

**PREVALENCE OF ECTOPARASITES AND ASSOCIATED RISK FACTORS IN THE
COMMUNAL SHEEP POPULATION OF MBASHE LOCAL MUNICIPALITY, EAST-
ERN CAPE PROVINCE**

by

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DECLARATION

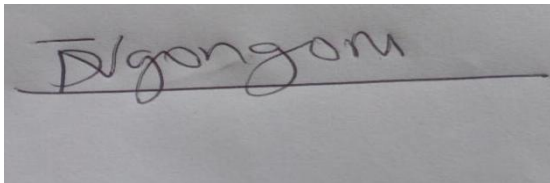
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I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.



SIGNATURE

DATE

____08/10/2026____

DEDICATION

This dissertation is dedicated to my mother, who never obtained a degree but through her prayers managed to raise four graduates all by herself. Secondly, I dedicate this dissertation to my cherished daughters, Mutsa Kuhle Ngongoni and Rindayi Alunamda Nocuze.

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LIST OF ABBREVIATIONS

%	Percent
°C	Degrees Celsius
g	gram
mm	millimeter
CI	Confidence Interval
CAES	College of Agriculture and Environmental Sciences
DAFF	Department of Agriculture, Forestry and Fisheries
<i>df</i>	Degrees of freedom
ELISA	Enzyme-Linked Immunosorbent Assay
OR	Odds Ratio
OTC	Oxytetracycline
<i>P</i>	Probability Value
SADC	Southern African Development Community
SPSS	Statistical Package for the Social Sciences
<i>spp.</i>	Species
UNISA	University of South Africa
WOAH	World Organisation for Animal Health
χ^2	Chi-square

ABSTRACT

Background: Ectoparasites pose a significant veterinary problem worldwide, including in South Africa. Ectoparasites pose a significant problem for welfare and animal health in the sheep producing areas. Infestations of sheep with ectoparasites are linked with a wide range of clinical manifestations and health issues, which include, among others, abscesses, mechanical tissue damage, weight loss, irritation, anaemia, lameness, and in extreme cases, affected animals even die. The study aims to identify the external parasites and associated diseases prevalent in the communal sheep population of the Mbhashe Local Municipality, Eastern Cape Province.

Methodology: The study employed a cross-sectional study design to achieve the objectives, which involved stratified randomly selected individuals from several sheep flocks. Data collection included the clinical examination, collection of ticks, skin scraping and other visible external parasites from the selected animals. A stereo microscope was used to examine the collected samples and identify them using morphological keys and descriptions. A structured questionnaire was administered through in-person interviews with the sheep owners during sample collections. The aim was to gather information of on the socio-economic profile of sheep farmers, their awareness of ectoparasites, and good animal health and husbandry practices.

Results: The overall prevalence of ectoparasites recorded was 42.0% (95% CI, 39-46%) among 697 sheep examined. Ectoparasite species found were *Rhipicephalus appendiculatus* (18.5%), *Hyalomma rufipes* (5.5%), *Psoroptes ovis* (13%), *Bovicola ovis* (12.1%), *Ligognathus africanus* (1%) and *Melophagus ovinus* (2.4). The assessment of tick infestations based on risk factors revealed slightly higher prevalence rates in males (24%), mixed breeds (30%), adult sheep (24%), and animals with good condition scores (24%), although these differences were not statistically significant. The prevalence of mite infestations was higher in male sheep than in female sheep, at 19.0% and 11.0%, respectively and differed significantly ($X^2 = 8.054$, $p = 0.005$). The prevalence of mite infestations was also positively associated with body condition scores of sheep ($X^2 = 616.436$, $p < 0.001$), with the highest infestations (95%) detected in sheep with poor body condition scores. Further multivariable regression analysis of the prevalence of mite infestation revealed that it was significantly associated with sex (OR = 1.9, 95% CI: 1.2-3.0, $p < 0.001$) and body condition score (OR = 45.78, 95% CI: 7.224-290.231, $p < 0.001$). The farmers' responses revealed that 97% considered sheep scab to be very important, followed by lameness at 74%, pulpy kidney at 70% and heartwater at 53%. The clinical signs observed by these farmers are consistent with those reported and documented in the literature regarding the clinical manifestations of sheep scab. The farmers stated observing itchiness or scratching

against fences or walls (33%). Loss of wool (27%), skin lesions/wounds (22%) and weight loss (18%) during sheep scab outbreaks.

Conclusion:

The outcomes of this study revealed ectoparasites that are prevalent in the sheep population of the Doti community, in the Idutwa area of Mbhashe local municipality. Ectoparasites pose a significant threat to the health, productivity, and welfare of sheep in most sheep farming areas. The results of this study reveal that sheep scab is the major challenge facing sheep farmers in this area. To reduce the effects of ectoparasites on sheep, control methods tailored to the endemic ectoparasites in the area should be carefully designed and implemented. Furthermore, raising awareness of the importance, prevention and control of ectoparasites among smallholder sheep producers is crucial.

KEY TERMS: Ectoparasites, prevalence, sheep scab, risk factors, diseases, control measures, Mbhashe local municipalities.

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CHAPTER 1: Introduction

1.1 Background

Ectoparasites are one of the major veterinary problems affecting livestock animals worldwide, including in South Africa (Teshome and Derso, 2015). Ectoparasites pose a significant problem for welfare and animal health in the sheep producing areas. The main sheep ectoparasites not only have impact on the health and welfare of infested animals. However, the treatments applied to prevent or control infestations are also being targeted by environmental and animal rights lobbyists (Plant, 2006). Ectoparasites, including lice, blowflies, sheep Keds, ticks and mange mites are associated with a wide range of clinical manifestations and health problems. These include, among others, abscesses, mechanical tissue damage, weight loss, irritation, anaemia, lameness, and in extreme cases, affected animals even die (Taylor *et al.*, 2016).

Infestation by ectoparasites in sheep causes intense skin irritation, leading to rubbing, scratching and biting of the affected areas, and compromising the health and welfare of the affected sheep (Corke and Broom, 1999). The stamping animal ends up inflicting serious self-injuries following rubbing against fences and other objects. Furthermore, the blood-sucking ectoparasites such as ticks may cause blood loss resulting in severe anaemia and possible contamination of fatal tick-borne infections like anaplasmosis and heartwater (Nejash, 2016; Latif, 2020).

Psoroptes mites (*Psoroptes ovis*) are prevalent in most South African sheep-producing areas and are the primary cause of a serious skin condition known as sheep scab or *brandsiekte* (Makwarela, Nangambi and Seoraj-Pillal, 2025). This mite can cause an exudative dermatitis that can be characterised by the formation of scabs and intense itchiness, leading to rubbing, scratching, wool loss, emaciation, and wounding (Bezuidenhout, 2011). Sheep can spread the mites directly by coming into contact with one another or indirectly by rubbing up against the same posts or fencing (Wall and Shearer, 2008). The disease can spread quickly throughout a flock and is extremely contagious, (Belete, 2015).

The majority of the hard tick species that have been found and identified infesting small ruminants across Africa are members of the genera *Rhipicephalus*, *Amblyomma*, and *Hyalomma* (Onyiche and MacLeod, 2023). Additionally, *Ixodes rubicundus*, commonly known as the Karroo paralysis tick, is a significant tick species recognised for causing paralysis it causes in South

African sheep (Spickett and Heyne, 1988; Spickett, 2013). The bont tick, *Amblyomma hebraeum*, is linked to the spread of *Ehrlichia ruminantium*, which causes heartwater in sheep. Due to its long mouth, it is also known to cause wounds and abscesses, and to predispose affected sheep to secondary screwworm strikes (Gashaw and Mersha, 2013; Latif, 2020). Among the biggest problems for small ruminants are skin conditions and other diseases related to ectoparasite infestations, which result in significant economic losses for smallholder farmers and associated industries (Zeru *et al.*, 2015).

1.3 Problem Statement

External parasites limit production in small stock in various ways, resulting in severe economic losses for the farmers (Wall, 2012). Ectoparasites can impact their hosts in several ways, both directly and indirectly, resulting in blood loss, myiasis, pruritus and even death (Wall and Shearer, 2008; Bedada *et al.*, 2015).

Hard ticks, such as *A. hebraeum*, are known to transmit fatal heartwater to susceptible hosts and, due to their large mouthparts, cause damage to teats and cause abscesses during feeding (Marufu *et al.*, 2011; Nyangiwe *et al.*, 2011). Psoroptic mites (sheep scab) are the most frequent type in sheep, which results in intense itchiness, self-inflicted wounds and skin and wool damage (Sertse and Wossene, 2007). There is a high risk of human infection by certain ectoparasite-borne pathogens in rural areas where animal and human cohabitation is common (Brennan, 2024).

The clinical manifestation of ectoparasitism in sheep results in reduced feed intake and growth rate, which subsequently negatively affects the productivity of affected sheep. Ectoparasite infestations can severely affect sheep production output and the livelihood of farmers if not properly addressed (Elati *et al.*, 2024). The total annual economic losses caused by tick-borne heartwater alone are estimated at US\$48 million across SADC countries (Sertse and Wossene 2007). This estimated economic loss will be much higher when considering the impact of other ectoparasite infections, such as sheep scab in wool production (Yawa *et al.*, 2024).

1.4 Justification of the Study

The aim of the study was to identify the external parasites and associated diseases prevalent in the Mbashe communal sheep population. The results of this study will enhance our understanding of the common ectoparasites and offer evidence-based knowledge and training on effective control methods and biosecurity measures for communal farmers in this area (Mehmedi *et al.*, 2025).

Since ectoparasites infest and affect animals differently, their therapeutic and preventative measures differ (Plant and Lewis, 2011). While some ectoparasites, like ticks and flies, have sporadic contact with their host and go through off-host, free-living developmental stages as part of their life cycles, others, like lice and mites, maintain a continuous association with their host throughout their life cycle (Leal *et al.*, 2020). It is therefore essential for farmers and veterinary officials to be aware of the prevalent ectoparasites in order to implement effective control measures (Lopes, Gomes and Cunha, 2022).

When farmers are aware of the risk factors associated with external parasites, they can plan for ways to improve the welfare and health and of their sheep flocks (Bedada *et al.*, 2015). In South Africa, sheep scab is a controlled animal disease, and state veterinary services implement certain control measures (Animal Disease Act, 1984). The research findings will also be beneficial to state veterinary services for evaluating the impact of the past interventions and assisting in developing new strategies.

South African communal wool farmers contribute 12% of approximately 46 million kilograms of wool collectively produced by South African sheep producers per year. The total gross value of wool and mutton production over the past 10 years is estimated to be approximately 3.3 million and 6.7 billion Rands, respectively (DALRRD, 2021). The contribution of communal farmers to national wool output could increase if appropriate methods to control external parasites, which negatively affect optimal wool production, are applied diligently. This study will therefore help identify areas where farmers require training and capacity building regarding ectoparasite control.

1.5 Aim and objectives

1.5.1 Aim

The aim of this study is to gain a better understanding of the common ectoparasites and associated risk factors in the communal sheep population of the Mbashe Local Municipality, Eastern Cape Province.

1.5.2 Objectives

- To determine the different species of ectoparasites prevalent in the communal sheep flocks of the Mbashe local municipality.
- To determine the diseases and/or conditions associated with ectoparasite infestations and to assess farmers' perceptions of the associated clinical diseases.
- To determine the risk factors associated with ectoparasite infestations in sheep within the study area.

1.6 Research Questions

- What is the prevalence of ectoparasites in the sheep population of the Mbashe communal area?
- Which diseases or conditions are associated with ectoparasite infestation in this area?
- What are the risk factors associated with the infestations?

1.7 Hypothesis

Objective 1:

Null Hypothesis (H_0):

- There is no significant difference in the prevalence of different ectoparasite species affecting communal sheep in Mbashe Local Municipality.

Alternative Hypothesis (H_1):

- There is a significant difference in the prevalence of different ectoparasite species affecting communal sheep in Mbashe Local Municipality.

Objective 2:

Null Hypothesis (H_0):

- There is no significant association between ectoparasite infestations intensity and the occurrence of clinical diseases or skin conditions in communal sheep flocks.

Alternative Hypothesis (H_1):

- There is a significant association between ectoparasite infestations and the occurrence of clinical diseases or skin conditions in communal sheep flocks.

Objective 3

Null Hypothesis (H_0):

- There is no significant association between ectoparasite prevalence and prevailing risk factors in communal sheep flocks in the Mbashe local municipality.

Alternative Hypothesis (H_1):

- There is a significant association between ectoparasite prevalence and risk factors prevailing in communal sheep flocks of the Mbashe local municipality.

CHAPTER 2. Literature Review

2.1 Introduction

Ectoparasites are arthropods of veterinary importance and fall under two major classes: Insecta and Arachnida (Taylor, Coop and Wall, 2016). The Insecta class comprises ectoparasites such as flies, lice and fleas, whereas the Arachnida class include ticks and mites (Kumsa, Beyecha and Geloye, 2012). Certain ectoparasites, like different species of lice, coexist, with their host continuously throughout their life cycle. As a result, their survival greatly depends on the host (Husnik, 2018). However, the majority of ectoparasites are free-living for most of their life cycles and only occasionally come into contact with their hosts. Nonetheless, certain species of ectoparasites, like mites, are very host specific (Wall and Shearer, 2001).

The ectoparasite receives a number of vital resources from the host. As a result, the host provides habitat, food, and shelter (Moss and Beeching, 2010). The food comes in the form of blood, lymph, skin debris, and hair (Labandeira and Li, 2021). The host body provides a suitable environment for many ectoparasites to live in (Mullen and O'Connor, 2019). The ectoparasite

utilises the host as a means of dispersal to a new location or a new host, a process known as phoresis (Dubey, 2018).

In addition to their direct effects, ectoparasites play a crucial role as the biological carriers of pathogens (Muhammad *et al.*, 2021). These pathogens include nematodes (roundworms), bacteria, viruses, cestodes (tapeworms), and protozoa (Gajadhar, Scandrett and Forbes, 2006). With ectoparasites serving as mechanical vectors, other pathogens like bacteria and viruses can spread directly to new hosts. Therefore, when the ectoparasite feeds on the host, these pathogens are either picked up on the body, feet, or mouthparts (Foil and Gorham, 2000).

The majority of vector-borne bacteria, rickettsia microorganisms, and protozoa must go through life cycle stages inside the arthropod ectoparasite's body (Jacobs *et al.*, 2015). During feeding, the vector picks up the pathogen from an infected animal's blood and then spreads it to other animals (Jacobs *et al.*, 2015). Unlike mechanical transmission, biological transmission necessitates a time interval between the pathogen's acquisition and the vector's infection maturation (Blitvich, 2025).

Epidemiological studies on the prevalence of ectoparasites have reported various factors associated with their occurrence in the sheep flocks (Tulu and Urge, 2018). It has been found that the *Melophagus ovinus* prevalence can be influenced by the animal's age, sex and the nutritional status. Sheep with poor body condition scores have significantly higher infestations of fleas and sheep keds, such as *ctenocephalides* spp., and *vinus*, respectively (Kassayeq and Kebede, 2010).

Sheep are important both socially and economically because they are used in cultural ceremonies and provide a source of revenue for some communities (Ngcobo *et al.*, 2026). Ectoparasitic infestations pose huge threat to low input livestock production. Therefore, if preventative measures are not taken, some ectoparasites may even cause diseases in humans (Muhammad *et al.*, 2021). Due to the harm they do to wool and skin, mange mites are linked to substantial economic losses. They also result in anaemia, poor physical health, reduced growth rates, and decreased production of milk and meat (Hopper, 2002).

2.2 Hard Ticks (Ixodidae)

The family Ixodidae is the largest tick family, with representatives occurring in all major biogeographical regions of the world. Members of this family parasitise domestic animals, wildlife and humans and are important vectors of numerous pathogens of veterinary and public health significance (Perumalsamy *et al.*, 2024). The morphological structure of the scutum or hard shield distinguishes them. In males, this covers the entire dorsal (upper) surface; in females, it only covers a portion of the surface. When viewed dorsally, the prominent capitulum, or mouth parts, protrudes forward from the body (Johnson, 2003).

Ticks are compelled, ectoparasites that feed on blood of vertebrates, especially birds and mammals. Hard ticks are typically larger and longer-lived than mites, with survival times of several years or more (Mullen and O'Connor, 2019). There are four stages in an ixodid tick's life cycle. These include an egg, a six-legged larva, an eight-legged nymph, and an adult with eight legs (Fig. 1). However, during this period, they feed regularly, ingest large amounts of blood at long intervals, and spend time away from the host between each meal. After a blood meal and mating, the female ticks detach from the ground or grazing pastures and produce thousands of eggs. Female ixodid ticks are usually larger compared to the males (Walker, Keirans and Horak, 2000; Horak *et al.*, 2018). It is during the bloodmeal-feeding period that vector ticks transmit pathogens through the salivary glands into their host.

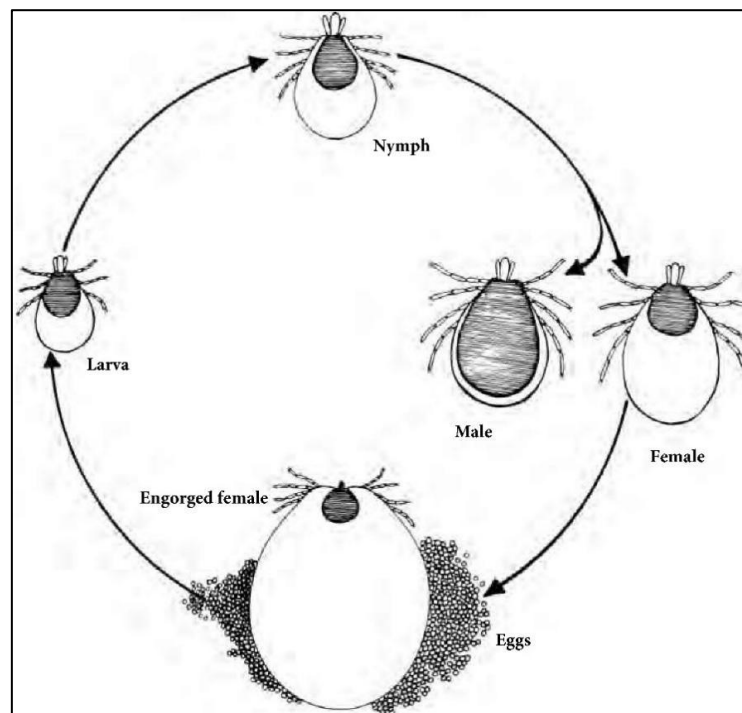


Fig. 1: Life cycle of hard ticks (source: Taylor, Coop and Wall, 2016)

The geographic and seasonal distribution of different tick species and instars is highly influenced by diverse ecological and climatic factors (Spickett, 2013). In South Africa, most of the paramount tick vectors are found in more humid eastern and coastal regions. These tick vectors include *Amblyomma hebraeum*, *Rhipicephalus (Boophilus)* species, and *R. appendiculatus*. The central regions serve as a transitional or barrier zone to their distribution patterns, but the more arid western regions also contain species with lower humidity requirements, such as the *Hyalomma* species and *Rhipicephalus evertsi evertsi* (Horak *et al.*, 2009). The climatic effects, along with other factors such as photoperiod, vegetation type, and structure, impact the seasonal abundance and distribution of different tick species' stages (Spickett, 2013; Horak *et al.*, 2018). This subsequently influences the temporal and spatial occurrence of various tick-borne conditions and diseases. Monakale *et al.*, 2024 reported the Free State Province (24.75%) as the most diverse in terms of tick-borne pathogens, followed by Eastern Cape (22.77%), KwaZulu-Natal (18.81%), Mpumalanga provinces (7.92%) and Western Cape Province being the least diversified at 2.97%. The prevalence of tick-borne diseases translates to the occurrence of its vectors in the reported provinces. In Limpopo province, single and multihost tick species were reported to be prevalent in ruminants in particular, *A. hebraeum*, *H. rufipes*, *H. truncatum*, *R. appendiculatus*, *R. (Bo.) decoloratus*, *R. (Bo.) microplus*, *R. evertsi evertsi*, and *Rhipicephalus sanguineus* (Monakale *et al.*, 2024). In Northwest Province, tick collections were made in cattle, goats and sheep. The *R. (B.) decoloratus* and *R. (B.) microplus* occurred sympatrically at some localities in the north-eastern region of the province (Spickett *et al.*, 2011). However, tick distribution across provinces is influenced by climate change, in particular single host ticks. This has a serious implication in diseases prevalence. The prevalence of *R. (B.) microplus* led to the spread of both Asiatic Redwater in non-endemic areas in South Africa and elsewhere (Horak *et al.*, 2018). Table 1 illustrates common diseases or conditions that are associated with different tick infestations in sheep.

Table 1: Diseases of sheep associated with tick infestations.

Tick species	Disease/Condition
<i>Amblyomma hebraeum</i> , <i>Amblyomma variegatum</i>	Heartwater, foot abscess
<i>Hyalomma truncatum</i> , <i>H. marginatum</i> and <i>H. anatolicum</i>	Foot abscess and lameness
<i>Ixodes rubicundus</i>	Karoo paralysis
<i>Rhipicephalus evertsi evertsi</i>	Spring lamb paralysis
<i>Rhipicephalus</i> spp. <i>Amblyomma</i> spp.	Foot abscess and lameness

Sources : Latif, 2020

2.3 Pathogenic effects of tick infestations

2.3.1 Tick worry

Tick worry in sheep is characterised by restlessness and irritation caused by ticks, mostly leading to significant deterioration of body condition and quality of wool (Thutwa, 2016). This has a substantial effect on productivity and growth of the animal (Rajput *et al.*, 2006). Growth and reproduction performance of sheep can be negatively affected by heavy tick infestations. Clinical signs like thickened, inflamed skin and pale mucous membranes were reported to be caused by the infestations of *R. appendiculatus* and *R. decoloratus* (Norval *et al.*, 1988; Jonsson, 2006), while *Amblyomma* spp. led to losses of about 63 g of body weight (Stachurski *et al.*, 1993).

2.3.2 Anaemia

Anaemia is a condition of low red blood cell count caused by heavy infestation with any blood-sucking ectoparasite (Jonsson, 2006). Ixodid females, if left to feed on sheep for a long time, will eventually cause death in young lambs. (Kemp, Stone and Binnington, 1982). Loss of body condition, weakness and lethargy are results of anaemia caused by a heavy tick infestation (Rajput *et al.*, 2006).

2.3.3 Wounds and myiasis

Hide damage is caused by the tick mouthparts when they puncture the skin during blood feeding. This is eventually seen as small, rounded areas of necrosis. If it continues, it can lead to a serious infection of the skin (Reck *et al.*, 2014). More serious damage is caused by ticks with

longer mouthparts, such as *Amblyomma* and *Hyalomma* genera, than those with shorter mouthparts, such as *Rhipicephalus* spp. (Gashaw and Mersha, 2013). The host's response, leading to severe tissue damage, may be due to inflammation. Eventually, the epidermal cells infiltrate and form lesions (Kitsou, Fikrig and Pal, 2021). Tick wounds may become infested with flies (flystrike), leading to myiasis in sheep. (Bambaradeniya, Magni and Dadour, 2023).

2.3.4 Tick Toxicoses

Tick paralysis is a potentially deadly, sudden neurological disorder in animals caused by neurotoxins released by the saliva of certain tick species (Diakou *et al.*, 2024). In South Africa, *Ixodes rubicundus* is known for Karoo tick paralysis in small ruminants in the western and central regions of the country (Spickett and Heyne, 1988; Fourie and Horak, 1994)

2.4 Mites

Ectoparasitic mites found on sheep consume blood, lymph, skin fragments, or oily secretions. They consume these by piercing the skin, gathering from the skin surface, or drinking from epidermal wounds (Taylor, Coop and Wall, 2016). Most of the mites spend their entire lives attached to their host. Therefore, the transfer from one host to another is mainly achieved through physical contact (Shiferaw, 2018). Mite infestations, termed acariasis, can lead to serious skin conditions, often called mange, which can result in considerable welfare issues and economic losses (Wall and Shearer, 2008). Most mites are species-specific, or adapted to a particular host species, except for the *Sarcoptes* mites, which are found on many animal species, including humans. (Bandi and Saikumar, 2013).

Psoroptes ovis is a surface-dwelling parasitic mite found on sheep, responsible for sheep scab, which significantly harms the productivity and health of affected animals (Hamer *et al.*, 2019). Infestation in sheep results in loss of wool, agitation, chewing and scratching of affected regions, weight reduction, and in certain instances, mortality. Scab mites can be transmitted through direct contact with both clean and infected animals and can live for 10 to 14 days away from their host (varying with environmental factors) (Meintjes, Fourie and Horak, 2002). In South Africa, sheep scab mites are endemic, particularly in sheep-farming regions (Bezuidenhout, 2011). The sheep scab can be quick to spread easily because it is highly contagious between flocks. It can therefore result in serious economic production losses as well as animal welfare problems. The challenge in treating sheep scab is that most farmers use pour-on while

plunge dipping is recommended for sheep affected with sheep scab as it is the effective external parasite control method (Yawa *et al.*, 2024). Farmer training is critical for better understanding and control strategies of the sheep scab.

The life cycle takes place solely on the ovine host and spans 11 to 19 days, from egg hatching to egg laying by the adult. The life cycle advances from egg through four developmental phases (larvae → protonymph → tritonymph → adult (male/female)) (Fig. 2). The mature female mite can live on the host for as long as 42 days, during which it may lay as many as 80 eggs. *Psoroptes ovis* mites can persist for a short duration (15–16 days) without a host, allowing their movement from one animal to another via fomites (Burgess *et al.*, 2019).

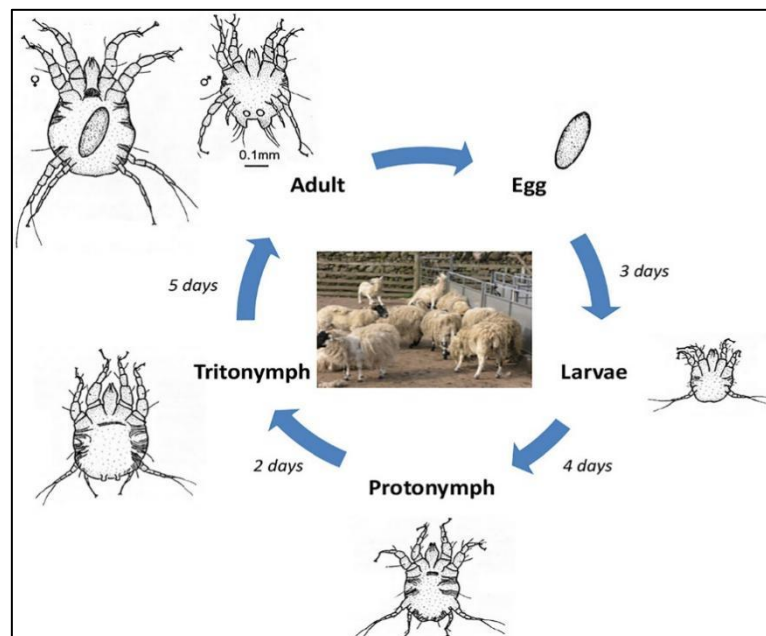


Fig. 2: Life cycle of *Psoroptes ovis* (source: Burgess *et al.*, 2019)

Sarcoptes scabiei, an obligate, burrowing mite that infects mammals and humans, causes a highly infectious skin disease known as sarcoptic mange (WAOH, 2022). *Sarcoptes* spp. significantly causes mange, leading to intense dermatitis, irritation and pruritus, which results in animals losing a substantial amount of grazing time and subsequently deteriorating their overall body condition (Iqbal *et al.*, 2015). Infestation with *Sarcoptes scabiei* is uncommon in sheep, but can occur, leading to serious mange lesions on the legs, face, and ears (Murthy, Nagesha and Gowda, 2013).

2.5 Lice

A severe lice infestation is referred to as pediculosis. Lice draw blood and transmit diseases. Nevertheless, lice hold significant importance due to the immediate harm they inflict (Bruno, 2022). This effect is typically dependent on their great quantity. The presence of a few lice is typical and poses no issue. Nonetheless, lice populations may surge rapidly over a short period, attaining elevated densities. The transmission of lice between animals and between groups is typically enabled by direct physical contact (Taylor, Coop and Wall, 2016). Because lice do not survive for long off their host, the potential for animals to pick up infestation from dirty housing is limited, but this cannot be ignored (Carbonaro, 2004).

Lice are divided into two groups: the red (biting) and the blue (sucking) lice. The red lice (*Bovicola ovis*, formerly: *Damalinia ovis*) are the most important lice species in sheep due to their impact on wool, hair and meat production and animal welfare (Oberem and Oberem, 2011). Older sheep in poor body condition are more commonly infested by the sheep biting louse (Taylor, 2012). They consume skin flakes and can be quite bothersome, prompting sheep to scratch forcefully against things. Sheep start chewing and tugging at their fleece. In sheep with severe infestations, the fleece becomes tattered and shredded, frequently leading to significant patches of wool being lost (Abbott, 2024). Sheep with lice typically produce less fleece and have low-quality wool (Legesse *et al.*, 2022).

Studies in Australia have elucidated the exact distribution of this ectoparasite in the fleece according to temperature gradients (Weqar, 2023). The red lice are mainly found 1.3 - 2.5 cm from the skin surface, with very few specimens more than 3.5cm from the skin (Sebei, 2006). Just as the common name implies, the louse is reddish to light brown in colour. It injures the skin of the host by biting, this results in the secretion of serum, which serves as a source of food for the parasite (Jacobs *et al.*, 2015). Although the 'scratch symptom', as observed, for example, in sheep scab caused by the mite *Psoroptes ovis*, is not usual, it may occur particularly in severe louse infestations (Steen *et al.*, 2004). This results in partial loss of fleece with typical 'pulled out' appearance. Therefore, care must take not to confuse this with sheep scab, but diagnosis by the recognition of the lice is simple (Foster, 2015).

In 2013, Swidan discovered that red lice have major economic impact on wool, hair and meat production. Observations on large scale infestation by red lice confirm the epizootiological pattern of the disease. That is, it occurs during relatively mild winter conditions when the preceding summer infestation has reached a certain base level, and in sheep with poor condition, mainly as a result of overall nutritional deficiency (Crawford, 2022). Secondly its spread is greatly accelerated by large scale direct contact such as occurs in auction yards, and to a lesser degree by indirect contact when uninfected sheep are immediately brought into premises previously vacated by infested sheep (Haleem, 2023).

As the eggs are resistant to the usual insecticide dips, a second dipping 10 - 14 days after the first is required (Datta, 2024). This procedure coupled with restriction of movement of infested sheep, ensures adequate control (Mc Guire, 2015).

2.5.1 Life cycle of red lice

The parasite normally completes its life cycle on one individual host and is very host specific (Hinchcliff, 2013). Oviposition is a slow process, and each ovum matures before it is laid (Regassa, 2009). The ova are tightly affixed to the wool fibers and as a rule are highly resistant to adverse conditions, including dipping. They are quite sensitive, however, to prolonged high temperatures.

Adult females lay eggs on the tail hairs, where large numbers are frequently seen (Meier, Kotrba and Ferrar, 1999). Eggs hatch in 9 to 25 days, influenced by the season (typically longer in colder conditions). Nymphs will travel across the skin and can be readily located near the eyes, snout, and vulva. Third instar nymphs move toward the tail head area. Adults are generally limited to the tail end. The entire lifecycle can be finished in as little as 25 days. This species reaches its peak abundance in the summer, unlike other species that thrive during the colder months (Taylor, Coop, and Wall, 2016).

2.5.2 Control

Red lice infestations normally do not occur throughout the whole year (Ghosh, 2024). Sheep usually dipped only once a year, particularly after shearing in mid-summer from November to January (Fox, 2015). Under normal conditions the single annual dip application is sufficient to keep the parasite population down to a low level of less than 2 lice per square inch. Heavily

infested sheep can easily be detected, but the so-called ‘carriers’ create a lot of problems. These animals appear completely normal, but small numbers of lice would be seen if the sheep were examined carefully (Radostits *et al.*, 2013).

2.6 Sheep ked

Sheep ked (*Melophagus ovinus*) is a bloodsucking ectoparasite that primarily infests sheep (Asman *et al.*, 2021). Besides inducing inflammation, hair loss, and skin harm in animal hosts, *M. ovinus* also acts as a vector for multiple pathogens and is very likely involved in the life cycle and spread of harmful organisms (Zhang *et al.*, 2021). *Melophagus ovinus*, known as the sheep ked, is a small, brown, hairy fly without wings, measuring approximately 4 to 6mm in length, with a head that looks similar to that of a tick. The sheep ked consumes by drawing blood from its host by piercing the capillaries under the skin with its pointed mouthparts (Small, 2010). Many sheep keds are typically found on the shoulders, neck and underside of the host animal. While commonly called the 'sheep tick', sheep keds live their whole life cycle on their host, setting them apart from actual ticks (Williams, 2009; Taylor, Coop and Wall, 2016).

The feeding of keds results in extensive scratching, itching, intensified by the hosts' rubbing, and biting due to the irritation. In young lambs, blood loss to keds can be enough to lead to a clear anemia, resulting in a subsequent decrease in growth rates and production (Small, 2010). Sheep ked distribution is native to most of Europe including Iceland, and the Faroe Islands, as well as North West Africa. They are also found in Mongolia and North India, they were introduced and established in Kenya, South Africa, Japan, Australia, New Zealand, most of North America and many parts of South America, including Tristan da Cunha and the Faikland Islands.

2.6.1 Immune response and effects

In lambs, the sheep ked may cause anaemia and reduce weight gain (Siminathan, 2020). It feeds on the blood of its host, so cause irritation to the sheep leading it to rub, producing both loss and damage of the wool (Rizwan, 2023). It also makes firm hard nodules that develop on the skin called cockie, this will reduce the value of the hide. The keds faeces also stain the sheep's wool thereby reducing its value (Vineeth, 2020). In 2023 Tahir found out that they also transmit *Trypanosoma melophagium* non-pathogenic protozoan parasite of sheep. The sheep keds can transmit Blue tongue virus in sheep, though little evidence suggests they are blue tongue vectors

in nature. A sheep's response to keds reduces capillary flow to the skin (Maity, 2020). Although this response is trying to combat the keds infestation, it also results in a less abundant and lower quality fleece (Borja, 2022).

2.6.2 Treatment

Adult keds can be killed using treatment dips and sprays most commonly containing ivermectin or pyrethrin (Li, 2020). However, the pupal stage is resistant to treatment, so treatment must be repeated at 24 to 28-day intervals (Basu, 2023). Using insecticides with a 3-to-4-week residual activity would also eliminate emerging adult keds (Das, 2024). Additionally, because both adults and pupae stages live in the wool of the sheep, shearing can dramatically reduce the keds population. It would be most beneficial to shear before insecticide treatment (Gram, 2020). Most modern treatments used to control sheep lice also control sheep keds infestations (Crawford, 2022).

2.6.3 Sheep resistance to keds

Some sheep have been shown to be resistant to the harmful effects of sheep keds (Zheng, 2020). Resistant sheep's skin was historically examined and showed arteriolar vasoconstriction in addition to fibrinoid degeneration of the tunica media in the lower dermis (Baird, 2020). This sub-epidermal region showed an increased infiltration of eosinophils and lymphocytes (Hou, 2020). The upper dermis of resistant sheep showed an increase of empty capillaries filled with red cells (Haleem, 2023). The resistance of some sheep to keds was due to prolonged cutaneous arteriolar vasoconstriction in resistant sheep keds were unable to obtain enough blood and eventually died from starvation (Shipley, 2020).

2.7 Control of external parasites in sheep

The preventive and prophylactic treatment of ectoparasites on sheep is primarily through the application of insecticides or acaricides. The common methods of applying acaricides in sheep flocks are through plunge dipping, belly-bathing, foot-bathing, and pour-on and patch treatments (Oberem, 2017). The acaricide groups currently registered for use in livestock in South Africa are synthetic pyrethroids (e.g., Deltamethrin), amidines/formamidines (e.g., Amitraz), macrocyclic lactones (e.g., ivermectin), organophosphates (e.g., diazinon), and Insect-growth regulators (e.g., novaluron) (Oberem, 2017). The selection of the application method and the type of acaricides is influenced by the species of ectoparasites to be treated or controlled in a

flock of sheep. In *A. hebraeum* endemic areas, a strategic application based on the seasonal tick abundance should be practised. These may include weekly acaricide applications during the summer or wet season and reduced to fortnightly during the winter months (Latif, 2020). For the effective treatment of mite infestations, acaricide applications should be repeated at appropriate treatment intervals, such as every 8-10 days (Oberem and Oberem, 2011; Msuntsha *et al.*, 2017).

The prevention of ectoparasite infestations is best achieved by the implementation of biosecurity measures, such as quarantine and treatment of newly introduced animals, keeping fences intact and managing wool shearers' hygiene practices (Oberem and Oberem, 2011). In terms of tick control, chemical control is still the most utilised method for tick control provided that acaricides are rotated to avoid acaricide resistance. The latter is more prevalent to single host ticks, like *R. (B.) microplus* or *R. (B.) decoloratus*.

2.8 Diagnosis of ectoparasites

Most ectoparasites of sheep are found either on or in the skin, except for some flies, whose larval stages may be found in the host's somatic tissues (Taylor, 2010). In every instance, the diagnosis of an infestation relies on gathering and identifying the relevant parasite(s). The processes of collecting and identifying lice (*Bovicola* and *Linognathus spp.*), keds (*Melophagus spp.*), and Ixodidae ticks are not complicated in sheep and are identified using the morphological identification keys described by Walker *et al.* (2003) and Taylor, Coop and Wall (2016).

Sheep scab has been conventionally diagnosed based on clinical signs and confirmed by taking skin scrap samples from areas suspected of lesions, which are then examined under a microscope for the presence of *P. ovis* mites (Taylor, 2010). This method of diagnosis is very specific for sheep scab; the sensitivity can vary dramatically due to the difficulties related to identifying lesions during the early phases of the disease. Sheep scab is frequently mistaken for a lice infestation, as both conditions lead to severe itching, scratching, and loss of wool. The clinical symptoms of sheep scab are not specific, and microscopic analysis of skin scrapings demonstrates only low to moderate sensitivity; thus, diagnosing *P. ovis* infestation in sheep using these conventional approaches is inadequate (Ochs *et al.*, 2001).

A newly developed ELISA (Enzyme-Linked Immunosorbent Assay) detects serum antibodies targeting *Psoroptes* antigen, achieving diagnostic sensitivity of 93.7% and diagnostic specificity of 96.5% (Ochs *et al.*, 2001; Burgess *et al.*, 2012). The test has been used to conduct serosurveillance for *Psoroptes ovis* in sheep populations in some countries, and for the identification of infected sheep to institute selective treatment of only infected animals within flocks (Jacobson *et al.*, 2006).

2.9 Conclusion

Ectoparasites are important constraints to communal sheep production. Information regarding the ectoparasites species, and their prevalence affecting sheep in communal areas of the Eastern Cape Province of South Africa is limited. There is need therefore to determine the ectoparasites species composition in Mbashe local municipality and prevalence across the different sheep breeds in this communal area. The main aim of the present study was to gain a better understanding of the common ectoparasites and associated risk factors in the communal sheep population of the Mbashe Local Municipality, Eastern Cape Province.

CHAPTER 3: Materials and Methods

3.1 Study area

The Mbashe Local Municipality is located in the Eastern Cape, within the Amathole District Municipality (Fig.3). This local Municipality comprises three main towns: Dutywa, Willowvale (Gatyana), and Xhora (Elliotdale). The total area of the Mbashe municipality is 3,169 km². This region is predominantly inhabited by poor communal farmers who are Xhosa-speaking (Ndawule, 2012). Dutywa's typical yearly high temperature is around 23.70 °C, while the average annual low temperature stands at 11.60 °C. The yearly average rainfall is 534mm (Chipindu *et al.*, 2023).

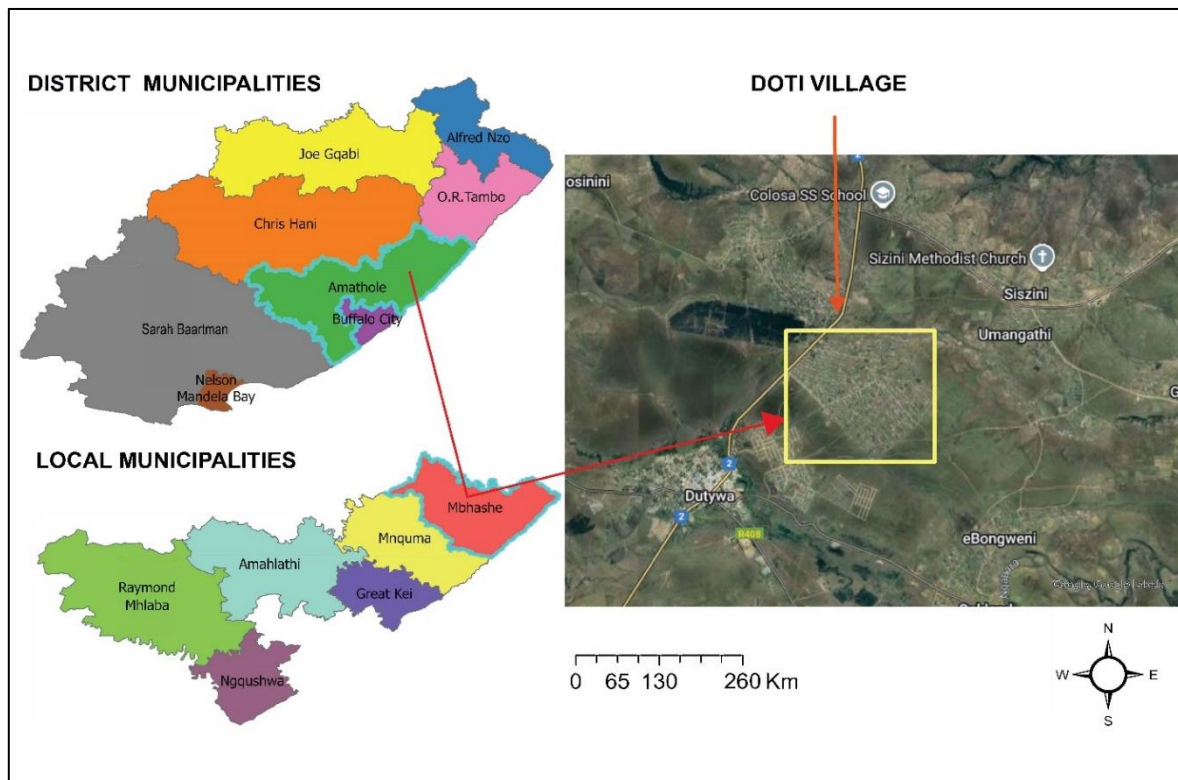


Figure. 3: Study area – Mbashe local municipality, Doti village

3.2 Study population.

There are approximately 250,000 sheep in the Mbashe communal areas, according to the 2023/2024 Mbashe local Municipality annual report. Mbashe Local Municipality has 59 villages; however, the researcher sampled a sheep from 30 farmers from the Doti community, with an approximate sheep population of 8,051. The research involved various age categories and

native sheep breeds maintained by local farmers in an area that implements a mix of crop-livestock farming system.

3.2.1 Livestock demographics and sheep populations in the Eastern Cape Province

The Eastern Cape is South Africa's leading livestock province, with 27.9% of households involved in agriculture. The province holds over 7.6 million sheep, representing about 29.5% to 30% of the national total, 38% of goats and 24.5 % of cattle thus making it the primary region of communal farming, wool and mohair production. Livestock is kept for income, food, cultural practices and insurance. The largest numbers of sheep are in the Eastern Cape (29.3%), Northern Cape (25.7%), Free State (20.0%), and Western Cape (11.0%) provinces. The Eastern Cape has the highest cattle population, with 3 million cattle, followed by KwaZulu-Natal with approximately 2.8 million cattle and then Free State has approximately 2.3 million (Stats, 2021).

3.3 Study design and sample size determination.

A cross-sectional study design was utilised to achieve the objectives of this study. This involved a stratified random selection of individuals from the sheep population. Data collection included tick collection, skin scraping, and other visible external parasites from the selected animals.

The sample size (n) was determined using the statistical formula by Thrusfield (2018):

$$n = Z^2 P (1 - P) / d^2$$

where n is the required sample size; Z is the 95% confidence interval (1.96), P is the estimated prevalence of infections, and d is the desired precision level (5 %). Since the prevalence of ectoparasite infestations in the study area's sheep flocks was not well documented, a 50% prevalence was assumed (Thrusfield, 2018). A minimum of 384 sheep and a 10% allowance were therefore planned to be sampled from this community.

3.4 Sampling approach

Although the minimum required sample size was 425 sheep, a total of 679 sheep were sampled from 30 sheep-owning households in the study area because more animals were made available by participating farmers than initially anticipated. A systematic random sampling was employed

by randomly selecting the first animal, after which subsequent animals were selected systematically until the predetermined number of animals allocated to each household had been sampled. Sheep were restrained in holding pens or kraals at selected homesteads for sample collection. Ectoparasites were collected from December to March, in the summer season.

3.4.1 Grading using Body Condition Scores (BCS)

Sheep were graded by body condition score by physically feeling the fat and muscle cover over the sheep's backbone and short ribs in the loin area. A standard scale of 1 - 5 was used to categorize animals into poor, medium and good as defined in table 2.

Table 2: Body Condition Score Grading

Grade	BCS	Description	Backbone Feel	Short Ribs Feel
Poor	1.0 - 2.0	Emaciated to thin	Sharp, prominent ridge	Sharp, easily pass fingers under ribs
Medium	2.5 - 3.5	Moderate to ideal	Rounded, need pressure to feel.	Rounded, firm pressure needed to feel ends
Good	4.0 - 5.0	Fat to obese	Hard to detect; Smooth/dimpled	Cannot be felt; Thick fat cover

3.5 Questionnaire Design and Administration

The questionnaire was designed to capture the socio-economic profile of sheep owners, their awareness of ectoparasites, and their adherence to good animal health and husbandry practices. The completion of the questionnaire lasted at least 60 minutes. A structured questionnaire was administered during in-person interviews with sheep owners during sample collection. Pre-test respondents were contacted and asked to participate in the questionnaire test. After the pilot test, respondents were asked additional questions about the questionnaire to help identify any design problems that may have caused misinterpretation of questions or issues with survey administration. The questionnaire is attached as Appendix and it comprises of 4 sections, namely; demographic information, sources of livelihood, sheep ownership and rearing as well as animal health practices.

3.6 Sample collection and Laboratory tests

3.6.1 Ticks

To identify ectoparasites, a clinical examination was conducted to provide a clearer view of the sheep. The skin was palpated, and the sheep's body was visually inspected using hands and brushes.

Ticks were detached from the sheep's skin using forceps whilst ensuring they maintain good condition for proper identification. This was achieved using high-quality steel forceps (Horak, 2014). These were medium sized with blunt points and saw-tooth like projections inner surfaces. The forceps were used to make a tight grasp of the scutum and mouthparts as closely to the host skin as possible and then pulled out of the skin. The targeted predilection sites for tick collection were inner surface of the ear, tail and perianal region, udder, scrotum, external genitalia, axilla, inner thighs, withers and back. Ticks from all different life cycle stages were collected whenever available.

3.6.2 Mites

Deep or superficial skin scrapings were used to sample and diagnose common mite infestations. A dulled, rounded scalpel blade (#10) and the scraped skin area were covered with mineral oil for a thorough skin scraping. The location chosen for scraping was at the edge of a lesion or the preferred area of the suspected parasite. The blade was pushed back and forth across the skin until blood was seen coming out.

3.6.3 Lice

The whole body of the sheep was examined and brushed with the main focus given to areas with longer fleece because that's where most lice would hide (Abbott, 2024).

3.6.4 Sample storage and Laboratory tests

All ectoparasites, namely the mites, lice and ticks, as well as any others found during inspections, were taken into sample bottles and stored in 70% alcohol as described by Tamerat and Zeryehun, 2015. Each species of ectoparasite was stored in a separate bottle per animal and labeled. The data sheet contained the unique identifier, host species, animal sex, animal age, collected ectoparasite species, collection site, sampling location, and the body condition score of the animal (Alemu *et al.*, 2016). The total number of animals in the flock or household, along with the socio-economic and demographic factors of the farmers, was recorded (Stoltz, 2014).

A checklist was created and used to record the number of ticks observed on animals during data collection (Madder, 2014).

The collected samples were examined under a stereo microscope and identified according to keys and descriptions prescribed by (Walker *et al.*, 2003) for ticks and (Taylor, Coop and Wall 2016) for lice and mites.

3.7 Data management and analysis

3.7.1 Data management

The collected data were entered into Microsoft Excel (Version 2509) spreadsheets and analysed using the Statistical Package for the Social Sciences (SPSS Version 26). Descriptive statistics of frequencies (prevalence rates) of various species of ectoparasites found were computed and presented in tables. Chi-square or Fisher's exact test was used to compare the categorical variables. These categorical variables were examined for potential associations with external parasite infestations (e.g., ticks, mites, lice, and keds) in relation to sex, age groups, and animal health and husbandry practices within the sampled flocks. Sex, age and body condition scores were independent variables, and ectoparasite infestations (Firstly, irrespective of type found, then sub-grouped by type of ectoparasite) were the dependent variable (outcome) for this study. A Binary logistic regression model was fitted to the data to assess factors significantly associated with infestation (Kumsa *et al.*, 2012).

3.8 Ethical clearance

The study commenced only after ethics clearance was obtained from the UNISA CAES Research Ethics Committee (2023/CAES_AREC/019). The researcher ensured that all participants in the data collection had protective clothing to prevent tick bites. The importance of the research was explained to the public. The researcher ensured that participants voluntarily signed the consent form. Additionally, the researcher respected the participants' privacy and dignity, ensuring their protection. Study conductors ensured that the animals' health care and welfare were maintained. The permission to conduct this research in terms of Section 20 of the Animal Diseases Act, 1984 (Department of Agriculture, land reform and rural development, Pretoria, South Africa; reference number: 12/11/1/1/23 & 12/11/16 (2496SS)).

CHAPTER 4: Results

4.1 Sociodemographic characteristics of the respondents

The socio-demographic characteristics of study participants are summarised in Table 2. A total of 30 sheep farmers were interviewed in the study. Most participants, 24 (80%), were men, while 6 (20%) were women. Ten (33%) of the respondents held tertiary-level qualifications, while 37% had completed Grade 12, 23% had only completed secondary school, and 7% had no formal schooling. The participants' ages ranged from 25 to 79, with an overall mean of 57 years.

Table 3: Sociodemographic characteristics of the respondents.

Variable	Category	Total (N = 30)	Percentage
Gender	Male	24	80
	Female	6	20
Age (Years)	<35	4	13
	36-60	11	37
	>60	15	50
Education level	No School	2	7
	>Grade 12	7	23
	Grade 12	11	37
	Tertiary	10	33
Household size	<10	24	80
	11-20	4	13
	>20	2	7
Number of sheep owned	<20	7	23
	21-50	6	20
	>50	17	57

4.2 Overall Prevalence of Ectoparasites:

The overall prevalence of ectoparasites recorded was 42.0% (95% CI, 39-46%) among 679 sheep examined. Ectoparasite species found were *R. appendiculatus* (18.5%), *Hyalomma rufipes* (5.5%), *Psoroptes ovis* (13%), *Bovicola ovis* (12.1%), *Ligognathus africanus* (1%) and *Melophagus ovinus* (2.4%) (Table 3).

Table 4: Overall prevalence of ectoparasites per species

Sheep (n= 697)			
Species	No. of positives	Prevalence (%)	95% CI *
<i>Psoroptes Ovis</i>	93	13.0	11-16
<i>Hyalomma rufipes</i>	38	5.5	4-7
<i>Rhipicephalus appendiculatus</i>	129	18.5	16-21
<i>Bovicola ovis</i>	84	12.1	10-14
<i>Linognathus africanus</i>	6	1.0	0-2
<i>Melophagus ovinus</i>	17	2.4	1-4
Overall/Average	295	42.0	39-46

* CI: Confidence intervals calculated on 1000 bootstrap samples.

4.3 The prevalence of tick infestations based on risk factors

The prevalence of tick infestations in male and female sheep, as shown in Table 4, was 24.0% and 23.4% respectively, but not statistically significantly ($X^2 = 0.027$, $p = 0.869$). However, the prevalence of tick infestations based on sheep breed was highest in mixed breeds (30.0%) and lowest in the Dorper breed (17.0%). Dohne Merino had a prevalence of 24% and Merino had a prevalence of 23.0%. There were no statistically significant differences in tick infestations among the breeds tested ($X^2 = 5.540$, $p = 0.136$). Adult sheep (23.5%) were more susceptible to tick infestations than young sheep (18.0%), statistically significant ($X^2 = 1.880$, $p = 0.170$). The prevalence of tick infestations was 23.0% (95% CI = 14-31) in sheep with poor body condition scores. Sheep having a good body condition score had the highest prevalence of 24.0% (95% CI = 20-27). The lowest prevalence of tick infestation was 18.0% (95% CI = 4-37) recorded for sheep with a medium body score condition. However, there was no statistically significant association between body condition score and tick infestations ($X^2 = 0.437$, $p = 0.804$).

Table 5: The prevalence of tick infestations on sheep

Variables	Category	Animals tested	No. of positives	Prevalence (%)	95% CI	χ^2	<i>df</i>	<i>P</i> -value
Sex	Male	192	46	24.0	18-30	0.027	1	0.869
	Female	505	118	23.0	20-27			
Breed	Dorper	144	25	17.0	11-24	5.540	3	0.136
	Dohne Merino	373	90	24.0	20-28			
	Merino	73	17	23.0	14-32			
	Mixed breed	107	32	30.0	21-39			
Age-group	Adults	593	145	24.5	11-28	1.880	1	0.170
	Young	104	19	18.0	11-26			
Body condition score	Poor	93	21	23.0	14-31	0.437	2	0.804
	Medium	22	4	18.0	4-37			
	Good	582	139	24.0	20-27			

CI: Confidence intervals based on 1000 bootstrap samples.

4.4 The prevalence of mite infestations based on risk factors

The prevalence of mite infestations in male and female sheep, as shown in Table 5, was 19.0% and 11.0% respectively. The Pearson Chi-squared test revealed a significant association between prevalence rates and sheep gender ($X^2 = 8.054$, $p = 0.005$). The prevalence of mite infestation varied by sheep breed, with the highest rate observed in the Dorper breed (17.0%) and the lowest in the Merino and mixed breeds (11.0%). The Dohne Merino had a prevalence of 13.0%. There was no statistically significant association between the prevalence of mite infestations and the breeds of sheep ($X^2 = 2.167$, $p = 0.538$). Adult sheep were more prone to mite infestations than young sheep, with a prevalence of 14.0% whilst young sheep had a prevalence of 11.0%, although not statistically significant ($X^2 = 0.809$, $p = 0.368$). The prevalence of mite infestations was 95.0% (95% CI = 89-99) in sheep with poor body condition scores. The lowest prevalence of mite infestations was 0.3% (95% CI = 0.0 – 1.0), in sheep with a good body condition score. Sheep with a medium body condition score had a prevalence of 14.0% (95% CI = 0.0–29.0). The prevalence of mite infestations was positively associated with body condition scores of sheep ($X^2 = 616.436$, $p < 0.001$).

The results of univariable analysis of potential risk factors demonstrated a significant positive association with gender and the body condition score ($\chi^2 = 8.054$, $p < 0.005$; $\chi^2 = 616.436$, $p < 0.001$, respectively). Further multivariable regression analysis revealed that the prevalence of mite infestation was significantly associated with gender (OR = 1.9, 95% CI: 1.2 - 3.0, $p < 0.001$) and the body condition score (OR = 45.78, 95% CI 7.224- 290.231, $p < 0.001$), as shown in Table 6 and Table 7.

Table 6: The prevalence of mite infestations on sheep

Variables	Category	Animals tested	No. of positives	Prevalence (%)	95% CI	χ^2	df	<i>P</i> -value
Sex	Male	192	37	19.0	14-25	8.054	1	0.005
	Female	505	56	11.0	8-11			
Breed	Dorper	144	24	17.0	11-23	2.167	3	0.538
	Dohne Merino	373	49	13.0	10-17			
	Merino	73	8	11.0	4-19			
	Mixed breed	107	12	11.0	6-18			
Age-group	Adults	593	82	14.0	11-17	0.809	1	0.368
	Young	104	11	11.0	5-17			
Body condition score	Poor	93	88	95.0	89-99	616.436	2	<0.001
	Medium	22	3	14 .0	0.0-29			
	Good	582	2	0.3	0.0-1.0			

CI: Confidence intervals based on 1000 bootstrap samples.

Table 7: Logistic regression analysis of potential risk factors for mite infestations.

Variables	Category	<i>T. parva</i> IFAT		
		OR	95% CI for OR	<i>p</i> -value
Gender	Male	Ref	-	-
	Female	1.9	1.2 - 3.0	0.005
Body condition score	Good	Ref	-	-
	Medium	45.789	7.224 – 290.231	<0.001
	Poor	5104.0	975.24 – 26711.83	<0.001

OR: Odds Ratio; CI: Confidence intervals

4.5 The prevalence of ked infestations based on risk factors

The prevalence of ked infestations in males and females, as shown in Table 7, was 2.0% and 3.0% respectively, but statistically insignificant ($X^2 = 0.141$, $p = 0.707$). The prevalence of ked infestations varied by sheep breed, with the highest (4.0%) in Merino and the lowest in Dorper (1.0%). Dohne merino had a prevalence of 3.0% and the mixed breed had a prevalence of 2.0%. There was no statistically significant association for ked infestations with the breeds of sheep ($X^2 = 1.761$, $p = 0.623$). Adult sheep seem to be more susceptible to ked infestations than young sheep, with the prevalence of 3.0% and 1.0% respectively. There is, however, no statistically significant association of the prevalence of ked infestations and the age group ($X^2 = 1.121$, $p = 0.290$). The prevalence of ked infestations was 0.0%, 0.0%, and 5.0% for poor, medium, and good body condition scores, respectively; however, this difference was not statistically significant ($X^2 = 6.2142$, $p = 0.045$).

Table 8: The prevalence of ked infestations based on risk factors

Variables	Category	Animals tested	No. of positives	Prevalence (%)	95% CI	χ^2	df	P-value
Sex	Male	192	4	2.0	0-4	0.141	1	0.707
	Female	505	13	3.0	1-4			
Breed	Dorper	144	2	1.0	0-4	1.761	1	0.623
	Dohne Merino	373	10	3.0	1-5			
	Merino	73	3	4.0	0-9			
	Mixed breed	107	2	2.0	0-5			
Age-group	Adults	593	16	3.0	1-4	1.121	1	0.290
	Young	104	1	1.0	0-3			
Body condition score	Poor	93	0	0.0	ND	6.2142*	2	0.045
	Medium	22	0	0.0	ND			
	Good	582	17	3.0	2-4			

CI: Confidence intervals based on 1000 bootstrap samples. ND: Not done. Likelihood Ratio χ^2 *

4.5 The prevalence of lice infestations based on risk factors

The prevalence of red lice infestations, as shown in Table 8, was slightly higher in female (13.0%) than male (10.0%) sheep, although statistically insignificant ($X^2 = 0.668$, $p = 0.414$). The prevalence in the Dohne Merino breed and the mixed breed was 13.0% and 12.0%, respectively. The prevalence was 10.0% for both Dorper and Merino breeds; however, there was no statistically significant association ($X^2 = 1.880$, $p = 0.165$). Adult sheep have a higher prevalence of red lice infestations than young sheep, at 13.0% and 8.0%, respectively; however, this difference is not statistically significant ($\chi^2 = 2.192$, $p = 0.139$). The prevalence of red lice infestations was 20.0%, 9.0% and 11.0% for poor, medium and good body condition scores, respectively. A statistically significant association was found between the body condition score and red lice prevalence of lice infestations ($X^2 = 7.168$, $p = 0.028$).

The prevalence of blue lice infestations was slightly higher in male (1.0%) than in female sheep (0.8%), but not statistically significant ($p = 0.669$) (Table 9). No blue lice were detected in the Dorper breed or mixed breeds. The prevalence was 1.0% for both the Dohne Merino and Merino breeds; however, this difference was not statistically significant ($\chi^2 = 5.837$, $p = 0.146$). The prevalence of blue lice was slightly higher in young sheep (1.0%) and adult sheep (0.8%), although not statistically significant ($p = 0.622$). The sheep with a poor body condition score had a prevalence of 1.0% and those with a good body condition score had a prevalence of 0.9%. There was no statistically significant association with the body condition scores ($\chi^2 = 0.427$, $p = 0.808$). Overall, the prevalence of red lice was higher than that of blue lice.

Table 9: The prevalence of red lice infestations on sheep

Variables	Category	Animal tested	No. of positives	Prevalence (%)	95% CI	χ^2	df	P-value
Sex	Male	192	20	10.0%	6-15	0.668	1	0.414
	Female	505	64	13.0	10-16			
Breed	Dorper	144	14	10.0	5-15	1.880	3	0.615
	Dohne Merino	373	50	13.0	10-17			
	Merino	73	7	10.0	3-16			
	Mixed breed	107	13	12.0	7-18			
Age-group	Adults	593	76	13.0	10-15	2.192	1	0.139
	Young	104	8	8.0	3-14			
Body condition score	Poor	93	19	20.0	12-28	7.168*	2	0.028
	Medium	22	2	9.0	0.0-24			
	Good	582	63	11.0	9-13			

CI: Confidence intervals based on 1000 bootstrap samples. Likelihood Ratio χ^2 *

Table 10: The prevalence of blue lice infestations on sheep

Variables (Risk Factors)	Category	Animals tested	No. of positives	Prevalence (%)	95% CI	χ^2	<i>df</i>	<i>P</i>-value
Sex	Male	192	2	1.0	0.0 - 3	-	-	0.669*
	Female	505	4	0.8	0.0 - 2			
Breed	Dorper	144	0	0.0	ND	5.837	1	0.146*
	Dohne Merino	373	5	1.0	0.0 - 3			
	Merino	73	1	1.0	0.0 - 5			
	Mixed breed	107	0	0.0	ND			
Age-group	Adults	593	5	0.8	0.0 - 0.2	-	-	0.622*
	Young	104	1	1.0	0.0 - 0.3			
Body condition score	Poor	93	1	1.0	0.0 - 4	0.427	2	0.808*
	Medium	22	0	0.0	ND			
	Good	582	5	0.9	0.0 - 2			

CI: Confidence intervals based on 1000 bootstrap samples. ND: Not done. Fishers Exact Tests or Likelihood Ratio χ^2 *

4.6 The prevalence of ectoparasites based on the type of kraals/pens

The prevalence of ectoparasites, based on rearing facilities, as shown in Table 10, was 14.0% (95% CI = 10-18) in sheep kept in fenced kraals. Sheep kept in a wooden kraal had a prevalence of 13.0% (95% CI = 10–17) for sheep scab. The prevalence of sheep scab in sheep kept in fenced and wooden kraals was 9.0% (95% CI 2–17). Tick infestations in sheep kept in fenced and wooden kraal recorded a higher prevalence of 27.0% (95% CI = 14–41), but lower prevalence (22.0%) (95% CI = 18–27) for sheep kept in wooden kraal. Sheep kept in fenced kraals had a prevalence of 25.0% (95% CI = 18–27) for tick infestations. The prevalence of red lice in sheep kept in fenced and wooden kraals was 12.0% (95% CI = 9 – 16) and 13.0% (95 % CI = 4-22). for sheep kept in fenced and wooden kraals. Sheep kept in fenced kraals had a prevalence of blue lice of 2.0% (95% CI = 0-3), whereas the prevalence in a wooden kraal was 0.3% (95% CI = 0-2). There were no blue lice detected in sheep kept in fenced and wooden kraals. The prevalence of ked in sheep kept in fenced kraal was 5.0% (95% CI = 2-7), and in wooden kraals it was 1.0% (95% CI = 0-2), but no ked in fenced and wooden kraals.

Table 11: Prevalence of ectoparasites by type of shelter or kraals

Type of Ectoparasites	Variables	Animals tested	No. of positives	Prevalence (%)	95% CI	χ^2	df	P value
Sheep Scab (Psoroptes Ovis)	Fenced kraal	285	41	14.0	10-18	1.138	2	0.566
	Wooden kraal	357	47	13.0	10-17			
	Fenced & Wooden kraal	55	5	9.0	2-17			
Tick Infestation	Fenced kraal	285	70	25.0	19-30	0.986	2	0.611
	Wooden kraal	347	79	22.0	18-27			
	Fenced & Wooden kraal	55	15	27.0	14-41			
Red Lice	Fenced kraal	285	34	12.0	8-16	0.028	2	0.986
	Wooden kraal	347	43	12.0	9-16			
	Fenced & Wooden kraal	55	7	13.0	4-22			
Blue Lice	Fenced kraal	285	5	2.0	0-3	4.555	2	0.103
	Wooden kraal	347	1	0.3	0-1			
	Fenced & Wooden kraal	55	0	0.0	ND			
Ked	Fenced kraal	285	13	5.0	2-7	9.379	2	0.009
	Wooden kraal	347	4	1.0	0-2			
	Fenced & Wooden kraal	55	0	0.0	ND			

CI: Confidence intervals based on 1000 bootstrap samples. ND: Not Done

4.7 Farmers' perception of the most important diseases on their flocks.

Participants were further asked to rank common diseases associated with ectoparasite infestations, as well as other important diseases affecting sheep, according to their perceived level of importance. As shown in Figure 4, sheep scab was perceived as the most important disease, with 97% of participants rating it as very important and only 3% rating it as least important. Pulpy kidney was the second most highly ranked disease, with 10% and 60% of participants considering it very important and important, respectively. Heartwater (ehrlichiosis) and lameness were also perceived as important diseases. Heartwater was rated as very important by 23% of participants and important by 30%, while lameness was rated as very important by 17% and important by 57%. Foot rot or foot abscess and Karoo paralysis were also regarded as important, with the majority of participants rating them as important or moderately important. In contrast, spring lamb paralysis received more varied responses, indicating less agreement among participants regarding its relative importance.

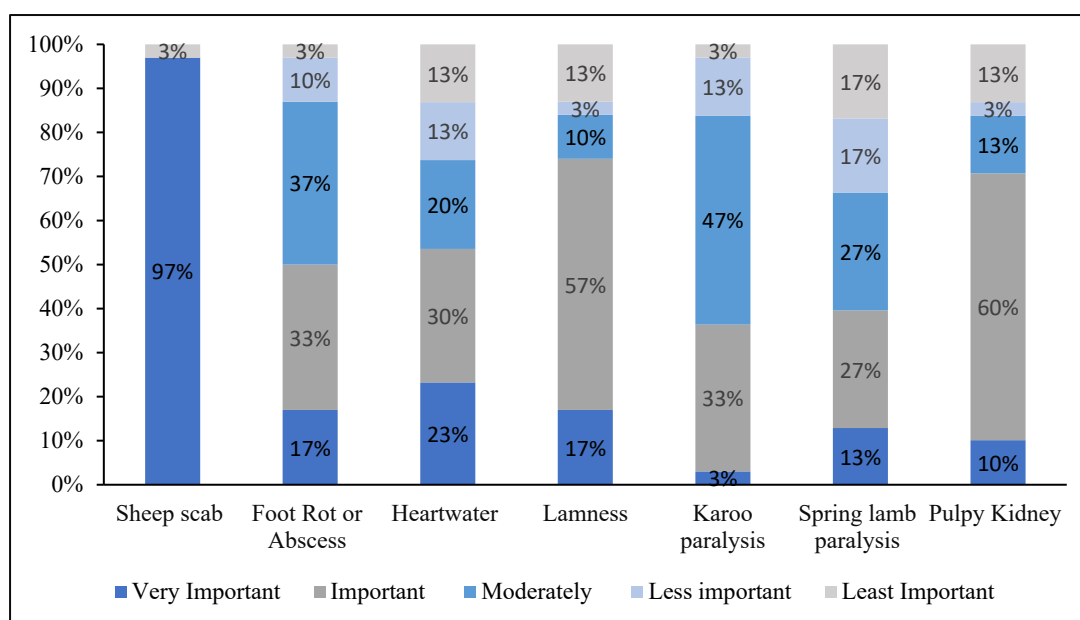


Figure 4: Common sheep diseases ranked by participants according to perceived importance

4.8 Farmer's knowledge of the clinical signs of sheep scab and control measure practices

To determine the level of knowledge about the common skin disease/s associated with ectoparasites, participants were asked about the clinical signs they observed, and the medications used for treatment in the event of a suspected outbreak. Figure 5 presents the responses from farmers regarding sheep scab, translated from the local language (isiXhosa) into English. The clinical

signs observed by these farmers are consistent with those reported and documented in the literature regarding the clinical manifestations of sheep scab (Bezuidenhout, 2011). The farmers observed itchiness or scratching against the fences or walls (33%). Loss of wool (27%), skin lesions/wounds (22%) and weight loss (18%). The participants indicated that the observed clinical signs primarily manifest in combination. The farmers employ various methods for ectoparasite control, with the majority believing that acaricides are effective. Most farmers used injectable formulations, such as ivermectin or doramectin, supplemented with amitraz-based dips. Table 11 lists acaricides mentioned by farmers, in no order of importance, but mainly dependent on their availability. The study also revealed that most farmers (90%) use oxytetracyclines (OTCs) to treat their animals during outbreaks of heart or infectious diseases. Some farmers (10%) also indicated the use of penicillin and Sulphadimethoxine antibiotics as well. Most respondents (80%) believe that the high prevalence of ectoparasites is mainly associated with the spring months (March and April) and the early summer months (May, June, July). Some participants (20%) reported observing clinical signs of infestations during the early autumn and winter months, specifically in April, May, June, and August.

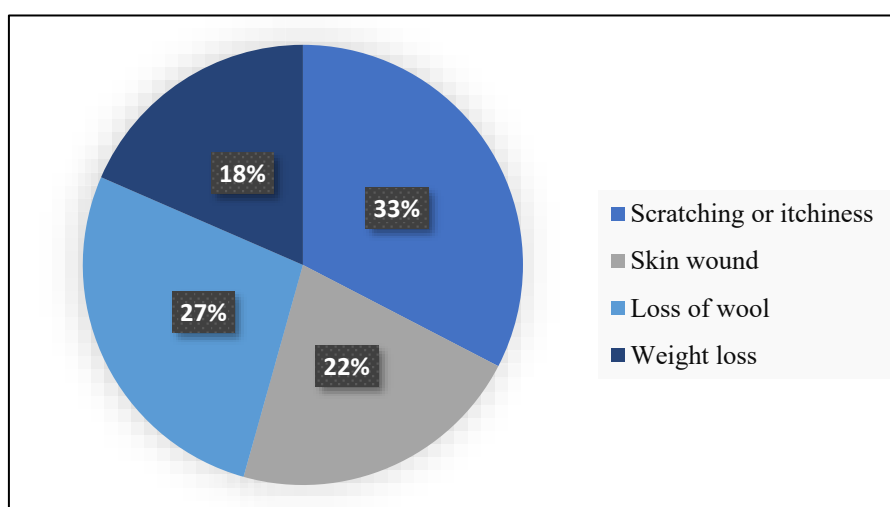


Figure 5: Clinical signs associated with sheep scab

Table 12: Participants' responses regarding the acaricides used in ectoparasite control.

Acaricides type	Farmers
Eraditick, ivermax	8
Eradick/Tactic and ecomectin	2
Dextomax, Tactic and ecomctin	4
Ivermectin, Ivomec super	9
Dectomax and Eraditick	2
Dextomax and eraditick	4
Tactic, eraditick	1

4.9 Limitations of the Study

The study provided valuable information about the ectoparasites prevalent in the study area; however, including more villages would have provided comprehensive information that could be used to infer the findings to the entire local municipality.

CHAPTER 5: Discussion

The findings of this study revealed valuable information on the prevalent ectoparasites of sheep in communal reared flocks. The overall prevalence of 42% recorded for ectoparasites is comparable to the findings in African regions. Amare et al. (2013) and Seyoum et al. (2015) reported a prevalence of ectoparasites of 44.9% and 47.7%, respectively, in different regions of Northwest Ethiopia. Zita et al (2014) reported an ectoparasite prevalence of 69.8% in sheep flocks in Anambra State, Nigeria. These relatively high infestation rates may be attributed to several key factors, including favourable climatic conditions, malnutrition, particularly during the prolonged dry season (Barta *et al.*, 2021). The inadequate husbandry systems, limited awareness among farmers of the effects of ectoparasites, and insufficient animal health services in the study area also contribute to the high infestation rates.

The prevalence of blue lice was slightly higher in young sheep (1.0%) and adult sheep (0.8%), although not statistically significant ($p = 0.622$). This might be because the young animal's wool and hair are not fully developed, leaving them unable to protect themselves from ectoparasite infestations. Therefore, the susceptibility of young animals to ectoparasite infestations is attributed to a higher ratio of accessible surface to body volume and poor grooming behaviour (Barmon *et al.*, 2010).

Among the various species of ectoparasites found, ixodid tick infestations (24%) were the dominant ectoparasites in this study area. These findings are contrary to those of Seyoum et al. (2015), who reported a higher prevalence of lice (26.3%) compared to ticks (18.4%). The identified species of ticks were adults of *Rhipicephalus appendiculatus* (18.5%) and *Hyalomma rufipes* (5.5%). The *R. appendiculatus* is a three-host tick mostly found in the higher-rainfall areas of South Africa. These include suitable regions in the southern-central and north-eastern regions of the Eastern Cape, most of KwaZulu-Natal, eastern Mpumalanga, the Limpopo, northern Gauteng, and the northeastern regions of the North West provinces. (Spickett, 2013). The adult *R. appendiculatus* are more abundant during the summer or wet season of the year (Spickett, 2013; Horak *et al.*, 2018). This seasonal occurrence is consistent with our results, as the study was conducted between December and March. These findings are comparable to previous reports on the occurrence of *R. appendiculatus* in the sheep population of the Eastern Cape province (Horak *et al.*, 1991; Nyangiwe *et al.*, 2023). Heavy infestations cause tissue

damage, resulting in abscesses, loss of ear pinnae and wounds on the udder (Spickett, 2013). A heavy tick load can also result in blood loss (anaemia), severe allergic reactions, and tick toxicosis, due to toxins contained in tick saliva (Onyiche and MacLeod, 2023). The findings of adult *H. rufipes* during the summer months in this study are consistent with previous reports on the seasonal occurrence of this tick in the Eastern Cape Province and south-western Free State (Horak *et al.*, 1991; Nyangiwe *et al.*, 2020). *Hyalomma spp.*, due to their large mouthparts, are associated with wounds that may be invaded by bacteria, resulting in the formation of abscesses, lameness, and foot rot. (Fourie and Kok, 1995).

The sheep scab mite (*Psoroptes ovis*) was the second-largest ectoparasite recorded, with an overall prevalence of 13%. These results are comparable to those of Tasawar *et al.* (2007), who reported an overall prevalence of *Psoroptes spp.* of 14% in Pakistan. On the contrary, Yasine *et al.* (2015) reported an overall prevalence of 1.6% of *Psoroptes spp.* in the Amhara Region, northeastern Ethiopia. Jaja and Wanga-Ungeviwa (2022) reported a seasonal prevalence of sheep scab of 58% in autumn, 18% in summer, 15% in spring, and 8% in winter, as diagnosed by the State veterinary laboratory services in the Eastern Cape Province. In this study, the prevalence of sheep scab mite infestations was significantly higher in males (19%) than in females (11%). Sheep with poor body condition scores were associated with significantly higher prevalence (95%) of mite infestations compared to those with good body condition scores. The large OR observed for sheep in poor body condition should be interpreted with caution, as the very low prevalence of infestation among sheep in good body condition likely inflated the effect estimates. However, the findings indicate a strong and statistically significant association between poor body condition and mite infestation. *Psoroptic* mange is a highly contagious and debilitating skin disease of sheep that severely affects the health and productive capacity of affected animals (Nadia, Haider, and Muna, 2016). A questionnaire survey by Bath *et al.* (2016) on diseases and problems affecting sheep and goats in communal farming regions of the Eastern Cape province revealed that sheep scab is ranked the highest priority by farmers and veterinary professionals.

The study revealed a prevalence of 13% for sheep red lice infestations among the examined animals, with a slightly higher prevalence in females (13.0%) compared to males (10.0%). The higher prevalence of red lice infestations was significantly associated with poor body condition scores. Kumsa *et al.* (2012) reported a 27% prevalence of sheep red lice (*Bovicola ovis*) in

central Oromia, Ethiopia, while Seyoum et al. (2015) reported a prevalence of 8.9% in the Northwest region of Ethiopia. Adang, Ayuba and Yoriyo (2015) reported a much lower prevalence of 3.9% of red lice in the sheep population in Gombe State, Nigeria. In this study, blue lice were only detected in 1% of sheep examined. Lice infestation may be higher in emaciated animals that suffer from malnutrition and other parasitic diseases (Seyoum *et al.*, 2015). Of the sheep examined, 2.4% were infested with *Melophagus ovinus* (sheep keds). High sheep infestations cause inflammation, wool loss, skin damage, and reductions in weight gain, and have huge economic consequences on the sheep industry (Zhang *et al.*, 2021). This prevalence is significantly lower than that reported by Seyoum et al. (2015), who reported a prevalence of 9.5% for *Melophagus ovinus*.

The farmers' responses on the interview questionnaire about important diseases in their flocks revealed that 97% regarded sheep scab as a very important disease. The second most significant disease was lameness, with 74% of participants considering it important. Approximately 70% of respondents considered kidney disease to be important, and 53% considered heartwater (ehrlichiosis) important. These results are comparable to those reported by Bath et al. (2016), in which the interviewed farmers identified sheep scab, heartwater, clostridial diseases (mainly pulpy kidney), endoparasites, and bluetongue as the most significant diseases affecting their flocks. Mthi and Nyangiwe (2018) reported that farmers ranked diseases and parasites as the major challenges for sheep production in the communal areas of the Eastern Cape Province.

The farmer's responses regarding the clinical signs associated with sheep scab on their flock were consistent with those reported and documented in the literature regarding the clinical manifestations of sheep scab (Bezuidenhout, 2011). The farmers reported observing itchiness or scratching against fences or walls, loss of wool, skin lesions/wounds, and weight loss. There are findings comparable to those reported by Yawa et al. (2024), who noted that most farmers observed wool loss (72.5%) and rubbing (27.5%) on fences and walls as the clinical signs associated with sheep scab. In this study, farmers reported employing various methods for ectoparasite control. Most farmers use injectable formulations, such as ivermectin or doramectin, supplemented with amitraz-based dips. The frequency of use varied among farmers, depending on the availability of necessary resources. Yawa et al. (2024) reported that farmers use pour-ons (61.25%), plunge dips (22.5%), and hand dressing (16%) in the treatment of sheepscab.

CHAPTER 6: Conclusion and recommendations

6.1 Conclusion

The results of this study showed ectoparasites that are prevalent in the sheep population of the Doti community in the Idutwa area of Mbhashe Local Municipality. The ixodid ticks were the most abundant ectoparasite in the study area, followed by the mite, lice and sheep ked, respectively. Ectoparasites pose a significant challenge to the health, welfare, and productivity of sheep in most sheep farming areas. These parasites irritate sheep, leading to rubbing and scratching, which further damages the wool and skin. The blood-sucking species cause anaemia, impairing overall health, weight loss, and reproductive function. This subsequently results in reduced sheep production, leading to economic losses through damaged wool, downgraded skins, reduced growth, and lower milk yields. The results of this study reveal that sheep scab is the major challenge facing sheep farms in this area. To reduce the impact of ectoparasites in sheep, control methods tailored to the endemic ectoparasites in the area should be designed and implemented diligently. Moreover, awareness creation about the importance and prevention of ectoparasites among smallholder sheep-producing farmers is crucial. The farmers' awareness and training should also include the prudent use of acaricides in a manner that adequately controls the ectoparasites while preventing the development of acaricide resistance.

6.2 Recommendation

- Control programs with involvement of all stakeholders should be prepared and put in practice.
- There is a need to educate farmers on appropriate control methods and determine which one works best for their flocks.
- Regular and updated information on new acaricide drugs available on the market. This will help farmers rotate the use of acaricides in a way that limits the overuse of a particular group, which may subsequently result in the development of resistance.
- Training of farmers on supplementary feeding. Sheep with good nutrition and body condition score are less susceptible to ectoparasite infestation.
- Raise awareness of the importance of applying good biosecurity and hygiene practices to their flocks.

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Appendix A: Questionnaire

PREVALENCE AND RISK FACTORS OF ECTOPARASITES IN SHEEP IN MBASHE MUNICIPALITY, EASTERN CAPE

Date:	Name of Interviewer:
Name of farmer:	Farm/Diptank:
Contact numbers	Village:
Province	District:

Part 1: DEMOGRAPHIC INFORMATION *(Please mark (with x) the appropriate answer)*

1.1. Age in years

1.2. Race

1.3. Sex

1.4 Education

No School	< Grade 12	Grade 12	Tertiary
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1.5 Household size

1.6 Farming experience (years)

Part 2: SOURCES OF LIVELIHOOD

1.1. Indicate your main source/s of income

Livestock sales	
Wage income/ salary	
Social grants	
Payment	
Other (specify):	

PART 3: SHEEP OWNERSHIP AND REARING

3.1 How many sheep do you own ?

Class	Ewe	Rams	Wether	lambs
Numbers				

3.2 Type of sheep overnight pens or kraals

Part 4 – ANIMAL HEALTH PRACTICES

4.1 What characteristics do you use to assess the general condition of your sheep?

Characteristics	Rank/Importance in classification (5-high & 1-least)
Body condition (including wool)	
Ticks or lice infestations	
Habitus	
Eating behaviour	
Other, specify.....	

4.2 Do you usually vaccinate your sheep?

If yes, please fill the following table.

Name of disease	Name of the vaccine

4.3 What are the most common diseases of sheep caused by ectoparasites in your area?

Diseases	Rank 1-5 (1- least common & 5 -most common)	Which ectoparasites are associated with the disease or condition?
Sheep scab		
Foot Abscess		
Heartwater		
Lameness		
Karoo paralysis		
Spring lamb paralysis		
Others (specify		

4.4 What are the most ectoparasites of sheep you encounter? (Rank 1-5) with 5 being the most prevalent ectoparasite and 1-least prevalent).

Ectoparasites	Rams	Ewe	Wether	Lambs
Ticks				
Mites				
Lice				
Other (specify).....				

4.5 During which month/s do you see them a lot?

.....

4.6 Do you control ticks, mites, and Lice?

Yes	No
-----	----

If yes, what control measures do you use and how often?

	Dipping	Pour-ons	spray	injectable	other
Weekly					
Monthly					
Quarterly					
Other (specify):					

4.7 What (product/s) do you use to treat ticks, mites and lice.....

.....

4.8 Who pays for your tick, mites and lice control?

.....

4.9 Have your sheep been affected by sheep scab before?.....

4.10 How did you know that it was sheepscab?.....

4.11 Can you please explain the clinical signs that you observed.....

.....

.....

.....

.....

4.12 How long (days or weeks) do they suffer from the Sheep scab?

.....

4.13 Do you treat sheep that are suffering from Sheep scab?

4.14 What do you use for treatment ?.....

4.15 For how long (weeks) do you treat.....

4.16 Do they get better after treatment?.....

4.17 Do you seek specialist advice for sheep that are suffering from sheep scab?.....

4.18 Whom do you normally consult?

.....

End

Thank You!