot	4 (3–6)
Kids		
Kukni/Deremen	Mange	1 (1–2)
Kurba/Hintit	Anthrax	1 (1–3)
Menti	Plant toxicity (Cyanides)	2 (2–4)
Azurit	Gid/C. cerebralis	2.5 (1–5)
Kitign, Afemendil	Orf	3 (2–4)

Respiratory disorders (pneumonia), perhaps caused by infections with Pasteurellosis and lung worms, and diarrhea were the major syndromes identified as causes of morbidity and mortality of lambs. Diseases such as sheep pox and ovine fascioliasis were found to be causes of mortality in lambs. In kids, mange and anthrax were more important diseases causing mortality. Plant toxicity and central nervous system signs such as gid (probably due to a parasitic cyst, *Cenurous cerebralis*) were among others identified.

3.1.2 Young stock mortality in Oromia Region

3.1.2.1 Herd structure and size

In the study districts of Oromia Region, 325 smallholder farmers were involved in the study. The farms of these study participants consisted of a total of 4,236 heads of cattle, 1,550 goats, and 676 sheep. The mean herd size for large and small ruminants in this study region was 9.25 (95% CI = 8.4–10.1), 5.5 (6.3–8.8), and 9.5 (6.3–12.7) for cattle, goat, and sheep, respectively. Similar to that of the Amhara Region, the breeding females in Oromia Region consists of 47.6% of the herd, and 31.3% of the heard was adult oxen and bulls commonly used for draught purposes. The proportion of young stock in the herd was only about 21%, indicating the small size of replacement stock. Mean weaning age was 9 months (6–12 months) for calves and 4.5 months (2–7 months) for small ruminants. About 88% (n = 287) of study herd owners reported livestock as the second-most important business for labor employment, income generation, and means of livelihood.

3.1.2.2 Estimates of young stock mortality

The mean annual mortality of young stock in the different species of ruminants in Oromia Region is documented by age group in Table 9. The young stock mortality reported in Oromia Region was relatively higher than in Amhara Region in calves and lambs. However, mortality difference between the two regions was statistically significant only in lambs, with higher mortality in Oromia Region.

Similar to the findings in Amhara Region, the mortality in newborn animals declined with increased age. Higher mortality was reported from early life up to one month of age and decreased with increased age of calves, lambs, and kids. Significantly higher mortality was reported in lambs compared to others. Of the total mortality in live born animals, the mortality during the first one month of age was 48.6% in calves and 52.8% in lambs and kids. The annual pre-parturient mortality in terms of abortion and stillbirth and the birth-to-weaning mortalities were significantly higher in calves and lambs in Oromia Region compared to Amhara Region.

3.1.2.3 Causes of young stock mortality

As per the individual interviews, owners reported various causes of young stock mortality in their herds of large and small ruminants in the study districts of Oromia Region (Table 10). Disease was the major problem causing mortality in all studied species of animals. Malnutrition as a result of insufficient milk (for calves dependent on residual suckling) and the seasonal shortage of feed during dry periods were reported as the second-most important problem in calves and lambs. Animals mainly depend on grazing, and provision of supplementary feed to young animals is very limited.

Poor mothering (in terms of denied suckling and poor milk yield) was also identified as an important contributor to mortality in calves and lambs. In the case of kids, the contribution of predators (wolf/fox, cheetah) and accidents (physical damage) in herds where young and adult animals share the same barns were important causes of mortality. The cause of mortality was stated as "unknown" when farm owners were unable to remember or describe the cause of death.

Table 9. Mean annual mortality of young stock and distribution by age category in Oromia Region, 2014 to 2015

Age group	Calf mortality (%) (95% CI)	Lamb mortality (%) (95% CI)	Kid mortality (%) (95% CI)
Abortion and stillbirth	8.7 (6.3, 11.8)	7.5 (4.3, 12.7)	9.3 (6.1, 13.9)
Perinatal (<48 hours)	1.7 (0.8, 3.4)	2.5 (1.0, 6.3)	0.5 (0.2, 2.6)
Neonatal (48 hrs.–1 month)	5.1 (3.3, 7.6)	5 (2.6, 10.0)	8.8 (5.7, 13.3)
Early pre-weaning (1–3 months)	3.6 (2.2, 5.9)	24.2 (18.4, 31.6)	4.2 (2.2, 7.7)
Late pre-weaning (>3 months)	3.9 (2.4, 6.2)	2.5 (1.0, 6.3)	1.9 (0.7, 4.7)
Mean annual birth-to-weaning mortality*	14.0 (10.6, 17.4)	33.5 (17.8, 49.3)	17.6 (11.6, 22.7)
Overall annual mortality**	20.9 (16.4, 25.4)	39.0 (22.2, 55.7)	23.3 (16.8, 29.8)

* Mean birth-to-weaning mortality calculated related to total number of born live (calf = 414, lamb = 160, kid = 216)

** Overall annual mortality calculated related to total number of born live + stillborn (calf = 450, lamb = 172, kid = 236)

Table 10. Relative importance of causes of young stock mortality and cause-specific mortality in Oromia Region

Cause of mortality	Relative contribution of causes (%)[a]			Cause-specific mortality (%)[b]		
	Calves	Lambs	Kids	Calves	Lambs	Kids
Disease	65.5	39	70.9	9.2	23.8	12
Malnutrition	5.2	3	5.5	0.7	1.8	0
Poor mothering	3.5	3	5.5	0.5	1.8	0.9
Predation	1.7	2	3.6	0.2	1.2	1.9
Accidents	1.7	4	7.3	0.2	2.4	0.5
Unknown reasons	22.4	4	7.3	3.1	2.4	2.3

[a] Each cause expressed as number of deaths due to the specific cause relative to the total number of deaths: calf (n = 58), lamb (n = 55), and kid (n = 38)

[b] Calculated mortality rate due to each cause relative to the number of live born: calf (n = 414), lamb (n = 164), and kid (n = 216)

Herd owners were able to describe diseases and syndromes they observed in morbid young animals prior to death during the questionnaire survey. In calves, diarrhea was incriminated as a major cause of mortality in nearly half of the deaths (see Table 11). According to farmers' observations, diarrhea occurred more frequently in neonates up to one month of age. Respiratory disorders (such as pneumonia, difficulty in breathing, and coughing) were the second-most important syndromes identified. In small ruminants, respiratory problems stand as the first cause of death in lambs and kids, followed by diarrhea. Non-specific disease syndromes such as anorexia, fever, emaciation, and depression were also identified in all ruminant species during birth-to-weaning life.

3.1.2.4 Effects of farm management practices on young stock mortality

Farm management practice of farmers was assessed through the questionnaire study and farm visits. Some livestock owners prepare isolated calving pens during calving time for both small and large ruminants, mainly to protect newborn animals from physical injury. Separate calving facilities can reduce the contamination of newborns by unhygienic environments. In this study, the statistically significant effect of maternal facilities was observed in lamb mortality (see Table 12). The mortality rate was slightly lower in cattle and goat in farms that had separate calving/kidding facilities compared to those that did not have such facilities. However, the mean mortality difference was not statistically significant in either cattle or goats.

Table 11. Relative importance of disease syndromes in young stock mortality in Oromia Region

Disease syndrome	Calves Proportion (%)	Lambs Proportion (%)	Kids Proportion (%)
Diarrhea	48.7%	10.3	19.2
Respiratory problem	20.5	53.8	46.1
Umbilical abscess	7.7	0.0	0.0
Non-specific syndromes	23.1	35.9	34.6

No. of deaths: calf (n = 39), lamb (n = 39), kid (n = 26)

Table 12. Effect of maternity facility on young stock mortality in Oromia Region

Species	Maternity facility	Mortality rate (%)	OR (95% CI)	P-value
Cattle	Calving pen	17.4 (9.0, 21.4)	1.0	
	Same barn	12.6 (9.3, 16.9)	0.6 (0.5, 1.6)	0.565
Goat	Kidding pen	20.0 (10.9, 33.8)	1.0	
	Same barn	14.0 (9.6, 20.0)	0.6 (0.3, 1.4)	0.254
Sheep	Lambing pen	39.7 (29.6, 50.6)	1.00	
	Same barn	26.8 (18.4, 37.2)	0.2 (0.8, 0.7)	0.008*

Observations: cattle (n = 414), goat (n = 216), sheep (n = 160) *significant difference

Time of birth is also important in the incidence of young stock mortality. Almost all farmers had the experience of assisting dams during difficult births. As presented in Table 13, the mortality rate was relatively higher in births at night, during which assistance by owners is low, and the possibility of exposure to cold climate and unhygienic conditions will lead to mortality in newborns in all species.

The effect of time of birth on mortality was statistically significant only in goats, but odds of mortality were reported as above one in cattle and sheep, probably due to wide differences in mean mortality. During the daytime, the possibility of assisting with difficult births and giving care to newborns is optimal, which might contribute to the low risk of newborn deaths.

Farmers in Oromia Region provide considerable care to newborns during and after birth. In this study, 77.4% of the participant farmers were aware of the importance of colostrum, and all of them provide colostrum for newborn calves before six hours of birth and even allow free suckling for about 2–3 weeks. In contrast to Amhara Region, only a small percentage (22.4%) of the farmers restricted provision of first milked colostrum and partially removed the first milked colostrum, assuming it causes calf/lamb scour. However, no statistically significant difference was reported in young stock mortality among those who allow free suckling and those who restricted suckling (see Table 14). Residual suckling is the common method of calf feeding, at least twice a day. Suckling of milk is free in small ruminants.

Table 13. Effect of birth time on young stock mortality in Oromia Region

Category	Time of birth	Mortality rate (%)	OR (95% CI)	P-value
Calves	Day	14.6 (10.9, 19.4)	1.0	
	Night	17.8 (11.9, 25.8)	1.1 (0.6, 2.1)	0.781
Kids	Day	12.9 (8.9, 18.3)	1.0	
	Night	45.5 (26.9, 65.3)	2.7 (1.1, 6.5)	0.003*
Lambs	Day	33.6 (25.8, 42.4)	1.0	
	Night	36.8 (23.4, 52.7)	1.1 (0.4, 3.0)	0.800

Observations: calf (n = 384), kid (n = 216), lamb (n = 160) * significant difference

Table 14. Effect of colostrum feeding practice on young stock mortality

Category	Colostrum feeding	Mortality rate (%)	OR (95% CI)	P-value
Calves	Allow full suckling	10.0 (5.5, 17.4)	1.0	
	Restricted suckling	12.5 (8.7, 18.1)	0.6 (0.4, 1.8)	0.616
Kids	Allow full suckling	21.3 (13.6, 31.9)		
	Restricted suckling	32.5 (20.1, 48.0)	0.7 (0.3, 1.9)	0.529
Lambs	Allow full suckling	13.8 (8.3, 22.2)	1.0	
	Restricted suckling	22.4 (17.4, 28.3)	1.6 (0.6, 4.3)	0.335

3.1.2.5 Participatory investigation of causes of calf mortality

Twenty focus group discussions consisting of 5–10 members were undertaken in Oromia Region using key herd informants. Causes of morbidity and mortality of young stock were identified by species and prioritized according to their importance. Local vernacular names were used by herd owners and translated to common English names in consultation with animal health personnel. Findings of the group discussion showed diseases such as blackleg, gastrointestinal disorders causing diarrhea, foot-and-mouth disease (FMD), and respiratory disorders as top disease problems causing the morbidity and mortality of calves (see Table 15), which were also identified by the questionnaire study. Chronic trypanosomiasis/Gandi is identified here as an important disease but is not so identified in the individual interview. This discrepancy could be due to the fact that informants in the group discussion have included trypanosomiasis as a major disease of cattle in general in the study area. Though some researchers reported high mortality of calves in tsetse areas compared to tsetse-free areas, the degree of the problem is expected to be less in calves compared to adult cattle. Incidence of diseases like LSD and FMD has increased due to recent outbreaks in the area. Bovine fascioliasis and infestations of ticks and lice were also considered by the key informants as important chronic and debilitating ailments leading to progressive emaciation and ultimately death of calves.

In small ruminants, data were not separated by species. Various diseases and syndromes such as gastrointestinal (diarrhea), respiratory (pneumonia), central nervous (gid) problems, blindness, bloat, and specific parasitic and infectious diseases such as orf, pox, fascioliasis, and external parasites (lice and ticks) were identified as important causes of morbidity and mortality in lambs and kids.

Table 15. Median rank of causes of young stock mortality in Oromia Region (n = 20)

Vernacular name	Common diseases/Syndromes	Median rank (range)
Calves		
Aba gorba/Sinchii	Black leg	1 (1–4)
Albasa	Diarrhea	2 (1–4)
Gandi	Trypanosomiasis	2 (1–5)
Maasa	Foot-and-mouth disease	3 (1–6)
Dhukuba/Somba	Respiratory/Pneumonia	4 (1–6)
Morma/Dhitessa	Bottle jaw/Fascioliasis	4 (1–6)
	Predation	4 (2–8)
	Poor mothering	4 (1–6)
Mariyye (Dorrobaa)	Lumpy skin disease	4.5 (1–8)
Bokoksa	Bloat	5 (1–6)
	Blindness	6 (4–8)
Cinii (Silmi & Injiraan)	External parasites (ticks and lice)	6 (2–7)
Lambs and kids		
Albasa	Diarrhea	2 (1–6)
Maramartoo	Circling/Gid	2 (1–5)
Bokoksa	Bloat	2.5 (1–4)
Dhukuba/Somba (Koksisa)	Respiratory problems/Pneumonia	3 (1–4)
Morma dhitessa (Ballee)	Bottle jaw/Fascioliasis	3 (1–5)
Mandarraa (Furroo)	Orf	3.5 (1–5)
Cinii (Silmi & Injiraan)	External parasites (ticks and lice)	4.5 (3–5)
	Blindness	5 (3–7)
Fanxoo hola (Handarraa)	Sheep and goat pox	5.5 (2–6)

3.2 Calf Mortality in Urban and Peri-urban Dairy Production Systems

3.2.1 Herd structure and size

The mean herd size of the study farms in the urban and peri-urban dairy system was 14.7 heads (95% CI: 12.5–17.0). A total of 332 farms consisting of 4,898 heads of cattle were studied. The largest herd size was in Oromia Region, 18.2 (95% CI: 14.3–22.2), followed by Addis Ababa, 14.2 (95% CI: 11.9–16.4), and 10.5 (95% CI: 5.6–15.5) in Amhara Region. All the farms consisted of Holstein Friesian crossbred cows targeted mainly for milk production. The proportion of cows was about 55.8% and the proportions of heifers and calves were 24.0% and 20.8%, respectively. Urban and peri-urban dairy production is a recently growing livestock sub-sector and a means of family income and livelihood for some smallholder farmers. In the present study, it was reported that dairy production is a primary business for 59.3% (n = 197) of farm owners.

3.2.2 Estimated calf mortality

The calf mortality in the urban and peri-urban dairy production system was skewed; 41.4% of farms recorded mortality. Pre-parturient and birth-to-weaning mortality in urban and peri-urban dairy farms in the different regions is summarized in Table 16. The mean annual birth-to-weaning mortality was significantly higher in Addis Ababa, 25.5 (95% CI: 10.0, 40.9%) compared to Oromia, 15.3 (95% CI: 10.5, 20.2%), and Amhara Region, 14.9 (95% CI: 8.7, 21%).

The pre-parturient mortality in terms of abortion and stillbirth during the study year was relatively higher in Oromia, 14.4 (95% CI: 7.2, 21.6), while reports were found to be similar in Addis Ababa, 6.9 (95% CI: 4.1, 9.7) and Amhara Region, 6.3 (95% CI: 1.7, 2.8) (see Table 16). Health status and parity stages of the dam, big size of fetus, and difficulty in birth were some of the reasons mentioned by farmers as causes of stillbirths.

Similar to the mixed crop-livestock production system, mortality was inversely related to age of calves. A higher mortality rate was reported at lower age groups in neonates and decreased with increased age. Early mortality for live-born calves during the first one month of life accounted for 64.2% of the total mortality and was particularly high during the third week of life. This result was comparable to the findings in smallholder farms in the mixed crop-livestock production system, in which a high mortality rate was reported during the first one month of life.

3.2.3 Causes of calf mortality

Among the causes of calf mortality recognized by the farmers during the individual interview (Table 17), disease was the major problem, followed by sudden deaths and accidents. The mean calf mortality owing to disease was 13.4%. The contribution of disease to calf mortality was higher in Addis Ababa (54%) and Oromia (33.5%). Death of small and weak calves at birth was also considered important, as these animals need frequent attention and support, but owners may actually not provide this extra support. Sudden deaths were deaths with unrecognized syndromes. Malnutrition was also reported as one of the problems. Hand feeding is practiced by a portion of the dairy farmers. Farmers give less attention to the feeding of male calves.

Table 16. Mean annual calf mortality and distribution by age category in urban and peri-urban dairy production system, 2014 to 2015

Age category	Mortality (%) (95% CI)
Abortion and stillbirth	10.1 (6.7, 13.6)
Perinatal (<48 hrs.)	2.4 (1.8, 3.3)
Neonatal (48 hours–1 month)	9.6 (8.3, 11.1)
Early pre-weaning (1–3 months)	2.2 (1.3, 3.0)
Late pre-weaning (>3 months)	1.5 (1.0, 2.2)
Mean annual birth-to-weaning mortality*	18.5 (12.6, 24.3)
Overall mean annual mortality**	26.7 (21.2, 32.2)

* Mean birth-to-weaning mortality calculated related to total number of calf born live (n = 1,706)

** Overall annual mortality calculated related to total number of calf born live + stillborn (n = 1,898)

Table 17. Causes of calf mortality in dairy production system

Cause of mortality	Relative contribution of causes, proportion, n (%)[a]	Cause-specific mortality (95% CI)[b]
Disease	229 (73.2)	13.4 (7.8, 19.0)
Small & weak at birth	18 (5.8)	1.1 (0.5, 1.5)
Bloating	11 (3.5)	0.7 (0.3, 1.0)
Accidents & sudden deaths	29 (9.3)	1.7 (1.1, 2.3)
Dystocia	6 (1.9)	0.4 (0.1, 0.6)
Malnutrition	12 (3.8)	0.7 (0.3, 1.1)

[a] Each cause expressed as number of calf deaths due to the specific cause relative to the number of deaths (n = 313)
[b] Calculated calf mortality rate due to each cause relative to the number of live born (n = 1,706)

Of 224 disease syndromes recorded prior to deaths of calves (see Table 18), the mean mortality attributable to diarrhea was the largest (63%), followed by respiratory disorders. Gastrointestinal problems causing diarrhea were very common in neonates, in the first one month of life. Considerable mortality was reported related to general disease syndromes (non-specific), such as shivering, anorexia, and sudden deaths. LSD was reported from a few farms that faced outbreaks during the study year.

3.2.4 Effects of farm management practices on calf mortality

Some common farm management practices and host-related variables were assessed for their impact on calf mortality. Navel treatment practice and milk/colostrum feeding method were identified as risk factors for mortality of calves (Table 19). Significantly higher mean mortality was reported in farms that practice hand feeding of colostrum and milk and in those that did not practice navel treatment. All other management variables showed no statistically significant effect on mortality. However, it was noted that the odds of mortality was >1 in dam parity and herd size, perhaps due to wide differences in mortality rates among categories.

Table 18. Disease syndromes related to calf mortality in dairy production system (n = 224)

Disease/syndrome	Mean mortality (%) (95% CI)
Diarrhea	63.0 (46.4, 79.4)
Respiratory	17.0 (9.4, 24.5)
Lumpy skin disease	4.9 (1.3, 8.5)
Bloat	2.2 (0.1, 4.6)
Non-specific	12.1 (4.1, 19.6)

Table 19. Multivariate logistic regression analysis of management-related risk factors for mortality of calves in the dairy production system

Variables	Category	Mortality rate n (%)	Odds ratio (OR)	95% CI (OR)	P-value
Time of birth	Day	193 (11.3)	1.0		
	Night	116 (6.8)	0.95	0.60, 1.52	0.835
Delivery status	Normal	107 (6.3)	1.0		
	Assisted	9 (0.5)	1.05	0.60, 1.98	0.886
Dam parity	Primiparous	107 (6.3)	1.0		
	Multiparous	194 (11.4)	1.08	0.60, 1.81	0.775
Herd size	1–10	96 (5.6)	1.0		
	10–20	61 (3.6)	1.13	0.63, 2.02	0.686
	20–30	112 (6.6)	1.63	0.83, 3.18	0.157
	>30	40 (2.3)	1.94	0.65, 5.78	0.236
Calving facility	Yes	37 (2.2)	1.0		
	No	272 (16.0)	0.76	0.3, 1.61	0.470
Navel treatment	Practiced	77 (4.5)	1.0		
	Not practiced	232 (13.6)	0.41	0.23, 0.73	0.003*
Colostrum feeding	Full suckling	301 (17.7)	1.0		
	Restricted	8 (0.5)	0.56	0.20, 1.53	0.256
Colostrum & milk feeding method	Hand feeding	216 (12.7)	1.0		
	Suckling	93 (5.5)	0.48	0.28, 0.83	0.008*

*Significantly different (P<0.05)

3.3 Young Stock Mortality in Pastoral Production System

3.3.1 Young stock mortality in Afar Region

3.3.1.1 Herd structure and size

The study was conducted in selected pastoral herds (n = 152) of Afar Region consisting of 1,349 heads of cattle, 609 camels, 591 sheep, and 1,809 goats. The mean herd size was 10.9 (95% CI: 9.14–12.6) for cattle, 15.3 (95% CI: 11.4–19.3) for camel, 11.3 (95% CI: 8.8–13.9) for sheep, and 21.5 (95% CI: 17.6–25.3) for goats. All ruminant species in the study area were pure local indigenous types raised under extensive pastoral and agropastoral management systems. The majority of the pastoral herds (75%) keep all species of ruminants as a means of livelihood, mainly for milk and meat production, and sales. The mean weaning age was 10.5 months (in the range of 6–12 months) for cattle and 11 months (8–12 months) for camel calves and 4.2 months (3–6 months) for lambs and kids.

3.3.1.2 Estimates of mortality

The annual pre-parturient mortality in terms of stillbirth and abortion and post-parturient mortality rate (birth-to-weaning) and the distribution by age group in small and large ruminants, and camels is presented in Table 20. The mean annual pre-weaning mortality and the premature loss as a result of stillbirth are higher in Afar Region than in smallholders' farms in the mixed and dairy production systems. The mortality rate from birth-to-weaning in general increased with age in calves of both cattle and camels. However, high calf mortality was also reported in the late pre-weaning stage that can be related to recurrent feed shortages and susceptibility to many of the endemic diseases prevalent in the area.

Table 20. Mean annual mortality of young stock and distribution by age category in Afar Region

Age group	Cattle calf mortality (%) (95% CI)	Camel calf mortality (%) (95% CI)	Lamb mortality (%) (95% CI)	Kid mortality (%) (95% CI)
Abortion and stillbirth	21.2 (14.3, 28.0)	48.8 (3.4, 66.2)	36.4 (20.0, 52.8)	40.9 (28.5, 53.4)
Perinatal (<48 hrs.)	0.6 (0.2, 1.3)	3.5 (0.4, 6.5)	7.7 (3.2, 12.2)	1.7 (0.2, 3.2)
Neonatal (48 hrs.–1 month)	5.3 (2.5, 8.1)	6.9 (1.5, 12.2)	10.7 (5.2, 16.2)	21.8 (15.0, 26.4)
Early pre-weaning (1–3 mo.)	5.6 (3.1, 8.1)	6.9 (2.3, 11.5)	15.8 (9.2, 22.4)	14.4 (9.0, 19.8)
Late pre-weaning (>3 mo.)	14.5 (9.1, 20.0)	18.6 (10.7, 26.6)	0.0	3.6 (0.8, 6.4)
Mean annual birth-to-weaning mortality*	26.0 (17.0, 35.0)	35.2 (17.8, 52.5)	35.0 (12.2, 57.9)	41.2 (27.4, 54.9)
Overall annual mortality*	41.6 (31.8, 51.4)	66.8 (51.8, 81.7)	58.7 (40.5, 77.0)	65.2 (53.4, 77.1)

* Mean birth–to–weaning mortality calculated related to total number of live born (cattle calf = 358, camel calf =145, lamb = 234, kid = 583)

** Overall annual mortality calculated related to total number of live born + stillborn (cattle calf = 454, camel calf = 283, lamb = 368, kid = 987)

3.3.1.3 Causes of young stock mortality

The causes of mortality in calves, lambs, and kids based on the questionnaire study are presented in Table 21. Various causes were responsible for the mortality of newborn animals, both large and small ruminants, of pastoral herds in Afar Region. Malnutrition or feed shortage and animal disease were the two major problems causing mortality in young stock across all species. The contribution of malnutrition in overall young stock mortality was in the range of 29.4% to 54.8%, and disease was from 26.7% to 41.2%. The specific mortality rate due to malnutrition was in the range of 10.4% to 19.6%, and disease was from 9.8% to 13.8% in all studied species of ruminants. Other causes such as poor mothering instinct and animals born weak at birth and small in size were also among the causes with considerable contribution to mortality. Unknown causes accounted for 9.8% of mortality in lambs and 4.2% in kids.

Table 21. Causes of young stock mortality and cause-specific mortality in Afar Region

Cause of mortality	Relative contribution of each cause (%)[a]				Cause-specific mortality (95% CI)[b]			
	Cattle calves	Camel calves	Lambs	Kids	Cattle calves	Camel calves	Lambs	Kids
Disease	37.6	41.2	29.3	26.7	9.8 (4.5, 15.1)	13.8 (6.9, 20.7)	10.3 (5.5, 15.0)	10.6 (7.8, 13.6)
Malnutrition/ Feed shortage	54.8	29.4	35.7	48.8	14.2 (7.8, 20.7)	10.4 (4.3, 16.4)	15.8 (10.1, 21.5)	19.6 (15.6, 23.5)
Predator	0	0	0	12.9	0	0	0	5.1 (3.1, 7.2)
Poor mothering	2.2	19.6	2.4	1.3	0.6 (0.2, 1.3)	6.9 (1.9, 11.9)	0.9 (0.3, 2.0)	0.5 (0.07, 1.1)
Weak at birth	5.4	9.8	14.6	6.3	1.4 (0.5, 2.8)	3.5 (1.3, 7.3)	5.1 (1.8, 8.4)	2.6 (1.2, 3.9)
Unknown causes	0	0	9.8	4.2	0	0	3.4 (0.8, 6.1)	1.7 (0.6, 2.8)

[a] Each cause expressed as number of deaths due to the specific cause relative to the number of deaths: cattle calf (n = 93), camel calf (n = 51), lamb (n = 82), and kid (n = 240)

[b] Cause–specific mortality due to each cause relative to the number of live born: camel calf (n = 358), cattle calf (n = 145), lamb (n = 234), and kid (n = 583)

Among disease syndromes observed by pastoral herders prior to deaths of young animals, gastrointestinal (diarrhea) and respiratory disorders were the major syndromes associated with mortality across species (see Table 22). These syndromes were reported at an early age, mainly in the first one month of life. A high proportion of cattle calf mortality (37.1%) was reported as a result of LSD outbreaks during the study year.

3.3.1.4 Effect of herd management practices on young stock mortality

The herd management practices of pastoral herders were assessed through the questionnaire study and farm visits. Many of the assessed management and host factors had no effects on the mortality of young stock. In contrast to practices of farmers in mixed crop-livestock and dairy production systems, no pastoral herder has made attempts to prepare any maternal facility for their herds during parturition, and none practiced navel treatment at all. Pastoral herders in Afar Region provide considerable care to newborns during and after birth. All herders in Afar (100%) were well aware of the use of colostrum and allow colostrum and milk without any restriction of suckling before six hours of age.

The effect of birth time was also assessed, as presented in Table 23. The mortality rate difference between day and night births was not significant in any species; however, the mortality rate was relatively higher in camels at night births. During the daytime, there is the possibility of assisting dams in difficult births, and care to newborns is optimal.

Table 22. Relative importance of diseases and syndromes to young stock mortality in Afar Region

Disease /syndrome	Cattle calves (%)	Camel calves (%)	Lambs (%)	Kids (%)
Diarrhea	31.4	6	28.6	7
Respiratory problems	22.9	11	52.4	9
Lumpy skin disease	37.1	0	0.0	0
Sheep/goat pox	0.0	0	0.0	5
Umbilical abscess	0.0	4	19.0	0
Non-specific	8.6	0	0	3

No. died from birth-to-weaning: cattle calf (n = 35), camel calf (n = 21), lamb (n = 24), kid (n = 64)

Table 23. Effect of birth time on young stock mortality in Afar Region

Category	Time of birth	Mortality rate (%) (95% CI)	OR (95% CI)	P-value
Cattle calves	Day	24.7 (11.8, 37.7)	1.0	
	Night	22.3 (11.8, 37.7)	0.91 (0.56, 1.47)	0.68
Camel calves	Day	10.5 (2.7, 18.0)	1.0	
	Night	25.5 (11.5, 39.6)	0.54 (0.24, 1.12)	0.077
Lambs	Day	61.5 (49.8, 73.3)	1.0	
	Night	38.9 (30.0, 47.8)	0.99 (0.58, 1.73)	0.982
Kids	Day	61.9 (48.2, 75.8)	1.0	
	Night	55.2 (41.6, 68.8)	1.06 (0.78, 1.45)	0.691

Observations: cattle calf (n = 145), camel calf (n = 358), kid (n = 583), lamb (n = 234)

3.3.1.5 Participatory investigation of causes of young stock mortality

Based on focus group discussions, pastoralist key informants were able to recognize and prioritize causes of young stock mortality. Various causes of mortality of young stock were listed by species and prioritized according to their importance using proportional piling and pair-wise ranking techniques. Local vernacular names were used to list diseases and syndromes by group discussants and were later translated to common English/scientific names in consultation with animal health personnel working in the area.

The median ranks of diseases of cattle and camel calf are summarized in Table 24. Mange was identified by the group informants as a major disease causing morbidity and mortality in both cattle and camel calves. Other diseases such as Contagious Bovine Pleuropneumonia (CBPP), fascioliasis, and LSD were also considered important diseases in cattle. Respiratory disorders (pneumonia, difficult breathing) and camel pox were important in camels calves. Non-descriptive syndromes associated with tongue problems (cattle calf) and head-region swelling and hind-limb paralysis were reported in camels.

In small ruminants, respiratory disease related to Contagious Caprine Pleuropneumonia (CCPP), and plant poisoning due to Prosopis and mange were found to be top-priority disease problems in the Afar pastoral area affecting young ruminants in the study region. Pneumonia and sheep pox were among important diseases incriminated for mortality of young stock.

3.3.2 Young stock mortality in Somali Region

3.3.2.1 Herd structure and size

In Somali Region, the study was conducted on 300 herds, of which 175 were from agropastoral and 125 were from pastoral herds. The mean herd size was 8.6 (95% CI: 6.9–10.4) for cattle, 14.2 (95% CI: 11.3–17.3) for camel, 8.3 (95% CI: 4.8–11.7) for sheep, and 24.9 (95% CI: 18.8–31.0) for goats. The study herds consisted of 2,218 heads of cattle, 1,348 sheep, 3,936 goats and 1,413 camels. Herders keep more female animals; for instance, 73% of cattle were breeding cows and heifers, and replacement calves made up 25% of the herd. The mean weaning age was 10 months (6–12 months) and 10.5 months (7–12

Table 24. Median rank for causes of young stock mortality in Afar Region (n = 10)

Vernacular name	Diseases and syndromes	Median rank (range)
Cattle calves		
Qagara	Mange	1 (1–3)
Masangale	CBPP	2 (1–5)
Kilmi	Tick	2 (2–5)
Rugaageyta	Bottle jaw/Fascioliasis	3 (2–3)
Aerkud	LSD	4 (3–5)
Nooke	Ephemeral fever?	5 (2–6)
Inkaqta	Lice	5 (4–7)
Arraba keena	Tongue problem	6 (4–8)
Camel calves		
Qagaara	Mange	1 (1–3)
Santilala/Myofuem	Respiratory disorder	2 (1–3)
Aerkudi	Camel pox	3 (2–4)
Kilimi/Silimi	Ticks	4 (4–6)
Qambula	Head swelling	5 (2–5)
Qataq	Hind limb paralysis	6 (5–6)
Lambs and Kids		
Masangale	CCPP	1 (1–3)
Prosopis toxicity	Plant poisoning	2 (1–3)
Qagaara	Mange	3 (1–4)
Unxaaci	Pasteurellosis/pneumonia	4 (2–4)
Korbidi	Sheep/goat pox	5 (4–6)
Inkaqta	Lice/Keds	6 (5–6)

months) for camel calves and 4.5 months (3–6 months) for lambs and kids. The livestock production system is mainly pastoral with a small agropastoral section. About 85% of herders keep either two or more species of ruminants, primarily as a means of livelihood.

3.3.2.2 Estimates of mortality

Analysis of mortality was done based on data from three districts (Gursum, Dire Dawa, and Shinile) but data collected from Afdem District was intentionally analyzed separately due to outlying mortality data as a result of severe drought starting in April 2015 and lasting until the study period, August 2015. The annual birth-to-weaning mortality in Afdem District was estimated at 66.7% (494/741) for calf, 50.2% (125/249) for camel calf, and 52.2% (2,057/3,943) for lambs and kids. This mortality estimate exceeds by 37.5% in cattle, 17.7% in camel, and 16.5% in small ruminants the aggregated mortality reported from other districts.

The pre-parturient and post-parturient annual mortality and the distribution in different age groups of young stock for the rest of three districts are presented in Table 25. Similar to Afar Region, pre-weaning and overall annual mortality, including premature loss, was reported to be higher in Somali Region.

Age–specific mortality across all species of ruminants was higher at a lower age during the first month of life that extended up to the third month of age. Unlike other production systems, prenatal mortality was reported higher. Among the districts, the highest proportion of mortality was reported in Dire Dawa District with mortality of 49.7% in kids followed by 48.3% in camel and 30.8% in cattle calves.

The mortality in newborn animals increased with age similar to the findings in other production systems. Significantly higher mortality was reported in early life up to one month of age and decreased with increased age of calves, lambs, and kids. The mortality rate in the first one month of age was 40.5% in cattle, 52.4% in camel calves, 29.6% in lambs, and 41.3% in kids.

3.3.2.3 Causes of young stock mortality

The relative contribution of various causes of young stock mortality in Somali Region is presented in Table 26. Based on the pastoralists' perceptions, disease was the major cause of mortality and contributed to the overall mortality in the range of 64–74% in all species of animals studied. Among all causes of mortality, the rate attributed to disease was 20–24%. Despite the current drought in some of the study districts, the contribution of feed shortage to the mortality of young stock was much less than that of disease. The contribution of poor mothering in all species and predation in camels was considerable.

Table 25. Mean annual young stock mortality and distribution by age category in Somali Region, 2014–2015

Age group	Cattle calf mortality (%) (95% CI)	Camel calf mortality (%) (95% CI)	Lamb mortality % (95% CI)	Kid mortality % (95% CI)
Abortion and stillbirth	1.5 (0.03, 2.9)	2.8 (0.5, 5.1)	7.0 (0.3, 14.3)	2.4 (0.6, 4.1)
Perinatal (<48 hours)	10.3 (5.8, 14.9)	19.1 (12.8, 25.3)	19.7 (6.7, 32.8)	11.3 (7.2, 15.4)
Neonatal (48 hrs.–1 month)	8.5 (4.4, 12.5)	6.4 (2.6, 10.1)	2.8 (1.1, 6.8)	10.9 (6.9, 14.9)
Early pre-weaning (1–3 mo.)	8.9 (4.8, 13.0)	9.5 (5.1, 13.9)	2.8 (1.1, 6.8)	8.6 (4.9, 12.2)
Late pre-weaning (>3 mo.)	1.5 (0.03, 2.9)	2.8 (0.5, 5.1)	7.0 (0.3, 14.3)	2.4 (0.6, 4.1)
Mean annual birth–to–weaning mortality*	29.2 (20.5, 37.8)	32.5 (21.8, 43.3)	35.2 (22.4, 66.2)	35.7 (23.8, 47.5)
Overall mean annual mortality**	41.5 (32.8, 50.1)	48.3 (37.2, 59.4)	54.9 (32.2, 77.6)	52.3 (42.4, 62.3)

* Mean birth-to-weaning mortality calculated related to total number of born live: cattle calf (n = 271), camel calf (n = 252), lamb (n = 71), kid (n = 468)

** Overall mean annual mortality calculated related to total number of born live + stillborn: cattle calf (n = 328), camel calf (n = 329, lamb (n = 102), kid (n = 632)

Table 26. Causes of young stock mortality and estimated mortality rate of causes in Somali Region

Cause of mortality	Relative contribution of each cause (%)[a]				Cause-specific mortality (%)[b]			
	Cattle calves	Camel calves	Lambs	Kids	Cattle calves	Camel calves	Lambs	Kids
Disease	68.4	74.4	64.0	64.7	19.9	24.2	22.5	23.1
Malnutrition/feed shortage	15.2	13.4	12.0	16.2	4.4	4.4	4.2	5.8
Poor mothering	12.7	8.5	24.0	7.2	3.7	2.8	8.5	2.6
Unknown reasons	3.8	0.0	0.0	9.0	1.1	0.0	0.0	3.2
Predation	0.0	3.7	0.0	3.0	0.0	1.2	0.0	1.1

[a] Each cause expressed as number of deaths due to the specific cause relative to the total number of deaths: cattle calf (n = 79), camel calf (n = 82), lamb (n = 25), and kid (n = 167)

[b] Cause-specific mortality due to each cause relative to the total number of live born: cattle calves (n = 271), camel calves (n = 252), lambs (n = 71), and kids (n = 468)

Among disease syndromes recognized by herders, gastrointestinal (diarrhea) and respiratory disorders were the two major problems reported as causes of young stock mortality at early age in all species (see Table 27). In cattle calves, LSD was incriminated as a major cause of mortality. The relative contribution of respiratory diseases such as pneumonia was twofold in lambs compared to diarrhea. Non-specific syndromes such as fever and anorexia were also identified in calves.

3.3.2.4 Effect of herd management practices on young stock mortality

Time of birth had significant effect only on kid mortality in Somali Region (see Table 28). Birth time had no effect on calf mortality in cattle and camels; however, the mortality rate was relatively higher in night births of camel, during which assistance by owners may be minimal.

Table 27. Relative importance of diseases/ syndromes to young stock mortality in Somali Region

Disease/syndrome	Cattle calf (%)	Camel calf (%)	Lamb (%)	Kids (%)
Diarrhea	31.4	6	28.6	7
Respiratory problems	22.9	11	52.4	9
Lumpy skin disease	37.1	0	0.0	0
Sheep/goat pox	0.0	0	0.0	5
Umbilical abscess	0.0	4	19.0	0
Non-specific	8.6	0	0	3

Cattle calf (n = 35), camel calf (n = 21), lamb (n = 24), kids (n = 64)

Table 28. Effect of time of birth on young stock mortality in Somali Region

Category	Time of birth	Mortality rate (%)	OR (95% CI)	P-value
Cattle calves	Day	25.6 (15.3, 36.5)	1.0	
	Night	21.6 (11.6, 31.6)	1.1 (0.5, 2.6)	0.797
Camel calves	Day	15.5 (5.3, 25.7)	1.0	
	Night	55.0 (34.6, 75)	1.6 (0.3, 1.9)	0.315
Kids	Day	19.0 (8.3, 29.6)	1.0	
	Night	44.0 (26.8, 61.4)	3.1 (1.6, 7.3)	0.010*

Observations: cattle calf (n = 162), camel calf (n = 116), kid (n = 195) *significant difference

Colostrum feeding practice had a statistically significant effect in cattle calves and kids (see Table 29). The majority of pastoral herd owners in Somali Region (85%) were well aware of the benefits of colostrum for young animals and make an attempt, especially for calves, to get them colostrum early, before six hours of birth. Only a small proportion (15%) of the herd owners restricted provision of first milked colostrum. Residual suckling is common, with higher frequency of suckling a day.

3.3.2.5 Participatory investigation of causes of young stock mortality

Health- and management-related causes of morbidity and mortality of young stock in Somali Region were listed by species and prioritized by key informants (see Table 30). Whereas malnutrition or starvation and dehydration due to drought were ranked as the most important problem in calves, respiratory problems were the first-ranked disease problem in camel calves.

Table 29. Effect of colostrum feeding practice on young stock mortality

Species	Colostrum feeding	Mortality rate (%)	OR (95% CI)	P-value
Cattle	Free suckling	39.5 (27.1, 51.9)	1.0	
	Restricted	3.6 (2.2, 16.3)	1.9 (1.1, 6.4)	0.011*
Camel	Free suckling	36.2 (21.9, 50.4)	1.0	
	Restricted	56.8 (36.3, 77.5)	1.1 (0.4, 3.0)	0.620
Goat	Free suckling	66.7 (42.3, 91.0)	1.0	
	Restricted	16.9 (3.8, 30.0)	2.5 (1.4, 6.7)	0.035*

Observations: cattle calf (n = 162), camel calf (n = 116), kid (n = 195) * significant

Table 30. Median rank for causes of young stock mortality in Somali Region (n = 10)

Vernacular name	Diseases and syndromes	Median rank (range)
Cattle calves		
	Malnutrition/Feed shortage	1 (1–3)
Sogudud	Tick borne disease/Babesiosis	2 (2–4)
Shoben	Diarrhea	2.5 (1–5)
Kukta	Anthrax	3 (2–6)
Injirta	External parasite (ticks & lice)	3 (3–7)
Amadelo	Circling/Gid	3.5 (3–6)
Sombob	CBPP	4 (4–5)
Camel calves		
Dhaxan/Oof	Respiratory problems/Pneumonia	1 (1–3)
Kud/ Xaran	Anthrax	2 (2–4)
Shuban	Diarrhea	2.5 (1–6)
Sogudud	Tick-borne disease	3 (2–5)
Malig	Trypanosomiasis	3.5 (3–6)
	Malnutrition/Feed shortage	4 (2–7)
Ajaro	Camel pox	5 (4–6)
Lambs and kids		
	Malnutrition/Feed shortage	1 (1–4)
Furuq	Peste des Petits Ruminants (PPR)	2 (2–5)
Sombob	CCPP	3 (2–5)
Ajaro	Sheep pox	3 (1–6)
Shuban	Diarrhea	4 (2–6)
Chini	External parasites (mange & ticks)	5 (3–6)
Amadelo	Circling/Gid	6 (4–7)

4. DISCUSSION

4.1 Young Stock Mortality in Mixed Crop-livestock Production System

Efficient livestock production and limited losses are important for farmers to realize maximum benefits from their livestock resources. Young stock mortality is the most frustrating part of keeping livestock and as such a terrible waste and a killer of profit in which the producer has to wait another year before he can make up for the loss. A fuller understanding of the causes of young stock deaths and mortality patterns helps in identifying the major management problems in the herds and areas for improvement, guiding research efforts, and guiding activities and decisions of extension personnel, veterinarians, and policy makers in the management of young stock health.

This study revealed that mortality of young stock is a significant problem of livestock production in the mixed crop-livestock production system. The reported mean annual calf mortality from birth-to-weaning in the crop-livestock production system was in the range of 9.2% (Amhara Region) to 14.0% (Oromia Region). This result is consistent with previous studies in Ethiopia and Eastern Africa (Amuamuta et al., 2006; Kivaria et al., 2006; Swai et al., 2010) that reported calf mortality in the range of 8.5–14.2 %. However, this study finding is slightly lower than the 19.7% mortality report of Asseged and Birhanu (2004) around Addis Ababa, 18% in and around Debre Zeit (Wudu et al., 2008), 17.4% mortality in Selale, Oromia (Lobago et al., 2006), 22% between birth and 90 days and 16% from 90 to 180 days (Assefa et al., 2014) in Wolaita Soddo, 38.1% in Bako (Tadesse et al., 2004) and 20.8% mortality in Tanzania (Msanga and Bee, 2006). The mortality difference may be due to differences in herd and breed composition, because many of the previous studies were done on crossbred dairy cows in smallholder farms. The herd composition in this study was dominated by local indigenous breeds, which are assumed to be less susceptible to diseases and environmental effects compared to crossbred calves. In most cases, the high incidence of mortality is associated with deficiencies in calf immunity or adaptation stress.

Some authors have also reported low calf mortality (10%) in traditionally managed calves compared to 16–25% mortality in intensively managed calves (Wymann et al., 2006). Mortality differences in relation to calf management, i.e., between traditional and intensive management, could be explained by the free suckling practice in traditionally managed calves that increases the possibility of acquiring sufficient immunoglobulins. In general, calf mortality incidence at farm level of above 5% is considered to be high and should not be economically tolerable (Moran, 2011).

In the mixed production system, calf mortality was found to be inversely related to age, with the highest mortality reported in early life in the first month of age. From the overall mortality, the proportion of calf mortality up to one month of age was in the range of 44.6% (Amhara Region) to 48.6% (Oromia Region). This finding was consistent with the reports of other researchers, 2.3% (Suzuki, 2005) and 3.6% perinatal mortality around Bahir Dar (Amuamuta et al., 2006). The high perinatal and neonatal mortality of calves is mostly related to poor farm management practices and calf susceptibility to diseases as a result of inadequate transfer of passive immunity. Newborn calves at an early age need more attention, because they will have low energy and are often exposed to an unhygienic environment and stress.

In the present study, the pre-parturient mortality in terms of abortion and stillbirth was reported in the range of 3.0% in Amhara Region to 8.7% in Oromia Region that upsurges the overall pre-parturient and birth-to-weaning calf loss to the range of 11.9% to 20.9% in Amhara and Oromia Regions, respectively. The premature loss in this study is comparable to previous reports; 3.1% abortion in Vietnam (Suzuki, 2005) and 4.7% stillbirth in Zimbabwe (French et al., 2001). However, the premature loss reported in this study is higher than the previous reports in Selale, North Shewa of Oromia (Lobago et al., 2006), which reported a calf loss of 1.4% due to abortion.

Both birth-to-weaning and premature mortality of calves were significantly different between Amhara and Oromia Regions. Calf mortality differences were also seen between moisture-surplus and -deficit districts of Amhara. These variations in mortality could be explained by the differences in disease prevalence, feed availability, and management practices.

Lamb and kid mortality in smallholder farm conditions is one of the main factors that adversely affect small ruminant production. The degree to which lambs and kids survive to marketable age is recognized as one of the key indicators of the efficiency of sheep and goat production. The mean annual mortality reported in live-born lambs and kids in the present study revealed that mortality is an important problem in the smallholder production of small ruminants in the mixed crop-livestock production system. The reported annual mortality rate varied between 14.9% and 33.5% in lambs and between 24% and 17.6% in kids in Amhara and Oromia Regions, respectively.

Similar to the calf mortality, birth-to-weaning mortality of lambs and kids was higher at an early age, 5.3% (Amhara) and 8.9% (Oromia) in neonates up to one month of age.

The neonatal mortality in the first month of age accounted for 51–52.8% of overall lamb-and-kid mortality in the mixed production system. The pre-weaning mortality findings in the present study were consistent with the previous pre-weaning mortality report of Belay and Haile (2011), which was 18.5% in Jimma, 7.5–20% lamb mortality in Jordan (Aldomy et al., 2009) and 8.6–16.5% kid mortality in Jordan and South Africa (Aldomy et al., 2009; Snyman, 2010). However, high pre-weaning lamb mortality has been reported in Amhara Region; 40% lamb mortality in Ebnat, South Gondar (Woldemariam et al., 2014) and 51.5% in Debre Berhan (Bekele et al., 1992). In traditionally managed small ruminant flocks, an estimated 10–50% lamb and kid mortality was recorded annually before weaning (Mugerwa et al., 2000). Petros et al. (2014) reported high mortality of kids: 30.3% within one month of age and 38.3–46.8% within two to three months of age in Adamitulu Jedokombolcha in the Rift valley of Ethiopia and 34.2% mortality on-farm (Debele et al., 2011).

The overall wastage of lambs and kids as a result of pre-parturient death and birth-to-weaning mortality in the mixed crop-livestock production system at present study was between 21.7–39.0% for lambs and 23.3–35.5% in kids. The mortality variation among study regions could be explained by variations in farm management, availability of feed, and presence or absence of parasitic and infectious diseases. Low survival rate or high mortality may be related to low standards of small ruminant husbandry.

Infectious and non-infectious causes of young stock mortality were identified in the study regions in young stock. Regardless of species, disease was the most important cause of young stock mortality in the mixed crop-livestock production system. The contribution of disease was 65.5–75.6% in calves and 39–71% of the overall lamb and kid mortality in Amhara and Oromia, respectively. Among diseases with multifactorial causes, gastrointestinal disorders causing diarrhea and respiratory problems were the major disease conditions identified by the participatory investigations. These two conditions, mainly reported in young animals of less than three months of age, have been reported as the most important causes of young stock mortality worldwide (Radostitis, 2005).

The cause-specific mortality due to diarrhea was between 32.4% and 61.0%, and mortality associated with respiratory problem was in the range of 15.8–42.3% in all species. Similar mortality findings were reported by George et al. (2010): 39.6% diarrhea-related and 17.7% respiratory problem-related mortality in calves below three months of age. In the present participatory study, specific infectious diseases such as FMD, LSD, blackleg, anthrax, and trypanosomiasis were reported by key informants in calves; pox, mange, C. cerebralis (gid), external parasites (ticks and lice) in sheep/goats; and plant toxicity in small ruminants. Trypanosomiasis was identified as one of the important diseases in Oromia. It is well understood that African trypanosomiasis is generally a disease of adult cattle rather than one of calves and small ruminants. However, some researchers reported a 2.95% prevalence of trypanosomiasis in calves less than one year old (Gechere et al., 2012) around Arbaminch, Ethiopia. Rowlands et al. (1994) has also reported 18% prevalence in young cattle between 6–36 months of age and an annual calf mortality rate of 8–24% in the first 12 months of life.

The causes of pre-weaning young stock mortality are directly associated to the production and the management system. Other study reports demonstrated that diarrhea and pneumonia are the most important constraints in food animal production (Lema et al., 2001, Shiferaw et al., 2002; Gitau et al., 2010). The higher risk of neonatal diarrhea and pneumonia in this study may be explained by poor management and poorly developed immunity against infectious diseases. According to Moran (2011), tropical environments with high temperatures and humidity introduce many potential diseases to milk-fed calves that impair replacement stock.

Diarrhea may be nutritionally induced or caused by infectious agents. Although effort was not done to identify causative agents during this study, it was reported that microbes like rotavirus, coronavirus, pathogenic E. coli that produces enterotoxin and septicemic colibacillosis in young calves, salmonella, and cryptosporidium were incriminated as causes of neonate diarrhea commonly found in calves. Environmental and management factors also hasten the occurrence of such conditions (Inamdar, 2012). Pneumonia is also multifactorial, caused by viruses and bacteria; proliferative and exudative types of pneumonia are prevalent in calves and lambs (Trigo et al., 1982). Other causes of mortality reported in this study include malnutrition, small weight at birth, exposure to predators, naval infection as animals are unattended during calving and lambing, dehydration, as young stock are allowed to join the dam and travel long distance without water, and lack of veterinary services.

Malnutrition was also stated as a major problem of young stock mortality, next to disease. This could be related to poor management in feeding or supplementing young animals. Malnutrition is more pronounced in calves as a result of human milk competition with calves. In the mixed production system, residual suckling is the only source of feed for calves and only happens twice a day. The calf suffers from starvation until it starts grazing, which is usually after one and a half or two months of age. Lambs and kids are left with their dams and are free to suckle; malnutrition could be associated with poor offspring-mothering relationship such as poor mothering instinct, multiple litters, and mis-mothering. Reports confirmed that starvation, mis-mothering, and exposure to cold

weather are common causes of lamb and kid mortality (Mugerwa et al., 2000; Sharif et al., 2005; Petros et al., 2014).

In this study, the effects of farm management practices by farmers such as the provision of a calving facility, time of birth, and colostrum feeding practices on young stock mortality was assessed. Calving facility and time of birth showed a statistically significant association with mortality of kids in Amhara and Oromia Regions. Though not statistically significant, a relatively high mean young stock mortality was reported on farms that did not use calving pens, for night-time deliveries, and on those farms with restricted colostrum feeding. In the study regions with a mixed production system, significant portions of the livestock owners attempt to separate dams immediately before parturition and assist dams during delivery and manage newborn animals. Almost all farmers allow calves and lambs/kids to suckle fully or partially before six hours of birth and even allow free milk suckling for one week to two months, especially during feed-deficient seasons.

Use of calving pens or houses could contribute to creating a hygienic environment and could minimize accidental mortality of young stock. Separated maternity pens also minimize the spread of disease. Stillbirths vary with the parity of the dam and management at the last stage of pregnancy (Singh et al., 2009). As parturition problems decrease with age and parity of the dam, the amount of colostrum available and concentration of colostral immunoglobulins increase (Inamdar, 2012).

In the present study, a large proportion of the participants (64%) was less aware of or wrongly perceived the use of colostrum and thought feeding the first milked colostrum causes neonatal diarrhea and loss of hair (alopecia). As a result, they restrict or deny suckling of colostrum by partially or fully milking the first colostrum that may contain a high concentration of colostral immunoglobulins.

Immunoglobulins are acquired by offspring through colostrum. In colostrum, immunoglobulins present include IgG1, IgM, IgA, and IgG2; however, IgG1 is predominant, representing 80% of the total immunoglobulins absorbed by the prenatal calf. Maximum absorption occurs within the first six to eight hours after birth (Blom, 1982). Colostral immunoglobulins present in the intestine and subsequently absorbed in to the circulation protect neonatal calves against enteric and respiratory disease and even from leg injuries (Singh et al., 2009). High mortality and morbidity due to diarrhea, pneumonia, and other diseases occurs in immunodeficient newborns (Braun and Tennant, 1983). Research has demonstrated that calves without adequate circulating IgG1 are four times more likely to die and twice as likely to become ill as calves with adequate circulating immunoglobulins (Singh et al., 2009). Awareness creation about the importance of colostrum to the calves' health, which was found to be deficient in the farmers covered by this study, is necessary to improve problems of calf mortality.

Management factors in calf/lamb houses, poor ventilation, overcrowding, and absence of regular cleaning and disinfection predispose stock to various diseases, especially respiratory tract diseases, and lead to high mortality. Tympani and milk indigestion also play an active role in the neonatal calf mortality.

4.2 Calf Mortality in the Urban and Peri-urban Dairy Production System

A high calf mortality that reaches up to a loss of a quarter of calves was observed in the urban and peri-urban dairy farms in Ethiopia. The mortality rate reported in this study was in the range of 15–25%. This finding is consistent with the previous calf mortality reports in the tropics of Asia and Africa, which is in same range of 15–25% (Moran, 2011). It was also closely comparable to previous calf mortality studies in Ethiopia, such as the 18% calf mortality reported in Debre Zeit milk shed (Wudu et al., 2008) and Bahir Dar milk shed (Ferede et al., 2015). This rate is very high as compared to calf mortality rates in developed dairy farming in the temperate world. For example, a calf mortality of less than 6% in the UK (Lorenz et al., 2011), 8% in the USA (DCHA, 2009), and 3% in Australia (McNeil, 2009) is achieved through better calf management.

The mortality rate was seen to vary by age category, the highest being in the first one month of age (9.6%). Generally, more than 64% of calf mortality occurred with one months of age and about 50% mortality occurs in the first week of a calf's life. Important calf diseases like calf scour (Wudu et al., 2008) occur in the early life of the calf, and this could be one of the reasons for high calf mortality in the first month of life. Calves may be also vulnerable to environmental stress at an early age. The high mortality of calves during the first month of age suggests there should be more attention on calf management in the first few weeks of calves' lives.

High calf mortality like that observed in this study seriously affects the business of the farms. Normally 20–25% of cows are expected to be replaced annually in dairy farms (Moran, 2011). A loss of 15–25% calves means the farms cannot raise enough to replace loss, let alone expand the herds. Due to less-developed milk processing and marketing in Ethiopia, the income from milk sales for most smallholder dairy farmers is not reliable, and most of them consider sales of heifer an important source of farm income. As such, high calf mortality is a very important problem for the businesses of smallholder urban and peri-urban dairy farmers in Ethiopia.

Premature loss of calves in terms of stillbirth in this study was also reported in the range of 6.7–13.6%, which is a significant challenge of the dairy production system. The overall annual mortality, including premature loss and post-parturient loss, was 26.7%. An excellent calf management program begins with care of the dam prior to calving. Reports showed that about 11–13% of calves born to first lactation dams are stillborn, while calves born to older dams are half as likely to be stillborn (Weigel, 2007). Calf mortality is influenced by the health of the dam. Additionally, calves have a better chance of survival if stress during the birth process is minimized. Key factors that influence stress include size of calf, health of dam, crowding and cleanliness of the calving environment, and quality of assistance provided (Weigel, 2007).

Based on the farmers' observations, disease was the most significant cause of mortality in the dairy production system. In the present study, the mean calf mortality attributed to diseases is 13.4% and the contribution to the overall mortality is 73.2%. This indicates that the most important areas of intervention in reducing calf mortality should be health management, which may include proper passive immunity transfer and biosecurity. Calves when born do not have specific immunity, and optimum passive immunity through proper colostrum feeding needs to be ensured to increase resistance of calves to early infections. Studies showed early ingestion of colostrum reduces calf morbidity (Wudu et al., 2008). Good hygiene in calf pens was also seen to be associated with reduced calf morbidity and hence may reduce calf mortality.

Among disease conditions, calf diarrhea was noted as the first disease problem of calves, followed by respiratory problems. Mortality as a result of diarrhea was 63%; 17% was related to respiratory problems. The major causes of calf mortality reported worldwide are diarrhea (scours) and respiratory diseases (Wymann et al., 2006; George et al., 2010). Previous studies in Ethiopia, which involved a longitudinal follow-up, also showed diarrhea as the first important disease of calves (Wudu et al., 2008; Ferede et al., 2015), and its prevalence appears to be management related, especially when calves are housed in unhygienic conditions (Wudu et al., 2008). These conditions can be controlled with significant reduction in calf mortality by observing good calf management that includes adequate colostrum intake soon after birth, good housing, and well-managed healthy dams.

High calf mortality is believed to be due to less attention given to, and limited resources devoted to, calf management by farmers because there is no immediate income derived from calves (Moran, 2011). Good calf rearing is important as it ensures availability of good future replacement stock. In this study, calves in most smallholder dairy farms are not performing well. Apart from that, farmers aim to optimize income by selling more milk and calves are, therefore, underfed. So intervention focusing on calf management could decrease the problem. Extension programs related to calf management were observed to decrease the high calf mortality in the tropics, e.g., in Kenya (Lanyasunya et al., 2006) and Sri Lanka (Nettisinghe et al., 2004).

Most farmers do not have enough knowledge of proper calf-feeding regimes. Farmers provided their calves with poor-quality feed, mainly natural grass and dry crop residues. The nutritional value (crude protein, mineral contents, and digestibility) of these feed stuffs has been found to be lower than that of legumes (Mtengeti et al., 2008). There was a scarcity of protein as there was no farmer who fed protein supplements to the calves during the study period. Poor calf body conditions observed during farm visits of the present study could be the impact of this poor nutrition. However, crop residues can be utilized more efficiently by offering them to animals along with urea molasses blocks, which have shown good results (Unal et al., 2005).

In a multivariate logistic regression analysis of different management- and host-related factors, navel treatment practice and milk/colostrum feeding methods were identified as risk factors for mortality of calves. High mean mortality was reported in farms that practice a hand-feeding method of colostrum and milk feeding and in those that did not practice navel treatment. All other variables had no statistically significant effect on mortality. Compared to hand feeding, suckling is a greater source of absorption of colostral immunoglobulins; therefore, it is generally recommended to allow a calf to suckle its mother for the first two days post-partum (Singh et al., 2009). Mortality can also be reduced by naval disinfection and by improving housing conditions.

4.3 Young Stock Mortality in Pastoral Production Systems

Higher mean annual young stock mortality was reported in the pastoral production system than in the mixed and dairy production systems. The recurrent drought may be one of the reasons for increased mortality of young stock. We were not able to compare the present study result with a normal year and estimate the increased mortality as a result of the drought, because the data available were only for the drought year of 2015. The annual mean young stock mortality rate from birth-to-weaning age in the pastoral production system was reported in the range of 26–29.2% for cattle, 32.5–35.2% for camel calves, and 35.7–41.2% for lambs and kids. Differences in mortality rates were recorded between districts; for instance, the rate was higher in Afdem District than in Somali Region.

Information about young stock mortality that could be compared to the present study is very scarce in pastoral settings. When available, many of reports are very general

and related to the seasons of droughts. Such reports may be related to a specific period of time and may not show the mortality in non-drought or normal periods (Catley et al., 2014). During a drought year, it is assumed that young livestock are first in line to suffer the calamities brought on by the drought.

Drought effects were observed during the time of field investigation starting from March 2015 to the end of the study period in August 2015. The mortality data for Afdem were observed as outlier and analyzed separately. The district-specific mortality was very high: 50.2% in camel, 66.2% in cattle calf, and 70.3% in lambs/kids. The high mortality reports of the herders might be exaggerated in their attempts to seek emergency assistance.

The mortality findings in the present study are comparable to the previous reports in Ethiopian pastoral areas (Catley et al., 2014) who reported 20.1–34.9% excess mortality in cattle and 20.3% in camels during a drought year. Nkedianye and colleagues (2011) have also reported overall livestock mortality in the range of 14–43% in Massailand following the 2005/6 drought.

Similar to other production systems, mortality was higher at early life stages of young animals. In cattle, calf mortality in the range of 41–49% was reported in the first month of age. The rates for camels and lambs/kids were high as well, 53% in camel calves and 30–53% in lambs and kids. Among the various causes of young stock mortality, malnutrition and disease make up the higher proportion. Disease accounted 64–74% and malnutrition 30–55% of young stock mortality. The present finding is also in line with Catley et al. (2014), who reported significantly increased disease-related mortality in a drought year. The high disease-related mortality rate can be exacerbated by the effect of malnutrition in terms of feed or milk shortages that could compromise the immunity of young stock and expose them to various diseases. At a younger age, animals fully depend on suckling; hence milk allowance to the calf is very critical, especially in the first three months of growth before the calf starts grazing. As pastoral herders stated, malnutrition in cattle and camel calves resulted from competition by humans for milk, and this is a major cause of mortality due to starvation and dehydration in the pre-weaning age.

Premature loss in terms of abortion and stillbirth was reported to be highest in the pastoral system compared to other production systems. The loss in cattle and camel calves was reported to be 1.5% and 2.8%, respectively and, in small ruminants, from 2.4–7% in Somali Region. But the loss in Afar Region was much higher, 21.2% and 48.8% in cattle and camel calves, respectively, and 36.4–40.9% for small ruminants. Stress as a result of feed shortage and occurrence of concurrent diseases could contribute to higher losses.

Based on the perceptions of pastoral herders, external parasitic infestations and infectious diseases that cause diarrhea and respiratory problems were incriminated for mortality from birth-to-weaning of young stock. LSD, CBPP, and respiratory problems were implicated in cattle; respiratory problems/pneumonia, pox, and mange were implicated in camel calves as common health problems causing frequent mortality in young stock as well as in adults.

The effect of herd management practices on mortality was not statistically demonstrated in the pastoral system. Many of herders did not prepare calving/lambing facilities, and did not practice navel treatment. Unlike farmers in other production systems, the awareness of pastoral herds of the value of colostrum was high, and a large portion of herders (85%) allow young animals full suckling of colostrum. Colostrum enhances survival and also cleans the stomach by facilitating passing of the first feces (meconium). Pastoral herders who allowed an unlimited amount of colostrum to the calf believe that colostrum strengthen calves and promotes growth.

5. CONCLUSIONS AND THE WAY FORWARD

5.1 Conclusions

Livestock husbandry is the main source of livelihood for millions of rural Ethiopians. Undoubtedly, ruminants represent a vital contribution to food security and human welfare in rural households. Pre-weaning mortality of young stock appeared to be one of the major constraints of livestock production in all major production systems of Ethiopia, hampering the development of replacement stock. Regardless of species and production system, a high loss of young stock was reported during the first one month of life extending up to the third month of age.

Disease and malnutrition appeared to be the most important causes of young stock mortality across the species and the production systems studied. Among diseases, diarrhea and respiratory infections were the most common challenges of raising young stock. The study also revealed malpractices in young stock management among the studied producers, including poor management, restricted colostrum feeding, and poor care, especially for the calves in terms of milk allowance, supplemental feeding, and health management. While many herders appeared to be aware of the challenges of young stock, they seemed not to have adequate knowledge to deal with the challenges. However, many of the health problems of young stock can be controlled by excellent early nutrition and management.

5.2 Recommendations

Based on the above conclusions the following recommendations are forwarded:

- Acting at the national level could improve young stock survivability by creating awareness, addressing nutritional requirements and endemic infectious diseases impacting health in all the production systems, and supporting further research.

- A broad range of preventive measures are fundamental to optimal young stock health during the period from birth-to-weaning. An emphasis on prevention is critical, limiting need for subsequent intervention, particularly in the management of diseases of the gastrointestinal and respiratory systems.

- Proper nutrition is critical for young stock growth and health. A good nutritional strategy optimizes rumen development and growth while minimizing stress and disease.

- Proper young stock management procedures such as adequate intake of good quality and quantity of colostrum within the first 12 hours of life and consistency in feeding should be ensured through creating awareness among producers of their value in improving the vigor and performance of newborns.

- Many of the endemic diseases could be largely prevented by the application of a suitable inoculation and drenching program for young stock.

- Suitable health and feeding practices during the third trimester of pregnancy and first part of lactation could address many of the stillbirths and early live-born losses.

- Thorough training of farmers/pastoralists on the existing young stock management technologies (feeding regimes, immunization, deworming, etc.) is required as these technologies have potential to improve the current situation.

5.3 Research Priorities

- Research into priority diseases such as gastrointestinal and respiratory infections of young stock is suggested to identify the causative agents and look for control means.

- Research into strategic treatment of parasitic diseases will help to reduce disease burden and effects in young stock.

- Research should be conducted into the improvement of young stock production and use of possible production and reproduction technologies that are available.

- Research should be conducted into feed and feeding regimens of young stock in smallholder settings.

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ANNEX

Questionnaire format used for young stock (cattle and camel calves, lambs and kids) mortality and management study

Part I. Young stock mortality information (the questionnaire was completed for each species separately)

1. Owners' name (optional): _____
2. Address: region/city _____ district_____
   Production system_____
3. Herd/flock size _____
4. How many cows/camels/sheep/goats in your herd abort or give still birth (birth dead offspring) in the last 12 months_____
5. How many off springs are born alive in the last 12 months?_____
   How many of them are died_____?
   (For each offspring complete the following information)
   - 5.1 Date of birth of the calf/lamb/kid_____
   - 5.2 Time of birth: a) day b) night
   - 5.3 Delivery: a) normal b) dystocia / assisted
   - 5.4 Sex of offspring: a) female b) male
   - 5.5 Breed of the offspring: a. local b) cross; if cross; % exotic gene level or filial generation (F1, F2, F3)
   - 5.6 Dam parity: 1st_____, 2nd_____;
     a) primiparous b) multiparous
   - 5.7 Colostrum is fed by: a) suckling b) hand fed c) not fed
   - 5.8 If colostrum fed; the time was: a) before 6 hrs b) 6-12 hrs c.12-24 hrs d) after 24 hrs
   - 5.9 Dam mothering instinct: a) good b) poor
   - 5.10 The dame daily milk yield at pick to lactation (milk off-take)_____liter/day
   - 5.11 At the time of questionnaire the offspring is a) alive b) died c) sold
   - 5.12 If alive; is the offspring weaned? a) yes If weaned; at what age_____ b) no
   - 5.13 If offspring is died; date of death/age at death_____
   - 5.14 Tentative causes of death;
     a) disease, b) drought/ feed shortage, c) predator, d) accident, e) poor mothering/ little milk available, f) bloating, g) theft, h) others (specify)_____.
   - 5.15 If the offspring has been sick before death, syndromes of disease; a) diarrhea, b) respiratory problem, c) abscess on umbilicus d) other/specify _____
   - 5.16 Measure taken, if any; a) treated; if treated, type of treatment _____ b) not treated
   - 5.17 If sold, date of sale_____;
     For what purpose: a) slaughter, b) breeding c) other (specify)_____

Part II. Calf management information

1.1. Owner educational status
a) Illiterate b) Read and write, c) Elementary school, d) Secondary, e) Tertiary

1.2. Herd size:
1.2.1 Cattle_____ Cows_____ Male calves_____ Bulls_____ Female calves_____ Heifers_____
How many of them are cross bred cattle?_____
1.2.2 Sheep total number_____
1.2.3 Goat total number_____
1.2.4 Camel total number_____

1.3 The farm (livestock) as a source of income: a) primary b) secondary

2. Management data
   2.1. Calf caretaker (attendant)
      3.1.1. Ownership a) owner (family member) b) hired
      3.1.2. Sex a) male b) female
      3.1.3. Experience a) <= 5 years b) >5 years
   2.2. Periparturient care
      2.2.1. Calving/lambing facilities a) calving pen b) the same barn
      2.2.2. Navel treatment a) practiced b) not practiced
      2.2.3. Awareness of importance of colostum to neonates a) yes b) no
         If yes, method of feeding a) suckling b) hand feeding
         Time of first feeding a) 6 hours b) 6-24 hours c) > 24 hours
         Duration of feeding a) for 24 hour b) 24 hour- 4 days c) > 4 days
         If hand feeding source of feeding a) dam b) another cow
   2.3. Feeding
      2.3.1. Type of feed a) milk b) milk replacer
         If milk; a) bucket fed c) residual suckling
      2.3.2. Amount of milk/milk replacer given daily per unit of body weight_____
      2.3.3. Frequency a) once/day, b) twice/day, c) thrice/day
      2.3.4. Time of introducing feed other than milk or milk replacer_____
      2.3.5. Type of supplementary feed and quantity given per unit of body weight
         a) grazing (hours of grazing),_____
         b) concentrates (quantity)_____
         c) hay (quantity)_____
      2.3.6. Weaning age_____
3. Housing
   3.1. Housing a) separate pen, b) together with cows in the cow barn, c) other_____
      If separate pen a) individual pen b) group pen
   3.2. Bedding a) present b) absent
      If present what is the bedding material and how frequently is it changed
      a) > once/week b) once/week c) <once/week
4. Experience on calf health problems and prevention and control of the problems
   4.1. Major health problem for the farm _____
   4.2 Number of calves the farm lost during the last one year_____
   4.3. Disease or disease syndrome responsible for sickness and death of calves in order of importance.
      1. _____, 2. _____, 3 _____
   4.4. Measures taken to treat sick calves_____
   4.5. Measures taken to prevent disease problems_____

13.3. Checklist for farm visits
- Recording number of calves/lambs/kids with sexes and ages
- Body condition/scoring of individual offspring
- Physical examination for apparent clinical condition
- Noting housing condition (type of housing, space, hygiene of house/barn, etc.
- Noting feeding condition (access, composition and quality)

13.4: Checklist for focus group discussions
- Identify and rank constraints of livestock production
- List causes of young stock morbidity and mortality by species
- Rank or prioritize for causes of mortality
- Time trend (seasonal calendar) of young stock mortality
- List and rank the options/ solutions for improvement