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KNOWLEDGE TEST TO ANALYSE THE KNOWLEDGE LEVEL OF FARMERS TOWARDS BIO-FERTILIZERS

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ABSTRACT

Bio-fertilizers play an important role in sustainable agriculture by improving the availability of nutrients in the soil. The rising awareness about the environment and sustainable agriculture has made these fertilizers more important, particularly for farmers. They supply nutrients to plants through the process of nitrogen fixing, solubilizing phosphorus, and producing growth hormones. However, there is a need for more adoption of efficient bio-fertilizers techniques by farmers to get better and higher-quality yields. The first stage of the innovation adoption process is the knowledge stage. There is a lack of standard and reliable tools to measure the knowledge of farmers regarding bio-fertilizers. The present study aimed to develop and standardize a knowledge test on bio-fertilizers and their application. It was conducted in the Hamirpur district of Uttar Pradesh with 30 randomly selected farmers using bio-fertilizers techniques. Initially, 29 items were selected and evaluated for reliability and validity. Finally, 24 items were retained with a Cronbach's alpha of 0.890, a discrimination index of more than 0.25, and a point biserial correlation coefficient of more than 0.3. These results indicate strong internal consistency and validity of the tool. It could assist extension staff in designing training programs and help in formulating policies to promote bio-fertilizer use.

Keywords: *difficulty index, discrimination index, reliability, sustainable agriculture*

INTRODUCTION

Agricultural production depends on the availability and quality of farm inputs. The productivity of agriculture in the country has increased dramatically since the "Green Revolution.' Beginning of the Green Revolution, high-yielding seeds, which are typically receptive to higher doses of chemical fertilizers, form the foundation of modern agriculture. The continuous use of chemical fertilizers causes environmental pollution, such as air pollution, soil contamination, and water pollution, which affects deep groundwater reservoirs and the water table. These environmental issues can lead to serious health problems for people and unsustainable crop production (Sahoo et al., 2021; Kappala and Bolla, 2022). Overuse of chemical fertilizers has resulted in groundwater pollution and soil degradation, ultimately reducing the productivity of agricultural fields. Consuming crops grown with artificial fertilizers and chemicals can cause significant health problems. The environment and public health are being negatively impacted by agriculture's heavy reliance on synthetic chemical fertilizers. Interest in alternative farming techniques has grown globally as people become more conscious of the health and environmental problems associated with the usage of chemical fertilizers (Priyadarshni et al., 2020l; Pavankumar et al., 2025; Reddy et al., 2024). To mitigate the harm caused by chemical fertilizers and to restore ecosystems and the natural state of soils, an organic movement has gained momentum in many parts of the world. This movement focuses on promoting understanding, awareness, and adoption of organic farming practices, where organic bio-fertilizers are vital inputs. Bio-fertilizers have been promoted due to awareness of the negative impacts of chemical fertilizers on soil, water, and air. Natural methods of enhancing soil fertility and crop quality, such as the use of bio-fertilizers, have proven to be effective (Sherin et al., 2023; Vegad et al., 2021). These are formulations based on carriers that include effective strains of microorganisms, such as bacteria, algae, and fungi, either singly or in combination, that can provide nutrients to plants through microbial activity (Malusa and Vassilev, 2014). Through natural processes including phosphorus solubilization, nitrogen fixation, and the synthesis of growth-promoting chemicals, biofertilizers

supply nutrients to plants. Because of the microorganisms there, they support the natural nutrient cycle and aid in the development of organic matter in the soil (Vanpariya et al. 2020). They enhance soil sustainability and health in addition to encouraging healthy plants. In addition to fixing atmospheric nitrogen or dissolving phosphorus in soil, biofertilizers also assist preserve soil fertility and enhance soil structure, texture, and water retention (Katole et al., 2017). Plant nutrients can be obtained in a sustainable and environmentally friendly manner through bio-fertilizers, which show great potential. When applied as a live formulation to seeds, roots, or soil, bio-fertilizers are ready to use and aid in improving soil health by enabling microorganisms to realise their full potential. These microbial preparations contain living cells of diverse microorganisms capable of mobilising plant nutrients in soil from unusable to usable through biological processes (Bhattacharjee and Dey, 2014; Rakesh and Naik, 2023). The application of bio-fertilizers has been linked to increased plant growth and higher yields, contributing to greater food production. Their application is becoming more widely acknowledged as an economical and environmentally beneficial way to increase soil fertility and crop yield while lowering the high prices of chemical fertilizers and meeting the global demand for green agricultural technologies (Fasusi et al., 2021). They have emerged as a more affordable and eco-friendlier alternative to chemical-based fertilizers (Kumar et al., 2021).

In light of the increasing significance of sustainable, it's crucial to evaluate farmers' awareness about bio-fertilizers before developing effective extension initiatives. A structured knowledge test assesses farmers' awareness and grasp of relevant practices. The importance of knowledge in education necessitates the development of a trustworthy and valid tool. A test is developed through a systematic process that includes item collecting, expert validation, item analysis, and reliability and validity assessment (Rashmita et al. 2025). A well-designed knowledge test assesses farmers' knowledge and identifies gaps that require training and capacity-building. An essential tool for creating focused interventions for sustainable agriculture is the knowledge test (Jha et al. 2025).

OBJECTIVE

To construct a knowledge test for assessing the knowledge level of farmers regarding bio-fertilizers.

METHODOLOGY

Locale of the study

A pilot survey was conducted in Aunta village in the Hamirpur district of Uttar Pradesh in order to create the knowledge test. The pilot study included 30 randomly chosen non-sample respondents who provided insightful input for improving the test. The final data collection did not include that village. The finalized knowledge test was subsequently conducted among selected respondents from a district in Uttar Pradesh for quantitative analysis.

Construction of knowledge test

To develop a knowledge test on bio-fertilizers and their application, the methodology proposed by Rashmita et al. (2025), Digarse et al. (2025), and Bardhan & Bhardwaj (2022) was adopted with necessary modifications made to suit the specific requirements of the study.

Collection of items

Items related to bio-fertilizers were gathered from relevant literature, personal experience, expert consultations, and a pilot study conducted in the study area. These items, focusing on bio-fertilizers and their application, were developed using inputs from literature, scientists, and extension personnel. They were then carefully edited and structured so that each item conveyed a single idea, remained unambiguous, and followed a logical sequence.

Item selection

To develop a knowledge test that encourages critical thinking while effectively distinguishing between well-informed and less-informed respondents, selecting appropriate items is essential. This phase requires the researcher to have an in-depth understanding and critical analysis of the subject. An initial set of 30 items was created based on these criteria, covering crucial elements of bio-fertilizers. Each item was structured in a binary (yes/no) format to ensure clarity and facilitate ease of response.

Expert validation

An expert review was then conducted on the set of 32 items to determine their relevance. Experts were asked to assess each item's accuracy in measuring respondents' understanding of bio-fertilisers and their application. To ensure that every item aligned with the test's goals, they were encouraged to suggest modifications, additions, or deletions. Items were scored using a binary (yes/no) format: one for "yes" and zero for "no." After two items were removed based on expert input, 29 items were finally selected as suitable for the knowledge test.

Difficulty index

The item difficulty index was determined based on the percentage of respondents who correctly answered

each item. This measure operates on the premise that item difficulty is directly related to respondents' knowledge of bio-fertilizers, ensuring that an item is considered less difficult when it aligns with the respondent's ability to answer it. In the present study, the difficulty level of each item in the test battery was assessed by computing the difficulty index. The Difficulty Index represents the proportion of respondents who correctly answered a particular question (Rashmita et al., 2025; Jha et al., 2025). The following formula was used to calculate the difficulty index:

$$\text{Difficulty Index (Pi)} = \frac{R_i}{N_i} * 100 \frac{R_i}{N_i} * 100$$

Where:

R = Number of farmers who provided the correct answer

N = Total number of farmers who took the test

Consequently, items with a difficulty index below 30 or above 80 were discarded, as they were considered either too easy or too difficult.

Discrimination index

The Discrimination Index indicates the extent to which an item distinguishes between respondents with higher and lower levels of subject-matter knowledge. It assumes that items answered correctly by either all or none of the respondents lack discriminatory power. To compute the discrimination index for each item, respondents' total scores were arranged in descending order. The top 27 per cent and bottom 27 per cent of respondents were then identified as the high and low groups, respectively (Rashmita et al., 2025). The discrimination index was calculated using the following formula:

$$\text{Discrimination index} = \frac{(U-L)}{N}\frac{(U-L)}{N}$$

Where:

U = Number of respondents in the upper group who gave correct answered

L = Number of respondents in the lower group who gave correct answered

N = Total number of respondents in 27 per cent upper group and 27 per cent lower group

Point bi-serial correlation coefficient

The point-biserial correlation coefficient, a statistical measure used to assess the internal consistency of dichotomous or binary items, indicates the relationship between an individual item response and the total test score (Rashmita et al., 2025). In the present study, the point-biserial correlation for each item in the initial knowledge test was calculated using the formula proposed by Garrett (1966):

$$r_{pbis} = \frac{MP - MQ}{\sigma} * \sqrt{pq}$$

Where:

r = point biserial correlation.

MP = mean of the total score of the respondents who answered the item correctly.

MQ = mean of the total score of the respondents who answered the item incorrectly.

p = proportion of the sample in the first group

q = proportion of the sample in the second group

σ = standard deviation of the entire sample

Final selection of the items

Those Items that satisfied all of the following criteria were ultimately selected for inclusion in the knowledge test: a Difficulty Index (DI) ranging from 0.30 to 0.80, a Discrimination Index greater than 0.25, and a point-biserial correlation coefficient of 0.30 or higher (Falvey, 1994; Jha et al., 2025; Rashmita et al., 2025; Priyadarshni et al., 2025). Based on these criteria, 24 out of the initial 29 items were retained in the final knowledge test.

RESULTS AND DISCUSSION

The item difficulty index analysis revealed that the p-values of the items ranged from 47 to 93 (Table 1). Items with values between 30 and 80 were selected for inclusion in the final test. Items with values below 30 were considered too easy, while those above 80 were regarded as too difficult. Since item numbers 14 (90.00) and 17 (93.33) had p-values exceeding 80, they were removed on the grounds of being too easy. Consequently, the remaining 27 items were subjected to further analysis.

The item discrimination index ranges from −1 to +1, with higher values indicating greater discriminatory power. Positive values close to +1 are considered desirable, while negative values may arise due to issues such as improper item rotation or polarity. If any item continues to show a negative value even after correct rotation, it should be revised (Priyadarshni et al., 2024). The analysis indicated that the

discrimination index values ranged from 0.13 to 0.88 (Table 1). A value greater than 0.25 was considered acceptable for item selection. It was observed that item numbers 3 (0.25) and 20 (0.25) had discrimination values below the acceptable threshold; therefore, these items were removed.

The point biserial correlation coefficient (rpbi) was used as a measure of the validity of the test items. This measure shows the correlation between the dichotomous response for each item and the test's overall score. A point-biserial correlation coefficient above 0.30 is generally considered good. However, Falvey (1994) and Priyadarshni et al. (2025) have indicated that items with values between 0.20 and 0.30 may still be acceptable, whereas values below 0.20 are regarded as unsuitable. Based on these criteria, item number 24 (0.24) was excluded from the test. Thus, considering item difficulty, discrimination index, and point-biserial correlation, a total of 24 items were retained for the final knowledge test.

Table 1: Difficulty index, discrimination index and point biserial correlation coefficient of knowledge items related to bio-fertilizers.

Sr. No.	Items	Difficulty index	Discrimination index	Point Biserial correlation coefficient
A	**Knowledge about types of bio-fertilizer**			
1	Do you know about Rhizobium?	70.00	0.38	0.38
2	Do you know about Azotobacter?	63.33	0.75	0.65
3	Do you know about Azolla?	63.33	0.25	0.38
4	Do you know about P.S.B.?	63.33	0.88	0.71
5	Do you know about Azospirillium?	70.00	0.75	0.61
6	Do you know about the bio-fertilizers consortia/Improved bio-fertilizers?	70.00	0.75	0.75
B	**Knowledge about the form of bio-fertilizer**			
7	Do you know about the liquid form of bio-fertilizers?	66.67	0.88	0.61
8	Do you know about the powder form of bio-fertilizers?	46.67	0.50	0.44
9	Do you know about the granule form of bio-fertilizers?	66.67	0.50	0.54
C	**Knowledge about sources of bio-fertilizers availability**			
10	Do you know you can get bio-fertilizers from Agriculture Universities & KVKs?	46.67	0.38	0.44
11	Do you know about the availability of bio-fertilizers at the agriculture department?	63.33	0.50	0.48
12	Do you know about the availability of bio-fertilizers in input dealers?	60.00	0.38	0.32
D	**Knowledge about the time of bio-fertilizers application**			
13	Can bio-fertilizers be used before sowing?	63.33	0.88	0.81
14	Can bio-fertilizers be used at the time of irrigation?	90.00	0.13	0.23
15	Can bio-fertilizers be used after sowing?	56.67	0.75	0.33
16	Can bio-fertilizers be used in sowing?	56.67	0.88	0.56
E	**Knowledge about the application methods of bio-fertilizer**			
17	Do you know bio-fertilizers can be used with manure or compost?	93.33	0.13	0.12
18	Do you know bio- fertilizers can be used as seed treatment/root dipping/sets treatment?	56.67	0.38	0.41
19	Do you know bio- fertilizers can be used as broadcast?	50.00	0.50	0.46
20	Do you know bio- fertilizers can be used as a split application?	53.33	0.25	0.32

21	Do you know bio- fertilizers can be used as a foliar spray?	56.67	0.88	0.56
22	Do you know bio- fertilizers can be used for soil application?	63.33	0.75	0.66
23	Do you know bio-fertilizers can be used as broadcast with chemical fertilizers?	53.33	0.38	0.36
F	**Knowledge about doses of bio-fertilizers**			
24	Do you know the use of bio-fertilizers at the rate of 1 to 2 litres with 25 to 50 kg of manure or compost for soil application?	46.67	0.38	0.24
25	Do you know the use of bio-fertilizers at the rate of 200gm/10kg seed for seed treatment?	50.00	0.38	0.34
26	Do you know the use of bio-fertilizers at the rate of 25 kg/acre for broadcast?	66.67	0.38	0.44
27	Do you know the use of bio-fertilizers at the rate of 500ml/acre for foliar spray?	70.00	0.88	0.60
28	Do you know the use of bio-fertilizers at the rate of 5 kg/acre for soil application?	66.67	0.63	0.67
29	Do you know the use of bio-fertilizers at the rate of 10 kg/acre for broadcast with chemical fertilizers?	50.00	0.50	0.39

Reliability of the test

It refers to the knowledge test's reliability. Cronbach's alpha was used in the calculation. According to Kline (1993) and Priyadarshni et al. (2025), a Cronbach's alpha threshold of 0.7 is required for the test to have the desired level of internal consistency. The results in Table 2 show that all items exhibited a Cronbach's alpha value greater than 0.70; therefore, all 24 items were retained. The overall Cronbach's alpha for the test was 0.890.

Table 2: Reliability of the test

Sr. No.	Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
A	**Knowledge about types of bio-fertilizer**				
1	Do you know about Rhizobium?	13.7667	37.151	0.351	0.888
2	Do you know about Azotobacter?	13.8333	35.592	0.603	0.882
3	Do you know about P.S.B.?	13.8333	35.178	0.678	0.880
4	Do you know about Azospirillium?	13.7667	35.909	0.579	0.883
5	Do you know about the bio-fertilizers consortia/ Improved bio-fertilizers?	13.7667	35.220	0.709	0.880
B	**Knowledge about the form of bio-fertilizer**				
6	Do you know about the liquid form of bio-fertilizers?	13.8000	36.097	0.527	0.884
7	Do you know about the powder form of bio-fertilizers?	14.0000	36.690	0.393	0.887
8	Do you know about the granule form of bio-fertilizers?	13.8000	36.234	0.502	0.885
C	**Knowledge about sources of bio-fertilizers availability**				
9	Do you know you can get bio-fertilizers from Agriculture Universities & KVKs?	14.0000	36.759	0.381	0.888
10	Do you know about the availability of bio-fertilizers at the agriculture department?	13.8333	36.213	0.493	0.885
11	Do you know about the availability of bio-fertilizers in input dealers?	13.8667	37.982	0.184	0.893
D	**Knowledge about the time of bio-fertilizers application**				
12	Can bio-fertilizers be used before sowing?	13.8333	34.833	0.741	0.879
13	Can bio-fertilizers be used after sowing?	13.9000	37.334	0.288	0.890
14	Can bio-fertilizers be used in sowing?	13.9000	36.024	0.510	0.884

E	**Knowledge about the application methods of bio-fertilizer**				
15	Do you know bio- fertilizers can be used as seed treatment/root dipping/sets treatment?	13.9000	36.714	0.392	0.887
16	Do you know bio- fertilizers can be used as broadcast?	13.9667	36.585	0.409	0.887
17	Do you know bio- fertilizers can be used as a foliar spray?	13.9000	36.024	0.510	0.884
18	Do you know bio- fertilizers can be used for soil application?	13.8333	35.661	0.591	0.882
19	Do you know bio-fertilizers can be used as broadcast with chemical fertilizers?	13.9333	36.892	0.359	0.888
F	**Knowledge about doses of bio-fertilizers**				
20	Do you know the use of bio-fertilizers at the rate of 200gm/10kg seed for seed treatment?	13.9667	37.137	0.317	0.889
21	Do you know the use of bio-fertilizers at the rate of 25 kg/acre for broadcast?	13.8000	36.924	0.379	0.888
22	Do you know the use of bio-fertilizers at the rate of 500ml/acre for foliar spray?	13.7667	36.047	0.553	0.883
23	Do you know the use of bio-fertilizers at the rate of 5 kg/acre for soil application?	13.8000	35.614	0.615	0.882
24	Do you know the use of bio-fertilizers at the rate of 10 kg/acre for broadcast with chemical fertilizers?	13.9667	36.930	0.351	0.889
	Overall Cronbach's Alpha	**0.890**			

Table 4: Final list of knowledge items which are included in the standard test.

Sr. No.	Knowledge test items
A	**Knowledge about types of bio-fertilizer**
1	Do you know about Rhizobium?
2	Do you know about Azotobacter?
3	Do you know about P.S.B.?
4	Do you know about Azospirillium?
5	Do you know about the bio-fertilizers consortia/Improved bio-fertilizers?
B	**Knowledge about the form of bio-fertilizer**
1	Do you know about the liquid form of bio-fertilizers?
2	Do you know about the powder form of bio-fertilizers?
3	Do you know about the granule form of bio-fertilizers?
C	**Knowledge about sources of bio-fertilizers availability**
12	Do you know you can get bio-fertilizers from Agriculture Universities & KVKs?
13	Do you know about the availability of bio-fertilizers at the agriculture department?
14	Do you know about the availability of bio-fertilizers in input dealers?
D	**Knowledge about the time of bio-fertilizers application**
15	Can bio-fertilizers be used before sowing?
16	Can bio-fertilizers be used after sowing?
17	Can bio-fertilizers be used in sowing?
E	**Knowledge about the application methods of bio-fertilizer**
18	Do you know bio- fertilizers can be used as seed treatment/root dipping/sets treatment?
18	Do you know bio- fertilizers can be used as broadcast?
20	Do you know bio- fertilizers can be used as a foliar spray?
21	Do you know bio- fertilizers can be used for soil application?
22	Do you know bio-fertilizers can be used as broadcast with chemical fertilizers?
F	**Knowledge about doses of bio-fertilizers**
1	Do you know the use of bio-fertilizers at the rate of 200gm/10kg seed for seed treatment?
2	Do you know the use of bio-fertilizers at the rate of 25 kg/acre for broadcast?
3	Do you know the use of bio-fertilizers at the rate of 500ml/acre for foliar spray?
4	Do you know the use of bio-fertilizers at the rate of 5 kg/acre for soil application?
5	Do you know the use of bio-fertilizers at the rate of 10 kg/acre for broadcast with chemical fertilizers?

CONCLUSION

The study found that creating a test requires complicated processes that must be carefully carried out in accordance with recommended literature. Test validity and reliability with an appropriate discrimination index must be prioritized during the testing procedure. One should decide whether to reject and modify the items based on the reliability and validity values. Based on the developer's purpose, the criterion could change. For an appropriate outcome, it is necessary to verify the test's validity, reliability, and discrimination index. The resulting knowledge was utilized to assess the farmers' level of knowledge and analyze any gaps, and more training was given to improve their understanding so they could apply bio-fertilizers practices more effectively.

RECOMMENDATION

The extension agents can use the knowledge test generated from the research to fill the gap areas and train the farmers on the use of bio-fertilizers. The capacity development approach through demonstration and advisory services needs to be enhanced to promote the adoption process.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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