P-ISSN 2322 - 0678 & E-ISSN 3048 - 9946
https://doi.org/10.56572/gjoee.2025.40.1.0001 Gujarat Journal of Extension Education Vol. 40 : Issue 1 : December - 2025

ASSESSMENT TOOL TO EVALUATE FARMERS' KNOWLEDGE LEVEL ABOUT SOIL HEALTH MANAGEMENT PRACTICES

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ABSTRACT

Soil health management practices play a major role in maintaining and improving soil fertility, structure, and biological activity to support sustainable agriculture and environmental conservation. The present study was conducted in the Punjab state, five districts were selected from each agro-climatic zones, two blocks were selected from each district and two villages were selected from each block. From each village 15 respondents were choosen randomly thus contributing to total number of 300 farmers. The present study assessed the knowledge level of the farmers regarding soil health management practices like direct seeded rice, poultry manure, farmyard manure, leaf colour chart, incorporation of paddy straw, laser levelling, fertilizer application on soil test basis etc., in the rice-wheat Cropping system. Following steps conducted while developing knowledge test viz. selection of items; item analysis and pre-testing; calculation of difficulty, discrimination index and point bi-serial correlation; final selection of items and testing of reliability and validity were followed to develop and standardize the test. A total 137 items were administered to group of experts. Based on experts responses, 97 items were selected, these 97 items were administered to 60 farmers from a non-sampled area. Item analysis was done using formula of item difficulty index and item discrimination index and the items with difficulty index ranged between 30 to 80, discriminatory value of more than 0.250 were selected for final test and point-biserial correlation coefficient (≥ 0. 268). Finally, 55 knowledge items were included in the final format of the knowledge test. It had high significant value of reliability co-efficient and construct validity. After implementation of this test it was found that majority i.e. 55.67 per cent of the respondents had medium level of knowledge followed by 29.00 per cent and 15.33 per cent of the respondents had low and high level of knowledge, respectively.

Keywords: *soil health management practices, leaf colour chart, farmyard manure and incorporation of paddy straw.*

INTRODUCTION

Soil health is a critical component of sustainable agriculture and environmental conservation, influencing plant growth, water retention, nutrient cycling, and the overall resilience of farming systems. As a foundational element of agroecosystems, healthy soils support biodiversity, regulate water flow, and play a vital role in carbon sequestration, thereby contributing to climate resilience and long-term productivity (Lal, 2020). Soil health is defined by its biological, chemical, and physical properties, which collectively determine its capacity to sustain plant and microbial life (Lal, 2020). These properties influence essential functions suchas nutrient cycling, water retention, and soil structure, making them central to agricultural productivity and ecological balance. Soil health management practices (SHMPs) refer to sustainable agronomic practices aimed at maintaining or improving these soil properties. Key SHMPs include cover cropping, crop rotation, reduced tillage, organic amendments, and integrated nutrient and water management (Doran & Zeiss, 2000; Hobbs et al., 2008).

The relevance of this topic is particularly high in low- and middle-income countries, where a significant proportion of the population depends directly on agriculture for their livelihoods (Ghosh et al., 2023). However, modern agricultural practices such as intensive tillage, mono-cropping, and excessive use of chemical fertilizers and pesticides have contributed to widespread soil degradation. This degradation manifests as declining fertility, erosion, organic matter loss, and a reduction in soil biodiversity (Schipanski et al., 2014), posing serious threats to food security and environmental sustainability. To address these challenges, farmers must adopt sustainable soil health practices. However, effective adoption depends heavily on farmers' knowledge and awareness of such practices. Knowledge influences decision-making and practice adoption and is shaped by multiple factors, including extension services and access to information. The integration of Information and Communication Technology (ICT) in agricultural extension can play a significant role in disseminating knowledge to farmers (Burman et al., 2023). According to Bloom's Taxonomy, knowledge forms the base for higher-order cognitive skills, and acquiring relevant knowledge is often the first step in the innovation-decision process (Bloom, 1956; Anderson & Krathwohl, 2001). Several studies have attempted to measure farmers' knowledge of specific soil-related practices. For example, Patel et al. (2017), Pagaria (2011), Srivastava and Pandey (1999), and Yadav et al. (2005) focused on knowledge of soil testing and the utility of Soil Health Cards. More recently, Dhivya et al. (2021) studied knowledge levels of Soil Health Card holders, and Thangjam and Jha (2025) highlighted disparities in farmers' awareness of sustainable agricultural practices.

Despite these efforts, only a limited number of studies have developed scientifically standardized knowledge tests specifically focused on comprehensive Soil Health Management Practices. Furthermore, most existing research tends to focus on isolated components such as soil testing, rather than assessing broader knowledge of integrated SHMPs. This represents a critical research gap, especially in the context of formulating effective extension strategies tailored to farmers' knowledge levels. In light of this, the present study aims to construct a standardized knowledge test on Soil Health Management Practices (SHMPs) to accurately measure farmers' understanding, identify knowledge gaps, and support the development of targeted interventions for sustainable agriculture.

OBJECTIVE

To construct a knowledge test for assessing knowledge level of paddy and wheat growers regarding soil health management practices

METHODOLOGY

Locale of the study

The study was conducted in Punjab state in five districts according to five agro-climatic zones i.e. Gurdaspur, Ropar, Jalandhar, Firozpur and Sangrur. From each district two blocks were selected randomly and from each block two villages were selected randomly. From each village 15 respondents were selected randomly comprising total of 300 respondents. To develop a knowledge test a pilot test was conducted in non sampled area among 60 respondents administering 97 items.

Construction of knowledge test

For developing a specialized knowledge test for soil health management practices, the procedure followed by Yadav *et al* (2009) and Mukherjee *et al* (2019) was adopted with desired modification. To measure the respondents' knowledge, a series of items such as multiple-choice questions, true/false statements and fill-in-the-blank questions were included in the test, covering all aspects of the recommended soil health management practices for paddy-wheat crop.

Collection of items

Items about soil health management practices were collected from the pertinent literature, personal experience, discussions held with the experts and pilot study conducted in the area of investigation. Finally 137 items covering all the knowledge aspects of soil health management practices were collected. The items related to the recommended recommended soil health management practices of paddy-wheat crop were developed by consulting various sources, including relevant literature, agronomy and soil scientists and extension personnel. The items were edited and drafted in such a way that each item highlighted only one idea and did not have any ambiguity and with a logical sequence.

Jury opinion

These 137 items were sent to the experts. The experts were requested to check each item carefully whether the items were really capable to measure the knowledge of the respondents about soil health management practices considered or not. They had been given full liberty to add / delete or modify those item/ items based on the suitability. After considering the opinion of the experts, 97 items were retained in the final knowledge test. These 97 items were administered to 60 farmers from a non-sampled area. The scores obtained by 60 respondents were arranged in descending order and divided into six group's i.e. 10 respondents in each group. The groups were named as G1, G2, G3, G4, G5 and G6. For the purpose of item analysis, the middle two groups G3 and G4 were eliminated keeping four extreme groups with high and low scores. The data containing to the correct response for all the items in respect of these four groups were tabulated for calculating the difficulty and discrimination indices.

Item analysis

The item analysis was done based on three kinds of information viz., index of item difficulty, index of item discrimination and index of item validity. The index of item difficulty indicated the extent to which an item was difficult to understand while the index of item discrimination was to find out whether an item really discriminated a well-informed farmer from a poorly informed one. The index of item validity provided the information on how well an item measured or discriminated in agreement with rest of the test. The 97 items were administered to 60 respondents from a non-sampled area. The whole test was consisting of multiple choice questions, fill in the blanks and true false. Each question was having two response categories either correct or wrong. Each correct answer was given one score while wrong answer was awarded zero score. Thus total score secured by all individual respondents on 97 items for correct answers was the knowledge score. After calculating the scores for all 60 respondents, the scores were then arranged in ascending order from lowest to highest.

Item difficulty index

The index of item difficulty was worked out as the percentage of the respondents answered on items correctly. The assumption behind this item difficulty index was that the difficulty is linearly related to the level of respondents' knowledge about soil health management practices. It was assured that when a respondent answered any item, the item was less difficult than his ability to cope with it. In this study with this assumption, the items with Pi values ranging from 30 to 80 were considered for final selection of knowledge test. It was calculated by following formula:

$$\text{Difficulty Index (Pi)} = \frac{Ni}{Ri} * 100$$

Where

R = Number of farmers who gave correct answer

N = Total number of farmers who take the test

Item discriminatory index

If the test and its items assess the same ability or competence, those with high overall test scores are more likely to answer the items correctly, while those with low overall scores are less likely to do so. Therefore, a well-designed test can effectively distinguish between well-informed and poorly informed respondents. The second criterion for item selection was the discrimination index which is indicated by E1/3 values of item. In the present study, the items with E1/3 values greater than 0.250 were considered for final selection. This index (E1/3) was calculated by the following formula:

$$E1/3 = \frac{RU-RL}{Ni/2}$$

Where,

E1/3 = Discrimination index of an item i

RU = Number of correct response from upper group (G5+G6)

RL = Number of correct response from the lower group (G1+G2)

Ni = Total number of respondents in both the groups

Point biserial correlation

For the purpose of judging the construct validity of test items, point biserial correlation was done. The criterion of validity is regarded as internal consistency that is the relationship of total score to a correct / incorrect response to any given item. It was worked by the following formula suggested by Guilford and Fruchter (1978).

$$r_{pbi} = \frac{\bar{X}_p - \bar{X}_q}{S_t} * \sqrt{pxq}$$

Where, rpbi = Point-biserial correlation coefficient

Xp = Mean score on continuous variable of successful group on dichotomous variable

Xq = Mean score on continuous variable of unsuccessful group on dichotomous variable

St = Standard deviation on continuous variable for total groups

p = Proportion of respondents who answered correctly on dichotomous variable

q = Proportion of respondents who answered wrong on dichotomous variable

The item with rpbi value more than or equal to 0.268 was considered for the selection in the final knowledge test. Finally, 55 items were selected in the knowledge test by considering the objective criteria as stated above.

Table 1: Difficulty index, discrimination index and point –biserial correlation coefficient of knowledge items related to soil health management practices

Sr. No.	Question	Difficulty index (Pi)	Discrimination index (E1/3)	Point-biserial correlation coefficient (rpbi)
1*	Which method among these is best method in Farmyard Manure preparation?	42.31	0.37	0.45
2*	What amount of FYM per acre is recommended by PAU for paddy crop?	68.27	0.53	0.36
3	What amount of urea dose should be reduced for paddy while applying 6 tonnes/acre of FYM?	12.34	0.06	0.21
4	How much fertilizer quantity is reduced when FYM is applied before sowing wheat?	10.21	0.04	0.01
5*	How much poultry manure should be applied for paddy?	30.32	0.50	0.69
6*	Which crop is typically incorporated as a green manure?	79.56	0.30	0.27
7*	Recommended seed rate of Dhaincha/Sunhemp for green manure crops	58.32	0.31	0.27
8	Incorporation of Dhaincha/Sunhemp in paddy leads to a reduction of urea dose by	16.48	0.25	0.30
9*	Incorporate __________ weeks old green manure crop before transplanting of paddy.	61.87	0.43	0.27
10*	Green manuring with Dhaincha ameliorates ___________ deficiency in paddy crop.	72.21	0.36	0.32
11*	What is the waiting period to apply irrigation after the ponded water for 15 days has infiltrated for paddy crop?	36.53	0.62	0.56
12*	After transplanting of paddy, for how many days water is kept ponded continuously?	62.34	0.51	0.26
13*	How many irrigations are required in the Direct Seeded Rice (DSR) technique?	30.05	0.31	0.56
14*	Recommended time of sowing in DSR technique is	32.21	0.53	0.58
15*	What is the recommended seed rate in Direct Seeded Rice (DSR) technique?	36.32	0.50	0.40
16*	In Direct Seeded Rice (DSR) technique, deficiency of which nutrient can occur?	66.33	0.49	0.29
17	Which method is best for maintaining soil health	95.21	0.11	0.01
18	Incorporating paddy straw effect soil characteristics by increasing	88.23	0.12	0.13
19	How many tonnes of prali char is recommended for application in wheat crop?	7.98	0.17	0.02
20*	What is the benefit of applying the recommended dose of prali char?	34.56	0.37	0.49
21	Which of the following is a zero tillage planter?	98.35	0.06	0.11
22*	The leaf colour chart support the decision regarding	78.33	0.43	0.47
23*	PAU Leaf Colour Chart is used for need based application of	72.42	0.50	0.53
24*	Colour of which plant part is matched with LCC chart.	74.56	0.43	0.44
25*	What are advantages/benefits of laser levelling?	32.76	0.46	0.29
26*	Soil testing is done to ensure the use of as per requirement	78.54	0.36	0.43
27*	Soil testing is done for determination of	78.56	0.50	0.45
28*	Which time period is suitable for soil sampling?	77.76	0.36	0.31
29*	Which shape of pit should be dig for collecting the sample?	34.57	0.56	0.58

Sr. No.	Question	Difficulty index (Pi)	Discrimination index (E1/3)	Point-biserial correlation coefficient (rpbi)
30	Which kind of sample should be taken for soil testing?	94.34	0.56	0.43
31	How deep the soil sample should taken for shallow rooted crop?	12.97	0.05	0.03
32	How deep the soil sample should taken for deep rooted crop?	10.65	0.02	0.02
33*	How much quantity of soil sample needed for testing?	34.87	0.81	0.78
34*	How much quantity of urea is recommended in wheat crop?	32.54	0.42	0.27
35*	How much quantity of urea is recommended in paddy crop?	44.13	0.41	0.55
36*	How much quantity of Diammonium phosphate (DAP) is recommended in wheat crop?	44.87	0.62	0.52
37*	How much quantity of Diammonium phosphate (DAP) is recommended in paddy crop	31.22	0.87	0.62
38*	Generally Zinc deficiency appears in paddy crop after transplanting	38.72	0.37	0.72
39*	Lower leaves becomes in paddy due to Zinc deficiency	52.46	0.37	0.47
40*	Apply amount of Zinc Sulphate to control zinc deficiency in paddy	32.87	0.75	0.29
41	Sowing of Moong crop should be done at row spacing of ?	8.56	0.25	0.78
42*	Sowing of Moong crop should be done in?	32.75	0.52	0.59
43*	The recommended seed rate of Moong crop is	31.47	0.28	0.48
44	Give the first hoeing after sowing of the Moong crop	12.85	0.06	0.47
45	The recommended dose of Urea and Single Super Phosphate in Moong crop is ?	7.56	0.05	0.28
46	Sowing of Summer Moong crop should be done at row spacing of?	14.46	0.25	0.03
47*	Sowing of Summer Moong crop should be done in?	74.65	0.52	0.37
48	The recommended seed rate of Summer Moong crop is for SML 668 and for other varieties	32.44	0.68	0.38
49	Sowing of Mash crop should be done at line spacing of by using the kera/pora method?	1.45	0.01	0.66
50*	The recommended seed rate of Mash crop is	32.98	0.48	0.32
51*	Sow the Mash crop from	34.66	0.65	0.51
52	The recommended dose of Urea and Single Super Phosphate in Mash crop is ?	2.21	0.01	0.65
53	Sowing of Summer Mash crop should be done at row to row spacing of ?	4.98	0.15	0.02
54	The recommended seed rate of Summer Mash crop is ?	8.13	0.18	0.356
55	Sow the Summer Mash crop from	32.11	0.65	0.38
56	Sowing of Groundnut crop should be done at row to row spacing and plant to plant spacing?	4.65	0.15	0.69
57	The recommended seed rate of Groundnut crop is ?	4.23	0.06	0.36
58	Sowing of Cowpea crop should be done at row to row spacing of ?	3.98	0.01	0.27
59	The recommended seed rate of CL-367 Cowpea crop is ?	1.86	0.01	0.00
60	Drill dose of Urea and of Single Super Phosphate in Cowpea crop at the time of sowing?	1.50	0.00	0.00
61*	Dimensions of pits for preparation of FYM are (8m x 2m x 1m)	38.98	0.56	0.35
62*	FYM gets prepared in (5-6) months in pit method.	34.55	0.52	0.76
63*	Apply (6) tonnes of FYM/acre before transplanting paddy.	56.82	0.47	0.57

Sr. No.	Question	Difficulty index (Pi)	Discrimination index (E1/3)	Point-biserial correlation coefficient (rpbi)
64	Practise (one) hoeing at one month after sowing of Mash crop.	6.72	0.18	0.25
65*	Farmers are advised to carry out soil testing in ___ (every 3 years).	38.22	0.47	0.48
66*	Long-term paddy straw incorporation (increase/ improves) the soil organic matter.	78.16	0.37	0.56
67*	Paddy straw takes approximately (three) weeks for decomposition.	74.19	0.37	0.34
68	Seed rate of Guara crop is (8-10) kg seed/acre.	2.84	0.06	0.34
69	Adopt Guara (Wheat) rotation in light textured soil for saving water and maintenance of soil health.	2.66	0.06	0.25
70	Farmyard manure are organic in nature.	94.31	0.06	0.22
71*	Farmyard manure improves the soil structure.	78.42	0.56	0.38
72*	Farmyard manure increases the soil water holding capacity.	46.33	0.43	0.51
73*	Microbial population is decreased in soil with the application of Farmyard manure.	36.27	0.56	0.57
74	FYM are ecofriendly in nature.	98.14	-0.06	0.62
75	FYM is prepared using cow dung, cow urine, waste straw, and other dairy wastes.	100.00	0.00	-0.22
76*	FYM decomposition releases harmful gases into the atmosphere.	32.46	0.47	0.27
77	Green manure have high organic matter content.	98.19	0.00	0.56
78*	Green manuring helps in reduction of weed for subsequent crop.	36.44	0.37	0.32
79	Green manuring improves nutrient availability in soil.	97.13	0.03	0.53
80*	Direct Seeded Rice (DSR) should not be done on light textured sandy soils.	32.13	0.52	0.43
81*	DSR technique reduces the labour requirement.	38.62	0.53	0.49
82	Inculcate the Winter Moong seed with recommended Rhizobium culture at the time of sowing.	4.54	0.12	0.48
83	Inculcate the Summer Moong seed with recommended consortium biofertilizer before sowing.	6.87	0.18	0.42
84	For synchronous maturity, stop irrigation at about 55 days after sowing.	2.43	0.02	0.59
85	The sowing of summer moong can be done with Zero-till drill if there is no Wheat straw but it can be sown with PAU happy seeder if Wheat straw is present in field.	4.98	0.15	0.01
86*	Soil testing helps to know fertility status of soil.	42.76	0.32	0.29
87*	Fertilizer application should be done on the basis of soil test report.	61.37	0.32	0.38
88*	Zinc sulphate should be applied preferably in Kharif crops.	44.44	0.47	0.28
89*	Manganese deficiency generally appears in wheat or berseem following paddy in sandy soils.	36.85	0.68	0.37
90*	Application of Gypsum is used for reclamation of alkali (sodic) soils.	72.42	0.43	0.43
91	Soil testing helps to know fertility status of soil.	86.65	0.18	0.67
92*	Paddy straw increase soil fertility and water holding capacity.	46.33	0.32	0.27
93	Prali char/biochar is a carbon-rich porous product.	6.12	0.18	0.12
94*	Incorporation of paddy straw a labor-intensive process.	71.50	0.32	0.54

Sr. No.	Question	Difficulty index (Pi)	Discrimination index (E1/3)	Point-biserial correlation coefficient (rpbi)
95*	Urea should not be applied if colour of leaves darker than shade number 4 of LCC in paddy crop.	34.21	0.26	0.42
96	The leaves selected for measuring greenness should be free of insect-pest incidence.	12.20	0.25	0.14
97	Use of LCC should be discontinued after initiation of flowering.	1.21	0.01	0.07

Note: * indicates the items selected in final knowledge test

Representative of the test

Finally, 55 knowledge items were included in the final format of the knowledge test based on the difficulty index (30 to 80), discrimination index (>0.250) and point-biserial correlation coefficient (≥ 0. 268). Though, the above-mentioned criteria were the main contemplations for the final selection of the knowledge items, thus far, care was taken not to eliminate the important aspects if any as a test item. For this purpose experts' opinion about the items was reconsidered. Thus, 55 items were finally selected, which formed actual (final) format of the knowledge test.

Reliability

The Kuder-Richardson method was used to estimate the reliability of the knowledge test by using their formula known as Kuder-Richardson Formula 20 (Guilford and Fruchter 1978). The reliability coefficient was 0.93, which was found to be significant.

$$r = \frac{K}{K-1}\left[1 - \frac{\sum_{i=1}^{K} p_i q_i}{\sigma_X^2}\right]$$

where:

r= reliablilty coefficient of the test k= number of items in the test

pj: Proportion of individuals who answered a test item correctly

qj: 1- pj

σ^2: Variance of scores for all individuals who took the test

The reliability coefficient provides an estimate of the internal consistency of the test and thus the dependability of the test scores. On the basis of reliability coefficients determined by the methods indicate that this knowledge test is quite reliable.

Validity

The biserial correlation (rbis) was considered as a measure of test items validity. Highly significant biserial correlation coefficient (rbis) values proved the construct validity of the items included in knowledge test. Talking about the "content validity", content validity as explained by Anastasi (1968) essentially involves the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured which is knowledge here. Accordingly, all possible statements, covering wide aspects of SHMPs were collected and the same were subjected to measure the difficulty as well as discrimination indices in order to select the final statements. Hence, it is reasonable to consider the developed test to be content valid. The intrinsic validity of these instruments was also calculated by using the following formula given by Guilford (1954). According to him, it is the degree to which the test measures the true score components. This validity is calculated by the square root of its reliability.

$$v = \sqrt{r} = 0.96$$

Level of knowledge regarding soil health management practices among farmers

On the basis of overall level of knowledge, majority (55.67%) of the farmers fell under the medium knowledge category, with scores ranging between 30 and 40. This indicated that most farmers possessed a moderate understanding of soil health management practices. While this level of knowledge was sufficient for basic application, it might not have been adequate to address advanced soil management challenges or ensure long-term soil health. About 29.00 per cent of the farmers demonstrated high knowledge levels (scores 40 to 50). This smaller proportion represented the group of farmers who were likely well-informed and equipped to implement comprehensive soil health management practices, such as fertilizer management, organic manures, and water-saving technologies. Very low (15.33%) of the farmers had low knowledge levels (scores 20 to 30). This group was at risk of practicing inefficient or harmful soil management techniques, potentially leading to declining soil fertility, lower crop yields, and unsustainable farming. Kalariya and

Gulkari (2024) reported that the majority (87.50%) of the farmers had medium to high level of overall knowledge about problematic soil reclamation practices. This finding conforms with those reported by Noorjehan (2015), Ingale et al. (2017), Patel et al., (2018), Yarazari et al. (2019), Raval et al. (2023) and contradictory to the findings of Luangduangsitthidetha et al. (2019), Jayan et al. (2023). The distribution of knowledge levels reflected a need for targeted interventions to enhance farmers' understanding of soil health management. While the majority were in the medium category, the data suggested that significant gaps still existed, particularly among those in the low-knowledge group. These gaps could have hindered the adoption of soil health management practices and compromised agricultural sustainability. The findings are in line with the studies of Kalariya and Gulkari (2024); Vegad et al., (2021); Mallappa et al., (2023); Vegad et al., (2021); Pratik and Vinaya (2022).

Table 2 : Distribution of respondents according to level of knowledge regarding soil health management practices

(n=300)

Sr. No.	Category	*f*	%	Mean ±SD
1	**Low** (20-30)	87	29.00	36.68±5.61
2	**Medium** (30-40)	167	55.67	
3	**High** (40-50)	46	15.33	

CONCLUSION

Knowledge about the technology significantly contribute towards the effective transfer of technologies and understanding the knowledge level of farmers is also very important as it influences the adoption of technologies to a great extent. A reliable and valid knowledge test is required to measure the knowledge level of individual farmers. In the present study a knowledge test on soil health management practices is developed and standardized. Better knowledge on SHM practices are critical inputs in farming activities and maintaining soil health. The knowledge test developed in this study could be used for assessing the knowledge level of farmers on SHM practices across the country. Knowledge test is essential to identify the lacunae existing in the technology transfer programs. Further, this knowledge test can pave a way for planning need-based training for the farmers by addressing the existing knowledge gap. This standardized test can serve as a valuable tool for researchers and extension professionals to assess knowledge levels and design targeted interventions for improving soil health management practices among farmers.

RECOMMENDATIONS

1 Development and Use of Standardized Knowledge Tests

Understanding farmers' knowledge levels is essential for the effective adoption and transfer of soil health management (SHM) technologies. The standardized knowledge test developed in this study provides a reliable tool to assess individual farmers' understanding of SHM practices. Policymakers and extension agencies should incorporate such validated tools into ongoing agricultural programs to identify knowledge gaps and enhance the effectiveness of technology dissemination.

2 Need-Based Training and Capacity Building

The use of this knowledge test can facilitate the design of targeted, need-based training programs for farmers by identifying specific areas where knowledge is lacking. This approach can improve farmers' decision-making, adoption of sustainable practices, and ultimately contribute to better soil health, increased productivity, and long-term agricultural sustainability. Extension systems should integrate these assessments into their regular planning and evaluation processes.

ACKNOWLEDGEMENT

I would like to express sincere gratitude to all those who contributed to the successful completion of this study. Special thanks are extended to the farmers who participated in the research and shared their valuable time and insights. The guidance and support received from major advisors, all committee members and extension personnel have been instrumental in the development and standardization of the knowledge test on soil health management practices.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this study.

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Received : August 2025 : Accepted : October 2025