Archives of Current Research International

Volume 25, Issue 8, Page 206-211, 2025; Article no.ACRI.140981
ISSN: 2454-7077

Advancing Calf Care: The Development and Standardization of Knowledge Test for Calf Management and Feeding Practices

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/acri/2025/v25i81409

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/140981

Short Research Article

Received: 28/05/2025
Published: 02/08/2025

ABSTRACT

Dairy farmers often lack proficiency in calf management and feeding practices, critical aspects of effective animal husbandry. This gap can result in substantial production and reproduction losses in the near future. To mitigate these issues, the development and standardisation of the knowledge

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Cite as: *Thakur, Niharika, Rajesh Kasrija, and Parminder Singh. 2025. "Advancing Calf Care: The Development and Standardization of Knowledge Test for Calf Management and Feeding Practices". Archives of Current Research International 25 (8):206-11. https://doi.org/10.9734/acri/2025/v25i81409.*

test was done to evaluate stakeholders' understanding of calf management and feeding practices. 74 items focusing on essential aspects of calf management and feeding practices were compiled as multiple-choice or open-ended questions. These were presented to 36 dairy farmers who own calves to solicit their responses and were specifically chosen for assessing test reliability and validity. The analysis of data was done for difficulty and discrimination index and only 32 items fulfilled the criteria of difficulty index 30-90 and discrimination index ranging from 0.1-0.8 were selected for further analysis of reliability and validity. The split-half reliability was determined using the Spearman-Brown prophecy formula, demonstrating a robust score of 0.91, indicating strong internal consistency. Furthermore, Cronbach's Alpha coefficient was computed at 0.88, affirming high reliability across the selected items. Item validity was determined with the help of Aiken's V coefficient, with all items displaying coefficients ≤ 0.80 ($P<0.05$), reinforcing the test's validity. Accordingly, the final knowledge test comprising 32 items on calf management and feeding practices was standardized. The test serves to assess stakeholders' knowledge gaps in calf management and feeding practices, facilitating targeted interventions to enhance their knowledge. This transformation of knowledge into productivity can optimize outcomes effectively. It can be said that the items involved in the test are straightforward and easy to understand, making the test practical and user-friendly.

Keywords: Aiken's coefficient; calf management; Cronbach's alpha; feeding; knowledge test; reliability; validity.

1. INTRODUCTION

Effective calf feeding and management practices are important factors for the health, growth, and productivity of dairy animals (Singh *et al*., 2018). Calves represent the future of a herd, and their early care is important in determining their long-term performance and profitability for farmers (Tiwari *et al*., 2007; Uyama *et al*., 2022). Proper management encompasses various aspects such as nutrition, housing, health monitoring, and handling techniques that collectively contribute to the well-being and development of calves (Mustafa *et al*., 2010; Relić *et al*., 2020). Balancing the right nutrients in the calf diet is essential for optimal growth and immune system development (Abuelo *et al*., 2019). A substantial obstacle to the adoption of scientific rearing practices is a lack of awareness among farmers, with 99.1% demonstrating insufficient knowledge of scientific animal husbandry techniques (Surkar *et al*., 2014). Therefore, having adequate knowledge directly influences the management of calves and their feeding practices. However, Inadequate knowledge or improper practices during calf rearing can lead to high morbidity and mortality rates, poor growth performance, delayed maturity, and reduced milk yields in adulthood, all of which collectively contribute to substantial economic losses at the farm level. Despite the recognized importance of calf management, there has been a lack of standardized tools to systematically assess and quantify farmers' knowledge in this area. Without reliable and valid assessment tools, it becomes challenging to design effective educational interventions, track improvements in understanding, or tailor extension programs to address specific deficiencies. Therefore, the development of a knowledge test focused on calf management and feeding practices is essential to bridge this gap and enhance the efficacy of dairy farming practices.

The success of any program or practice largely depends on individuals' awareness and understanding of innovations (Mahendran *et al*., 2022; Machado & Ballou, 2022). Hence, it is crucial to quantitatively evaluate stakeholders' knowledge levels prior to undertaking any developmental initiatives. For this study, "knowledge" is operationalized as the extent of information dairy farmers possess regarding calf management and feeding practices. Kerlinger (1964) defined a test as a systematic procedure in which someone is presented with a set of structured stimuli and are required to respond accordingly. These responses enable the evaluator to infer the targeted traits or characteristics. A knowledge test is defined as a tool designed to assess an individual's current level of proficiency, mastery, and understanding in both general and specific knowledge domains (Kubiszyn & Borich, 2024). Doyle *et al*. (2024) found positive perceptions of the practices based on animal research are considered to improve calf welfare, including social housing and increased milk allowance. To assess respondents' understanding of the above mentioned practices, a customized knowledge test was developed.

2. MATERIALS AND METHODS

The knowledge test was framed as per the methodology outlined by Edwards (1957). It consisted of various questions graded in difficulty from very easy to very hard by known steps or intervals referred to as scale items or test items (Garret, 1966). On the basis of information obtained from various sources such as literature reviews, research articles, subject matter experts, field extension personnel, and academicians the test items were framed. 74 items were selected according to the criteria led by Edwards (1957) encompassing major areas of calf management and feeding practices. The selected items were tailored to match the comprehension level of dairy farmers. A preliminary knowledge test comprising 74 items was developed and administered to the non-sample farmers for item analysis, with the aim of identifying and eliminating non-relevant or weak items. Knowledge check was administered to 36 dairy farmers of Barnala district (non-sample area). A correct reply results in one score and a zero score for the incorrect one. Correct key was ascertained in consultation with the literature and specialists. Therefore, the total number of correct responses given by an individual represented their knowledge score, with the possible range of scores spanning from 0 to 74.

The analysis of the items was done using both the difficulty and discrimination indices. This process typically provides two key metrics: the item difficulty index and the item discrimination index. For calculating discrimination index, 36 respondents were divided into six equal groups, arranged in descending order based on their test scores. These groups were labelled G1 to G6. For the purpose of item analysis, the middle groups (G3 and G4) were excluded. Only the four extreme groups—those with the highest and lowest scores—were used to calculate the difficulty and discrimination indices. The ranges of scores obtained by the four selected groups of respondent were as follows: G1 (23-15), G2 (25-23), G5 (41-35) & G6 (50-42).

The item difficulty index indicates the level of difficulty of a particular question. It was calculated as the percentage of correct responses received for each item. This was calculated by using the formula:

$$\mathrm{Pi} = \frac{\mathrm{ni}}{\mathrm{Ni}} \times 100$$

(Pi- Difficulty index in percentage of i^{th} item; ni = Number of dairy farmers giving correct answers to i^{th} item; Ni- Total number of livestock owners to whom i^{th} item was administered)

The item Discrimination Index is the power of an item to discriminate between a knowledgeable and a less knowledgeable person. For this purpose, $E_{1/3}$ technique as suggested by Mehta (1958) was used in this study. The formula for calculating item discrimination index is given below:

$$\mathrm{E1/3} = \frac{\{(\mathrm{S1} + \mathrm{S2}) - (\mathrm{S5} + \mathrm{S6})\}}{\mathrm{N/3}}$$

(Where, S1, S2, S5 and S6 are the frequencies of correct responses in G1, G2, G5 and G6 respectively; N- Total no. of dairy farmers in the sample of item analysis)

Based on the results of the difficulty and discrimination indices, a final set of items was selected and compiled into the finalized version of the knowledge test. This led to reduction in number of test items from 74 to 32. Items with a difficulty index ranging from 30-90 and a discrimination index between 0.1-0.8, as recommended by Mehta (1958), were considered suitable for inclusion. The assessment of the reliability and validity of the selected items. In this study, reliability was evaluated using the split-half method. The 32-item test was divided into two halves of 16 items each and administered to a sample of 36 dairy farmers. The scores from both halves were correlated to obtain the split-half reliability coefficient (r). The reliability of the entire test was then estimated using the Spearman-Brown Prophecy Formula, also known as the Spearman-Brown Prediction Formula and is given as under:

$$\mathrm{R} = \frac{2\mathrm{r}}{1 + \mathrm{r}}$$

(R- Reliability of full test; r- Correlation between two half sets)

Additionally, the internal consistency of the test was measured by calculating Cronbach's alpha (α) using the following formula:

$$\alpha = \frac{\mathrm{N} \times \mathrm{c}}{\mathrm{v} + (\mathrm{N}-1) \times \mathrm{c}}$$

(**N**- Number of items; **c**- Average covariance between item pairs; **v**- Average variance)

In the final selection of items, careful consideration was given to ensure comprehensive coverage of all aspects related to calf management and feeding. Items were gathered from various sources including literature, research articles, subject matter experts, advisory committee, field extension personnel, academicians, etc. Therefore, it can be said that the scores obtained from administering this test accurately reflected the respondents' knowledge as intended. Consequently, the scale was considered a valid indicator of the targeted construct, a concept known as content validity. The knowledge test validity was also established through Aiken's Validity (V) coefficient given by Aiken (1985). For calculating Aiken's V coefficient, all 32 items of the knowledge test were evaluated by 20 field experts. The experts rated each item on a scale from 1 to 5, where 1 indicated an invalid item and 5 represented a highly valid item. The ratings given by the experts were denoted as 'r'. Each expert's score for an item was then converted to 'S' by subtracting the lowest possible score from the obtained score (S = r − lowest score). Once 'S' was computed, Aiken's V coefficient was calculated using the following formula:

$$V = \frac{\sum S}{\{n(c-1)\}}$$

(n- number of experts; c- maximum obtainable score)

3. RESULTS AND DISCUSSION

3.1 Selection of Test Items

Responses to 74 items pertaining to knowledge of calf management and feeding practices were obtained from 36 respondents. For selecting items to include in the last draft of the knowledge test, two criteria were considered: the item difficulty index and the item discrimination index. The fundamental assumption behind the item difficulty statistics was that it is linearly related to the individual's knowledge level about calf management and feeding practices. According to Coombs (1950), when an item is answered correctly by a respondent, an assumption is made that the item is easier than the respondent's ability to handle it. Based on the results of the difficulty and discrimination indices and as per the recommendations given by Mehta (1958), 32 Items were finalized for the knowledge test format. (see Table 1).

3.2 Assessment of Knowledge Test Reliability

According to Kerlinger (1964), reliability can be referred as the consistency or precision of a measuring instrument. It was assessed using the split-half method (Noble *et al*., 2019). The correlation coefficient came out to 0.85 between the two halves. However, this coefficient tends to underestimate the reliability of the full-length test, as a longer test usually samples a broader content domain and generates a wider range of scores, both of which tend to increase reliability estimates. Therefore, the Spearman-Brown Prophecy Formula was applied to adjust this coefficient and estimate the reliability of the complete test. Using this formula, the reliability of the full-length test (R) was calculated to be 0.91. Additionally, the test's internal consistency yielded α=0.88, indicating strong internal consistency. All reliability coefficients were statistically significant at the 1% level. These results demonstrate that the constructed knowledge test is highly stable and reliable.

Table 1. Indices of difficulty, discrimination and Aiken's V coefficients in the final knowledge test

S. No.	Knowledge Item	Difficulty Index (Pi)	Discrimination Index ($E_{1/3}$)	Aiken's V Coefficient
1.	Care of dam during transition period (before calving-after calving)	33.33	0.83	0.81*
2.	Calcium fed at which pregnancy stage	38.89	0.67	0.82*
3.	Basic calf assistance provided during parturition	41.67	0.42	0.80*
4.	Ligation of the naval cord of calf immediately after birth	50.00	0.50	0.83*
5.	At what length ligation of the naval cord done	41.67	0.58	0.85*
6.	Antiseptic application after ligation of the naval cord	47.22	0.58	0.91**
7.	Removal of mucus from nostrils & mouth	47.22	0.58	0.83*
8.	How much colostrum is fed to calves?	50.00	0.33	0.87*
9.	Deworming of calves?	50.00	0.17	0.83*
10.	Record of newborn calf	47.22	0.25	0.86*
11.	Weaning	44.44	0.33	0.88**

S. No.	Knowledge Item	Difficulty Index (Pi)	Discrimination Index ($E_{1/3}$)	Aiken's V Coefficient
12.	Disbudding	38.89	0.33	0.88**
13.	Methods of disbudding	61.11	0.17	0.85*
14.	Calving pen provision before parturition	41.67	0.58	0.81*
15.	Disinfection of calving pen before parturition	36.11	0.58	0.88**
16.	Shed offered to calves?	50.00	0.50	0.85*
17.	Type of floor in calf sheds	36.11	0.42	0.86*
18.	Separate pen for male and female calf	33.33	0.50	0.83*
19.	Bedding material offered in calf sheds?	61.11	0.17	0.80*
20.	How often you change bedding in calf sheds?	52.78	0.45	0.86*
21.	Feeding of calf starter to calves?	44.44	0.67	0.93**
22.	Hay is introduced to calves at what age?	36.11	0.58	0.86*
23.	Green fodder introduced to calves at what age?	52.78	0.42	0.80*
24.	First grain /concentrate introduced at what age to calves?	36.11	0.25	0.83*
25.	Do you offer mineral mixture to calves?	61.11	0.17	0.83*
26.	Do you know about the ingredients of calf starter?	33.33	0.67	0.85*
27.	FMD vaccination done in calves?	36.11	0.25	0.88**
28.	HS vaccination done in calves?	33.33	0.33	0.83*
29.	Brucellosis vaccination done in calves?	41.67	0.25	0.81*
30.	Knowledge about naval ill?	30.56	0.42	0.86*
31.	Knowledge regarding parasitic infestation in calves?	58.33	0.25	0.85*
32.	In case of any problems related to health what do you usually do?	55.56	0.17	0.82*

***Significant (P<0.01), *Significant (P<0.05)*

3.3 Validity of the Knowledge Test

The knowledge test validity was established through Aiken's Validity (V) coefficient given by Aiken (1985) as shown in Table 1. The coefficients of all the knowledge items were found significant at 5% (P<0.05) and 1% (P<0.01). Therefore, the constructed knowledge test demonstrated high stability and validity. Content validity was also ensured, referring to the extent to which the items in the test accurately represent the knowledge domain of calf management and feeding that the test is intended to measure. During the final selection of items, care was taken to include questions that comprehensively covered all relevant behavioral aspects related to respondents' knowledge of calf management and feeding practices. It is thus assumed that this test effectively measures the respondents' knowledge as intended.

4. CONCLUSION

It is a useful tool for researchers, institutions, and organizations to evaluate the knowledge levels of their target respondents. Additionally, the test can help estimate knowledge gaps, particularly in areas such as organic waste management, thereby informing policy development (Schild *et al*., 2020). It is also effective for measuring knowledge gains and evaluating the impact of knowledge-enhancing interventions (Singh *et al*., 2022). It can be said that the items involved in the test are straightforward and easy to understand, making the test practical and user-friendly.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/140981