Research Tool

Indian Journal of Extension Education
Vol. 61, No. 4 (October–December), 2025, (180-184)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Development and Validation of a Knowledge Test on Scientific Walnut Cultivation

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HIGHLIGHTS

- The developed knowledge test provides valuable insights in making logical decisions towards any psychological objects, as it will act as a diagnostic tool to ascertain the knowledge gaps.
- Reliability coefficient through the split-half method yielded the highly reliable value of 0.90, whereas the reliability coefficient using Cronbach's alpha (0.83) was within the good range of internal consistency.
- The value of Scale- content validity index (S-CVI) was 0.89, which falls near the excellent range.

ARTICLE INFO

Keywords: Knowledge, Difficulty index, Discrimination index, Reliability, Validity, Internal consistency.

https://doi.org/10.48165/IJEE.2025.614RT05

Citation: Rafiq, R., Slathia, P. S., Peshin, R., Gupta, S. K., Bakshi, P., Sharma, M., Sharma, R., & Kumar, R. (2025). Development and validation of a knowledge test on scientific walnut cultivation. *Indian Journal of Extension Education*, *61*(4), 180-184. https://doi.org/10.48165/IJEE.2025.614RT05

ABSTRACT

Knowledge is the foundation for shaping attitudes, encouraging adoption of innovations, and guiding logical decision-making. Since knowledge forms the first step in the innovation-diffusion process, followed by persuasion and attitude change. In 2024, a study was carried out in the Pulwama district of the Kashmir region of J&K UT to design a knowledge test for systematic walnut growers with the aim to assess their understanding of various production recommendations. The test was developed using standard psychometric methods to ensure accuracy and reliability. Initially, 32 knowledge-based statements were framed with the help of subject experts. Each statement was analyzed using the difficulty index and discrimination index, which helped identify the most suitable for effectively measuring farmers' knowledge. Based on this analysis, 14 statements were retained for the final test. To check reliability, the split-half method was applied, yielding a high reliability coefficient of 0.90, using the Spearman-Brown prophecy formula. Furthermore, internal consistency was assured using Cronbach's alpha, which gave a coefficient of 0.83. It confirmed that the knowledge test was both reliable and valid, making it a strong tool for evaluating the knowledge of walnut growers.

INTRODUCTION

The economy of Jammu and Kashmir is strongly supported by horticulture, which contributes between Rs. 5,000 and Rs. 7,000 crores annually to the region's GDP (Bhat et al., 2019). This sector plays a vital role in enhancing the livelihoods of small and marginal farmers, serving as one of the major sources of income in the region. Among the various horticultural crops, walnuts occupy a prominent position. The walnut (*Juglans regia* L.), belonging to the family Juglandaceae, is one of the most important tree nuts in global trade. While the English walnut (*J. regia*) traces its origin to Persia (present-day Iran), the black walnut (*J. nigra*) is native to Eastern - North America.

Globally, China is the leading producer of walnuts, contributing about 1.1 million metric tons in 2021–22, followed by the United States with 657.71 thousand metric tons. India ranked seventh with a production of about 36 thousand metric tons (Shahbandeh, 2022). In India, Jammu and Kashmir dominates walnut cultivation,

Received 25-08-2025; Accepted 11-09-2025

accounting for nearly 98 per cent of the country's total output, with smaller contributions from Himachal Pradesh, Uttarakhand, and Arunachal Pradesh. Despite holding this near-monopoly in India, the walnut industry in Jammu and Kashmir has witnessed a decline in both production and exports. For instance, walnut exports fell from 3,292 MT in 2015–16 (valued at Rs. 117.92 crores) to just 1,504.87 MT in 2018–19, fetching only Rs. 55.02 crores (DOS, 2020–21) which may be due to the non - adoption of scientific walnut cultivation practices. Lack of scientific knowledge regarding different cultivation practices may be one of the main reasons leading to its decline in its production and export. Thus, the devised knowledge test will act as a benchmark for assessing the knowledge gaps in production, protection and post-harvest practices of walnut. Furthermore, walnuts represent a crucial cash crop for the people of Jammu and Kashmir and significantly influence their economic well-being. Therefore, addressing these knowledge gaps is essential. So, in this direction an attempt was made to formulate the knowledge test for assessing the same and will help in guiding future interventions to enhance walnut production and improve the economic resilience of growers in the region.

METHODOLOGY

In the current study, "farmers' knowledge" refers to the degree of understanding that a particular farmer has on the various methods used in walnut farming. Once knowledge is gained, it causes a person's thought process to alter, which in turn causes a change in attitude and aids the farmer in making logical decisions and adopting any agricultural intervention. It has been evaluated based on how well the farmer answered the knowledge test statements, and for that purpose research tool was formulated. According to Roy & Mondal (1999), a test consists of a series of questions with proper answers for each like those who answered correctly were given 1, and those who did not answer the item correctly were given 0. The knowledge test formulation includes processes like item collection, item analysis, which includes the difficulty index and the discrimination index. For calculating the reliability of the research tool, the Split-half method and Cronbach's Alpha were also calculated. After which, the final statements that fall within the range were retained. For validity, 40 items were sent to a panel of 25 judges, experts in the field of extension education with a request to critically scrutinize and evaluate each item for its relevancy, out of which 10 experts responded who had critically scrutinized and evaluated the knowledge tool. The judges were requested to give their response on 4- 4-point continuum viz, 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant). The relevance score of each item was calculated by using Lynn's scale, in which the item content validity index (I-CVI) and scale content validity index (S-CVI) were calculated. After calculating the item content validity index (I-CVI) and scale content validity index (S-CVI), only 14 statements were valid.

Firstly, 32 knowledge statements were developed after thorough consultations with relevant literature. The selection of items was based on their representativeness, simplicity, and apparent absence of ambiguity. Domain specialists were consulted throughout the framing knowledge test statements. The purpose of knowledge test statements is to distinguish between well-informed respondents and those who are not; they were designed to encourage critical thinking rather than memorization. Based on the two mentioned criteria above, a total of 32 knowledge test statements were first made to elicit the response from non-sampled respondents. Every item that was gathered to create the knowledge test was in the right combination and appropriate mix.

Two types of information are often obtained from a test's item analysis: item discrimination and item difficulty. While the item difficulty index shows how challenging a particular item is, the discrimination index shows how much an item separates respondents with good knowledge from those with low knowledge. The knowledge test was administered on walnut growers of non-sampled area. The knowledge score of each walnut grower was obtained by counting the correct answers provided by a particular farmer. Every respondent who answered the correct answer was given a score of 1 and 0 otherwise (Kour et al., 2022). The possible scores ranged from 0 to 32. Afterwards, the total scores of all the respondents were arranged in descending order and six groups were formed, each having six respondents. The corresponding names of these groups were G1, G2, G3, G4, G5, and G6. The middle two groups, G3 and G4, were eliminated for item analysis. Four extreme groups with high and low scores were considered, after calculating item difficulty and discrimination.

The difficulty index for a knowledge test statement was the percentage of respondents who correctly answered that specific question. This was determined using the formula as given below:

$$P_i = \frac{N_i}{N_i} \times 100$$

Where P_i = Difficulty index in percentage of i^{th} item, n_i = Number of walnut growers gave correct answer

N_i = Total no. of walnut growers to whom i^{th} item is administered.

The difficulty index of all the knowledge test statements included for item analysis was calculated.

For calculation of discrimination index, the formula used by Verma et al., (2018); Rani et al., (2020) as given below:

$$E^{1/3} = \frac{(S_1+S_2) - (S_5+S_6)}{N/3}$$

Where, $E^{1/3}$ is the discrimination index, S_1, S_2, S_5 and S_6 indicated the frequencies of correct answers given for the respective G_1, G_2, G_5 and G_6 groups of respondents respectively for an item in the test.

N=Total number of respondents to whom the item was applied.

When a respondent answered an item correctly, it was assumed as that item was less difficult than his ability to cope with it (Coombs, 1950). For the knowledge test, items with discrimination index 0.20 to 0.80 and difficulty index ranging from 20 to 80 per cent were retained. Thus, 14 items were retained for the assessment of knowledge based on discriminating index and difficulty index. However, keeping in mind the importance of other knowledge test statements in the research pursuit 14 out of 18 valid statements, whose CVI also falls within the valid range were retained as per the recommendations of domain experts and the advisory committee members. Therefore, the final knowledge test comprised of 28 statements.

The test's content validity was judged. According to Kerlinger (2004), content validity refers to the representativeness and sampling adequacy of a measuring instrument's content, substance, and themes. The test's content validity was determined to be satisfactory because it was based on numerous literatures and submitted to varying expert opinions. The content validity index CVI is calculated by using Lynn Method (1986), based on 4-point relevance scale i.e., 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant). In this method, firstly the item content validity index (I-CVI) and scale content validity index (S-CVI) was calculated by using the formula given below:

$$\text{Item-Content Validity Index I-CVI} = \frac{\text{Number of experts rating 3 or 4}}{\text{Total number of experts}}$$

Valid items are those with I-CVI ≥ 0.78 (Lynn's rule of thumb for adequate content validity when panels are ~6+ experts)

$$\text{Scale - level Content Validity Index (S-CVI)} = \frac{\Sigma\text{I-CVI}}{\text{Total items}}$$

According to Lynn (1986), S-CVI ≥ 0.80 = Acceptable, S-CVI ≥ 0.90 = Excellent

According to Kerlinger (2004) reliability refers to the consistency and stability of a measurement or research instrument over time. It indicates the degree to which an instrument yields the same results under consistent conditions**.** Reliability refers to a measuring instrument's accuracy or precision. According to Guilford (1954), a test is considered trustworthy when it regularly produces the same results when applied to the same sample. For the present study, reliability was determined by applying split-half method and Cronbach's alpha method.

Split-half method

In this method, the test was divided into two equal halves. One half contains odd numbered items and other half contains even numbered items. Then Pearson correlation formula given below was put forth to calculate the half test reliability.

Pearson's Correlation (without mean method):

$$r = \frac{\{N\,\Sigma XY - (\Sigma X)\,(\Sigma Y)\}}{\sqrt{\{(N\,\Sigma X^2 - (\Sigma X)^2)\,(N\,\Sigma Y^2 - (\Sigma Y)^2)\}}}$$

Where, N = number of respondents

ΣXY = sum of cross-products of paired scores

ΣX, ΣY= sums of scores on each half

ΣX^2, ΣY^2 = sums of squared scores

The value of correlation coefficient (r) was 0.824 which indicates the reliability of half-length test. After which Spearman Brown prophecy was used to calculate the reliability of full- length test which yielded the value 0f 0.90 by using the formula given below. The value of reliability r_{xx} = 0.90 which indicates that the test is highly reliable. Typically, 0.70 or above is considered acceptable in social sciences (Nunnally & Bernstein, 1994).

$$r_{xx} = \frac{2 \times r_{hh}}{1 + r_{hh}}$$

Where, r_{xx} = reliability of the full-length test

$r_{1/2}$ = correlation between two half score

Another method which was used to calculate the internal consistency of the test items were Cronbach's alpha. Cronbach's alpha (α), introduced by Lee J. Cronbach (1951), is a measure of internal consistency reliability of a test or scale. It assesses how closely related a set of items are as a group, indicating the degree to which items measure the same underlying construct. A higher alpha value suggests greater reliability. Interpretation guidelines given by Lee J. Cronbach:

α ≥ 0.90 → Excellent

α ≥ 0.80 → Good

α ≥ 0.70 → Acceptable

α ≥ 0.60 → Questionable

α ≥ 0.50 → Poor

α < 0.50 → Unacceptable

Then Cronbach's alpha was calculated by using the formula given below:

$$\alpha = \frac{k}{k-1} \times \left(1 - \frac{\sum \sigma^2 y_i}{\sigma^2 x}\right)$$

α = Cronbach's alpha,

k = Number of items (questions) in the test

σ_i² = Variance of the scores for the i^{th} item

σ_T² = Variance of the total test scores (sum of all items)

Σ = Sum over all items

RESULTS

The Content Validity Index (CVI) was calculated for each item and for the overall scale using Lynn's (1986) method. The I-CVI values for each of the 40 items, as formulated through the expert panel, are presented below in Table 1. The Scale-CVI (S-CVI) computed across all 40 test items was 0.84, indicating acceptable content validity. When only the 32 items that met the minimum acceptable I-CVI threshold were considered, the Scale-CVI increased to 0.89, demonstrating stronger overall content validity for the refined set of items. For the knowledge test, items with a discrimination index of 0.20 to 0.80 and a difficulty index ranging from 20 per cent to 80 per cent were selected. Thus, 14 items were selected for the final knowledge test as shown in Table 2. Furthermore, the reliability of the knowledge test was calculated using the split–half method, in which the Spearman-Brown prophecy formula was applied (Kerlinger, 1973). The full test reliability yielded a value of 0.90, which indicates that the test was highly reliable. Cronbach's alpha was also put forth to determine the test's internal consistency, which was found to be 0.83, which falls within a good range of internal consistency, indicating that the test was reliable (Nunnaly & Bernstein, 1994). However, keeping in mind the importance of other knowledge test statements in the research pursuit, 14 out of 18 valid statements, whose CVI also falls within the valid range were retained as per the recommendations of domain experts and the advisory committee members. Therefore, the final knowledge test consisted of 28 statements.

Table 1. Item-level content validity index

Item no.	I-CVI	Item No.	I-CVI	Item No.	I-CVI	Item No.	I-CVI
1	0.50	11	1.00	21	1.00	31	0.90
2	1.00	12	1.00	22	0.90	32	0.90
3	1.00	13	0.90	23	0.90	33	0.80
4	0.60	14	0.90	24	0.60	34	0.80
5	1.00	15	0.80	25	0.80	35	0.80
6	1.00	16	0.90	26	0.80	36	0.80
7	0.70	17	0.80	27	0.90	37	0.80
8	0.70	18	0.60	28	0.90	38	0.80
9	0.70	19	0.80	29	0.90	39	0.90
10	0.70	20	0.80	30	0.90	40	0.60

Table 2: A test to gauge the knowledge of walnut growers towards walnut cultivation

S.No	Statements	Difficulty Index (P_i)	Discrimination Index ($E^{1/3}$)
1.	What should be the ideal dimensions of a pit for a walnut tree	63.66	0.59
2.	Which of the following planting systems are used	72.22	0.67
3.	Which of the following planting system is used for walnuts in undulating areas	58.33	0.25
4.	In which month FYM should be applied to the walnut trees	61.11	0.64
5.	How much urea is required for your walnut trees	30.55	0.50
6.	How much MOP is required for your walnut trees	22.22	O.24
7.	What is the best time to apply the first half dose of urea	50.00	0.66
8.	What is the training system of walnut	66.66	0.75
9.	Name any insect that occurs in walnut	66.66	0.75
10.	What is the management strategy for that insect pest damage	69.44	0.50
11.	Name any disease that occurs in walnut	36.11	0.66
12.	What is the management strategy for that disease	41.66	0.58
13.	Name the chemical that should be used as pre-harvest treatment of walnut	38.88	0.42
14.	What are the methods of dehulling walnut	69.44	0.57

DISCUSSION

Knowledge test statements were formulated with input from domain experts after analyzing item difficulty and discrimination indices. Content validity was established by identifying key subject matter areas through an extensive review of relevant literature and consultations with subject matter experts to find the relevancy of the items by calculating item content validity index (I-CVI), scale content validity index (S-CVI) following the methodological framework outlined by Lynn (1986); Polit & Beck (2006) & Polit et al. (2007); Velamuri et al., (2024). To ensure the reliability of the instrument, both the split-half method and Cronbach's alpha were employed, confirming a high level of internal consistency following the methodological frameworks outlined by Roy et al., (2025); Vijayan et al., (2022); Vijayan et al., (2023); Anshida et al., (2022); Ghouse et al., (2022) & Kumar et al., (2016) & Chandhana et al., (2022). The finalized knowledge test includes a comprehensive set of well-structured and validated statements that reflect the critical domains of walnut cultivation including varietal selection, orchard management, pest and disease control and post-harvest practices. This test instrument is both valid and reliable for assessing the knowledge level of walnut growers. It also serves as a practical diagnostic tool for identifying specific knowledge gaps, thereby informing the design of targeted capacity-building and extension programs. For example, if a large proportion of growers answer orchard management questions correctly but struggle with post-harvest practices, the test clearly diagnoses a knowledge gap in post-harvest handling.

CONCLUSION

It is a matter of concern that there is drop in demand of walnut due to the lack of quality and uniformity in the size of walnut kernel which also hampers the export industry. The knowledge test developed is of immense utility in extracting information about the major concerning areas that needs to be addressed so that walnut industry may not dip further. The knowledge test so developed will act as a benchmark in assessing the knowledge gaps of walnut growers regarding different production, protection and post -harvest practices. Moreover, this devised knowledge test will help the field extension functionaries of straight- lined departments and other concerned stakeholders to formulate the need-based training programmes for the farmers to mitigate the knowledge gaps in walnut production technologies.

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 purposes.

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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