



Psychometric Development of a Knowledge Test on Tick Infestation in Small Ruminants

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HIGHLIGHTS

- 30 out of 48 knowledge items met the selection criteria and were retained.
- Items with difficulty index (P) between 0.30–0.70 and discrimination index (D) above 0.30 were selected.
- Test items showed acceptable validity with point-biserial correlation values > 0.30.
- Test showed high reliability with a KR-20 coefficient of 0.9162.

ARTICLE INFO

Keywords: Knowledge test, Reliability, Small ruminants, Tick infestation, Validity.

<https://doi.org/10.48165/IJEE.2025.614RT03>

Citation: Sahu, M., Goyal, J., Chaturvedani, A. K., Sarkhel, S. P., Kumar, S., Vineeth, M. R., & Vishwakarma, R. (2025). Psychometric development of a knowledge test on tick infestation in small ruminants. *Indian Journal of Extension Education*, 61(4), 170-175. <https://doi.org/10.48165/IJEE.2025.614RT03>

ABSTRACT

A test was developed to assess farmers' knowledge on tick infestation in small ruminants. Following the literature review, experts' input, and pilot findings, a list of 48 items was identified and screened for relevancy by experts, resulting in 36 items retained for item analysis. These items were pretested during 2024-25 on 60 purposively selected farmers from non-sampling areas using a direct interview method with dichotomous scoring of '1' for correct and '0' for incorrect response. Based on item difficulty and discrimination indices, 30 items were finalized. Validity of the instrument was established using point-biserial correlation, with all items exhibiting acceptable correlation values of more than 0.30. Reliability of the tool was measured by the Kuder-Richardson Formula 20 and was found to be excellent with the value of 0.9162. Finally, the test consisted of 30 well-structured items organized under six thematic dimensions of tick infestation. The developed test offers a valuable means to assess farmers' knowledge, serving as a foundation for developing targeted awareness and capacity-building interventions.

INTRODUCTION

India holds the distinction of having the largest goat population and the second-largest sheep population in the world (FAO, 2019). As per the 20th Livestock Census, the country is home to approximately 223.2 million small ruminants, including 148.9 million goats and 74.3 million sheep, reflecting a growth of 10.13 per cent and 14.13 per cent, respectively, since 2012 (DAHD, 2019). These animals are primarily reared for milk, meat and fibre, with India

producing 7.81 million tons of goat milk, 1.59 million tons of chevon, 1.14 million tons of mutton and 33.69 million kg of wool in 2023-24 (DAHD, 2024). Small ruminants are especially important for the livelihoods of resource-poor and marginalized rural households, serving not only as sources of food and income but also as liquid assets that can be converted into cash during times of financial need (Birthal & Taneja, 2012). Moreover, India stands as the largest exporter of chevon and mutton (Bhateshwar et al., 2022), having exported 11,027 metric tons valued at Rs. 646.66

crores in 2023–24 (APEDA, 2025). Despite their economic and social importance, small ruminant production in India faces several challenges, including poor social acceptance, lack of defined breeding policies, degradation of grazing lands, and inadequate veterinary and health management services (NAAS, 2021). Among the most critical issues are health-related constraints, particularly the prevalence of diseases and ectoparasites such as ticks, which significantly reduce productivity and profitability, especially among smallholder farmers (Makwarela et al., 2025). Ticks are blood-feeding ectoparasites that inflict direct damage through bites, blood loss, skin lesions, and reduced livestock performance in terms of growth and milk yield (Rajput et al., 2006). Additionally, tick infestations lead to hypersensitivity, anaemia, immunosuppression and secondary infections (Ghosh et al., 2007), along with a 20–30 per cent decline in the market value of damaged skins (Rashid et al., 2018).

Ticks and tick-borne diseases impose a significant global economic burden, contributing to estimated annual losses ranging from USD 22 to 30 billion through their detrimental effects on livestock health, productivity, fertility, and survival (Singh et al., 2022; Shahzad et al., 2025). In India alone, ticks and associated diseases represent a major economic burden to India's livestock sector, particularly in the dairy sector, estimated at approximately \$787.63 million USD annually (Singh et al., 2022). With nearly 80% of the global livestock population vulnerable to tick infestations, the issue represents a major constraint to livestock-dependent livelihoods worldwide (Wall & Shearer, 2001).

Currently, there is no standardized instrument available to assess farmers' knowledge regarding tick infestation in small ruminants. While previous studies have developed knowledge assessment tools for dairy animals (Kumari et al., 2023), the literature reveals a clear gap in measuring small ruminant farmers' understanding of tick infestation. To address this gap, the present study aimed to develop a valid and reliable test instrument capable of systematically evaluating farmers' knowledge on tick infestation in small ruminants.

METHODOLOGY

The knowledge test on tick infestation in small ruminants was developed using a standard procedure outlined in the ICAR Handbook of Agricultural Extension (Padaria et al., 2020). A total of 48 items related to tick infestation were initially compiled from scientific literature, expert consultations in veterinary sciences, personal experience, and findings from a pilot study. These items were subsequently revised and refined using standard guidelines proposed by Edwards (1969), ensuring each item was clear, relevant, and easy to understand.

Following initial screening, an expert panel comprising 30 subject matter specialists evaluated each item using a structured relevancy rating scale, in line with the methodology utilized by Vijayan et al., (2022). Each expert rated the items on a 5-point relevancy scale and from these ratings, relevancy measures (relevancy percentage, weighted relevancy scores and mean relevancy scores) were calculated for each item. The resulting selected items, structured as multiple-choice and yes/no questions, underwent a pilot test among 60 small ruminant farmers from non-sample areas in the Chhattisgarh Plain agro-climatic zone during 2024–25.

Participants responded to each item, and scores were assigned based on their correctness viz., for correct answers a score of '1' and for incorrect '0'. The sum of the scores from all participants for each item provided the basis for subsequent psychometric evaluation namely, difficulty index (P) and discrimination index (D) using established formulas.

$$P_i = \frac{k_i}{K_i}$$

Where, P_i = item difficulty index of the i^{th} item, k_i = total number of participants who responded correctly to i^{th} item, K_i = total number of participants

$$D = \frac{a_1 H - a_2 L}{a}$$

Where, D = item discrimination index, $a_1 H$ is the number of correct responses from the top 27 per cent of farmers (high scorers), $a_2 L$ is the number of correct responses from the bottom 27 per cent of farmers (low scorers) and a is the total number of farmers in these two groups.

Items with a moderate difficulty index (between 0.30 and 0.70) were preferred for inclusion, whereas items outside this range (too difficult, less than 0.30, or too easy, more than 0.70) were removed to maintain the effectiveness of the assessment. Similarly, items with a discrimination index above 0.30 were retained due to their effectiveness in distinguishing farmers' knowledge levels. Items below this threshold were considered insufficiently discriminating and therefore eliminated (Hopkins, 1998; Kline, 2000).

To further establish validity, point-biserial correlations ($r_p b$) were computed to evaluate the internal consistency of the test items. Mathematically, point-biserial correlation aligns with Pearson product-moment correlation and is used to measure the relationship between a dichotomously scored item and the total test score, thereby indicating internal validity (Khandelwal & Dangi, 2013).

$$r_p b = \frac{\mu_1 - \mu_0}{s} \sqrt{\frac{pq}{N}}$$

Where μ_1 = mean score of the group answered correctly, μ_0 = mean score of the group answered incorrectly, s = standard deviation of the total scores, p and q refer to the proportions of the sample in groups 1 and 0, respectively, and N = total number of observations

Since the response format was dichotomous, the internal consistency of the knowledge test was evaluated using the Kuder-Richardson Formula 20 (KR-20).

$$KR - 20 = \frac{t}{(t - 1)} \left[1 - \frac{\sum d_i q_i}{\sigma^2} \right]$$

Where, t = total number of test items, d_i = proportion of farmers that answered i^{th} item correctly, q_i = proportion of farmers that answered i^{th} item incorrectly, σ^2 = variance of the total scores.

RESULTS

Farmers' knowledge regarding tick infestation in small ruminants served as the foundational construct of the present study. To ensure comprehensive coverage, 48 items were compiled and organized across key thematic dimensions, including 'tick

biology and identification', 'tick ecology and transmission routes', 'clinical signs and symptoms in small ruminants', 'tick-borne diseases in small ruminants', 'zoonotic potential of ticks' and 'control and prevention'.

Expert-based relevancy evaluation

An expert panel assessed these items for relevance, appropriateness, and representativeness. Items were quantitatively evaluated based on relevancy percentage, weighted relevancy, and mean relevancy scores derived from their ratings. Items satisfying

predefined criteria (relevancy percentage >70%, relevancy weightage >0.70, and mean relevancy score >3.0) were retained. Accordingly, a total of 36 items qualified for the subsequent psychometric analysis.

Psychometric analysis of items

The selected items were subjected to psychometric evaluation based on the difficulty (P) and discrimination indices (D) calculated from respondents' data. Table 1 reflects 30 items selected as appropriate and relevant for the knowledge assessment tool after

Table 1. Psychometric properties of knowledge items on tick infestation in small ruminants

Items	P	D	$r_p b$	KR-20
Tick biology and identification				
What type of parasite is a tick?	0.32	0.75	0.58	0.9162
Other than ticks, what are the other external parasites that can infest small ruminants?	0.65	0.63	0.53	
Do ticks infest animal species other than small ruminants?	0.48	0.50	0.50	
In which developmental stage does a tick not require attachment to a host?	0.15*	—	—	
What do ticks feed on when they are attached to animals?	0.33	0.75	0.61	
Do ticks prefer soft or hidden areas on an animal's body for feeding?	0.42	0.56	0.44	
Tick ecology and transmission routes				
Can ticks survive in cracks and crevices of animal sheds?	0.35	0.56	0.43	
Are grazing areas, animal sheds and contact with infested animals are potential sources of tick infestation in small ruminants?	0.48	0.63	0.51	
During which season does the tick population generally increase?	0.65	0.81	0.64	
Does tick infestation vary between male and female animals?	0.63	0.69	0.59	
Are older animals more likely to have tick infestations than younger ones?	0.62	0.56	0.56	
Which of the following is the most likely way ticks attach to animals?	0.17*	—	—	
Clinical signs and symptoms in small ruminants				
What is a common early sign of tick infestation in small ruminants?	0.45	0.50	0.42	
Can untreated tick infestations lead to weight loss in animals?	0.53	0.75	0.60	
Can ticks cause anemia in heavily infested animals?	0.67	0.38	0.36	
Does tick infestation improve the productivity of small ruminants?	0.67	0.44	0.39	
Do some animals develop fever due to tick-borne infections?	0.73†	—	—	
In severe cases, can tick infestation lead to the death of the animal?	0.67	0.63	0.47	
Do ticks remain permanently on an animal's body unless removed or killed?	0.27*	—	—	
Tick-Borne Diseases in small ruminants				
Which type of pathogens can ticks transmit to animals?	0.58	0.50	0.49	
Do tick-borne diseases such as Babesiosis, Anaplasmosis, and Theileriosis affect small ruminants?	0.57	0.69	0.54	
What can happen if tick-borne diseases in small ruminants are left untreated?	0.62	0.56	0.46	
Can ticks spread diseases from one animal to another?	0.40	0.69	0.55	
What is a common consequence of tick-borne diseases in small ruminants?	0.55	0.75	0.64	
Zoonotic potential of ticks				
Can ticks bite both animals and humans?	0.48	0.81	0.66	
Which method helps to reduce the risk of tick bites in humans?	0.52	0.63	0.57	
How do humans typically contact tick-borne diseases?	0.52	0.69	0.56	
What are possible symptoms of tick bites in humans?	0.63	0.69	0.56	
Should a doctor be consulted after a tick bite?	0.65	0.75	0.61	
Can tick bites transmit diseases to humans?	0.43	0.25‡	—	
Control and prevention				
Can tick infestation in animals be identified by examining their body parts?	0.33	0.50	0.48	
Which method is commonly used to kill ticks on animals?	0.33	0.81	0.66	
Does regular use of acaricides help in preventing tick infestation?	0.67	0.19‡	—	
Should acaricides be used as per a veterinarian's advice?	0.32	0.63	0.49	
Can improper use of acaricides lead to resistance in ticks?	0.53	0.69	0.48	
Should new animals be quarantined before being introduced into the flock?	0.63	0.81	0.60	

Note: *items with P values <0.30; †items with P values >0.70; ‡items with D values <0.30

systematically removing items that failed to fulfill the established selection standards. Items 4, 12 and 19 were excluded due to their high difficulty levels ($P < 0.30$), while item number 17 was removed for being excessively easy ($P > 0.70$). Additionally, items 30 and 33 were discarded due to low discrimination indices ($D < 0.30$), indicating poor ability to differentiate between well-informed and less-informed respondents. Consequently, psychometric analysis resulted in the selection of 30 items, which were subsequently subjected to validity and reliability assessment for inclusion in the final knowledge assessment instrument.

Assessment of validity and reliability

The consistency of the final 30-item knowledge test was confirmed by establishing content validity through expert evaluations and construct validity using the point-biserial correlation coefficient (r_{pb}). All items demonstrated r_{pb} values greater than 0.30 (Table 1), indicating acceptable internal consistency and construct validity. Furthermore, the reliability of the test was assessed using the Kuder-Richardson Formula 20 (KR-20), which yielded a coefficient of 0.9162, well above the acceptable threshold of 0.70 and thus confirmed the high reliability of the instrument (Table 1).

Assessment of knowledge level

In total, the final test consisted of 30 carefully selected items organized under six thematic areas associated with tick infestation. This assessment aimed at determining the knowledge level among small ruminant farmers outside the primary sampling frame. Each respondent's knowledge score could vary from a minimum of 0 to a maximum of 30 score. The respondents' knowledge was classified into three distinct categories viz., high, moderate and low, based on equal score intervals (Table 2). Among the non-sample respondents, 36.67 per cent exhibited moderate knowledge, followed by 33.33 per cent with high and 30.00 per cent with low knowledge on tick infestation in small ruminants.

Table 2. Classification of farmers based on knowledge score

Knowledge category	Score range	Per cent (%)
High	21-30	33.33
Moderate	11-20	36.67
Low	0-10	30.00

DISCUSSION

The present study focused on the development and validation of a standardized instrument for assessing farmers' knowledge regarding tick infestation in small ruminants. The meticulous process began with an exhaustive identification of potential items across six comprehensive thematic dimensions. Including a wide range of relevant themes follows recommended test development practices and helps improve both the content coverage and accuracy of what the test measures (Boateng et al., 2018). Expert relevancy analysis resulted in a refined set of 36 items, indicating strong consensus among subject matter specialists about their appropriateness, clarity and representativeness. Similar methodological approach was employed by Kumar et al., (2016);

Kumari et al., (2023); Shruti et al., (2022); Vijayan et al., (2022) & Vijayan et al., (2023) in their study. Subsequent item analysis further strengthened the test's psychometric robustness by evaluating each item's difficulty and discrimination indices. Items that were either excessively difficult ($P < 0.30$) or overly easy ($P > 0.70$) were systematically excluded to maintain optimal test balance and effectiveness. Additionally, items exhibiting poor discrimination ($D < 0.30$) were discarded to ensure the test's capacity to distinguish effectively between respondents with varying levels of knowledge. Similar item analysis methodology was adopted by Kumari et al., (2023) & Roy et al., (2025). The finalized test comprised 30 items that demonstrated strong internal consistency and construct validity, confirmed through point-biserial correlation coefficients (r_{pb}) greater than 0.30 for all retained items. The high KR-20 reliability coefficient (0.9162), substantially exceeding the standard acceptance threshold (0.70), indicates excellent internal reliability of the developed test, thus making it a dependable measure for evaluating farmers' knowledge. The provisional findings suggested that a considerable proportion of small ruminant farmers in the non-sampled area had moderate knowledge about tick infestation. Probable factors contributing to this include limited formal education, absence of targeted training programs and low awareness of the zoonotic potential of ectoparasites and their capacity to transmit diseases to humans. The observed results align with earlier research that highlighted comparable deficiencies in knowledge among small ruminant farmers in relation to the management of parasitic infestations (Insyari'ati et al., 2024; Ullah et al., 2024; Ramzan et al., 2018; Sertse & Wossene, 2007). Similarly, Jadav (2021) observed that the majority of dairy farmers in Gujarat possessed only a medium level of knowledge concerning bovine ectoparasites. Overall, the developed knowledge test provides a reliable and valid tool for both diagnostic assessment and educational interventions. It can effectively identify knowledge deficiencies, thereby guiding targeted training programs and extension activities aimed at improving farmers' capacity to manage tick infestations sustainably. However, regional variability and socio-cultural factors influencing knowledge toward tick management should be considered when applying this instrument in broader contexts or diverse geographical settings.

CONCLUSION

Tick infestation remains a critical constraint to optimal productivity in small ruminant farming, primarily due to insufficient farmer awareness and knowledge. Addressing this knowledge gap, a context-specific test was developed to reliably assess farmers' understanding of tick infestation management. This instrument not only evaluates current knowledge levels but also informs targeted policies, training programs and extension interventions tailored specifically to farmers' needs. By identifying precise knowledge gaps, the test supports evidence-based decision-making aimed at improving tick management practices. Ultimately, enhanced farmer knowledge can lead to improved animal health, reduced tick burden and increased productivity and profitability. Thus, the developed knowledge test represents a valuable tool for future research, capacity-building and extension strategies in small ruminant health management.

DECLARATIONS

Ethics approval and informed consent: The experts to judge the items were well informed regarding the purpose and only the responses of the judges who consented have been included for analysis purpose.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, they thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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