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Research Article

Factors Associated with Morbidity and Mortality of Goat in Extensive and Semi-Intensive Farming Systems in the Eastern Province of Sri Lanka

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ABSTRACT

The present study was conducted to identify the associated factors with morbidity and mortality of goats in extensive and semi-intensive farming systems. A sample of 266 goat farmers of three districts i.e., Ampara, Batticaloa and Trincomalee in the eastern province were randomly selected with the assistance of veterinary offices. A pre-tested questionnaire with face-to-face interviews, farm visits and observations were used to collect the data. The study found that goat farming is a male-dominant (>90%) activity regardless of the farming system. Young and middle-aged farmers with better educations adopted semi-intensive farming systems while the older and poorly educated farmers adopted extensive farming system while being self-employed. The factors i.e., ectoparasites, lack of feed, lack of water, age of the goats, rainy season, and the lack of veterinary services significantly associated ($p<0.05$) with morbidity and mortality of goats in both extensive and semi-intensive farming systems. The factors i.e., disease, poor housing, dry season and predator attack were not associated with morbidity and mortality of goats in semi-intensive farming system whereas the association was significant ($p< 0.05$) in the extensive farming system. Hence, it is concluded that the semi-intensive farming system is effective in protecting goats from morbidity and mortality caused by disease, dry season, predator attack and poor housing compared to the extensive farming system. The factors associated with morbidity and mortality in extensive farming are inherent to the system except for the lack of veterinary services.

Introduction

Goat production has gone up due to its economic viability and importance all over the world during the last decades, mainly in countries that are exposed to harsh environmental conditions. Goats (*Capra hircus*) contribute highly to the livelihood of rural farmers being one of the most important farm animals. There are 82,578 registered goat farmers rearing 757, 983 goats in Sri Lanka and most of them are rural and small-scale farmers (DAPH, 2021). The majority of Sri Lankan goats with smaller body sizes at mature stages and with slow growth rates are considered poor producers (Silva et al., 2017) though they are mainly reared for meat purposes. The highly prolific breeding nature of goats being a farm animal among all domesticated species under harsh climatic conditions makes them more preferred by rural farmers (Yadav and Yadav, 2008). Further, the wider adaptability of goats has helped them to thrive in a wide range of agroecological regions (Silanikove, 2000) and require less capital as they can be completely maintained on pasture, browse and agricultural waste products. Goat farming is concentrated mainly in the dry zone of Sri Lanka and 35.4% of the total goat population is distributed in the eastern province (DAPH, 2021). Farmers keep their goats mainly under a semi-intensive management system in the Ampara district, which is a part of the eastern of province in Sri Lanka (Abeysinghe et al., 2022). However, the farming systems in different areas in the eastern province vary.

In addition to the inherent issue of poor meat production of the local goats, the economic benefits of these animals remain largely marginal due to the disease incidence resulting in death. Our preliminary analysis showed that the mortality and morbidity of goats are major problems faced by the farmers in the eastern province of Sri Lanka mainly during the rainy season. As a result, farmers lose their investments and in certain cases their livelihood. Previous studies in

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different parts of the world indicated the gravity of morbidity and mortality issues in goats. Ershaduzzaman et al. (2007) found that the mortality rate was 28.97% in kids, 22% in young goats and 11.78% in adults and the mortality in kids was due to diarrhoea and pneumonia and among adult goats due to enterotoxaemia and the highest occurrence of diseases was during hot and wet conditions. They further indicated a higher mortality in semi-intensive rearing systems resulting from a higher incidence of diseases. Dessie and Tilahun (2021) found that the overall pre-weaning mortality rate of kids was 24.4%. Tifashe et al. (2017) concluded that the majority of mortality was reported during the dry season mainly due to diseases and feed shortages, further, at the end of the short rainy season, morbidity and mortality are aggravated due to some infectious diseases. Upadhyay et al. (2015) concluded that the overall average mortality rate was 10.93% under semi-intensive farm conditions, further, the mortality was higher during the rainy season followed by winter and summer and it was higher in kids than in adults caused by digestive, respiratory and parasitic diseases. Turkson et al. (2004) found that the sex, type of birth, season of birth, and birth weight of kids have an effect on mortality at pre and post-weaning periods up to one year of age under an intensive management system. Though extensive studies were carried out with regard to the factors associated with morbidity and mortality of goats separately in the extensive farming system and the semi-intensive farming system, studies comparing the morbidity and mortality in both farming systems are limited.

An understanding of the factors associated with the mortality and morbidity of goats in extensive and semi-intensive farming systems will be helpful in activating measures to minimize mortality and morbidity of goats. Thereby, it will be helpful for sustaining and improving goat farming activities that are important to sustain the livelihood of goat farmers in the eastern region of Sri Lanka. Hence, this study was an attempt to identify the associated factors with morbidity and mortality of goats under semi-intensive and extensive farming systems.

Materials and Methods

Ethics review

The Ethics Review Committee (ERC) approval for the study was obtained (ERC/FT/2022/09) from the Ethics Review Committee of the Faculty of Technology of the South Eastern University of Sri Lanka.

Study area

The eastern province in Sri Lanka includes three districts; those are Ampara, Trincomalee, and Batticaloa and the study was conducted among goat farmers in all three districts. The Batticaloa district consists of 16 veterinary divisions, 20 in Ampara and 11 veterinary divisions in Trincomalee district. The eastern province belongs to the low country dry zone according to the agroecological regions of Sri Lanka. The rural areas in the eastern province are thinly populated with vast land areas having potential for livestock keeping.

Sample size and data collection

A sample of 266 goat farmers was randomly selected among farmers from Batticaloa, Ampara, and Trincomalee districts in consultation with officers from the Department of Animal Production and Health (DAPH). To ensure the inclusion of all the veterinary divisions in each district, 100 goat farmers from Ampara, 106 from Batticaloa and 60 farmers from Trincomalee were selected. A questionnaire was prepared and pre-tested and necessary changes were made. The questionnaire was filled with face-to-face interviews with farm visits and observations.

Data analysis

The data from the questionnaire was transferred to MS Excel, percentages were obtained and tabulated. To examine the factors associated with goats' mortality and morbidity, SPSS (Version 25.0, IBM SPSS, Chicago, USA) with Wilcoxon – Signed Ranked Test (P – value at 0.05) was used.

Results and Discussion

Socio-Economic Information of goat farmers

Table 1 provides details on the respondents' socio-economic status i.e., farmers' gender, age, family size, farm size, civil status, education level, occupation and experience in livestock farming, and monthly income in off-farm and on-farm activities. According to Table 1, it was observed that the majority of the farmers were male - 90.9% and 92.3% in extensive and semi-intensive farming respectively. The gender involvement in all three districts indicated a high percentage of males and a low percentage of females in goat farming activity. It could be expected since, herds are taken to long distances for browsing for both farming systems, and it is difficult to manage bucks and highly active goats by females. Most of the goat farmers (79%) in the semi-intensive farming system were found below 45 years old whereas 45.1% of farmers found below 45 years old in the extensive farming system (Table 1). Further farmers with ordinary to tertiary education practice semi-intensive farming systems while farmers with primary education (63.1%) mainly practice extensive management system. The results may indicate that young and educated farmers turn toward semi-intensive system while old and poorly educated farmers still widely follow extensive management system.

According to the results obtained, almost all of the farmers (96.7%) who engaged in extensive farming system was self-employed whereas it was 58.1% in the case of farmers engaged in semi-intensive system. Most farmers in extensive (80.3%) and semi-intensive (83.2%) systems had similar monthly income from farming. The socio-economic data reveals that goat farming in the eastern province is a male-dominated job. The goat farmers who adopted the extensive farming system are found to be in their older age with more experience, poorly educated, and self-employed. Whereas farmers in the semi-intensive farming system are found to have with better education level, in their young/middle-aged with less experience, and engaged in different income generation activities.

Table 1. Socio-economic characteristics of goat farmers in extensive and semi-intensive management systems

Characteristics	Number of respondents (percentage)	
	Extensive system	Semi-intensive system
Age		
25 - 35	10 (8.2)	56 (39.2)
36 - 45	45 (36.9)	57 (39.8)
46 - 55	42 (34.4)	26 (18.2)
>55	25 (20.5)	4 (2.8)
Gender		
Male	111 (90.9)	132 (92.3)
Female	11 (9.1)	11 (7.7)
Education		
Primary	77 (63.1)	26 (18.1)
Secondary	32 (26.2)	28 (19.6)
Ordinary	11 (9.1)	23 (16.1)
Advance level	2 (1.6)	24 (16.8)
Tertiary	0 (0)	42 (29.4)
Occupation		
Government	3 (2.5)	35 (24.4)
Private company	12 (9.8)	25 (17.5)
Self	118 (96.7)	83 (58.1)
Monthly on-farm income (Rs.)		
10,000.00 – 20,000.00	98 (80.3)	119 (83.2)
20,000.00 – 30,000.00	24 (19.7)	23 (16.1)
>30,000.00	0 (0)	1 (0.7)
Monthly off-farm income (Rs.)		
20,000.00 – 30,000.00	3 (2.5)	1 (0.7)
30,000.00 – 40,000.00	12 (9.8)	10 (7.0)
40,000.00 – 50,000.00	107 (87.7)	132 (92.3)
Family size		
3 – 5	92 (75.4)	125 (87.4)
6 – 7	30 (24.6)	18 (12.6)
Goat farming experience		
< 1 year	1 (0.8)	6 (4.2)
1 – 5 years	53 (43.5)	99 (69.2)
5 – 10 years	52 (42.6)	32 (22.4)
> 10 years	16 (13.1)	6 (4.2)

Factors associated with morbidity and mortality in the extensive and semi-intensive farming system

The data obtained was analyzed to find out the factors affecting morbidity and mortality of goats in the extensive and semi-intensive farming systems and the results are given in Table 2 and Table 3. Table 2 shows the factors i.e., disease, parasites, lack of feed, lack of water, poor housing, age of goats, rainy season, dry season, lack of veterinary services and predator attacks significantly affecting goat mortality and morbidity in the extensive farming system. Out of the aforementioned factors, disease, parasites and rainy season seem to be the dominant factors associated with goats' morbidity and mortality. Whereas, in the semi-intensive farming system factors i.e., disease, poor housing, dry season and predator attack did not affect the morbidity and mortality in goats (Table 3). The results in the present study indicated that factors i.e., parasites, lack of feed, lack of water, age of goats, rainy season and lack of veterinary services affected goats' morbidity and mortality regardless of the management systems whether it is either extensive or semi-intensive. Concerning the effect of disease on morbidity and mortality, the comparison of its prevalence in goats

between extensive and semi-intensive goat farming is limited. So-In and Sunthamala (2023) found that the goats in the free-range system had significantly more nematode eggs than the goats under the semi-intensive system and this finding may support the findings in the present study.

Table 2. Factors affecting morbidity and mortality of goats in the extensive farming system and their mean rank

Factors	Mean rank	T value	P value
Disease	1.00	-6.782	0.000
Ectoparasites	1.00	-6.782	0.000
Lack of feed	0.91	-6.538	0.000
Lack of water	0.72	-6.206	0.000
Poor housing	0.54	-6.096	0.000
Age of goats	0.65	-6.147	0.000
Rainy season	1.00	-6.782	0.000
Dry season	0.15	-6.398	0.000
Lack of veterinary services	0.96	-6.651	0.000
Predator attack	0.78	-6.289	0.000

Willcox – Signed Ranked Test where the factors with P< 0.05 are significant.

Karthik et al. (2021) found that the disease incidence was higher in sheep in the extensive rearing system in the rainy season compared to the semi-intensive system in other seasons. The present results indicate that disease is a serious problem affecting goats' morbidity and mortality in the extensive farming system than the semi-intensive system in the study area. Goats in the extensive farming system browse in free-range areas wherein they are exposed to infection. Further, goats are not dehorned and during the fight, there is a risk of getting injuries by which they become prone to infection (Pham et al., 2020). According to Côté (2005), goats reared under the extensive system are found with aggressive behaviour which predisposes the animal body to injuries and provides easy access to disease-causing agents. Despite the findings in the present study, previous studies found that disease effect on morbidity and mortality was severe at 17.26% (Kashem et al., 2011) and 54.12% (Chowdhury et al., 2002) mortality in semi-intensive farming system.

Table 3. Factors affecting morbidity and mortality of goats in the semi-intensive farming system and their mean rank

Factors	Mean rank	T value	P value
Disease	2.91	-1.290	0.197
Ectoparasites	3.77	9.149	0.000
Lack of feed	2.63	-4.628	0.000
Lack of water	2.07	-3.153	0.002
Poor housing	2.78	-1.000	0.317
Age of goats	2.48	-3.464	0.001
Rainy season	3.69	9.608	0.000
Dry season	2.93	-0.333	0.739
Lack of veterinary services	3.44	6.230	0.000
Predator attack	2.46	-1.645	0.100

Willcox – Signed Ranked Test where the factors with P< 0.05 are significant.

As stated already, the present study found that ectoparasites significantly affected morbidity and mortality in both extensive and semi-intensive farming systems. The animals in the extensive system usually browse in the common grazing lands where they possibly come into direct contact with ectoparasites and infested. Likewise, in the present study, it was observed that goats under a semi-intensive system were taken to common grazing lands from where the infestation of ectoparasites possibly occurred. Through our discussion with the goat farmers, it was found that the same ectoparasites infested goats in most cases in both extensive and semi-intensive systems confirming the findings in the present study. Hence, the common grazing sources become the source of ectoparasite transmission. The findings in the present study are, however, contradictory to previous studies. Rony et al. (2010) found that the prevalence of ectoparasites was significantly higher in animals, reared under a free-range system than that of a semi-intensive system and similar results were obtained by Ajith et al. (2017). Whereas, according to Rabbi (2006), the highest

ectoparasitic infestation was found in the semi-intensive system (59.7%) than in the extensive system (33.5%).

The lack of feed and lack of water significantly affected the morbidity and mortality of goats in both the extensive and semi-intensive farming systems in the present study. Feed and water scarcity during the drought become a serious problem and common in both extensive and semi-intensive farming systems. In the extensive farming system, goats are normally reared on free browsing and in the dry season feed and water scarcity is a normal occurrence causing nutrition deficiency and ultimately leading to morbidity and mortality of goats. Whereas, during the rainy season, most of the uplands which are used for grazing are cultivated by crop farmers. This causes a short supply of feed leads to nutrient deficiency and ultimately causes morbidity and mortality in goats. The findings in the present study are consistent with previous findings (Mayberry et al., 2018; Slayi et al., 2014; Seresinhe and Marapana, 2011). The scarcity of clean water and fresh feed in addition to environmental stress in the dry season led to mortality in goats in Hambantota district in Sri Lanka where mainly extensive farming system is practiced (Seresinhe and Marapana, 2011). Ershaduzzaman et al. (2007) found that most of the mortality (69%) in goats was found due to a lack of feed in range lands which restricted grazing and browsing in semi-intensive farming systems which agrees with the findings in the present study. Previous studies also found that mother goats with lower feeding levels had a higher level of kids' mortality (Slayi et al., 2014; Chowdhury et al., 2001). The present study reveals that the lack of feed and water is mainly a seasonal dependent issue (feed scarcity during dry and rainy seasons while water scarcity during dry season) both in extensive and semi-intensive goat farming systems and causes morbidity and mortality. Farmers can minimize the morbidity and mortality of goats by adopting seasonality-dependent stall feeding and strategic feeding practices. Further, under the severe conditions, farmers can downsize their flock.

With regard to the housing for goats, the factor i.e., poor housing is an important factor which caused morbidity and mortality in the extensive farming system whereas the effect was not significant in the semi-intensive farming system. However, the mean rank for poor housing was low in both extensive (0.54 out of 1) and semi-intensive (2.78 out of 4) farming compared to the disease, parasite and feed factors in relation to the effect on morbidity and mortality. The poor housing in the extensive goat farming system exposes the animals to detrimental conditions in the environment ultimately increasing morbidity and mortality compared to the semi-intensive farming system. From our field observation, it was found that farmers keep their animals inside the house during the extreme climatic conditions in the semi-intensive farming system which minimizes the exposure of goats to such extreme conditions ultimately minimizing the morbidity and mortality. According to our field observation of goat housing in the study area, it was found that it is difficult to bring all the housings in the extensive system into one category since houses were highly diverse in structure and varied from non-roof to full roofs that are used to house the animals at night. The goat farmers suggested that by improving the housing, they can minimize morbidity and mortality. The findings in the present study are in agreement with the previous study, accordingly, poor housing-related factors in the extensive farming system led to mortality in goats (Slayi et al., 2014). The lack of shade or shelter against wind, rain, or snow, which are the characteristics of an extensive farming system, may result in poor welfare conditions, especially for young animals, hence, good housing needs to be provided to improve the animal welfare and productivity (Silanikove, 2000; Silva et al., 2022). The poor housing in the extensive farming system exposes the goats to extreme weather conditions such as high rainfall, extreme cold and heat which lead to lower productivity, morbidity and mortality of goats (Sebei, 2005; Rumosa-Gwaze, 2009).

Though the poor housing in the present study was not an important factor affecting the morbidity and mortality of goats, previous studies indicated that poor housing affects the mortality in the semi-intensive farming system. Chowdhury et al. (2001) found that housing affects the mortality of kids in semi-intensive farming systems. Kid mortality and cases of predation could be reduced by providing appropriate housing for kids particularly when the rest of the flock is released to foraging (Mhlanga, 2018). Further, provision of the age-specific housing will maximize the survivability of kids (Singh et al., 2008) in the semi-intensive farming system. The results indicate that the age of goats is an important factor affecting morbidity and mortality both in extensive and semi-intensive farming systems. Though the comparative studies on age factors affecting morbidity and mortality of goats are limited, previous studies investigated the age effect separately in extensive and semi-intensive farming systems. Dohare et al. (2013) found that the age of goats was the most important factor associated with mortality and the morbidity in the age group of 0 -3 months, 6 – 9 months and above 9 months which were 39.29%, 28.57% and 32.14% respectively in the village conditions. In separate studies, it was found that the mortality in kids was higher compared to adult goats in

traditionally managed systems and in semi-intensive rearing systems (Ershaduzzaman et al., 2007; Tifashe et al., 2017). Ershaduzzaman et al. (2007) found that higher mortality in semi-intensive rearing systems compared to intensive management is due to increased stresses on the animal. In another study, it was found that the mortality among kids and adults was significantly different under a semi-intensive farming system (Kashem et al., 2011). The findings in the present study are in agreement with the aforementioned previous studies which show that the age of the goats is one of the important factors affecting the mortality in goats regardless of farming systems either extensive or semi-intensive. The findings of the present study reveal and confirm the previous findings that age-specific (i.e., kids, growing kids and adults) management measures are required to minimize the morbidity and mortality of goats regardless of the farming systems.

The eastern province of Sri Lanka is characterized by two seasons i.e., dry season and rainy season. The rainy season commences in the month of December with the onset of north-east monsoon rain and ends in March. The rest of the months are usually dry; however, dry spell is experienced during the month from April to September in the eastern province. In the present study, the morbidity and mortality were highly significant during the rainy seasons in both extensive and semi-intensive farming systems. However, in the dry season, the morbidity and mortality were not significantly different ($p<0.05$) in the semi-intensive farming system, which is an interesting finding in the present study. Because, a semi-intensive production system increases stresses on the animal which lead to higher disease incidence and mortality (Chowdhury et al., 2002). Further, the finding in the present study is not in agreement with previous studies. For example, according to Dohare et al. (2013), the effect of season on goats' mortality was significant and the death of goats was highest (41.07%) in winter and lowest (21.43%) in summer season under village conditions. Kashem et al. (2011) found that seasons influence the mortality of goats i.e., adults (35.81%) and kids (64.19%). They further found that the highest mortality rates in adults and kids were 22.22% and 25.93%, respectively in the rainy season and the mortality was lowest during the dry season in the semi-intensive farming system. In general, the present study and the previous studies indicate that the season is an important factor influencing the morbidity and mortality in goats and a higher risk of death can be foreseen in the rainy season indicating the need for additional management measures to protect goats from morbidity and mortality during the rainy season.

According to the results obtained, lack of veterinary services significantly affected morbidity and mortality in goats in both extensive and semi-intensive farming systems. This finding indicates that veterinary services provided by the government are not sufficient in the eastern province of Sri Lanka. In Sri Lanka, animal production-related services are provided by the divisional veterinary offices coming under the Department of Animal Production and Health. Timely veterinary services mainly during the rainy season are necessary for goat farming since rural goat farmers partially or fully depend on goat farming for their livelihood. From our field observations, it was found that the accessibility to veterinary office by rural farmers was a real problem and extension services/regular visits by the veterinary office is not practiced which is in agreement with Slayi et al. (2014). The veterinary services are provided mainly on request by farmers. Therefore, immediate measures need to be taken to regularize the close communication between farmers and veterinary services in the eastern province of Sri Lanka. Previous studies indicated the necessity for veterinary services. For example, Tifashe et al. (2017) based on their study, on morbidity and mortality, recommended that sheep and goat owners should be trained in animal husbandry practices i.e., feeding, housing, breeding, health management and biosecurity. Mayberry et al. (2018) emphasized government interventions for the better management of smallholder goat production. Further, the systematic control of infectious diseases and vaccination program in goat and sheep production is necessary (Tifashe et al., 2017) for which regular veterinary-related services by the government are necessary. Further, the veterinary services are much needed by the extensively managed farms since the disease is a major threat in those farms compared to the semi-intensive farms.

According to the results, predator attacks significantly affected goats' morbidity and mortality in both extensive and semi-intensive farming systems. The results presented indicate that protection from predators is important in goat production in the eastern province of Sri Lanka. Previous studies indicated that predators as one of the causes of goats' mortality (Ershaduzzaman et al., 2007; Slayi et al., 2014; Tifashe et al., 2017; Silva et al., 2022;). The findings of the present study and the previous studies clearly show that predator attack in extensive and semi-intensive goat farming is unavoidable, because, goats are taken to far-away places for browsing with minimal care by a single person for browsing during which time predator attack takes place. According to Slayi et al. (2014), in the communal areas, goats are left unsupervised and this exposes the kids to the risk of predators such as hunting dogs and jackals. Anyhow, predator attacks can

be minimized to a lesser extent by keeping goats inside the house at night and allowing the kids and pregnant doe to browse close to the homestead (Tifashe et al., 2017).

Conclusion

The present study found that the factors i.e., disease, poor housing, dry season and predator attack were not associated with morbidity and mortality of goats in the semi-intensive farming systems whereas these factors were highly associated with morbidity and mortality in the extensive farming systems. Hence, the present study concludes that the semi-intensive farming system is effective in protecting goats from morbidity and mortality caused by disease, dry season, predator attack and poor housing compared to the extensive farming system. The factors associated with morbidity and mortality in the extensive system are inherent/specific to the system except the factor i.e., lack of veterinary services.

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