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Review article

Sex/age of kid/lamb and dam age/parity and managing dam nutrition as determinants of mortality in small ruminants

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ABSTRACT

Mortality is one of the prime after effect on viability of commercial goat and sheep meat production efficiency, through its consequential compromised ewe/doe performance and economic losses in production. Several factors are potential determinants of kid/lamb mortality such as birth type, sex and age, birth weight, dam's milk yield, parity order, dam age, dam weight and condition etc. However, the present review will focus on sex/age of kid/lamb, dam age and parity, and dam nutrition/season as determinants of kid/lamb mortality. Although results on the influence of sex on mortality has been inconsistent, several studies have reported a trend where mortality rates have been sex biased in goat and sheep. Male kids/lambs have lower survival rates and higher mortality hazard ratios as compared to female kids/lambs. Mortality is highest during the initial phase of kid/lamb life and have a propensity to decline as age progresses. Kids/lambs delivered to low parity order dams have low chances of survival due to poor maternal instinct. The advancement of maternal behavior gets better with parity order, as parity order progresses maternal instinct is consolidated. On the other hand, improvement in dam nutrition will enhance dam milking capacity which has been associated with high survivability of kids/lambs. This entails understanding of nutritional management of dams becomes an essential tool to curtail mortality in goats and sheep. Kidding/lambing season should coincide with seasonal availability of high quality forage to feed nursing dams hence high survivability of kids/lambs. The present discussion will give an insight on the influence of sex/age, dam parity

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and dam nutrition/season as determinants of mortality in goat and sheep meat production.

1. Introduction

Mortality during pre and post weaning is possibly the single primary cause of low productivity and economic loss in small ruminants (Snyman, 2010). The number of marketable kids/lambs is dependent on pre and post-weaning survivability which later influence the viability of goat and sheep enterprise. Therefore, management practices aimed at minimising mortality in kids/lambs would result in improved meat production efficiency and economic gains in goat and sheep enterprise (Petros et al., 2014). Comparable high mortality rates for males have been extensively observed across several animal species (Kim et al., 2013). One outstanding, and often reported feature of mortality is the tendency for it to be sex biased, where male kids and lambs were at higher risks of mortality than female /lambs (Bangar et al., 2016; Ukanwoko et al., 2012). On the other hand, Debele et al. (2011) working with Arsi-Bale kids reported higher mortality rates in females than males in a comparable environment. However, based on sex/age-influenced mortalities, the likelihood of surviving from birth to later ages was 29% for males and 34% for females (Festa-Bianchemt et al., 1994). Mortality was higher among older lambs than those of maiden ewes (Warren et al., 2005). In contrast, Sarmah et al. (1981) who observed that mortality increased with age of kids, mostly appearing after 30 days. Parity was equally an important source of variation on mortality in various breeds (Bologum et al., 1993). Vostrey and Milerski (2013) observed that weaned lambs born from three to four year of ewe's age had the highest survival. It's reasonable to assume that balancing the proportion of replacement rates between maiden dams and old ones may contribute to exploitation of dams' prolificacy and maximize survivability of kids/lambs. In terms of nutrition provision of adequate dam nutrition might minimise kid/lamb mortality in small ruminants through its indirect effect on milking capacity to feed its young ones. If nutrition has an influence on kid/lamb mortality, then most death cases should be experienced in late winter meanwhile forage is least available exposing kids to several months of poor-quality forage (Burles and Hoefs, 1984). This implies seasonal and/or yearly variation of feed resources will definitely affect kid/lamb mortality. It becomes critical for goat and sheep producers to recognise the nutritional requirement and appropriate management of young and old dams which will improve kid/lamb survivability. The present discussion will give an insight on the influence of sex, dam parity and nutrition as determinants of mortality in goat and sheep.

2. Sex/age of kid/lamb influencing mortality

The dynamics of sex subjective mortality in goats and sheep are unsatisfactorily understood and happen to differ amongst flock and production systems. Sex and age of kid/lamb have a profound effect on kid/lamb mortality, however, such components are problematic to manipulate in goat and sheep production systems. Nonconformity observational evidence have been reported in literature, where survival rates of kids in mountain goats did not vary as specified by gender (Festa-Bianchemt et al., 1994). This has been associated with sexually dimorphism in adult goats, as males possess about 60% more mass than females, however this variation does not manifest in kids (Houston et al., 1989). This might actual explains the non-existence of sex-related differences in mortality in mountain goats at an early stages of life. The influence of gender was non-existence on pre-weaning mortality (Mtenga et al., 1993), which was inconformity with previous studies of Awemu et al. (1999). Sex had no influence on survivability of kids in Central Highland * Boer crosses in Ethiopia (Tesesma et al., 2017). The sex wise mortality hazard ratio was negligible for females and males, with 59.3 and 40.7%, respectively. The probably explanation for the insignificant variation might be due good management practices. Furthermore, male and female lambs had similar chances of surviving to weaning (Perez-Razo et al., 1998). This is in line with results of Matos et al. (1993), who reported that males and females had comparable survival rates. Debele et al. (2011) reported higher mortality rates in females than males in Arsi-Bale kids kept under same management system. A similar result was observed Dera Din Panah goat breed which experienced higher mortality in female than in males due to low birth weight of female kids as compared to male in this breed (Fiaz et al., 1993). This was supported by Turkson and Sualisu (2005) in Ghana who reported mortality rates of 42.2% for females as against 16.7% for males.

Jiwuba et al. (2016) observed that more females died than their male counterparts before weaning. While most reports were not accordance with the findings of (Soundararajan et al., 2006), kid mortality was higher in male kids than female kids, having 61.11 and 38.89% for males and females respectively (El-Abid and Abu Nikhaila, 2009). In support of this result, Turkson et al. (2004) observed a different trend in mortality rates among male kids which were higher than in female kids. This difference in mortality between the male and female in lambs has been attributed to sex linked determinants which according to Mandal et al. (2007) are yet to be identified. This difference in mortality in animal species is meant to balance the sex ratio as animals get older, where at eight months of age there were approximately 5% males and 48% females (Venkatachalam et al., 1949). In a similar study in wool (Everett-Hincks et al., 2014) and hair sheep (Hinch and Brien, 2014), reported that male lambs had higher mortality than females. Male lambs were at higher hazards of mortality than female lambs (Bangar et al., 2016). Male lambs were heavier at birth and had a 4.5% higher mortality than females. This agrees with the mortality rates values reported by Berger (2000) who reported 10.5% for males and 9.5% for females, while Turkson (2003) reported 54.2% for males and 27.6% for females. Atashi et al. (2013) found that Iranian male lambs showed higher survival rate than females. It could be that Katahdin dams are not drastically affected by the greater size and weight at birth of male lambs, which leads to longer labor, compared to females (Dwyer, 2003) and eventually tend to have higher mortality than females. In agreement, Perez-Razo et al. (1998), Aganga et al. (2005) and Hailu et al. (2006) reported sex differences related to mortality rates, where mortality was higher mortality in male kids compared to females. Higher mortality in males than in females sometimes is ascribable to dam's failure to sustain higher milk requirement in males (Singh, 1991). However, from age-dependent mortalities, the likelihood of surviving from birth to 4 years was 29% for males and 34% for females. Therefore, just few of a third of the females born stayed alive to the least age at first reproduction for this population. Elsewhere, relatively high mortality rate for males have been widely observed across several animal species (Kim et al. 2013). Mortality hazard ratio of lambs was highest during the first three days following birth (Rowland et al., 1992). This implies improvement in general management practices during this phase may increase the survival chances of lambs. It was noted that is rare for the death of the lamb to occur prior to the start of parturition; the generally accepted incidence of ovine antenatal deaths is as low as 2% (Haughey, 1991). One interesting, and often discussed, aspect of mortality is the propensity for it to be sex-biased. The probable known physiological and behavioural` indicators of small ruminant survival differed between the sexes was associated with parental investment were being displayed different flocks. Therefore, expected differences in mortality which are gender related might appear at a later stage of development among young males (yearlings to 3-year-olds) than among females of the same age, because a higher growth rate is often associated with more hazard to mortality during periods of food insufficiency (Clutton-Brock et al., 1985). The ages between 90 to 120 days were associated with highest lamb mortality (Mustafa et al., 2014). It was noted that mortality was highest in the initial stage of lamb life and tends to decline as age progresses (Sharif et al., 2005; Rajab et al., 1992). This could result from the limited capacity of the ewe to provide pre-natal nourishment for the development of the foetus. Therefore, where twins are concerned, feed supplementation may be necessary to compensate for the deficiencies they might have acquired in their pre-natal environment and while competing for maternal milk (Braddford, 1985). Radostits et al. (1994) reported that most mortalities are experienced in the early days soon after birth which is a sign of the changeover from a separately intrauterine life to an unrelated extrauterine life. This was in conformity with reports by Khan et al. (2006) and Sharif et al. (2005) who reported 82% and 62.1% mortality, respectively, in the first week of life of lambs. The comparable high mortality during this period was ascribable to nutrition and management in Sokoto kids, due to low feed resources during the long dry season (Ahmed et al., 2010). In some cases, low temperatures during wet season, in addition to low quantity of milk from maiden dams which are also inclined to poor mothering ability due to inexperience among such dams have been implicated to high mortality in goats and sheep. It should be noted that apart from the influence of age on mortality, litter size could be a n indirect cause of the observed cases as kid/lamb mortality increases with birth type, a relationship that is associated with a decline in birth weight as litter size increases.

3. Parity order influencing kid/lamb mortality

Parity order, age and dam nutrition have been implicated as important factors that influence kid/lamb mortality. Koul et al. (1988) reported that kids born to nulliparous dams suffered greater mortality (17.0%) probably due to low birth weight than those out of multiparous dams (7.2%). Smith (1977) reported that maiden

ewes of 1 year olds had lambs with lower vigor and at high risk of mortality than lambs from mature ewes. Parity order and other maternal attributes such as ewe/doe age (Deribe et al., 2014), maternal body condition, the teat number or udder morphology of teat circumference (Osuagwuh and Inwang, 1987), have an influence on milk production capacity as a result providing enough milk for nursing kids/lambs with greater chances of survival. The development of maternal behavior improves with parity order, as parity order progresses maternal instinct is consolidated. El-Abid and Abu Nikhaila (2009) observed that initial parity order experienced higher mortality rates in goats as compared with the ultimate parities, with magnitude of 50, 22 and 28% for parity order one, two and three, respectively. This was explained by older dams providing enough pre and postnatal nutriment, as a result giving birth to heavier birth weights and later faster growth rates which enhanced survivability of progeny (Hailu et al., 2006). There was a linear relationship between milk production and parity order in goats and sheep where parity affected lactation milk in a curvilinear manner, which increased firmly during the seventh parity and decline from that time forward. An increase in milk yield with increase in parity order has been observed in sheep and goats by which was ascribed to mammary gland development. Both the first kidding event and prior experience of the dam in both kidding and the rearing of a kids influenced subsequent kid mortality. Therefore, while a prior kidding will reduce the incidence of kidding problems in a later parity, a prior rearing also seems to establish some further benefits for current kid survival, perhaps because it illustrates better development of mothering attributes and a prior successful lactation. Mortality of lambs from higher parity order experienced high mortality due to morphological teat deformations and ewes age three to four year had highest survival of weaned lambs (Vostry and Milerski, 2013). Hailu et al. (2006) reported a steady decline in mortality in growing kids up to the fourth parity, and thereafter it increased. For example, young ewes/does usually drop lower-birthweight kids/lambs more frequently, and seasonal variation or flock parity structure might also affect calf birthweights. On the other hand, previous status, udder traits observed at kidding such as teat size or deformities are associated with kid/lamb mortality.

4. Dam age influencing kid/lamb mortality

Mortality differed with dam age group where minimum survival rate was experienced in lambs from dams with 2 and 6 years of age and maximum survival rate reported in lambs from ewes with 4 years of age (Hatcher et al., 2009). The results indicate that the mortality between the classes of dam age was different which entails that age of dam is one of the important components affecting the kids' mortality. Litter size dependent mortality were reported to be progressively increasing as dam age increases (Dadi et al., 2008). The increase in litter size due to increased dam age has an indirect implication on mortality due to its effect on compromised birth weight in multiple birth. Haga et al. (2014) noted that the chances of multiple birth increased with increased dam age up to 4 year of age and slightly declined at 5 year of age. Older ewes due to their improved maternal instinct tend to produce large litter with low birth weight hence reducing survival chances of kids/lambs. There is a tendency of low birth weight in larger litter resulting to low survival. This main reason was that there is improved maternal instinct and reproductive efficiency as the dams age progresses or mature. In a similar study, Levasseur and Thibault (1980) observed that despite the average litter size of ewe lambs is much lower than of mature ewes, the mortality rate of their lambs is relatively higher. This was attributable to low maternal instinct in replacement young ewes which are less likely to take care of their young ones promptly, leading to starvation and hypothermia. The low capacity to produce milk due to an under developed udder and probably body condition of young mothers, immature does may not produce adequate milk for nursing kids/lambs hence high mortality rates. On the other hand, as the age of dams progresses it reaches a plateau and then dams start to give low birth weight kid/lams hence reducing kids'/lambs survival chances from aged ewes/does. Similarly, Chowdhury et al. (2002) for Black Bengal goat, and Al-Najjar et al. (2010) for Shami goats reported that pre weaning survivability was found to be increases linearly with increasing parity or dam age. Greater focus to the management of younger ewe/doe is justifiable to minimise kid/lamb mortality survival. Improved nutritional management, particularly ewes/does nursing twins and triplets, is critical to reduce mortality rate of lambs and kids. Counterbalancing of replacement rates between young ewes and old ones may be possible solution to minimise mortality rates in addition to exploitation of reproductive capacity in a flock. More ewes/does with previous kid/lamb losses during their early parities are likely to have another progeny loss in the consecutive year, and this could be treated as a reason for culling. Losses are therefore mainly being a result of ewe/doe related attributes rather than general management. It is also important that these newborn animals get colostrum as quickly as possible. Elsewhere, Warren et al.

(2006) reported a negative association between lamb mortality and age of dam which may be associated with the quality of maternal care provided by ewes of different ages. In a dam age dependent mortality study lambs 2-year-old ewes experienced 2.2% higher mortality as compared with lambs from dams of 3, 7 and 9-year-old ewes, however, no mortality was reported in 8-year-old ewes (Chniter et al., 2009). Risk in lamb mortality got less with increases in dam age (Southey et al., 2001; Sawalha et al., 2007; Riggio et al., 2008), which was confirmed by the works of Morris et al. (2000) who observed that there was a slight decline in mortality hazard ratios of lambs born to dams of more than 5 years of age. Fahmideh et al. (2010) reported that effect of dam age on survival of lambs was not important, but its effect was experienced on longevity. In contrary to other studies, Hatcher et al. (2009) observed a non-linear trend between dam age and mortality hazard ratios in Merino lamps. On longevity minimum ratings were reported from dams with 6 and 7 years of age and lambs born from dams with 2 years of age, while lambs from aged ewes had the longest longevity. Variation between maturity status of dams could probably explain the reason of prominence effect of dam age on longevity. Barazandeh et al. (2012) reported a non-significant influence of dam age on mortality in Iranian Kermani sheep. This was in conformity with the reports by Ramezani Akbar Abad and Ghavi Hosseein-Zadeh (2015) reported effect of dam age on longevity in Iranian Mehraban sheep.

5. Dam nutrition/season influencing kid/lamb mortality

Mortality fits itself as a function of kids'/lambs' potential growth rate and survival rates as influenced by milking capacity of their dams. This implies that apart from promoting kid/lamb growth rate, milk production capacity of dams will also influence pre and post survival rates. Plane of nutrition for dams will indirectly influence the rate of mortality in kids/lambs (Mustafa et al., 2014). Dam nutrition will promote dam milking capacity for feeding young ones as a result enhancing growth and the chances of survival. There is a positive correlation between dams' milk production and body condition which is enhanced by good nutrition. Does/ewes in poor body condition due to inadequate feeding have complications in mobilization of their body reserves to sustain the increasing demand for lactation for kids/lambs. This implies that does in good body condition due to adequate feeding are likely to produce more milk for the suckling kids/lambs. Due to nutrient mobilization during lactation the dams body composition changes considerably to a large extent to loss of fat and protein. This has negative effect on the does' body weight. Underpinned by plane of nutrition maiden dams produce less milk than older ewes/does and also milk production is influenced by the doe's body condition during lactation. Studying four groups of Angora goat dams fed either high/low protein/energy diets during the last six weeks of gestation, Van der Westhuizen (1980) observed mortality rates of 8%, 83%, 42% and 100%, on groups dams fed high: high, high: low, low: high and low: low protein: energy rations, respectively.

Understanding the attributes that influence the drivers milk production is crucial in curtailing mortality. Suggestions are that the detrimental effects of suboptimal maternal nutrition during lactation on milking capacity and the indirect kids'/lambs survival can be easily corrected through appropriate nutritional modification and intervention enforced during the dam's lactation window. This implies that mortality of kids/lambs is dependent on maternal behavior, especially in provision of sufficient milk which influenced by dam nutrition regime, and also sometimes dam parity order. In a situation where nutrition is inadequate dams will mobilize energy from their body reserves which constitutes a significant portion to the energetic cost of milk production in initial stages of lactation through distinct metabolic transformation. It has been acknowledged that nutrient mobilization for milk production causes a discord between dams' nutritional requirements and its nursing kids/lambs, mainly over the proportion of milk each kid/lamb consume, especially in multiple birth. This conform to the notion that nutrient requirement in terms of energy and protein for milk synthesis can be met by both dietary intake and body reserve mobilization. Suboptimal nutrition during the initial phase of lactation induces a negative energy balance because the maintenance and milk production energy demands are not met. Litter size promote the number of functional mammary glands through their suckling simulative effects. The number of littermates contributes to the determination of milk production in the sense that milk yield increase as litter size increases. In retrospect embryo development is enhanced during the last six weeks of gestation as a result the nutritional requirement of dams at this phase increases. The provision of adequate nutrition at this phase will result in dams dropping heavier kids/lambs which have a high chances of survival. Due to the physiological demand on lactation, the nutritional requirements of dams also increases if they are suckling twins or triplets, the level of nutrition can have implication on multiple birth kid/lamb survival. Jordan and Le Feuvre (1989) noted that below average maintenance rations

resulted in higher mortality rates due to starvation, poor mothering ability and desertion than in dams provided with above maintenance rations. Mortality rates due to starvation were even worse in dams with deformed udder than dams with morphologically sound udder.

The effect of year and season on mortality may be explained partly by the climatic conditions and feed resources availability which has a direct influence on the dam's nutrition hence amount of milk available to weanlings and their chances of survival. In this case heavier kids/lambs after birth due to improved supply of dams' milk have high survival rates. Kids/lambs receiving adequate milk from the dam are less likely to die between birth to weaning. There is a tendency of abundance of feed in wet summer which improves dam nutritional status. The dams are in good body conditions and give adequate milk for the young ones. In dry seasons there is inadequate nutrition on range land which compromised the milk production potential of the mothers resulting in lower birth weights and increased mortality. In order to reduce the economic losses due to lamb mortality, implementation of improved farm practices according to seasonal variation, flock structures (pregnant ewes, newly born lambs etc.) is suggested (Bangar et al., 2016). Nutrition of the ewe at the end of gestation, during nursing of kid/lamb and number of young ones per dam are factors affecting the weight traits of the lambs and their survival chances. Undernourished ewes will give birth to smaller lambs prone to an early death, whereas the single lamb of an over nourished ewe may be too big for a chance of survival. Suggestions are that the detrimental effects of suboptimal maternal nutrition during lactation on milking capacity and the indirect kids'/lambs survival can be easily corrected through appropriate nutritional modification and intervention enforced during the dam's lactation window.

6. Implication

Kid/lamb mortality is influenced by both genetic and non-genetic factors and is the major determinant of profitability function, since it affects the total number of meat animals which reach slaughter age. Sex/age, dam parity/age and dam nutrition/season influence kid/lamb mortality from birth to weaning. The differentiated milk production capacity for lower parity order as compared with higher order parity is ascribable to variation in the degree of mothering ability, where mature ewes/does have better maternal instinct than lower order parity dams. Nutritional management that promote milking capacity, particularly of dams nursing kids/lambs and/or multiple birth is crucial to reduce mortality rate in flocks. Good plane of nutrition during nursing of kid/lamb is the keystone for a healthy strong kid/ lamb crop as a result reducing mortality in flock. Seasonal variation in terms of feed resources fluctuation in quality and quantity is important factor which need to be considered in mortality minimization management plan in goat and sheep production.

7. Highlights

✓ Despite the inconsistence in research results on sex dependent mortality, males have relatively higher mortality rates than females.
✓ Mortality is highest during the initial phase of kid/lamb life and have a propensity to decline as age progresses, management intervention is critical at this stage.
✓ Parity is an equally important source of variation on kid/lamb mortality in various breeds, where maternal attributes are improved as parity order increases.
✓ Increase in litter size as parity increases result in steady decline in birth weight hence increased mortality rates.
✓ Poor quality and inadequate feed resources results in compromised dam milking potential which might translate to increased kid/lamb mortality.
✓ Counterbalancing of replacement rates between young dams and old ones may be a possible solution to minimise mortality rates in a flock.

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