Review article
UDC 636.2:595.42(68)
https://doi.org/10.46784/e-avm.v18i1.410

A SYSTEMATIC REVIEW AND META-ANALYSIS OF CATTLE TICK INFESTATIONS AND ASSOCIATED RISK FACTORS IN SOUTH AFRICA

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Abstract

Cattle farming is a vital component of the South African agricultural landscape through its contribution to sustainable livelihoods and stability of the national economy. The South African cattle production system has various genotypes that succumb differently to environmental and management-related stressors. Tick-borne diseases are among the challenges faced by cattle farmers in South Africa. Ticks tend to evolve with time and their characterization is key for effective control measures and treatment of tick-related diseases. A systematic review of the tick species was carried out and risk factors associated with tick infestations in different cattle genotypes in South African communities were identified. Twenty-four studies covering the period from 2002 to 2022 were reviewed. The studies reported a diversity in cattle sample sizes that ranged from 52 to 650. The genotypes comprised Nguni, Bonsmara, Hereford, and non-descript cattle breeds. In summary, results showed that tick infestations were widespread in cattle. The most frequently reported tick species are *Rhipicephalus decoloratus, Rhipicephalus microplus, Amblyomma variegatum,* and *Hyalomma truncatum*. The review further indicates tick infestation as a significant challenge to communal cattle farmers in South Africa, affecting animal health, productivity, and economic well-being. The evaluation of risk factors has revealed an intricate interaction among animals, environmental, and management factors influencing the prevalence and intensity of tick infestations. Understanding the significance of these factors is essential for implementation of successful tick control measures, which should consider environmental variations, address the challenge of acaricide resistance through measures

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such as rotational grazing, and emphasize selection of tick-resistant genes.

Key words: Acaricide resistance, *Amblyomma variegatum,* cattle genotypes, *Rhipicephalus decoloratus,* tick-borne, tick-resistance

SISTEMATSKI PREGLED I META ANALIZA INFESTACIJA GOVEDA KRPELJIMA I FAKTORI RIZIKA U JUŽNOJ AFRICI

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Kratak sadržaj

Stočarstvo je ključna komponenta poljoprivrenog sektora Južne Afrike zbog doprinosa održivom razvoju i stabilnosti nacionalne ekonomije. Prozvodnja stoke u Južnoj Africi sastoji se od raznih genotipa koji različito reaguju na izvore stresa iz životne sredine kao i one vezane za menadžment. Jedan od izazova stočarske proizvodnje u Južnoj Arfici su i bolesti koje prenose krpelji. Krpelji se tokom vremena razvijaju i njihova karakterizacija je ključa za efektivno sprovođenje mera kontrole kao lečenje bolesti koje oni izazivaju. Izvršen je sistematski pregled vrsta krpelja, a identifikovani su faktori rizika povezani sa infestacijama krpeljima kod različitih genotipova goveda u zajednicama Južne Afrike. Izvršena je analiza 24 studije iz perioda od 2002. do 2022. godine. Studije su otkrile da postoji raznolikost u veličini uzoraka, u rasponu od 52 to 650. Genotipi su se sastojali od rasa Nguni, Bonsmara, Hereford kao i nekih nedefrenciranih rasa. Rezultati su pokazali da su infestacije krpeljima kod stoke izuzezno rasprostranjene. Najčešće vrste koje su pronađene u studijama bile su *Rhipicephalus decoloratus, Rhipicephalus microplus, Amblyomma variegatum, i Hyalomma truncatum*. Pregled dalje navodi da infestacija krpeljima predstavlja veliki izazov za farmere u Južnoj Africi kao i da utiče na zdravlje životinja, proizvodnju i ekonomiju. Procena faktora rizika pokazala je da na infestaciju krpeljima utiču faktori kao što su životna sredina, interakcija između životinja kao i upravljanje farmama. Razumevanje značaja ovih faktora je ključno za implementaciju uspešnih mera kontrole krpelja. Potrebno je uzeti u obzir promene u životnoj sredini, rešiti problem otpornosti na akaricide kroz mere poput rotacionog sistema ispaše kao i naglasiti važnost selekcije gena otpornih na krpelje.

Ključne reči: Otpornost na akaricide, *Amblyomma variegatum,* genotipi stoke, *Rhipicephalus decoloratus,* bolesti koje prenose krpelji, otpornost na krpelje

INTRODUCTION

Ticks have severe implications on animal health due to their ability to transmit various diseases. Al-Hosary et al. (2021) stated that ticks are hematophagous arthropods that suck out blood from the host resulting in severe economic losses due to anemia, damage to animal hides, weight, and production losses as well as toxicoses. Furthermore, ticks act as vectors of pathogens such as *Theileria, Babesia, Ehrlichia,* and *Anaplasma* species which are the causative agents of tick-borne diseases in animals. Tick-borne diseases lead to losses through livestock mortality and decreased productivity, resulting in significant economic setbacks and adverse effects on food security. Global annual livestock losses due to tick-borne diseases and the costs associated with treatment are estimated to be between USD 22-30 billion, while annual losses due to heartwater disease in South Africa are estimated to be around USD 1.059 million (Makwarela et al., 2023). Nuttall (2022) observed that the presence and behavior of ticks in a geographical area are highly influenced by the local climate conditions. Changes in climate conditions can result in higher prevalences of ticks and tick-borne diseases. Makwarela et al. (2023) reported that tick species tend to be more active in warmer and humid climates as these conditions are suitable for metamorphosis. Yusufmia et al. (2010) noted that the generally warmer climate conditions in the southern African region promote the prevalence of various genera of ixodid ticks infesting cattle such as *Amblyomma*, *Dermacentor, Haemaphysalis, Hyalomma, and Rhipicephalus spps.* Santos et al. (2022) reported genetic diversity in cattle populations as being one of the major factors that may influence cattle susceptibility to tick-borne diseases and the effectiveness of tick control measures. For example, the Nguni cattle breed is reported to possess a higher genetic resistance to ticks compared to other cattle breeds in South Africa. Muchenje et al. (2008) indicated that environmental factors, management practices, and climate conditions can further complicate the dynamics of tick infestations and their associated risks. Therefore, understanding the characteristics of tick populations and risk factors influencing their prevalence is vital for developing targeted control strategies. This systematic review aims to highlight the existing knowledge on tick characteristics, infestations, and risk factors specific to various cattle genotypes in South Africa thereby contributing to improved cattle health care, sustainable agricultural practices, and in turn national economic stability.

MATERIAL AND METHODS

Article eligibility criteria

This review followed the principles and recommendations outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, as specified by (Page et al., 2021).

Search strategy

A comprehensive literature search was conducted to identify the studies on cattle tick infestations and associated risk factors in South Africa. The databases searched include PubMed, Google Scholar, Science Direct, and ResearchGate. The search was conducted using the key terms "tick species identification," "prevalence," "risk factors," "mitigation strategies," "cattle tick infestations," and "South Africa". Boolean operators (AND, OR) were used to refine the search. Reference lists of relevant articles were also screened for additional studies.

Article selection criteria

The criteria used to determine eligibility and inclusion in this search were studies focusing on tick characteristics and risk factors on different cattle genotypes within twenty-year period, from 2002 to 2022, and published in the English language. Figure 1 presents a PRISMA flowchart illustrating the filtering process.

Data extraction

The researchers extracted the study content and carefully reviewed it to ensure agreement on all key elements. To maintain the data accuracy and quality, each article underwent a thorough review, and the necessary information was carefully documented.

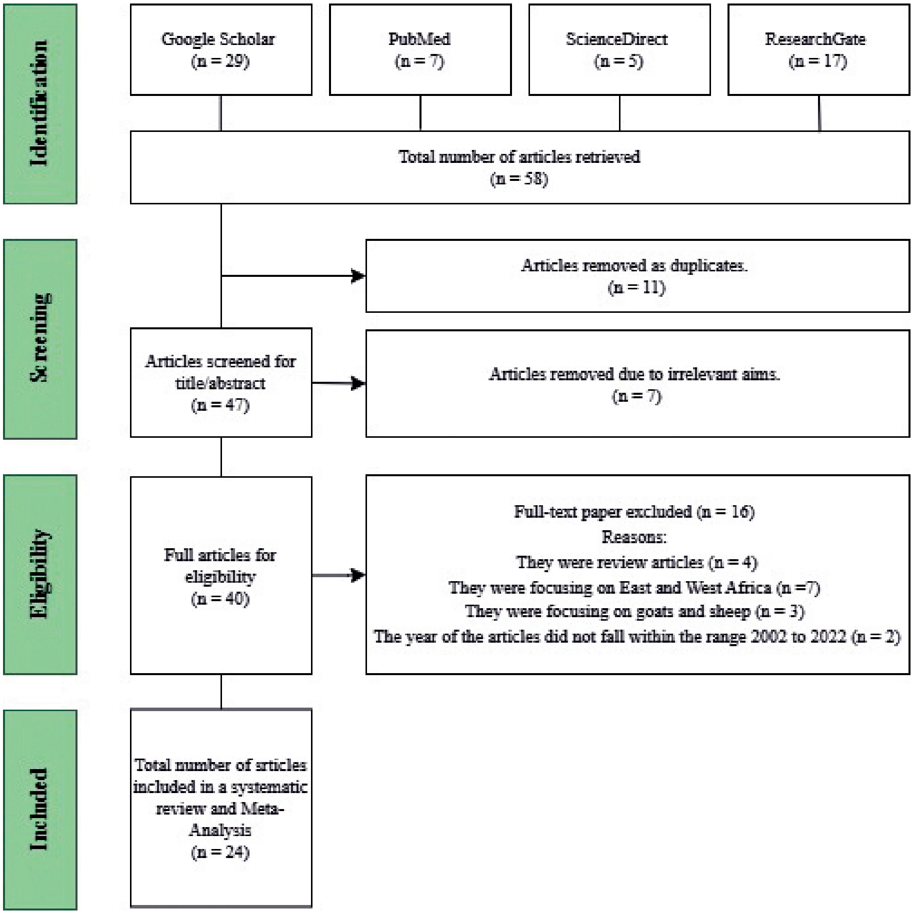

Figure 1. PRISMA flow diagram according to Page et al. (2021)

RESULTS

The outcome of the literature search

A total of 58 papers were gathered from four databases: Google Scholar (29), PubMed (7), ScienceDirect (5), and ResearchGate (17). After the initial screening, 11 duplicate articles were removed, leaving 47 articles for further consideration. During the title and abstract screening process, 7 papers were excluded because they had different aims. Subsequently, 40 articles were deemed ineligible after screening. Upon full-text analysis, 16 papers were excluded; 4 were reviews, 7 originated from the countries outside of South Africa, 3 focused on sheep, goats, and non-domesticated animals and 2 did not cover the years 2002 to 2022. Twenty-four articles were considered appropriate and are discussed in this review.

Characteristics of studies that were included in the systematic review

Table 1 summarizes the key characteristics of the studies that formed part of this review. These studies primarily relied on morphological methods for tick identification in multiple communities across South Africa. Based on the studies, *Rhipicephalus (Boophilus)* species were the predominant tick species. This observation was consistent across numerous studies such as Nyangiwe and Horak (2013), Mapholi et al. (2017), and Dzemo et al. (2023). The studies varied in terms of sample sizes, with the number of cattle genotypes sampled ranging from 52 to 650. The cattle genotypes included Nguni, Bonsmara, Hereford, and non-descript cattle breeds. Most (88%) of the eligible studies focused on tick sampling from non-descript and Nguni cattle breeds.

Table 1. Characteristics of the reviewed studies

Authors and Year	Location	Province	Cattle breed	Sample size (cattle)	Tick species identified
Bryson et al., 2002	Rietgat, Madinyane, Bethany, and Geluk	Northwest	Non-descript cattle breed	110	*Amblyomma hebraeum, Boophilus decoloratus, Boophilus microplus, Hyalomma marginatum rufipes, Hyalomma truncatum,* and *Rhipicephalus tricuspid.*
Mapholi et al., 2022	Ulundini	KwaZulu-Natal	Bonsmara	125	*Amblyomma hebraeum,* and *Rhipicephalus appendiculatus*

Authors and Year	Location	Province	Cattle breed	Sample size (cattle)	Tick species identified
Choopa, 2015	Mnisi	Mpumalanga	Non-descript cattle breed	145	*Rhipicephalus (Boophilus) microplus, Rhipicephalus decoloratus, Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Dzemo et al., 2023	Bozisa, Mapuzi, Zanci, Mpafane and Ndakana	Eastern Cape	Nguni and Bonsmara	75	*Rhipicephalus (Boophilus) microplus*
Guo et al., 2019	Amathole, Hooningkloof, and Umsinga	Eastern Cape	Non-descript cattle breed	102	*Amblyomma hebraeum*
Hlatshwayo and Mbati, 2005	Bochabela, Namahadi, Tseki, and Lejwaneng	Free State	Non-descript cattle breeds	98	*Rhipicephalus (Boophilus) microplus, Rhipicephalus decoloratus, Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Katswara and Mukaratirwa, 2021	Lucingweni, Mthata, and Caquba	Eastern Cape	Non-descript cattle breed	76	*Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus (Boophilus) microplus*
Makgabo et al., 2023	Mnisi	Mpumalanga	Non-descript cattle breed	105	*Rhipicephalus decoloratus*

Authors and Year	Location	Province	Cattle breed	Sample size (cattle)	Tick species identified
Manamela et al., 2001	Ixopo, Umviti, and Ladysmith	KwaZulu-Natal	Non-descript cattle breed	450	*Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Mapholi, 2015	Matatiele	Eastern Cape	Nguni and Bonsmara	650	*Rhipicephalus (Boophilus) microplus*
Mapholi et al., 2017	Mukhuthali Nguni community	KwaZulu-Natal	Nguni	87	*Rhipicephalus (Boophilus) microplus, Rhipicephulus decoloratus, Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Marufu et al., 2010	Magwiji and Cala	Eastern Cape	Nguni	119	*Rhipicephalus appendiculatus, Rhipicephalus evertsi evertsi, Rhipicephalus (Boophilus) microplus*, and *Hyalomma spp.*
Marufu, 2008	Magwiji, and Ukhahlamba.	Eastern Cape and Kwa-Zulu-Natal	Nguni	418	*Amblyomma hebraeum*

Authors and Year	Location	Province	Cattle breed	Sample size (cattle)	Tick species identified
Marufu et al., 2011	Sakhisizwe	Eastern Cape	Nguni	149	*Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus (Boophilus) microplus*, and *Hyalomma spp.*
Moyo et al., 2009	Cala	Eastern Cape	Non-descript cattle breed	59	*Rhipicephalus (Boophilus) microplus*
Moyo and Masika, 2009	Qolora and Nontshinga	Eastern Cape	Nguni and Bonsmara	52	*Rhipicephalus (Boophilus) microplus, Rhipicephalus decoloratus, Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Msimang et al., 2021	Mokala	Northern cape	Non- descript cattle breed	579	*Hyalomma trancatum* and *Hyalomma rufipes*
Ndlovu et al., 2009	Switsha, Nyandeni, Matobo, and Gwanda	Matabeleland South	Non-descript cattle breed	286	*Amblyomma hebraeum, Boophilus decoloratus, Rhipicephalus simus, Hyalomma truncatum,* and *Rhipicephalus tricuspis.*

Authors and Year	Location	Province	Cattle breed	Sample size (cattle)	Tick species identified
Ndlovu and Combrink, 2015	Skukuza	Mpumalanga	Non-descript cattle breed	348	*Rhipicephalus (Boophilus) microplus,* and *Rhipicephalus decoloratus*
Nyangiwe and Horak, 2013	Dohne	Eastern Cape	Non-descript cattle breed	146	*Rhipicephalus (Boophilus) decoloratus* and) *microplus*
Ramudzuli, 2014	Tshamutava, Maramanzhi, and Mbodi	Limpopo	Non- descript cattle breeds	280	*Rhipicephalus decoloratus*
Randela, 2005	Louis Trichardt	Limpopo	Non-descript cattle breed	427	*Rhipicephalus appendiculas*
Spickett et al., 2011	Tswaing and Mafikeng	Northwest	Nguni, Bonsmara, and Hereford	302	*Rhipicephalus (Boophilus) microplus, Rhipicephalus decoloratus, Amblyomma hebraeum, Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi.*
Yawa et al., 2018	Ulundini, Senqu, and Walter Sezulu	Free State	Non-descript cattle breed	177	*Rhipicephalus decoloratus*

Publications by year

Figure 2 illustrates the publication timeline of the 24 studies that were reviewed in the study. These studies cover a period of over 20 years, from 2002 to 2022.

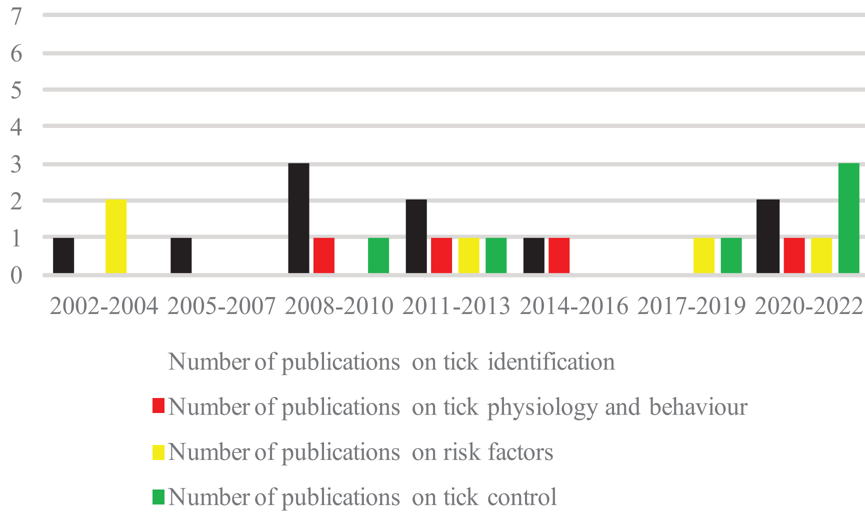

Figure 2. Number of qualifying publications during the study period (2002 to 2022)

Table 2. Cattle tick species, pathogens transmitted, and prevalence in South Africa

Tick species	**Description**	**Pathogens transmitted**	**Average prevalence**
Rhipicephalus (Boophilus) spp.	Bluish ticks with hexagonal basis capitum, short compressed and ridged palps, faint/absent anal groove	*Babesia bigemina, Babesia bovis, Anaplasma marginale.*	31.2%,7.8%, and 14.3% respectively
Rhipicephalus appendiculatus	Brownish, reddish-brown, or dark ticks with short palps and reddish-brown legs	*Thelileria parva*	1.7%
Amblyomma hebraeum	Brightly ornamented ticks, with eyes and long, robust mouthparts	*Ehrlichia ruminantium*	42%
Rhipicephalus evertsi evertsi	Medium-sized, beady-eyed, dark brown ticks with reddish-orange legs	*Anaplasma marginale*	22%
Hyalomma spp.	Dark-brown-bodied ticks with numerous punctations on the scutum and long, banded legs.	*Anaplasma marginale*	5%

Source: Marufu (2008); Mapholi et al. (2022)

DISCUSSION

Physical, physiological, and behavioural characteristics of ticks

Ticks are obligate external parasites that feed on blood, belonging to the phylum Arthropoda and comprising the largest group within the Acarina order (Marufu, 2008). They are categorized into two main groups based on their behaviour and lifecycle as single-host or multiple-host (Manamela et al., 2001). Their geographical distribution varies across different climate zones; some thrive in cool and highly moist environments, while others are adapted to hot and dry climates. Ndlovu et al., (2009) reported an overall tick prevalence of 97.5% in cattle, with the most common tick species being *Rhipicephalus decoloratus, Rhipicephalus microplus*, *Amblyomma variegatum,* and *Hyalomma truncatum.* Table 2 shows the cattle tick species, pathogens transmitted and their prevalence in South Africa. Different tick species show varying preferences for attachment sites on the animals. For instance, *Amblyomma variegatum* is commonly found on the legs, ears, tail region, and head. *Hyalomma truncatum* prefers the tail, ear, and legs (Ndlovu et al., 2009). *Rhipicephalus decoloratus* and *Rhipicephalus pulchellus* tend to attach to the head, ear, and tail region (Ndlovu et al., 2009). *Amblyomma* ticks often cluster in large numbers and remain attached around the feet (Ndlovu et al., 2009) *A. hebraeum*, on the other hand, prefers hairless areas such as the axillae, genitalia, udder, and under the tail of the host. Various stages of tick life cycles occur on different parts of the animal's body. Larvae are often found on the face, neck, dewlap, and feet, while nymphs are commonly attached to the feet and legs, inguinal and perineal areas, sternum, and neck (Ndlovu et al., 2009). Adult ticks are usually found on larger animals like cattle and exhibit active host-seeking behaviour, climbing up the hooves and attaching themselves to their preferred feeding sites (Mapholi et al., 2017). Climate conditions play a significant role in favouring different life stages of ticks. For example, adult ticks of *A. hebraeum* are more abundant during the warm and wet summer months compared to the colder and drier late autumn and winter months (Horak et al., 2011).

Risk factors and mitigation strategies

Mapholi et al. (2017) investigated risk factors associated with tick infestations in cattle in the Northwest province of South Africa. The authors reported that age, breed, and grazing management practices were significant risk factors for tick infestations. The study emphasized the need for applying regular tick control measures and improved management practices to reduce the economic impact of tick infestations in the region. Masika et al. (1997) investigated the socio-economic factors associated with tick infestations in cattle in Zimbabwe and reported that farmers who owned larger herds, practiced transhumance, and did not use acaricides regularly were more likely to have tick-infested cattle. Eisen and Dolan (2016) discovered that farmers' age, education level, and herd size were significantly linked to tick-borne disease management practices. Monkwe et al. (2023) reported that farmers who own larger herds, have higher incomes, and are well educated were more likely to use tick control-related measures and had lower cattle tick infestation rates, while factors for tick infestation were found to vary based on tick species, cattle breed, geographic location, environmental factors, and husbandry practices.

Animal factors

Numerous studies have identified factors associated with tick infestations, which can differ depending on the tick species, region, and the animal species involved. Guo et al. (2019) indicated some animal-related factors that can contribute to tick infestations. Dzemo et al. (2023) added that factors such as hair coat type, skin thickness, and behavioural patterns influence the susceptibility of animals to ticks. Young animals such as calves or lambs are more susceptible to tick infestations due to their developing immune systems (Asrate and Yalew, 2012). In the same way, animals that are in poor health or have weakened immune systems are more susceptible to tick infestations and may suffer from more severe infestations and associated health problems. Several studies (Manamela et al., 2001, Mapholi, 2015 and Katswara and Mukaratirwa, 2021) reported that some animal breeds may exhibit greater resistance or tolerance to tick infestations. This resistance can be due to genetic factors, including innate immunity or traits that deter ticks, such as grooming behaviour or thicker skin. Indigenous cattle are reported to be resistant to most diseases including those that are transmitted by ticks (Dzemo et al., 2023). Hlatshwayo and Mbati (2005) mentioned that, identifying, and promoting the use of genetically resistant or tolerant breeds can help in controlling tick infestations and other livestock diseases. Jongejan and Uilenberg (1994) reported that coat length and density are additional factors that contribute to creating favourable environments for ticks, particularly in animals with longer and denser fur. These types of coats provide more hiding spots for ticks, making it more difficult to detect and remove them manually. Dense coats also impede the effectiveness of acaricides. Cattle are known as bulk grazers due to their larger body sizes, which demand more forage to fulfil their nutritional requirements. As a result, cattle usually spend more time grazing to consume enough forage. During this time, they also access tick-prone areas such as tall grass, wooded regions, or brushy vegetation, which increases the risk of tick infestations (Makwarela et al., 2023). Mapholi et al. (2022) noted that the behaviors of certain animals can enhance the likelihood of exposure to ticks. For example, animals rubbing against trees or walls can dislodge ticks from vegetation onto their bodies, increasing the chances of tick attachment. Animals that have been previously exposed to ticks may develop some level of immunity or resistance. However, this immunity can vary depending on the tick species and the specific immune response generated by the animal (Bryson et al., 2002).

Environmental factors

Environmental factors play a significant role in the prevalence and distribution of ticks, as well as their infestation rates in cattle (Rajput et al., 2006). A study by Hlatshwayo and Mbati (2005) highlighted some environmental factors that increase the chances of tick infestations in communally raised cattle. Makgabo et al. (2023) stated that ticks are highly influenced by climate conditions with warm and humid environments being conducive to tick survival and development. Tick populations tend to increase during favourable seasons, such as spring and summer when temperature and humidity levels are optimal. In contrast, cold and dry conditions can suppress tick activity. The type and density of vegetation in an area can affect cattle tick infestation. Guo et al. (2019) stated that tick density was related significantly to vegetation index ranging from 1-5. Most ticks (15%) were observed along transects in areas with the highest vegetation index. Marufu et al. (2010) suggested that ticks are drawn to environments with tall grass, dense vegetation, and wooded areas, as these habitats provide ideal conditions for questing (waiting for a host) and seeking shelter. Overgrown pastures, areas with dense shrubs, and wooded edges near grazing areas provide suitable environments for ticks to thrive (Boyard et al., 2007). Al-Hosary et al. (2021) indicated that one of the environmental factors affecting the occurrence of ticks in cattle is grazing practices and habitat management. Continuous grazing systems can result in higher tick populations due to continuous exposure. Implementing rotational grazing can help to reduce tick infestations by allowing natural breaks in tick life cycles (Cruz-Gonzalez et al., 2023). Wildlife, such as deer or rodents, can act as reservoirs for ticks. This observation is supported by Keesing et al. (2013) who reported that cattle that graze in the areas where there is interaction with wildlife are exposed to a higher risk of tick infestations. Abbas et al. (2014) highlighted that microclimate conditions such as temperature, humidity, and precipitation within an area can influence tick distribution since ticks are ectothermic organisms. Marufu et al. (2011) reported that high temperatures and relative humidity are favourable for tick survival, reproduction, and development. Warmth and moisture contribute to the questing behaviour of ticks, where they climb up vegetation to attach to the hosts. According to Sungirai et al. (2017) tick-refuge areas, such as tall grasses, brush piles, or shaded areas, provide shelter for ticks during adverse environmental conditions or when they are not actively questing for a host. These refuge areas can contribute to tick survival and increase the chances of infestations in cattle. The geographic location and regional prevalence of specific tick species influence the likelihood of tick infestations. Different tick species have specific habitat preferences and host ranges, which can vary across different regions.

Husbandry factors

According to a study by Ndlovu et al. (2009), the intensity and timing of cattle grazing can affect tick populations. Msimang et al. (2021) added to this observation by saying that longer grazing time can increase the chances of tick infestations. Overgrazing can reduce vegetation height, making it easy for ticks to climb on cattle. Implementing tick control measures can significantly reduce tick infestations. These measures may include the use of acaricides applied on cattle, treating premises with acaricides to reduce tick populations in the environment, or using acaricide-impregnated ear tags or collars to provide continuous protection against ticks (Byaruhanga et al., 2020). Ndlovu et al. (2009) and Asmaa et al. (2014) stated that providing suitable housing or resting areas for cattle can help reduce tick exposure. Sheltered areas or barns with concrete flooring can limit contact between cattle and tick-infested environments, reducing the chances of tick attachment. Spickett et al. (2011) recommended selecting cattle breeds or genetic lines that exhibit resistance or tolerance to tick infestations combined with guidance from veterinarians on appropriate tick control strategies, performance of regular health checks, and treatment of tick-related diseases when necessary. Bryson et al. (2002) indicated that the primary tick species affecting cattle are *Rhipicephalus (Boophilus) decoloratus*, *Rhipicephalus appendiculatus*, *Amblyomma hebraeum*, *Rhipicephalus evertsi evertsi*, and *Hyalomma margid natum rufipes*. These findings align with those of Yawa et al. (2018). Notably, small ruminants such as goats were infrequently subjected to tick control measures in rural farming communities, a pattern consistent with the observations made by Ndlovu and Combrink (2015). Consequently, small ruminants and untreated cattle served as reservoirs for ticks, contributing to the re-infestation of treated animals. Tick management is essential to ensure the well-being and optimum productivity of cattle. Acaricides have traditionally played a significant role in integrated tick control strategies (Moyo and Masika, 2009). Proper application is critical for effectiveness, as misuse can contribute to acaricide resistance. Some farmers manually remove ticks from cattle using specialized tools. Although time-consuming, this method can be effective, especially for localized infestations. Implementing good farm management practices, such as rotational grazing and maintaining clean surroundings, can help reduce tick habitats and minimize infestations (Randela, 2005).

Mitigation strategies

Cattle tick infestations are a significant concern in South Africa due to their impact on livestock health and productivity. There are some common mitigations used in South Africa to control cattle tick infestations.

Chemical control

The primary method involves the use of acaricides, which are chemicals specifically designed to kill ticks. These can be applied to cattle through sprays, dips, or pour-on. The repeated use of a single acaricide commonly results in the rapid development of resistance (Ramudzuli, 2014). Regular monitoring of ticks for resistance to various acaricides can play a vital role in reducing the selection of resistant ticks. It is essential to educate livestock owners and farm workers on tick control and resistance management. Acaricides have different modes of action, so alternating their use can help reduce the selection for resistance. Due to the high cost of commercial acaricides, rural farmers rely on ethno-veterinary remedies such as *Ptaeroxylon obliquum*, *Aloe ferox*, *Lantana Camara*, *Tagetes minuta* as alternative tick control methods (Moyo et al., 2009). It is recommended to rotate acaricides such as pyrethroids with coumaphos (OPs) (Obaid et al., 2022).

Biological control

Introducing natural tick predators, like specific species of predatory mites or nematodes, can assist in controlling tick populations. For example, the fungus *Metarhizium anisopliae,* parasitoid wasps, *Bacillus thuriengesis,* nematodes as well as insectivorous birds have been used as a biological control agent against ticks (Rajput et al., 2006).

Pasture management

Maintaining pastures and grazing areas through practices such as mowing, controlled burning, and removing leaf litter can reduce tick habitats and population density. Implementing rotational grazing, where pastures are rested and rotated, can help break the tick life cycle and reduce the buildup of tick populations (George et al., 2004). Resting pastures after grazing can also allow for the natural desiccation of tick larvae and decrease the availability of hosts for ticks. Maintaining pastures by mowing them, clearing brush, and removing overgrown vegetation helps reduce tick habitats and decrease tick populations. Well-maintained pastures with shorter grasses and reduced vegetation density make it more challenging for ticks to quest and attach to cattle (Mapholi et al., 2017).

Tick-resistant cattle breeds

Breeding and selection of cattle breeds that show resistance or tolerance to tick infestations can reduce the need for chemical treatments. Selecting cattle breeds or genetic lines that exhibit resistance or tolerance to tick infestations can be beneficial. Some cattle breeds have inherent traits, such as grooming behaviour or thicker skin that make them less susceptible to ticks. Breeding for tick resistance can help improve overall resilience to tick infestations (Mapholi et al., 2022). Some indigenous cattle breeds in South Africa have developed natural resistance to ticks. Nguni cattle, Bonsmara, and Hereford cattle breeds have demonstrated high levels of resistance according to index determinations, indicating superior levels of natural immunity in these breeds (Spickett et al., 2011). Mapholi (2015) suggested the selective breeding of cattle with natural resistance to ticks, as certain breeds, like the Nguni, are recognized for their genetic resistance to tick infestations. Mapholi et al. (2022) suggested utilizing estimated breeding values for tick counts to select for tick resistance.

Tick monitoring and surveillance

Regular monitoring of tick populations and the occurrence of tick-borne diseases is crucial for guiding control strategies and identifying emerging resistance to acaricides. Randela (2005) and Spickett et al. (2011) emphasized that regular veterinary care and monitoring are essential for the early detection and management of tick infestations. Veterinarians are well-equipped to provide guidance on effective tick control strategies, conduct routine health checks, and treat tick-borne diseases when needed.

CONCLUSION

This systematic review and meta-analysis provide a comprehensive assessment of cattle tick infestations in South Africa, highlighting key environmental, management, and host-related risk factors that influence tick infestation rates. The findings underscore the need for targeted interventions to control tick populations and reduce their impact on cattle health and productivity. To enhance control efforts, it is essential to educate and train farmers on effective tick control methods, the proper application of acaricides, and the significance of integrated pest management (IPM). Additionally, continued research into new acaricides, vaccines, and alternative control methods is essential to combat tick resistance. Developing environmentally friendly, stable, cost-effective, and easily accessible acaricides, along with anti-tick vaccines, will be critical in sustaining long-term tick control strategies. By considering the identified risk factors and adopting integrated, context-specific management approaches, policymakers, veterinarians, and farmers can work together to enhance cattle health and productivity across South Africa.

ACKNOWLEDGEMENT

This systematic review has been supported and approved by the University of Limpopo.

Author’s Contribution:

Conceptualization, T.C; Study design, O.T; Electronic literature search, AK; Data extraction, AK; Data analysis and interpretation, A.K. O.T and T.C; Quality assessment, T.C; Supervision, T.C. and O.T.; Writing—original draft, A.K; Writing—review and editing, O.T and T.C. All authors have read and agreed to the published version of the manuscript.

Competing interest

The authors declare that they have no conflict of interest.

Data availability statement

All data generated during this study are available through a request to the corresponding author.

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Received: 25.09.2024.
Accepted: 10.02.2025.