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Farmers' Knowledge of Soil Testing: A Multi-Context Analysis Across Different Irrigation Systems

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Authors' contributions

This work was carried out in collaboration between both authors. Author CGH conceptualized and designed the study, collected and analyzed data, wrote, reviewed and edited the manuscript. Author KS supervised the study, provided resources, and reviewed and edited the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out during 2022-23 in the districts of Mandya, Chikkaballapura, and Tumakuru in Karnataka to assess farmers' knowledge of soil testing across different farming situations. Additionally, the study aimed to examine the relationship between farmers' profile characteristics and their knowledge of soil testing, as well as the extent to which these characteristics contribute to that knowledge. A total of sixty soil-tested farmers from each district were personally interviewed using a pre-tested interview schedule. The results showed that a large majority of farmers (76.10%) possessed medium to high knowledge about soil testing. Correlation analysis indicated that, a majority of profile characteristics showed significant associations with knowledge levels across all irrigation types. Furthermore, all 19 profile

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characteristics collectively accounted for 68.40%, 71.10%, and 66.90% of the variation in knowledge levels under assured, protected, and rainfed conditions, respectively. These findings suggest the need for targeted extension programs to enhance soil testing awareness, especially in rainfed regions.

Keywords: Soil testing; knowledge; irrigation; relationship; extent of contribution.

1. INTRODUCTION

Agriculture continues to be the backbone of the Indian economy, with food production playing a crucial role in sustaining human life. In India, the adoption of intensive farming practices—such as the use of high-yielding seed varieties, chemical fertilizers, and assured irrigation—has significantly boosted food grain production. However, these advancements have also raised concerns about the long-term sustainability of soil health. Soil nutrient management is a cornerstone of sustainable agriculture. It involves two key components: soil testing and the application of fertilizers based on test results. Soil testing serves multiple purposes—it optimizes crop yields, prevents environmental pollution caused by fertilizer runoff and leaching, diagnoses nutrient-related plant health issues, enhances nutrient balance in the soil, and supports cost-effective and energy-efficient fertilizer usage. While fertilizers are vital for improving agricultural productivity, their continuous and unregulated use can degrade soil health. Sustainable farming starts with strategic cropping patterns and the rational use of fertilizers (Bangre et al., 2021).

Maintaining soil health is essential to ensure long-term agricultural productivity. In recent years, declining soil fertility has become a growing concern, often leading to inefficient input use. In India, fertilizer recommendations are typically limited to nitrogen (N), phosphorus (P), and potassium (K), often neglecting the importance of secondary and micronutrients—particularly in the diverse cropping systems followed by small and marginal farmers (Chandan Gowda et al., 2023). A survey by Kumar et al. (2021) found that farmers generally have a low level of awareness and adoption of Sustainable Forest Management (SFM), with only about 8% of them being familiar with the concept.

To address these challenges, the Government of India is actively promoting Integrated Nutrient Management (INM), which advocates the combined use of chemical fertilizers, bio-fertilizers, and locally available organic manures. When informed by soil testing, this approach helps maintain soil health while improving crop yields. Given its critical role, soil testing has emerged as an essential tool for evaluating soil fertility (Munzel et al., 2023). It enables the assessment of organic matter content, influencing the soil's physical and biological characteristics, and helps estimate nutrient availability for plant growth (Kaur et al., 2020). Launched by the Indian Government on February 19, 2015, the Soil Health Card (SHC) initiative seeks to reduce the excessive use of chemical fertilizers by promoting soil testing and offering crop-specific recommendations every three years (Patel et al, 2021). The Soil Health Card (SHC) offers a holistic assessment of soil quality by evaluating its functional characteristics and nutrient levels, and it delivers customized fertilizer recommendations based on specific soil types and crop requirements (Singh et al., 2023). To improve fertilizer use efficiency and ensure the appropriate application of nutrients tailored to specific soils and crops, soil test reports are indispensable. These reports provide farmers with vital information on the condition of their soils, enabling them to make informed, science-based fertilizer decisions.

1. To assess the knowledge of farmers on soil testing in different farming situations
2. To find out the relationship and extent of contribution of profile characteristics of farmers on the knowledge on soil testing.

2. METHODOLOGY

The study employed an ex-post facto research design. It was conducted in Mandya, Chikkaballapur and Tumakuru districts which falls in assured irrigation situation, protected irrigation situation and rainfed situation, respectively. In each selected district 60 farmers each who have tested their soils during last 3 years were selected. Thus 180 soil tested farmers constituted the sample of the study. The knowledge of farmers on soil testing was considered as the dependent variable for the study. Information different farming situation were collected using a structured schedule with suitable scales.

Based on the mean (41.14) and standard deviation (8.22) the respondents could be categorized into three knowledge categories, *viz.*, low, medium and high. Higher score indicates that the respondent has high knowledge on soil testing and the lower knowledge score indicates that the respondent has low knowledge on soil testing. The collected data were scored, tabulated and analyzed using frequency, mean, percentage, correlation test and multiple regression analysis.

3. RESULTS

3.1 Statement-Wise Knowledge of Farmers on Soil testing in Different Farming Situations

The results in the table 1 represent statement-wise knowledge of farmers on soil testing in different farming situations. In assured irrigation situation, among top order 80.00 per cent of farmers knew that "Samples must be collected in a clean cloth/ polythene bag" followed by "Soil testing should be done before taking up of a crop" (78.30%). In contrast, 40.00 per cent of farmers had knowledge about "Separate samples should be drawn from fields that differ in colour, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system etc" and "Soil sampling must be avoided near dead furrows, wet spots, main bunds, manure heaps, irrigation channels, trees etc." (35.00%).

In protected irrigation situation, among top order equal (96.70%) per cent of farmers knew that "Soil testing should be done before taking up of a crop" and "Collected soil sample bag should be labelled with information like name of the farmer, location of the farm, survey number, previous crop grown, present crop, crop to be grown in the next season and date of collection". In contrast, equal (63.30%) of farmers had knowledge on "Soil samples must be collected by making 'V' shaped cut and removing thick slices of soil from top to bottom of exposed face" and "Soil test recommended amendments should be followed accordingly".

In rainfed situation, among top order, 81.70 per cent of farmers knew that "Soil testing should be done before taking up of a crop" followed by "Samples must be collected in a clean cloth/ polythene bag" (73.00%). In lower order, 36.70 per cent of farmers had knowledge about "Soil sampling must be avoided near dead furrows, wet spots, main bunds, manure heaps, irrigation channels, trees etc." (36.70%) and "Separate samples should be drawn from fields that differ in colour, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system etc" (31.70%).

In pooled sample, among top order 85.60 per cent of farmers had knowledge about "Soil testing should be done before taking up of a crop" followed by "Samples must be collected in a clean cloth/ polythene bag" (80.60%). In contrast, 46.10 per cent of the farmers knew that "Separate samples should be drawn from fields that differ in colour, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system etc" and "Soil sampling must be avoided near dead furrows, wet spots, main bunds, manure heaps, irrigation channels, trees etc." (45.00%). The findings were in line with the findings with Khan et al., (2019) and Sheetal et al., (2020).

3.2 Overall Knowledge of Farmers on Soil Testing in Different Farming Situations

Table 2 illustrates the overall knowledge of farmers regarding soil testing**.** The findings indicate that in areas with assured irrigation, 41.70% of farmers fell into the medium knowledge category, followed by 31.70% in the high category and 26.70% in the low category. Under protected irrigation conditions, 40.00% of farmers had medium knowledge, while 38.30% had high knowledge and 15.00% had low knowledge. In rainfed condition, 43.30% of farmers exhibited medium knowledge, followed by 30.00% with low knowledge and 28.70% with poor knowledge. Considering the pooled sample, 42.20% of farmers were classified under the medium knowledge category, followed by 33.90% in the high category and 23.90% in the low category. The chi-square value (5.73) indicates that there was no significant difference in knowledge levels across the different farming situations. These findings are consistent with those reported by Arulmanikandan (2020), Kaur (2019), Madhu (2019), Singh et al. (2020), and Yogesh (2021). Cheruiyot (2020) showed that 31.8% of the farmers rated their knowledge on soil conservation as either low or very low.

Table 1. Statements-wise knowledge of farmers towards soil testing in different farming situations

Sl. No.	Knowledge statements	Knowledge level of Soil tested farmers								
		Assured irrigation situation (n_1=60)		Protected irrigation situation (n_2=60)		Rainfed situation (n_3=60)		Pooled (N=180)		
		No.	%	No.	%	No.	%	No.	%	Rank
1	Soil testing should be done before taking up of a crop	47	78.30	58	96.70	49	81.70	154	85.60	I
2	Soil sample should be collected from- four corners and centre of the field	36	60.00	50	83.30	38	63.30	124	68.90	V
3	Separate samples should be drawn from fields that differ in colour, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system etc.	24	40.00	40	66.70	19	31.70	83	46.10	XXI
4	For shallow rooted crops, soil samples should be collected up to 15 cm depth	35	58.30	42	70.00	27	45.00	104	57.80	XVI
5	For deep rooted crops, soil samples should be collected up to 30 cm depth	29	48.30	52	86.70	26	43.30	107	59.40	XV
6	In standing crops, soil sample should be collected between rows	35	58.30	46	76.70	31	51.70	112	62.20	XII
7	Soil samples must be collected in zig-zag pattern	39	65.00	50	83.30	33	55.00	122	67.80	VI
8	Soil sampling must be avoided near dead furrows, wet spots, main bunds, manure heaps, irrigation channels, trees etc.	21	35.00	38	63.30	22	36.70	81	45.00	XXII
9	Surface litter and stones should be removed at top of the sampling spot before taking soil samples	32	53.30	42	70.00	26	43.30	100	55.60	XVIII
10	Soil samples must be collected by making ‘V’ shaped cut and removal of thick slices of soil from top to bottom of exposed face.	38	63.30	38	63.30	34	56.70	110	61.10	XIV
11	Samples should be mixed thoroughly and remove foreign materials like roots, stones, pebbles and gravels.	38	63.30	40	60.70	36	60.00	114	63.30	XI
12	Quartering technique of soil partition is used to obtain desired sample size	28	46.70	45	75.00	26	43.30	99	55.00	XIX
13	Samples must be collected either in a clean cloth or a polythene bag	48	80.00	55	91.70	42	73.00	145	80.60	II

Sl. No.	Knowledge statements	Knowledge level of Soil tested farmers								
		Assured irrigation situation (n_1=60)		Protected irrigation situation (n_2=60)		Rainfed situation (n_3=60)		Pooled (N=180)		
		No.	%	No.	%	No.	%	No.	%	Rank
14	Collected soil samples must be dried under shade	36	60.00	54	90.00	28	46.70	118	65.60	VII
15	Collected soil sample bag should be labelled with information like name of the farmer, location of the farm, survey number, previous crop grown, present crop, crop to be grown in the next season and date of collection	39	65.00	58	96.70	42	70.00	139	77.20	III
16	Quantity of soil for testing should be 250-500gms.	37	61.70	44	73.30	34	56.70	115	63.90	X
17	Soil test based recommended amount of primary, secondary and micro nutrients should be applied to the crops	46	76.70	53	88.30	36	60.00	135	75.00	IV
18	Soil test based recommended amount of nitrogen fertilizer should be applied to the crops.	35	58.30	51	85.00	31	51.70	117	65.00	VIII
19	Soil test based recommended amount of phosphorous fertilizer should be applied to the crops.	37	61.70	48	80.00	31	51.70	116	64.40	IX
20	Soil test based recommended amount of potassium fertilizer should be applied to the crops.	32	53.30	50	83.30	34	56.70	116	64.40	IX
21	Soil test based recommended amount of secondary nutrient (sulphur) should be applied to the crops.	33	55.70	48	80.00	30	50.00	111	61.70	XIII
22	Soil test based recommended amount of micro nutrients should be applied to the crops.	31	51.70	52	86.70	29	48.30	112	62.20	XII
23	Soil test recommended amount of organic manure should be applied to the crops.	35	58.30	52	86.70	35	58.30	122	67.80	VI
24	Soil test based recommended amount of biofertilizers should be applied to the crops.	28	46.70	48	80.00	25	41.70	101	56.10	XVII
25	Soil test recommended amendments should be followed accordingly	27	45.00	43	71.70	23	38.30	93	51.70	XX

Table 2. Overall knowledge level of farmers on soil testing in different farming situations

Sl. No.	Knowledge categories	Soil tested farmers								X^2 value
		Assured irrigation situation (n_1=60)		Protected irrigation situation (n_2=60)		Rainfed situation (n_3=60)		Pooled (N=180)		
		No.	%	No.	%	No.	%	No.	%	
1.	Low (<37.03)	16	26.70	9	15.00	18	30.00	43	23.90	5.73^{NS}
2.	Medium (37.03-45.25)	25	41.70	25	41.70	26	43.30	76	42.20	
3.	High (>45.25)	19	31.70	26	43.30	16	26.70	61	33.90	
Total		60	100	60	100	60	100	180	100	
Mean		41.14								
Standard deviation		8.22								

*NS= Non-Significant; * = Significant at 5 %; ** = Significant at 1 %*

3.3 Relationship Between Profile Characteristics and Knowledge Level of Farmers on Soil Testing in Different Farming Situations

Correlation test was applied to know the relationship of profile characteristics with knowledge level of farmers on soil testing in different farming situations. Some variables used in this study were previously defined in Gowda et al, (2023) as they represent standard parameters in the model under investigation. Table 3 indicates that in assured irrigation situation the variables, achievement motivation (r=0.388) and extension agency contact (r=0.397) had positive and significant relationship at one per cent level. Similarly, education (r=0.267), farming experience (r=0.274), annual income (r=0.269), innovativeness (r=0.263), scientific orientation (r=0.294), risk orientation (r=0.311), cosmopoliteness (r=0.267), management orientation (r=0.269), social participation (r=0.283), mass media exposure (r=0.265), social media exposure (r=0.218) and extension participation (r=0.311) had positive and significant relationship with knowledge at five per cent level. The remaining variables viz., age, family size, land holding, livestock possession and material possession had non-significant relationship with knowledge level of farmers.

It is also observed from the table 3 that in protected irrigation situation the variables, education (r=0.376), innovativeness (r=0.388), achievement motivation (r=0.421) scientific orientation (r=0.384), extension agency contact (r=0.413) and extension participation (r=0.367) had positive and significant relationship at one per cent level. Similarly, farming experience (r=0.301), annual income (r=0.301), risk orientation (r=0.315), cosmopoliteness (r=0.284), management orientation (r=0.296), social participation (r=0.291), mass media exposure (r=0.317) and social media exposure (r=0.287) had positive and significant relationship with knowledge at five per cent level. Variable, age (r=-0.253) had negative and significant relationship with knowledge level at five per cent level. The remaining variables family size, land holding, livestock possession and material possession had non-significant relationship with knowledge level of farmers.

Further, it is revealed from the table 3 that in rainfed situation the variables extension agency contact (r=0.384) had positive and significant relationship at one per cent level. Similarly, education (r=0.291), farming experience (r=0.266), annual income (r=0.248), innovativeness (r=0.275), achievement motivation (r=0.313), scientific orientation (r=0.287), risk orientation (r=0.252), cosmopoliteness (r=0.288), management orientation (r=0.251), social participation (r=0.279), mass media exposure (r=0.292), social media exposure (r=0.285) and extension participation (r=0.271) had positive and significant relationship with knowledge at five per cent level. The remaining variables namely age, family size, land holding, livestock possession and material possession had non-significant relationship with knowledge level of farmers. Similar findings were obtained by Mishra (2020) and Sheetal et al*.,* (2020).

3.4 Extent of Contribution of Profile Characteristics on the Knowledge of Farmers on soil Testing in Different farming Situations

The contribution of independent variables towards knowledge of farmers on soil testing in

assured irrigation situation was assessed and illustrated in the Table 4. Some variables used in this study were previously defined in Gowda et al, (2023) as they represent standard parameters in the model under investigation. The findings indicates that fourteen out of nineteen independent variables such as education, farming experience, annual income, innovativeness, achievement motivation, scientific orientation, risk orientation, cosmopoliteness, management orientation, social participation, mass media exposure, social media exposure, extension agency contact and extension participation have contributed significantly towards knowledge of farmers on soil testing. The remaining variables have not contributed significantly towards variability in knowledge. The R^2 value (0.684) indicated that all the 19 independent variables have contributed to the tune of 68.40 per cent of variation in knowledge of farmers on soil testing.

The contribution of independent variables towards knowledge of farmers on soil testing in protected irrigation situation was assessed and illustrated in the Table 4. The findings reveals that fifteen out of nineteen independent variables such as age, education, farming experience, annual income, innovativeness, achievement motivation, scientific orientation, risk orientation, cosmopoliteness, management orientation, social participation, mass media exposure, social media exposure, extension agency contact and extension participation have contributed significantly towards knowledge of farmers towards soil testing. The remaining variables have not contributed significantly towards variability in knowledge on soil testing. The R^2 value (0.711) indicated that all the 19 independent variables have contributed to the tune of 71.10 per cent of variation in knowledge of farmers on soil testing.

Table 3. Relationship between profile characteristics and the Knowledge level of farmers on soil testing in different farming situations

Sl. No.	Characteristics	Correlation coefficient 'r' values		
		Assured irrigation situation (n_1=60)	Protected irrigation situation (n_2=60)	Rainfed situation (n_3=60)
X_1	Age	0.082^{NS}	-0.253*	0.096^{NS}
X_2	Education	0.267*	0.376**	0.291*
X_3	Family size	0.112^{NS}	0.105^{NS}	0.118^{NS}
X_4	Land holding	0.077^{NS}	0.112^{NS}	0.082^{NS}
X_5	Farming experience	0.274*	0.301*	0.266*
X_6	Livestock possession	0.177^{NS}	0.159^{NS}	0.198^{NS}
X_7	Annual income	0.269*	0.301*	0.248*
X_8	Innovativeness	0.263*	0.388**	0.275*
X_9	Achievement motivation	0.388**	0.421**	0.313*
X_{10}	Scientific orientation	0.294*	0.384**	0.287*
X_{11}	Risk orientation	0.311*	0.315*	0.252*
X_{12}	Cosmopoliteness	0.267*	0.284*	0.288*
X_{13}	Material possession	0.165^{NS}	0.189^{NS}	0.133^{NS}
X_{14}	Management orientation	0.269*	0.296*	0.251*
X_{15}	Social participation	0.283*	0.291*	0.279*
X_{16}	Mass media exposure	0.265*	0.317*	0.292*
X_{17}	Social media exposure	0.218*	0.287*	0.285*
X_{18}	Extension agency contact	0.397**	0.413**	0.384**
X_{19}	Extension participation	0.311*	0.367**	0.271*

*NS= Non-significant; *=Significant at 5%; **= Significant at 1%*

Table 4. Extent of contribution of profile characteristics on the knowledge of farmers on soil testing in different farming situations

Sl. No	Characteristics	Assured irrigation situation			Protected irrigation situation			Rainfed situation		
		Regression coefficient	SE of Regression coefficient	't' value	Regression coefficient	SE of Regression coefficient	't' value	Regression coefficient	SE of Regression coefficient	't' value
X_1	Age	0.33	0.26	0.78^{NS}	0.11	0.26	2.28*	0.33	0.26	0.78^{NS}
X_2	Education	0.38	0.81	2.12*	0.38	0.81	2.08*	0.30	0.65	2.12*
X_3	Family size	0.46	0.67	1.45^{NS}	0.46	0.67	1.45^{NS}	0.47	0.63	1.34^{NS}
X_4	Land holding	0.79	0.54	0.68^{NS}	0.66	0.45	0.68^{NS}	0.54	0.46	0.84^{NS}
X_5	Farming experience	0.20	0.51	2.44*	0.13	0.35	2.54*	0.13	0.32	2.44*
X_6	Livestock possession	0.08	0.11	1.28^{NS}	0.37	0.48	1.28^{NS}	0.34	0.44	1.28^{NS}
X_7	Annual income	0.27	0.61	2.19*	0.24	0.58	2.38*	0.41	0.38	0.91^{NS}
X_8	Innovativeness	0.37	0.81	2.14*	0.20	0.65	3.14**	0.29	0.63	2.12*
X_9	Achievement motivation	0.39	0.88	2.21*	0.25	0.84	3.31**	0.15	0.34	2.21*
X_{10}	Scientific orientation	0.38	0.78	2.05*	0.27	0.85	3.05**	0.15	0.31	2.05*
X_{11}	Risk orientation	0.25	0.62	2.41*	0.17	0.42	2.41*	0.22	0.54	2.38*
X_{12}	Cosmopoliteness	0.27	0.60	2.18*	0.29	0.69	2.31*	0.33	0.58	1.71^{NS}
X_{13}	Material possession	0.21	0.21	0.99^{NS}	0.43	0.43	0.99^{NS}	0.31	0.37	1.18^{NS}
X_{14}	Management orientation	0.16	0.42	2.51*	0.22	0.47	2.11*	0.35	0.83	2.31*
X_{15}	Social participation	0.26	0.56	2.11*	0.21	0.46	2.13*	0.20	0.45	2.18*
X_{16}	Mass media exposure	0.25	0.60	2.40*	0.20	0.52	2.48*	0.38	0.82	2.40*
X_{17}	Social media exposure	0.32	0.76	2.33*	0.40	0.86	2.15*	0.22	0.48	2.18*
X_{18}	Extension agency contact	0.19	0.57	2.96**	0.11	0.46	3.86**	0.21	0.51	2.35*
X_{19}	Extension participation	0.26	0.61	2.26*	0.26	0.61	2.33*	0.12	0.29	2.26*

*NS= Non-significant; *=Significant at 5%; **= Significant at 1%*

The contribution of independent variables towards knowledge of farmers on soil testing in rainfed situation was assessed and illustrated in the Table 4. The findings indicates that twelve out of nineteen independent variables such as education, farming experience, innovativeness, achievement motivation, scientific orientation, risk orientation, management orientation, social participation, mass media exposure, social media exposure, extension agency contact and extension participation have contributed significantly towards knowledge of farmers towards soil testing. The remaining variables have not contributed significantly towards variability in knowledge on soil testing. The R^2 value (0.669) indicated that all the 19 independent variables have contributed to the tune of 66.90 per cent of variation in knowledge of farmers towards soil testing. These findings were in line with the findings of Gowda et al (2022), Himmatbhai (2018), Sanjana (2019) and Mishra (2020).

4. DISCUSSION

The study showed that farmers were generally aware of basic soil testing practices—such as correct timing, sample collection, and labeling—particularly in protected irrigation areas. However, knowledge of technical aspects like sampling depth, field variability, and partitioning was low, especially in rainfed regions, indicating a need for focused training (Khan et al., 2019; Sheetal et al., 2020). Overall, most farmers fell into the medium knowledge category across all farming situations, with no significant differences observed. This suggests that farming context alone does not determine knowledge levels; instead, factors like education, extension contact, and media exposure are more influential (Kaur, 2019; Madhu, 2019; Singh et al., 2020; Yogesh, 2021).

Positive correlations were observed between knowledge and behavioral traits such as education, experience, motivation, and extension contact. In contrast, structural attributes like age, landholding, and material possession showed no significant effect (Mishra, 2020; Sheetal et al., 2020). Regression analysis confirmed that psychological and communication-related factors—especially achievement motivation, scientific orientation, and extension involvement—significantly influenced knowledge levels, particularly in protected irrigation areas. Structural factors remained non-significant, indicating that access to information and advisory support is more crucial than resources alone (Himmatbhai, 2018; Sanjana, 2019; Mishra, 2020; Madhuri et al., 2024).

Strengthening extension services, promoting media outreach, and encouraging scientific attitudes are essential to improve soil testing knowledge, especially in rainfed regions where gaps persist.

5. CONCLUSION

The results revealed that, majority of farmers (76.10%) possessed medium to high knowledge on soil testing. The correlation test revealed that 14 out of 19 independent variables in case of assured and rainfed situation and 15 out of 19 variables in case of protected irrigation situation were found to be having a significant to highly significant relationship with the knowledge of farmers on soil testing in all three situations. Further, all the 19 profile characteristics of farmers had contributed to the tune of 68.40, 71.10 and 66.90 per cent in assured, protected and rainfed situations respectively in developing high knowledge on soil testing. The study indicates that, around 40 per cent of respondents are having medium knowledge level on soil testing. This alerts the extension functionaries to conduct more awareness programme and capacity development activities to improve the knowledge level of farmers on importance of soil testing.

HIGHLIGHTS

- About 76% of farmers in Karnataka showed medium to high knowledge of soil testing across different irrigation systems.
- The study included 180 farmers from three districts representing assured, protected, and rainfed irrigation conditions.
- Most farmer profile characteristics (14-15 out of 19) were significantly linked to their knowledge of soil testing.
- These characteristics explained around 67-71% of the differences in farmers' soil testing knowledge.
- The findings highlight the importance of promoting soil testing and government programs like the Soil Health Card for sustainable farming.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models,

etc have been used during writing or editing of this manuscript. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. Chatgpt - GPT 4.5 (Orion) – Used for vocabulary improvement only.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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