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RESEARCH ARTICLE

EVALUATING THE IMPACT OF CYPERMETHRIN AND MANAGEMENTAL PRACTICES ON THE PREVALENCE OF TICK-BORNE DISEASES IN DISTRICT KHYBER

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ABSTRACT

Tick-borne diseases (TBDs) are a major challenge to livestock productivity in Pakistan, particularly in Khyber District, where climatic conditions favor tick proliferation. This study evaluated the impact of cypermethrin spraying frequency and management practices on the prevalence of TBDs. Data were collected from 33 dairy farms (government-sponsored and private) using structured questionnaires, physical examinations, OPD records, and microscopic blood smear analyses. A total of 508 cattle were examined, with 26.18% testing positive for TBDs. Anaplasmosis (15.5%) was most prevalent, followed by theileriosis (9.6%) and babesiosis (0.98%). Weekly spraying significantly reduced TBD prevalence (10.5%) compared to monthly (12.8%), occasional (18.4%), and seldom (58.6%) spraying ($P < 0.001$). Farm cleanliness was also significant ($P = 0.03$), with excellent hygiene associated with the lowest mean TBD occurrence, while poor hygiene showed the highest. Herd size had a notable effect ($P = 0.002$), as large herds averaged more cases compared to small herds. Other factors such as ventilation, bedding, and floor cracks were statistically non-significant. These findings highlight that regular acaricide application combined with strong farm hygiene and smaller herd sizes are key to minimizing TBD prevalence. The study underscores the need for integrated control measures to improve livestock health and productivity in the region.

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Introduction

Livestock plays a vital role in Pakistan's rural economy, contributing nearly 61% to agricultural output and 14.6% to national GDP (Pakistan, 2025). In Khyber Pakhtunkhwa, livestock is especially important due to limited cultivable land. However, livestock productivity is severely constrained by ectoparasites such as ticks which transmit pathogens causing theileriosis, babesiosis, and anaplasmosis (Jabbar et al., 2015). These diseases not only reduce milk yield and growth but also increase morbidity, mortality, and economic losses. Ticks (family *Ixodidae* and *Argasidae*) thrive in warm, humid environments typical of Khyber District. The spread of exotic breeds such as Holstein-Friesian has further increased susceptibility to TBDs. Control strategies typically involve acaricides such as cypermethrin, deltamethrin, and ivermectin, alongside management practices like sanitation and herd management in the Pakistan (Hussain et al., 2021). Despite the widespread use of acaricides, limited field-based studies exist in merged tribal districts of Pakistan, including Khyber. Given the socio-economic importance of livestock and the scarcity of epidemiological data, this study was designed to assess the effects of cypermethrin spraying frequency on TBD prevalence as well as to evaluate the role of farm management practices (cleanliness, herd size, infrastructure) in disease occurrence.

Materials and Methods

Study Area

The study was conducted in District Khyber, Khyber Pakhtunkhwa, Pakistan. The district has rugged mountains, hot summers, cold winters, and

low rainfall. Data were collected across six localities of district Khyber for the span of 3 months, i.e., January to March.

Study Design and Sampling

A cross-sectional study was conducted on 33 dairy farms, stratified into government-sponsored farms (n = 22) and privately owned farms (n = 11). Farms were categorized by herd size (small ≤10, medium ≤25, large ≥25 cattle). Data sources included structured questionnaires with farmers, OPD records from Civil Veterinary Hospitals in Jamrud and Landi Kotal, physical inspection of farms, and blood smears from ear vein samples, stained with Giemsa and examined microscopically for theileriosis, babesiosis, and anaplasmosis.

Study Parameters

Study parameters of this research work included Cypermethrin spraying frequency, divided into weekly, monthly, occasional and seldom basis. Farm cleanliness was scored as excellent, average, poor. Herd size divided into small, medium, and large as well as other managemental factors such as housing system, ventilation, bedding, and floor cracks. Grading system was introduced to assess these managemental parameters from 1 to 12 and respective grade was given as per ground studies. Concentration of cypermethrin was kept constant at standard rate of 1ml per 1 liter of water.

Statistical Analysis

Descriptive statistics, chi-square tests, ANOVA, and correlation analyses were performed using GENSTAT and MS Excel. Significance was set at $P < 0.05$ (Hussain et al., 2021).

Results

Prevalence of TBDs

Of 508 cattle examined, 133 were infected, giving an overall prevalence of 26.18%. Anaplasmosis was most common (15.5%), followed by theileriosis (9.6%) and babesiosis (0.98%). A chi-square goodness-of-fit test revealed a highly significant difference in the distribution of infections among the three diseases ($\chi^2 = 62.50$, df = 2, $p < 0.001$), indicating that anaplasmosis occurred at a significantly higher frequency compared to theileriosis and babesiosis.

Effect of Cypermethrin Spraying

Spraying frequency significantly reduced TBD prevalence ($P < 0.001$). Farms spraying weekly recorded the lowest occurrence, while seldom-spraying farms showed the highest disease burden. (Table 1).

Table 1: Impact of spraying frequency on tick-borne diseases in District Khyber

Spraying Frequency	Mean ± SE (cases)	Prevalence (%)	P-value
Weekly	1.40 ± 0.62	10.52	<0.001
Monthly	2.83 ± 1.01	12.78	
Occasional	3.00 ± 0.76	18.40	
Seldom	8.66 ± 1.34	58.64	

Effect of Farm Cleanliness and Herd Size

Farm hygiene was significant ($P = 0.03$), with excellent cleanliness yielding the lowest, while poor hygiene farms had the highest mean TBD occurrence. (Table 2). Similarly, herd size influenced prevalence ($P = 0.002$), with larger herds facing greater infection rates. (Table 3).

Table 2: Impact of Farm Cleanliness on tick-borne diseases in District Khyber

Farm Cleanliness	Mean ± SE (cases)	P-value
Excellent Cleanliness	1.00±0.36	0.030
Average Cleanliness	3.29±1.05	
Poor Cleanliness	6.23±1.06	

Table 3: Impact of herd size on tick-borne diseases in District Khyber

Herd Size	Mean ± SE (cases)	P-Value
Small	2.00±0.71	0.002
Medium	4.00±1.19	
Large	6.09±1.36	

Non-Significant Factors

Housing features such as cracks, ventilation, and bedding type showed no statistically significant impact on disease prevalence. Farm cracks were

divided into higher (5.20±0.84) average (4.14±1.88) and lower (2.36±1.20) cracks with non-significant value (p-value: 0.507). Similarly, farm ventilation was found (2.33±1.14) for excellent, (3.75±0.91) for average and (6.5±1.57) for poor ventilation with significance rate to be relatively close (p-value: 0.07). Bedding was divided into concrete (3.87±0.86) and loose (4.40±1.22) soil with significance value higher than normal (p-value: 0.938).

Discussion

This study highlights the pivotal role of spraying frequency and farm management in controlling tick-borne diseases (TBDs). Weekly cypermethrin application substantially reduced TBD prevalence, consistent with Buczek et al. (2015) because frequent treatments interrupt the tick life cycle, reducing adult survival, egg laying, and larval development, thereby lowering pathogen transmission. However, overreliance on chemical control can lead to acaricide resistance and potential health risks from residues in milk and meat (Taylor et al., 2015; Sindhu et al., 2022).

Farm hygiene emerged as a critical determinant. Farms with excellent cleanliness recorded the lowest disease occurrence, supporting findings by Kabir et al. (2011), as well as other studies showing that removing waste, repairing cracks, and maintaining proper drainage and ventilation reduce off-host tick refugia, which are essential for tick survival and reproduction (Abbas et al., 2014).

Larger herds were more susceptible to TBDs, likely due to higher host density and increased difficulty in uniformly applying acaricides and maintaining hygiene. This observation aligns with Hussain et al. (2021) who reported higher infestation and disease prevalence in large herds. Uniform biosecurity practices are harder to implement in larger herds, further contributing to tick exposure (Zeb et al., 2019).

Structural factors such as cracks, bedding, and ventilation were non-significant in this localized study, though broader surveys emphasize their importance in tick survival and habitat (Abbas et al., 2014). The dominance of anaplasmosis in Khyber, in contrast to theileriosis in Punjab, indicates regional variation in vector ecology, tick species composition, and environmental conditions influencing pathogen transmission (Jabbar et al., 2015).

Overall, these findings highlight that chemical control alone is insufficient. Sustainable TBD control requires an integrated approach combining regular acaricide application, good farm hygiene, manageable herd sizes, and biosecurity measures to reduce tick burden, prevent disease transmission, and minimize risks of resistance and residues (Abbas et al., 2014; Jabbar et al., 2015; Zeb et al., 2019).

Conclusion

This study concluded that weekly cypermethrin spraying combined with good hygiene minimizes TBD prevalence. Poor farm cleanliness and large herd sizes significantly increase infection risk. It was found that Anaplasmosis was the most prevalent TBD in Khyber District, and structural farm factors showed limited influence in this study but may be relevant in larger datasets as indicated by studies having more than one district.

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Authors' Contributions

AR designed and supervised the study. MAK collected and processed the data and wrote the initial draft of the manuscript. AM and MR analyzed the data. All authors reviewed the final draft of the paper.

Conflict of interest

All authors declare no conflict of interest.

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