



Psychometric Validation and KR-20 Reliability of a Knowledge Tool for Semi-Intensive Pig Production

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HIGHLIGHTS

- Items with item difficulty (P) values ranging between 0.30-0.70 were retained.
- Items with item discrimination (D) value ≥ 0.30 were included in the knowledge test.
- Items with point-biserial correlation coefficient (r_{pb}) ≥ 0.30 were considered to be valid.
- KR-20 coefficient ≥ 0.70 , deemed the tool to be reliable and acceptable for the test.

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ABSTRACT

An instrument was constructed to assess the knowledge level of pig farmers with respect of scientific pig production under a semi-intensive rearing system. Primary review of relevant literature was the initial step in the identification of relevant items. A list of 42 items was prepared and then refined for preliminary assessment on sixty purposively selected pig farmers hailing from non-sampling areas. Data was collected during 2024-25, through direct questioning method using an interview schedule by registering dichotomous responses, “correct” and “incorrect”, scored in binary format as “1” and “0”, respectively for each item. The raw data was analysed to determine item difficulty (P) and item discrimination (D), which sorted thirty relevant items. Validity of selected items was confirmed through a point-biserial correlation test, with all items having an $r_{pb} \geq 0.30$. The overall internal reliability of the knowledge tool was established by KR-20 test, which yielded a coefficient value of 0.92, signifying very high reliability of the tool in measuring knowledge of pig farmers. The 30 items, encompassing five well-structured items under six major thematic dimensions, were incorporated to comprehensively assess the knowledge level of respondents. Based on equal class intervals, majority of respondents had medium level of knowledge.

INTRODUCTION

Globally, pig production constitutes the second most significant livestock industry, owing to consumer-driven demand for pork (Food and Agriculture Organization of the United Nations, 2011). The semi-intensive rearing system represents a modified form

of the traditional scavenging approach, wherein pigs are typically housed within sturdy enclosures constructed from wood or durable fencing materials (Directorate of A.H. & Veterinary, Assam, n.d.). Distinction between intensive, semi-intensive and traditional backyard rearing systems are relatively minimal and rather blurred in developing countries, with visible overlapping of management

practices (Conan et al., 2023). Studies show that small holder pig farmers operate their farms in hybrid blend of semi-intensive and backyard rearing system (Banik et al., 2021). The management of pig farms in developing countries of South and Southeast Asia are transitioning from scavenging to semi-intensive and intensive systems, with evident shift towards semi-intensive systems among smallholder pig farmers (Conan et al., 2023; Deka et al., 2014). Pig farming constitutes a significant component of India's agricultural sector, notably in the north-eastern region. Assam, in particular, hosts the highest pig population among all Indian states, with approximately 2.099 million pigs. The import value of pork, including fresh, chilled, and frozen varieties, rose from Indian rupee (INR) 22.6 crore in 2021–22 to INR 25.02 crore in 2022–23. This increase is likely due to the fact that pork production in India represents just 3.85 per cent of the country's total meat output of 9.77 million tonnes. (Ministry of Finance, Government of India, 2023). With projected increase in pork consumption by over 160.00 per cent in India by 2030 (Food and Agriculture Organization of the United Nations, 2011), the growing reliance on imports of this high-demand livestock commodity requires comprehensive analysis, and implementation of strategic measures, including the enhancement of domestic production chains and promotion of entrepreneurship, to counter import dependency.

Knowledge encompasses factual information, practical skills, and individual comprehension of a subject (Kesänen et al., 2014). Farmers who demonstrate innovation, recognize opportunities, effectively identify and utilize resources, and remain persistent in pursuing their objectives are more likely to achieve success (Chandraker et al., 2021). Factors such as education level, socio-economic status, interest in scientific practices, land ownership, social participation, and marketing abilities have a positive impact on the acquisition of knowledge (Sharma & Singh, 2023). Several knowledge tests developed to assess the scientific knowledge of pig farmers have been reliable instruments to analyse the knowledge level of pig farmers. However, these tools primarily focused on smallholder farmers, limited to backyard or scavenging-type rearing systems. Therefore, a need arose to ascertain the knowledge level of farmers who are shifting to a semi-intensive system of pig rearing. To address this, a tool was planned and tailored in accordance with the current trends in pig production using psychometrics to discriminate the level of difficulty of the test. Validity and reliability of the tool was done to assess its precision and consistency.

METHODOLOGY

The study was conducted during 2024-25, on sixty non-sample pig farmers practicing a semi-intensive system of pig production, residing in non-sample study areas of the six agro-climatic zones of Assam (Government of Assam, 2019). Psychometric analysis is the scientific process of measuring latent psychological attributes like knowledge, skill, attitudes, personality traits, or abilities using well-designed tools including questionnaires, tests, or scales (DeVellis, 2017). Systematic development, validation, and statistical evaluation of the tool ensure its reliability, validity, and accuracy as an instrument of measurement. The preliminary review of relevant literature and previously developed measurement tools was the first step in developing the knowledge

tool. In accordance with Haladyna (2016), consultation with subject experts helped identify and design possible items for the preliminary schedule. A list of 42 items was initially prepared to design the knowledge test and administered to the intended respondents. The provisional knowledge test was administered to respondents to check the reliability and validity of the knowledge test. All items were given equal weightage, with binary scores of '1' attributed to correct responses, whereas '0' was marked for incorrect answers. The total score for each respondent was calculated by summing up the scores received for each item. Well-established methodologies in psychometrics and educational research for the construction and validation of survey tools were employed. The level of difficulty of selected items was ascertained using the item difficulty index (P) (Anastasia & Urbina, 1997). The degree to which an item discriminates between high-performing and low-performing respondents based on scores obtained in the knowledge test was calculated using the item discrimination index (D). A point biserial correlation test was conducted to validate each item within the construct. It is a measure of the relationship between a dichotomous variable and a continuous variable. The point-biserial correlation coefficient (r_{pb}) measures the degree to which performance on an individual item correlates with overall test performance, which helps to determine how well an item discriminates between high and low-scoring respondents (Allen & Yen, 2002; DeVellis, 2017). The reliability test is a measure to check the consistency and dependability of a measurement instrument. A reliable test gives similar results under consistent conditions. As dichotomous responses were registered, the internal reliability was checked using Kuder-Richardson Formula 20 ($KR-20$), formulated by Kuder & Richardson (1937).

RESULTS

Psychometric item analysis

Item analysis was conducted to evaluate how well individual items perform within a measurement tool during the developmental stage. Item difficulty index (P) is the proportion of respondents who responded to an item correctly to the total number of non-sample respondents selected for the preliminary test. (Anastasia & Urbina, 1997).

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

Where, P_i = difficulty index of the i^{th} item, k_i = total number of non-sample respondents who responded correctly to i^{th} item, K_i = total number of non-sample respondents selected for the preliminary test.

To calculate item discrimination (D), test responses were rearranged in descending order. Top one-fourth of total respondents, i.e., the high scorers ($n_1=15$) & bottom one-fourth, i.e., the low scorers ($n_2=15$) were identified as criterion groups. The scores obtained by these criterion groups was instrumental in measuring D value.

$$D = \frac{b_1H - b_2L}{b}$$

Where, D = discrimination index, b_1H = number of non-sample respondents in top 25 per cent (high score) group who answered correctly, b_2L = number of non-sample respondents in bottom 25

Table 1. Psychometric item analysis, validity and overall reliability of the knowledge tool

S.No.	Items	<i>P</i>	<i>D</i>	<i>r_p b</i>	<i>KR-20</i>
Piglet care					
1.	At what age should piglets be given iron supplementation?	0.55	0.37	0.54	0.92
2.	Name one common disease affecting piglets.	0.42	0.33	0.51	
3.	Why is needle tooth removal practiced in piglets?	0.40	0.37	0.59	
4.	At what age is castration generally done in piglets?	0.53	0.30	0.51	
5.	When should piglets be weaned?	0.52	0.33	0.52	
6.	What is the average litter size in pigs?	0.75*	-	-	
7.	Why is nostril of piglets cleaned right after birth?	0.50	0.07**	-	
Feeding					
8.	What is the average daily feed intake of pigs of 5-6 months age?	0.58	0.43	0.65	
9.	What is the average water requirement of growing pigs?	0.57	0.40	0.54	
10.	What are the crop by products that can be fed to pigs?	0.50	0.43	0.60	
11.	What type of cereal can be fed to pigs?	0.50	0.37	0.60	
12.	What are the animal protein supplement that can be fed to pigs?	0.48	0.40	0.65	
13.	Why should feeders or troughs be cleaned?	0.87*	-	-	
14.	What is the protein percentage required in pig starter feed?	0.28*	-	-	
Breeding					
15.	What is the average gestation period of a pig?	0.62	0.33	0.50	
16.	Name a breed of pig	0.55	0.40	0.60	
17.	What is the ideal boar-to-sow ratio in a breeding unit?	0.38	0.33	0.57	
18.	How many litters can a sow produce in a year?	0.57	0.47	0.68	
19.	What is the ideal age of a gilt for first mating?	0.45	0.30	0.38	
20.	What is standing reflex?	0.22*	-	-	
21.	Which season is preferable for breeding pigs?	0.88*	-	-	
Housing					
22.	What is the ideal floor space for a grower pig?	0.62	0.33	0.53	
23.	Why is proper drainage important in pig housing?	0.58	0.37	0.58	
24.	What is the preferred flooring material for pig pens?	0.48	0.40	0.61	
25.	How should pig houses be oriented?	0.58	0.40	0.59	
26.	Why is proper ventilation necessary in pig houses?	0.55	0.37	0.59	
27.	What is the primary reason for constructing drains in pig housing?	0.58	0.20**	-	
28.	Name a common bedding material used in pig houses.	0.75*	-	-	
Health					
29.	How often should pigs be dewormed?	0.62	0.37	0.56	
30.	Name one vaccine recommended for pigs	0.55	0.40	0.60	
31.	Why should newly introduced pigs be quarantined?	0.52	0.43	0.68	
32.	Name one common disease affecting pigs.	0.48	0.37	0.56	
33.	Are classical swine fever infected pigs safe for consumption?	0.37	0.30	0.49	
34.	Which vitamin is essential to prevent rickets in pigs?	0.35	0.23**	-	
35.	What does deworming prevent in pigs?	0.72*	-	-	
General management					
36.	What are the methods of carcass disposal?	0.60	0.37	0.58	
37.	Where should foot baths be placed?	0.30	0.33	0.52	
38.	What is the marketable weight for a grower pig?	0.70	0.33	0.53	
39.	Amount of manure generated by an adult pig per day?	0.65	0.40	0.59	
40.	What is the dressing percentage of pig?	0.62	0.37	0.52	
41.	Name one disinfectant used in pig farms.	0.78*	-	-	
42.	How many times in a day should feed be provided to pigs?	0.35	0.23**	-	

Note: “*” items with *P* values not ranging between 0.30-0.70; “**” items with *D* values <0.30

per cent (low score) group who answered correctly, *b* = total number of non-sample respondents in top 25% (high score) group ($n_1=15$) and bottom 25% (low score) group ($n_2=15$), i.e., 30 in this case.

Table 1 presents the final set of 30 items deemed relevant and valid for inclusion in the knowledge test, following the stepwise elimination of items that did not meet the specified criteria. The

items with *P* values ranging between 0.30-0.70 (moderate) were deemed optimal and retained, whereas, items with *P* values < 0.30 (difficult) or, > 0.70 (easy) were discarded to preserve test balance. Items with *D* value ≥ 0.30 were included in the tool, as they denoted good discrimination, whereas, items with *D* value <0.30 were considered poor, and were dropped (Hopkins, 1998; Kline, 2000).

Validity of selected items

Items with point-biserial correlation coefficient (r_{pb}) ≥ 0.30 were considered to be valid (Table 1). The analysis was done using Jamovi (Version: 2.6.26.0) statistical software.

$$r_{pb} = \frac{\mu_1 - \mu_0}{s} \sqrt{\frac{pq}{N}}$$

Where, μ_1 = mean of the continuous variable for group with value 1, μ_0 = mean of the group with value 0, s = standard deviation of the continuous variable, p = proportion of 1s, q = proportion of 0s (i.e., $q = 1 - p$), n = total number of observations

Reliability of the tool

The KR-20 coefficient was calculated for the selected 30 items sorted after psychometric analysis and validity test. The KR-20 coefficient value was ≥ 0.70 , i.e., 0.92 (Table 1), hence the tool was deemed to be reliable and accepted for the test.

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

Where, c = total number of items, d_i = proportion of respondents who answered item i^{th} correctly, $q_i = 1 - d_i$, i.e., the proportion of respondents who answered i^{th} item incorrectly, σ^2 = variance of the total test scores.

Assessment of knowledge level

A total of 30 items were finally included in the schedule, encompassing five well-structured items under six major thematic dimensions, viz. “piglet care”, “feeding”, “breeding”, “housing”, “health” and “general management”, to comprehensively assess the knowledge level of non-sample respondents. The total score for all the items ranged between 0 to 30. The respondents were categorised into low, medium and high knowledge groups based on equal class intervals as presented in Table 2. It can be observed in Table 2 that majority of the farmers fell under medium level of knowledge, followed by those in high and low knowledge level categories, respectively.

Table 2. Distribution of respondents based on knowledge level (n=60)

Knowledge level	Class interval	Frequency
High	21-30	16
Medium	11-20	29
Low	0-10	15

DISCUSSION

The items selected preliminarily were useful in identifying the gap in knowledge of the farmers. The use of binary scoring of responses allowed for simplicity in administration and interpretation, which is crucial for field-based studies. The interpretation for item difficulty (P) and item discrimination (D) was done based on widely established literature relevant to classical test theory. The item difficulty (P) test yielded items that were considered moderately difficult and were retained for inclusion in the final tool. Items that were too difficult or very easy to respond

to were siphoned and eliminated from the final schedule. Retention of items based on item discrimination (D) test values ≥ 0.30 confirmed their capacity to distinguish between high and low performers. Similar methodology was employed by Kumar et al., (2016); Maji (2018); Vijayan et al., (2022); Vijayan et al., (2023) in their study. The point-biserial correlation coefficients ($r_{pb} \geq 0.30$) further support the individual item validity, confirming each item's ability to reflect real differences in knowledge among respondents. Johnson et al., (2023) adopted similar evaluation criteria in their study on the development of a tool to assess knowledge of tribal organic poultry farmers. These criteria enhanced the overall sensitivity of the tool to detect variations in knowledge level among respondents. The KR-20 coefficient of 0.92 signifies excellent internal consistency, reaffirming the reliability of the test instrument. Coefficients below 0.70 were considered to be poor. A high reliability metric is indicative of a minimal measurement error, implying that the tool consistently measures the construct of scientific piggy knowledge across multiple domains, which establishes robustness of the analytical framework. Mukhopadhyay et al., (2020); Ntumi et al., (2023) and Powell et al., (2017), utilised this test to measure the reliability of their tools. The provisional study revealed that majority of the respondents possessed medium level of knowledge with respect to scientific pig production. The findings are in line with those of Verma et al., (2007) in their study on knowledge level of tribal pig farmers regarding scientific pig farming. The items covered under different dimensions of pig farming can act as a solid tool to assess dimension wise knowledge of the farmers in respect of scientific pig farming. This tool also serves dual function, as a reliable measurement instrument, and as a diagnostic guide to identify gaps in knowledge. Its thematic structure aligns with the core competencies required for successful pig farming and is adaptable to training programs, monitoring initiatives, and policy interventions aimed at promoting sustainable piggy practices in India.

CONCLUSION

This study successfully developed and validated a knowledge assessment tool designed to evaluate the scientific awareness of pig farmers engaged in semi-intensive production systems. The instrument offers a standardized method to categorize farmers by their knowledge level, enabling targeted extension interventions. It can also serve as a benchmark for future studies assessing the impact of training programs or policy changes in pig husbandry. Given the increasing reliance on pork as a protein source in north-eastern region of India and the strategic importance of Assam in domestic pig production, such tools are indispensable as it provides empirical grounding for capacity-building initiatives and can help reduce the knowledge-attitude gap that often hampers livestock productivity. Future studies may consider adapting this tool for digital administration or expanding it to include attitudinal and practice dimensions, thereby providing a holistic understanding of adoption of new technologies in pig farming.

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