

## Tick Infestation, Distribution, Identification, and Risk Factors on Large Ruminants in Southern Regions of Pakistan

Muhammad Jamil

*PARC Arid Zone Research Centre, Dera Ismail Khan-29050-Pakistan, jamilmatrah@gmail.com*

Muhammad Imran

*Livestock and Dairy Development (L&DD) Punjab Pakistan, drmuhammadimran65@gmail.com*

Mukhtar Ahmad

*Livestock and Dairy Development (Extension) Department, Khyber Pakhtunkhwa, Pakistan, mukhtarahmad2010@gmail.com*

Fawad Ahmad

*Livestock and Dairy Development (Extension) Department, Khyber Pakhtunkhwa, Pakistan, drfawadvet@gmail.com*

Mubarik Ali

*Animal Science Institute, National Agricultural Research Center, Islamabad-54000-Pakistan, mubarikalicheema@gmail.com*

*See next page for additional authors*

Follow this and additional works at: <https://corescholar.libraries.wright.edu/jbm>



Part of the [Animal Sciences Commons](#), and the [Entomology Commons](#)

---

### Recommended Citation

Jamil, M., Imran, M., Ahmad, M., Ahmad, F., Ali, M., Basit, A., Rehman, A. U., Muhammad, G., & Jabeen, N. (2023). Tick Infestation, Distribution, Identification, and Risk Factors on Large Ruminants in Southern Regions of Pakistan, *Journal of Bioresource Management*, 10 (1).

ISSN: 2309-3854 online

(Received: Nov 28, 2022; Accepted: Feb 5, 2023; Published: Mar 30, 2023)

This Article is brought to you for free and open access by CORE Scholar. It has been accepted for inclusion in Journal of Bioresource Management by an authorized editor of CORE Scholar. For more information, please contact [library-corescholar@wright.edu](mailto:library-corescholar@wright.edu).

---

# Tick Infestation, Distribution, Identification, and Risk Factors on Large Ruminants in Southern Regions of Pakistan

## Cover Page Footnote

All authors are highly thankful to the concerned organizations for support.

## Authors

Muhammad Jamil, Muhammad Imran, Mukhtar Ahmad, Fawad Ahmad, Mubarik Ali, Abdul Basit, Atta Ur Rehman, Gul Muhammad, and Norina Jabeen

© Copyrights of all the papers published in Journal of Bioresource Management are with its publisher, Center for Bioresource Research (CBR) Islamabad, Pakistan. This permits anyone to copy, redistribute, remix, transmit and adapt the work for non-commercial purposes provided the original work and source is appropriately cited. Journal of Bioresource Management does not grant you any other rights in relation to this website or the material on this website. In other words, all other rights are reserved. For the avoidance of doubt, you must not adapt, edit, change, transform, publish, republish, distribute, redistribute, broadcast, rebroadcast or show or play in public this website or the material on this website (in any form or media) without appropriately and conspicuously citing the original work and source or Journal of Bioresource Management's prior written permission.

## TICK INFESTATION, DISTRIBUTION, IDENTIFICATION, AND RISK FACTORS ON LARGE RUMINANTS IN SOUTHERN REGIONS OF PAKISTAN

MUHAMMAD JAMIL<sup>1</sup>, MUHAMMAD IMRAN<sup>2</sup>, MUKHTAR AHMAD<sup>3</sup>, FAWAD AHMAD<sup>3</sup>, MUBARIK ALI<sup>4</sup>, ABDUL BASIT<sup>5</sup>, ATTA UR REHMAN<sup>6</sup>, GUL MUHAMMAD<sup>7</sup>, AND NORINA JABEEN<sup>8</sup>

<sup>1</sup>PARC Arid Zone Research Centre, Dera Ismail Khan-29050-Pakistan

<sup>2</sup>Livestock and Dairy Development (L&DD) Punjab Pakistan

<sup>3</sup>Livestock and Dairy Development (Extension) Department, Khyber Pakhtunkhwa, Pakistan

<sup>4</sup>Animal Science Institute, National Agricultural Research Center, Islamabad-54000-Pakistan

<sup>5</sup>University of Poonch Rawlakot, Faculty of Veterinary and Animal Sciences, Azad Kashmir

<sup>6</sup>Faculty of Veterinary and Animal Sciences, Gomal University Dera Ismail Khan-29050-Pakistan

<sup>7</sup>Research Officer, Veterinary Research Institute Peshawar, Pakistan

<sup>8</sup>Department of Rural Sociology, University of Agriculture Faisalabad, Pakistan

Corresponding author's E-mail: jamilmatrah@gmail.com

### ABSTRACT

The livestock sector plays fundamental role in Pakistan's economy, and a variety of ruminants (cattle and buffaloes) are raised to meet the rising demand for milk, meat, and hide goods. Ticks are the most common vectors for the transmission of tick-borne disease and several pathogens to animals and people. Ticks are widespread in Pakistan due to the country's favorable subtropical climate, and they parasitize large and small ruminants, causing infestation and mortality, as well as economic losses to herdsman. Therefore, the study aimed to investigate the tick's epidemiology in large animals in the selected Southern regions of Pakistan, during the year 2020-21, along with the identification of infesting ticks and their associated risk factors. For this purpose, a total of 2637 tick specimens were collected from 2813 animals and seven tick species belonging to five genera were identified from examined animals. The identified species were *A. variegatum*, *D. marginatus*, *H. anatolicum*, *H. excavatum*, *H. dromedarii*, *Hae. punctata* and *R. sanguineus*. *D. marginatus* was not found on buffaloes, while *A. variegatum*, *Hae. punctata* and *H. excavatum* were not recorded on cows. Age and sex of the animals were non-significantly ( $p > 0.05$ ) associated with the prevalence of tick infestation. However, the females and younger animals were significantly ( $p \leq 0.05$ ) infested with ticks as compared to males and older animals. The most common sites of tick attachment were the tail and ear regions, while the thigh region was the least common. This study concluded that *H. anatolicum* is the most prevalent tick species found on both hosts (cows and buffaloes), which bear a major risk of protozoan transmission in the livestock population and may badly affect the health status and production of the animals.

**Keywords:** Amblyomma, dermacentor, hyalomma, prevalence, risk factors, ticks.

### INTRODUCTION

The economy of Pakistan is primarily depends upon the agriculture business because Pakistan is an agro-based country. Livestock is one of the major subsectors of Pakistan's agriculture, and it contributes nearly 12% of the country's

gross domestic product (GDP) of Pakistan (Economic Survey of Pakistan, 2021-22).

Ticks are well-known for having a severe influence on animals (wild, domestic) and human health by infesting and transmitting a wide range of pathogens. In Pakistan, ticks infestation is the major problem faced by livestock keepers and these tick species remain the

significant source for the spread of tick-borne diseases. For example, in Pakistan, the *Hyalomma anatolicum* spreads babesiosis, anaplasmosis, theileriosis, ehrlichiosis, and spirochaetosis and *Amblyomma* spreads heartwater disease and ehrlichiosis in (Jabbar et al., 2015; Gondard et al., 2017). All of these illnesses are economically significant, inflicting not only significant losses each year by decreasing milk and meat output, causing abortions and frequently causing mortality, but also resulting in significant expenditures due to management methods.

The climatic conditions of Pakistan are warm and humid and are recorded as most favorable for tick distribution, growth and development and especially the *Hyalomma*, *Amblyomma* and *Rhipicephalus* species of ticks, etc are endemic in Pakistan (Rehman et al., 2017; Rehman et al., 2022). Ticks are widely distributed in different ecological and geographical regions of Pakistan and cause severe problems for livestock holders who are mainly low-income farmers associated with the marketing of milk and dairy products (Karim et al., 2017). In Pakistan majority of the farmers are unaware of tick species and their side effects on humans and animals even though consider all ticks as one species (Jabbar et al., 2015).

The study aimed to investigate the tick's epidemiology in large animals in the selected Southern regions of Pakistan, along with the identification of infesting ticks and their associated risk factors and the tick-borne diseases transmitted through these ticks.

## **MATERIAL AND METHODS**

### ***Study Area and Tick Collection***

Five different districts (Dera Ismail Khan, Bhakkar, Bannu, Mianwali, and Peshawar) of Pakistan were selected in the Southern regions and the collection was done randomly from these sites to perform the study objectives of identification of

infesting tick species and tick-borne diseases along with the associated risk factors. A cross-sectional study was conducted from May 2020 to May 2022 for tick distribution, collection, and estimation of their prevalence and epidemiology. The overall climate of the area is very dry with little humidity and winter is mild with hot summers. These study areas are hot spots for livestock rearing and therefore, such environment was quite favorable for ticks transmission and incidence. A total of 30 farms were visited from the 05 districts of Pakistan including Dera Ismail Khan, Bhakkar, Mianwali, Bannu and Peshawar were visited and a total of 2637 tick specimens (1190 males and 1447 females), were collected from 500 animals including 300 cows and 200 buffaloes.

### ***Examined Sites of Animal and Tick Preservation***

The study included random sampling from the farmers of study areas and a proper questionnaire Performa was developed to record all the necessary information from the farmers about the ticks transmission, incidence and health hazards to the infested animals. Animals were properly restrained before collecting specimens from the animal body. The body sites were thoroughly examined including ear, tail, neck, dewlap, shoulder, udder and testes. The healthy, as well as non-healthy animals (goats, sheep, buffaloes, and cattle), were screened to collect ticks. Ticks were preserved in a tube containing 70 % alcohol labeled with host species, body location, sample ID, and farm ID. Specimen and host-related information such as breed, species, age, and sex were also recorded on predesigned Performa.

### ***Investigation of Risk Factors and Identification of Ticks***

The preserved tick samples were sent to the Parasitology Laboratory and

identified at the species level under a stereomicroscope using morphological keys (Walker et al., 2014; Jamil et al., 2022). The statistical program for social science (SPSS) version 20 was used to assess the data about tick prevalence and other related risk variables, using One-way ANOVA test with a *p*-value of 0.05 considered significant for risk factors linked with tick burden.

## RESULTS AND DISCUSSION

Ticks belong to the phylum Arthropoda of Kingdom Animalia and are notorious for infesting and transmitting a wide range of pathogens in the wild and domestic animals. In Pakistan, ticks infestation is the major problem faced by livestock keepers and these tick species remain the significant source for spread of tick-borne diseases including protozoal, bacterial and viral diseases *viz* Crimean Congo hemorrhagic fever (CCHF), Lyme disease, babesiosis, rickettsiosis, anaplasmosis, and borreliosis. The symptoms of these parasites range from moderate itching and irritation to great aggravation and weariness, malnutrition, and even mortality due to tick-borne parasite infection. In national and international communities, such diseases are regarded as public health or veterinary issues. There is relatively little information available regarding the identification, prevalence, and distribution of tick infestation in specific geographical areas, particularly in these study areas. (Ramzan et al., 2020; Ullah et al., 2023; Sarfraz et al., 2023).

A total of 2637 tick specimens (1190 males and 1447 females), were collected from 500 animals including 300 cows and 200 buffaloes. Seven tick species belonging to five genera were identified from examined animals. The identified species were *A. variegatum*, *D. marginatus*, *H. anatolicum*, *H. excavatum*, *H. dromedarii*, *Hae. punctata* and *R. sanguineus*. *D. marginatus* was not found

on buffaloes while *A. variegatum*, *Hae. punctata* and *H. excavatum* were not recorded on cows in the current study areas (Table 1). Ramzan et al., (2020) collected and identified *D. marginatus* from buffaloes, not from cows which is contradict the current study. The difference in findings may be due to climatic/geographical variations.

*H. anatolicum* was recorded most prevalent tick species followed by *H. dromedarii*, *R. sanguineus*, *H. excavatum*, *D. marginatus*, *A. variegatum* and *Hae. punctata* (Figure 1). Many early researchers had also reported *H. anatolicum* a dominant species from various areas of Pakistan, for example; Ramzan et al., (2019) from district Multan; Rehman et al., (2017) from arid and semi-arid zones; Sultana et al., (2015) from Rawalakot and Jafarbekloo et al., (2014) from border of Iran-Afghanistan.

It was also recorded that older and female hosts carried more ticks than younger males (Table 2). Burger et al., (2014) reported similar findings on age and sex-wise tick prevalence. Different researchers Kabir et al. (2011) and Singh and Rath (2013) and Kabir et al. (2011) concluded that younger animals infested higher as compared to older ones, not support the current study findings. The older animals can be less infested with tick species due to the development of immunity against ticks or their body becomes unsuitable for tick attachment. The significant differences in tick infestation were recorded among animal breeds ( $\chi^2 = 63.83$ ,  $P < 0.001$ , and  $df = 3$ ), where crossed hosts/animals had a smaller tick population than local animals ( $P < 0.001$ ). No significant difference was noted between exotic and crossbred animals (Table 3). The female tick population was high in all districts as compared to males (Table 2).

The prevalence of tick species in Dera Ismail Khan, Bhakkar, Bannu, Mianwali and Peshawar districts was 22.07, 20.86, 20.06, 19.30, and 17.70 %, respectively.

respectively. The highest tick population was collected from different areas of Dera Ismail Khan while the lowest was from areas of Peshawar. The presence of a high tick population in Dera Ismail Khan may be due to the presence of reservoirs for tick hosts and favorable climatic conditions for tick growth and development. Our findings are in line with the findings of Ullah et al., (2022) and Jamil et al., (2021; 2023) who also collected the highest tick population from Dera Ismail Khan.

Out of 300s, 64.58 % were infested with tick species, while out of 200 buffaloes, 56.31 % were infested as shown in Figure 2. It was also noted that in poor body conditions (poor body scores) animals were highly infested with tick burden as compared to healthy animals. Similar findings have been reported by Ramzan et al., (2019). A sum of 36.26 and 63.75 % tick prevalence was recorded in cows and buffaloes, respectively (Table 4).

Among body parts of animals, the tail and ear were found the most preferable sites for tick attachment in the present study (Table 5) while Shoaib et al., (2021) reported that external genitalia was the found most favorite site for tick

infestation. The dissimilarities in the findings may be due to changes in host breeds. Researchers Ali et al., (2016); Ramzan et al., (2020) and Jamil et al., (2021; 2022) reported the udder as the most infested site of ticks which is not in line with the previous study. According to the researchers Atif et al., (2012b) and Abbasi et al., (2017), the udder, perineum, and external genitalia were the most attached sites for ticks in animals.

Nili Ravi breed of buffaloes was highly infested with tick species than Kundi and the Friesian breed of cows was highly infested with ticks while crossbreed was found resistant (Figures 3 and 4).

**Table 1: Tick species caught in cows and buffaloes**

Tick collected	Hosts	
	Cows	Buffaloes
<i>Amblyomma variegatum</i>	×	✓
<i>Dermacentor marginatus</i>	✓	×
<i>Hyalomma anatolicum</i>	✓	✓
<i>Hyalomma excavatum</i>	×	✓
<i>Hyalomma dromedarii</i>	✓	✓
<i>Haemaphysalis punctata</i>	×	✓
<i>Rhipicephalus sanguineus</i>	✓	✓

**Table 2: Sex-wise tick species collected from different districts of the study area**

Species	Dera Ismail Khan		Bhakkar		Bannu		Mianwali		Peshawar	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<i>A. variegatum</i>	41	40	30	36	35	47	37	36	23	34
<i>D. marginatus</i>	36	37	36	48	31	38	34	31	33	39
<i>H. anatolicum</i>	49	56	49	51	44	58	39	39	38	48
<i>H. excavatum</i>	37	51	37	42	31	39	31	37	27	32
<i>H. dromedarii</i>	34	48	30	41	31	38	28	59	31	38
<i>Hae. Punctata</i>	32	43	34	39	30	34	33	32	28	35
<i>R. sanguineus</i>	37	41	32	45	32	41	30	46	30	31
<b>Total</b>	266	316	248	302	234	295	232	277	210	257
	<b>582</b>		<b>550</b>		<b>529</b>		<b>509</b>		<b>467</b>	
<b>Grand total</b>	<b>2637</b>									

**Table 3: Effect of host characters on tick burden in cows and buffaloes**

Variable	Statistics	Cows	Buffaloes
Breed	P-value	<0.001	0.206
	95% CI	NA	-14.760–1.460
	Wilcoxon-statistic	50.370 <sup>A</sup>	2356
Age	P-value	<0.001	0.040
	Spearman's rho	0.290	0.172
Sex	P-value	<0.001	0.004
	95% CI	6.740–35.560	4.620–25.310
	Wilcoxon-statistic	63.830 <sup>A</sup>	2586

Note: NA= Not applicable; CI= Confidence interval; A Kruskal-Wallis  $\chi^2$

**Table 4: Intensity of tick species infection in cattle and buffaloes recruited from various districts of Pakistan's southern territories. The P-value indicates the result of the Chi-square test.**

Tick collected	Hosts		P-value
	Cows	Buffaloes	
<i>A. variegatum</i>	0.00	359	P < 0.001**
<i>D. marginatus</i>	363	0.00	
<i>H. anatolicum</i>	213	258	
<i>H. excavatum</i>	0.00	361	
<i>H. dromedarii</i>	171	207	
<i>Hae. punctata</i>	0.00	340	
<i>R. sanguineus</i>	209	156	

P < 0.001 = Highly significant (\*\*\*)

**Table 5: Prevalence percentage (percentage) of tick species on various body parts of examined animals (cows and buffaloes).**

Species	Body parts									
	Udder	Ear	Tail	Testes	Dewlap	Shoulder	Genitalia	Neck	Legs	Thighs
<i>A. variegatum</i>	14.00	82.00	147.00	82.00	31.00	1.00	2.00	0.00	0.00	0.00
<i>D. marginatus</i>	32.00	98.00	135.00	61.00	34.00	0.00	0.00	0.00	0.00	0.00
<i>H. anatolicum</i>	57.00	118.00	170.00	91.00	28.00	2.00	3.00	2.00	0.00	0.00
<i>H. excavatum</i>	41.00	108.00	125.00	59.00	30.00	0.00	0.00	1.00	0.00	0.00
<i>H. dromedarii</i>	52.00	114.00	128.00	49.00	32.00	0.00	1.00	2.00	0.00	0.00
<i>Hae. punctata</i>	10.00	79.00	137.00	73.00	37.00	0.00	3.00	1.00	0.00	0.00
<i>R. sanguineus</i>	34.00	95.00	131.00	67.00	36.00	0.00	0.00	2.00	0.00	0.00
Total	240.00	694.00	973.00	482.00	228.00	3.00	9.00	8.00	0.00	0.00
Prevalence	9.10%	26.31	36.90	18.27	8.64%	0.11%	0.34%	0.3%	0.00	0.00 %
%		%	%	%					%	

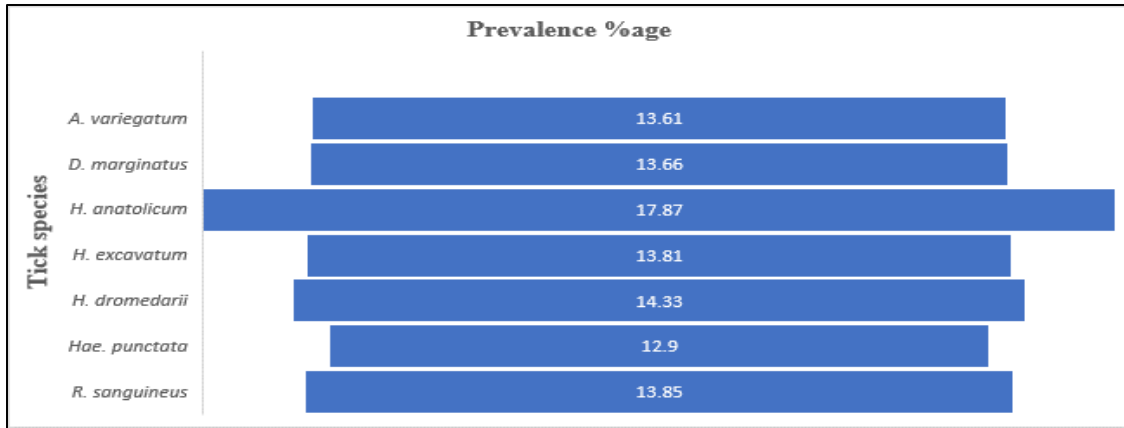


Figure 1: Prevalence percentage of tick species on selected animals

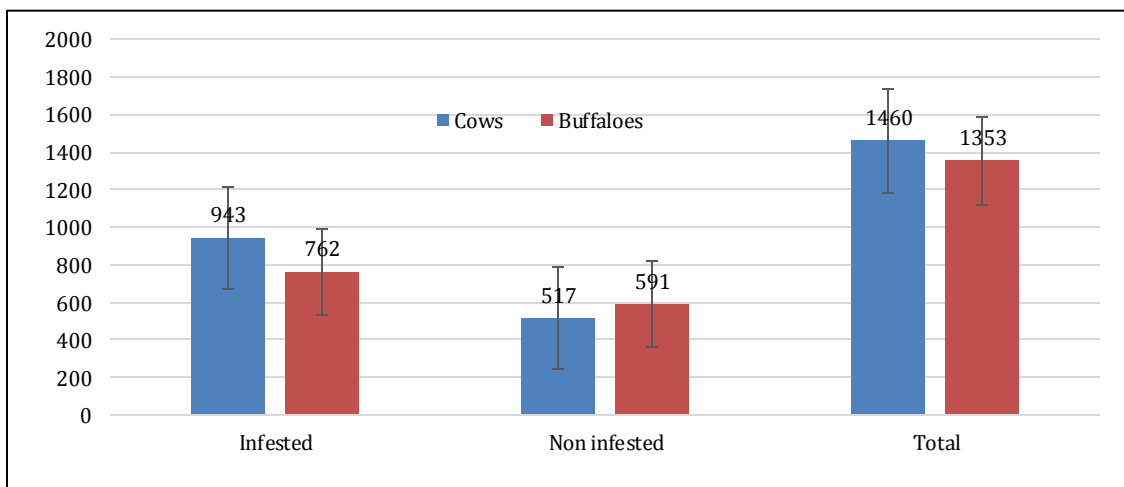


Figure 2: Number of infested and non-infested cows and buffaloes

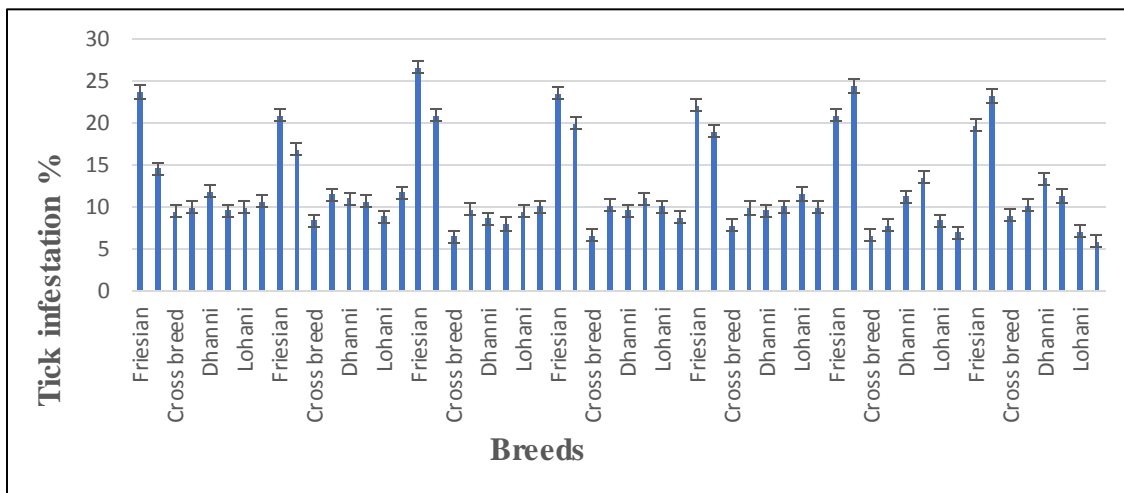
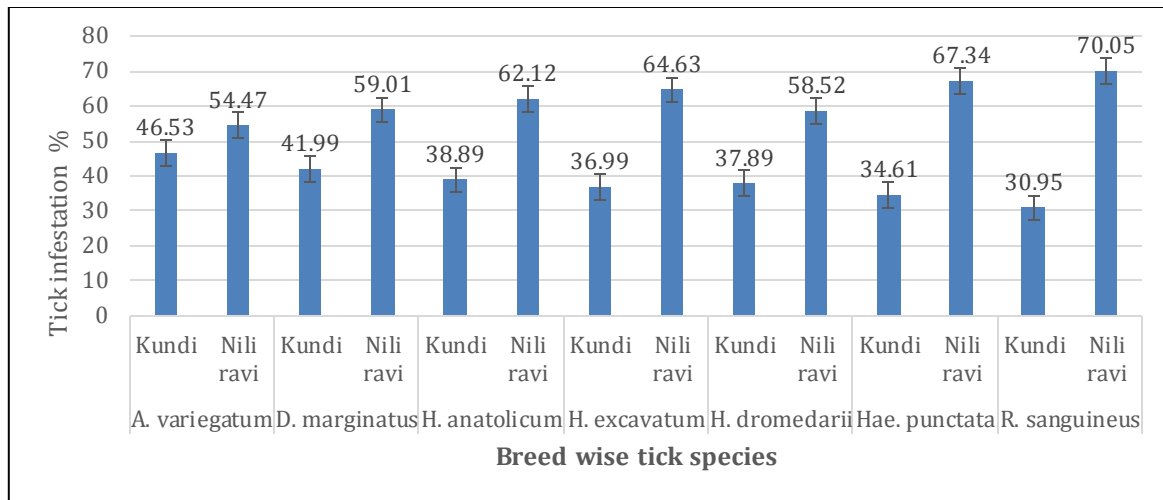


Figure 3: Cow breed-wise tick infestation percentage





**Figure 4: Buffaloes breed-wise tick species prevalence**

## CONCLUSION

Ticks are the main threat to humans and animals which are widely distributed. The current study concluded that *H. anatolicum* is a dominant and widely distributed tick species followed by *H. dromedarii*, *R. sanguineus*, *H. excavatum*, *D. marginatus*, *A. variegatum*, and *Hae. punctata*. Female and young animals carry high tick population than males and old while crossbreed carried the least number of ticks as compared to local animals.

## ACKNOWLEDGMENT

All authors are highly thankful to the concerned organizations for their support.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## INFORMED CONSENT

Consent was taken from all the farmers.

## FINANCIAL SUPPORT

None

## AUTHORS CONTRIBUTION

All authors have equal contribution in this article.

## REFERENCES

- Abbasi F, Abbasi IHR, Nissa TF, Bhutto ZA, Arain MA, Soomro RN, Siyal FA, Fazlani SA (2017). Epidemiological study of tick infestation in buffalo of various regions of district Khairpur, Pakistan. *Vet World.*, 10:688–694.
- Ali S, Ijaz M, Durrani AZ, Maqbool A, Ali MM, Mehmood K (2016). Epidemiological aspects of bovine tick infestation in the river Ravi Region, Lahore. *Pak J Zool.*, 48 (2).
- Atif FA, Khan MS, Iqbal HJ, Ali Z, Ullah S (2012). Prevalence of cattle tick infestation in three districts of the Punjab, Pakistan. *Pak J Sci.*, 64(1):49.
- Burger TD, Shao R, Barker SC (2014). Phylogenetic analysis of mitochondrial genome sequences indicates that the cattle tick, *Rhipicephalus* (*Boophilus*) *microplus*, contains a cryptic species. *Molec Phylogen Evol.*, 76:241-53.
- Economic Survey of Pakistan 2021-22. Finance Division Government of Pakistan.
- Gondard M, Cabezas-Cruz A, Charles RA, Vayssier-Taussat M, Albina E, Moutailler S (2017). Ticks and

- tick-borne pathogens of the Caribbean: Current understanding and future directions for more comprehensive surveillance. *Front Cell Infec Microbiol.*, 7:490.
- Jabbar A, Abbas T, Sandhu ZU, Saddiqi HA, Qamar MF, Gasser RB (2015). Tick-borne diseases of bovines in Pakistan: major scope for future research and improved control. *Parasit Vec.*, 8(1):1-3.
- Jafarbekloo A, Vatandoost H, Davari A, Faghghi F, Bakhshi H, Ramzgouyan MR, Nasrabadi M, Telmadarrai Z (2014). Distribution of tick species infesting domestic ruminants in borderline of Iran-Afghanistan. *J Biomed Sci Engin.*, 7(12):982.
- Jamil M, Ali S, Gul J, Kashif M, Ullah N, Ali M, Jabeen N, Khan I, Qazi I (2023). Taxonomical and epidemiological study of tick species on domesticated animals. *Pure Appl Biol.*, 12(1):523-530.
- Jamil M, Bhatti AB, Zia R, Shabana K, Kashif M, Ullah N, Ali, M, Jabeen N, Bilal, Amin A, Khan I, Rasheed M (2022b). Collection, prevalence and identifying hard tick species among small ruminants in Southern Khyber Pakhtunkhwa, Pakistan. *Biosci Res.*, 19(2): 893-898.
- Jamil M, Idrees A, Khan S, Alwaili MA, Al-Qahtani WS, Qadir ZA, Morsy K (2022e). Distribution and identification of tick species infesting donkeys, in district Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. *Syst Appl Acarol.*, 27(8):1518-1524.
- Jamil M, Idrees A, Qadir ZA, Elahi ME, Imran F, Qasim M, Khan MS, Aziz H, zafar I, Qazi I, Sadia B, Khan I, Shah SH, Rashid M, Ali M (2022c). Medical and Veterinary Ectoparasites' Importance: An Insight on Alternative Control. *Pakistan Pak J Med Heal Sci.*, 16 (01):667.
- Jamil M, Kashif M, Mubeen M, Jelani G, Ullah N, Tariq A, Ali M (2021b). Identification of tick species infesting livestock in Dera Ismail Khan Pakistan. *Syst Appl Acarol.*, 26(12):2247-2252.
- Jamil M, Khan A, Zeeshan M, Hasan SM (2021a). Collection and Identification of Tick Species on Goats and Sheep in Dera Ismail Khan, Pakistan. *ARSC Biol.*, 25(6):18389-18394.
- Jamil M, Khan S, Kashif M, Maha Abdulla Alwaili MA, Qahtani WSA, Alshaya DS, Javed M, Muhammad M, Ali M and Rasheed M (2022a). Tick collection and infestation on buffaloes at Dera Ismail Khan, KPK, Pakistan. *Biosci Res.*, 19(1):665-670.
- Jamil M, Latif N, Ullah A, Ullah N, Ali M, Jabeen N, Khan I, Qazi I, Ramzan M (2022d). Identification and Morphological Key of Pakistani Ticks. *Egypt Acad J Biol Sci.*, 14(2):1-5.
- Kabir MH, Mondal MM, Eliyas M, Mannan MA, Hashem MA, Debnath NC, Miazi OF, Mohiuddin C, Kashem MA, Islam MR, Elahi MF (2011). An epidemiological survey on investigation of tick infestation in cattle at Chittagong District, Bangladesh. *Afr J Microbiol Res.*, 5(4):346-52.
- Karim S, Budachetri K, Mukherjee N, Williams J, Kausar A, Hassan MJ, Adamson S, Dowd SE, Apanskevich D, Arijo A, Sindhu ZU (2017). A study of ticks and tick-borne livestock pathogens in Pakistan. *PLoS Neg Trop Dis.*, 11(6):e0005681.
- Rahman A, Kashif M, Nasir A, Idrees A, Jamil M, Ehsan M, Sana MA (2022). A Review of Tick and Tick Control Strategies in Pakistan. *Pak J Med Heal Sci.*, 16(01):652-655.
- Ramzan M, Murtaza G, Sattar A, Munawar N, Ullah A, Ejaz A,

- Ayaz F, Anwar S, Jameel K, Kamran F (2021). Techniques for managing ticks and tick-borne diseases under changing climate; A review. *Egypt Acad J Biol Sci, B. Zool.*, 13(1):117-28.
- Ramzan M, Naeem-Ullah U, Abbas H, Adnan M, Rasheed Z, Khan S (2019). Diversity of hard ticks in goats and sheep in Multan, Punjab, Pakistan. *Int J Agric Biol Res.*, 35:7-9.
- Rehman A, Nijhof AM, Sauter-Louis C, Schauer B, Staubach C, Conraths FJ. Distribution of ticks infesting ruminants and risk factors associated with high tick prevalence in livestock farms in the semi-arid and arid agro-ecological zones of Pakistan. *Parasites & vectors.* 2017 Dec;10(1):1-5.
- Sarfraz R, Jamil M, Ali M, Ullah M, Jabeen N, Ramzan F, Shakirullah, Khan A, Khan I, Khan MZ (2023). Identification, prevalence, distribution of ectoparasites and associated host-related risk factors on domestic animals in district Dera Ismail Khan, KPK, Pakistan. *Pure Appl Biol.*, 12(2):931-938.
- Shoaib M, Rashid I, Akbar H, Sheikh AA, Farooqi SH, Asif M, Khan MA, Mahmood S, Khan FA (2021). Prevalence of *Rhipicephalus* and *Hyalomma* ticks in cattle and associated risk factors in three districts of Khyber Pakhtunkhwa, Pakistan. *Pak J Zool.*, 53:777.
- Singh NK, Rath SS (2013). Epidemiology of ixodid ticks in cattle population of various agro-climatic zones of Punjab, India. *Asian Pac J Trop Med.*, 6(12):947-51.
- Sultana N, Shamim A, Awan M, Ali U, Hassan M, Siddique R (2015). First pilot study on the prevalence of tick infestation in livestock of Tehsil Hajira, Rawalakot, Azad Kashmir. *Adv Anim Vet Sci.*, 3:430-.
- Ullah H, Jamil M, Anwar A, Imran M, Ramzan F, Muhammad Zarar Khan MZ, Shakirullah, Manzoor R, Ali M, Jabeen N (2023). Distribution and identification of tick species on different breeds of livestock in Pakistan. *Pure Appl Biol.*, 12(2):939-947.
- Ullah N, Jamil M, Ramzan M, Arshad A, ul Haq MZ (2022). Identification and new record of tick species on livestock from district Dera Ismail Khan, Pakistan. *Pers J Acarol.*, 11(1):159-62.
- Walker AR (2003). Ticks of domestic animals in Africa: a guide to identification of species. Edinburgh: Biosci Rep.