# An Evaluation of Farmers' Knowledge on Soil Sampling Procedures and Soil Test Based Nutrient Management in Karimnagar District of Telangana State


## Abstract

Soil testing and soil health card (SHC)-based nutrient management are pivotal components of sustainable agriculture. This study evaluated the knowledge level of 120 farmers in Karimnagar district, Telangana State, India, concerning soil sampling procedures and soil test-based fertilizer recommendations. Employing an ex-post facto research design with a pre-tested structured interview schedule, data were collected and analysed using descriptive statistics and Pearson's correlation coefficient. The findings reveal that a majority of respondents (60%) possessed a medium level of knowledge, while 24.17% demonstrated high knowledge and 15.83% showed low knowledge. The highest awareness was recorded for the availability of soil testing services (88.33%), the need to apply nitrogen in three split doses in paddy (87.50%), and the role of balanced fertilization in maintaining soil health (85.83%). Conversely, knowledge gaps were most pronounced concerning the recommended zinc sulphate dose for correcting zinc deficiency in paddy (56.67%), the prescribed quantity of muriate of potash for paddy (58.33%), and the variation of fertilizer dose for paddy with soil test values (57.50%). Correlation analysis identified education (r = 0.462**), training undergone (r = 0.518**), extension contact (r = 0.487**), scientific orientation (r = 0.436**), and innovativeness (r = 0.401**) as highly significant predictors of knowledge at the 1% level. Farm size (r = 0.298*), economic motivation (r = 0.321*), and achievement motivation (r = 0.354*) were significant at the 5% level. Age and farming experience did not exhibit significant relationships with knowledge. These results underline the critical need for targeted extension training, field demonstrations, and digital outreach to bridge knowledge gaps and enhance adoption of soil test-based nutrient management among farming communities.



**Keywords:** Soil Health Card, Soil Sampling, Nutrient Management, Farmers' knowledge, Extension Contact.




## Introduction:

Soil health is the cornerstone of agricultural productivity and long-term environmental sustainability. In a country like India, where smallholder farmers constitute over 85.00% of the agricultural workforce, soil degradation due to imbalanced and indiscriminate use of chemical fertilizers has emerged as a critical challenge (Manna *et al*., 2022; Srivastava *et al*., 2016). Soil testing, a scientifically validated diagnostic tool, provides crop-specific and site-specific fertilizer recommendations that optimize input use efficiency, minimize economic costs and protect ecosystem services (Bhatt *et al*., 2021; Sharma & Bali, 2018).

The Government of India launched the Soil Health Card (SHC) Scheme in February 2015 to extend soil testing services to every farmer in the country. The scheme envisages testing of 12 nutrient parameters – comprising three macro-nutrients (N, P, K), two (three) secondary nutrients (S, Ca, Mg) and five micronutrients (Zn, Fe, Mn, Cu, B) along with physical parameters (chemical parameters) such as soil pH and electrical conductivity (EC) and issuing farmers a card carrying crop-wise fertilizer recommendations (Ministry of Agriculture & Farmers Welfare, 2022). By March 2022, more than 230 million SHCs had been distributed nationwide, yet studies consistently report a divergence between card receipt and actual adoption of recommendations (Mukhopadhyay *et al*., 2021; Ramesh *et al*., 2019).

A persistent bottleneck is inadequate farmer knowledge of soil sampling procedures and the scientific rationale underlying SHC recommendations. Farmers who do not understand when, where, and how to collect representative soil samples may generate erroneous test results that translate into suboptimal management decisions (Das *et al*., 2020). Several studies conducted across different agro-climatic regions of India have documented varying levels of farmer knowledge on soil health management (Kumar *et al*., 2020; Patel *et al*., 2018; Singh & Singh, 2017). However, region-specific studies are essential because soil type, cropping system and the socio-economic fabric of farming communities differ substantially across districts.

Telangana, carved out as India's $29^{th}$ state in 2014, has accorded high priority to soil health management through state-sponsored testing laboratories and Krishi Vigyan Kendras (KVKs). Karimnagar district, situated in the Northern part of the state, is characterized by Alfisol and Vertisol soils with significant variation in micronutrient status, particularly zinc and iron deficiencies (Rajendran *et al*., 2020). The district is an important producer of rice, maize and cotton crops for which soil test-based fertilization has been shown to yield significant economic and environmental dividends (Yadav *et al*., 2019). Despite these contextual imperatives, no comprehensive study has specifically evaluated farmer knowledge on soil sampling and SHC-based recommendations in Karimnagar.



Against this backdrop, the present investigation was undertaken with the following objectives:

1. To assess the personal, socio-economic and psychological profile of respondent farmers.
2. To evaluate their knowledge level on soil sampling procedures and soil health card-based nutrient Management.
3. To examine the relationship between farmers' profile characteristics and their knowledge level.

**Material and methods:**

### 2.1 Study Area and Research Design

The study was conducted in erstwhile Karimnagar district of Telangana State. An ex-post facto research design was adopted since the study aimed to investigate an existing phenomenon, farmers' knowledge of soil health management without any experimental intervention (Kerlinger, 1986). The district was purposively selected owing to its agronomic significance, varied soil types and the active presence of soil testing infrastructure.

### 2.2 Sample Size and Sampling Procedure

A multi-stage random sampling technique was employed for the selection of respondents. In the first stage, six mandals were randomly selected from erstwhile Karimnagar district. In the second stage, four villages were randomly chosen from each selected mandal, resulting in a total of 24 villages. In the final stage, from each village, 05 farmers who had received Soil Health Cards were randomly selected, making a total sample size of 120 respondents. The sample size satisfies the minimum requirement for reliable Pearson correlation analysis at the 5% significance level (Cochran, 1977).

### 2.3 Data Collection

Primary data were collected through personal interview using a pre-tested, structured interview schedule. The schedule was developed in consultation with subject matter specialists in soil science and agricultural extension, translated into Telugu for ease of administration and pre-tested on 15 farmers outside the study villages to assess clarity and reliability. The schedule comprised two sections: (a) personal, socio-economic and psychological profile variables (age, education, farm size, farming experience, training undergone, extension contact, scientific orientation, economic motivation, achievement motivation, and innovativeness) and (b) a knowledge assessment component consisting of 26 fill in the blank, multiple choice and true/false statements on soil sampling procedures and SHC-based nutrient management. Each correct response was awarded one mark and each incorrect or 'don't know' response was awarded zero, yielding a maximum possible knowledge score of 26.

### 2.4 Measurement of Variables

Profile variables were measured using standardized scales wherever available (Samiuddin, 1984). Knowledge scores were categorized into three levels *viz*; low (up to 8), medium (9–17) and high (18–26) based on mean ± standard deviation of the obtained scores. Pearson's product-moment correlation coefficient (r) was computed to examine the relationship between each profile variable and the knowledge score, with significance tested at 1% and 5% probability levels.

### 2.5 Statistical Analysis

Data were compiled, coded and analysed using IBM SPSS Statistics. Frequency distribution and percentage analyses were used for the profile characteristics and individual knowledge items. Correlation analysis was performed to identify predictors of farmer knowledge.

**Results and Discussions:**

**3.1 Profile Characteristics of Respondent Farmers**

Table 1 presents the distribution of respondents based on their personal, socio-economic, and psychological attributes.

**Table 1: Distribution of respondents based on their personal, socio-economic and psychological attributes of the farmers under the study**

**n=120**

| S. No. | Variable | Category | Respondents | |
|---|---|---|---|---|
| | | | Frequency | Percentage (%) |
| 1 | Age | | | |
| | | Young age (up to 35 years) | 28 | 23.33 |
| | | Middle age (35 to 50 years) | 62 | 51.67 |
| | | Old age (above 55 years) | 30 | 25.00 |
| 2 | Education | | | |
| | | Illiterate | 02 | 01.67 |
| | | Primary school | 24 | 20.00 |
| | | High school | 42 | 35.00 |
| | | Intermediate | 32 | 26.67 |
| | | Under graduation | 16 | 13.33 |
| | | Post graduation and above | 04 | 03.33 |
| 3 | Farm size | | | |
| | | Marginal (0.1- 1.0 ha) | 24 | 20.00 |
| | | Small (1.1-2.0 ha) | 44 | 36.67 |
| | | Semi- medium (2.1-4.0 ha) | 32 | 26.67 |
| | | Medium (4.1-10.00 ha) | 18 | 15.00 |
| | | Large (above 10.00 ha) | 02 | 01.66 |
| 4. | Farming Experience | | | |
| | | Low farming experience | 28 | 23.34 |
| | | Medium farming experience | 56 | 46.66 |

| | | | | |
|---|---|---|---|---|
| | | High farming experience | 36 | 30.00 |
| 5. | Training undergone | | | |
| | | Low | 33 | 27.50 |
| | | Medium | 58 | 48.34 |
| | | High | 29 | 24.16 |
| 6. | Extension Contact | | | |
| | | Low | 25 | 20.83 |
| | | Medium | 63 | 52.50 |
| | | High | 32 | 26.67 |
| 7. | Scientific Orientation | | | |
| | | Low | 38 | 31.67 |
| | | Medium | 54 | 45.00 |
| | | High | 28 | 23.33 |
| 8. | Economic Motivation | | | |
| | | Low | 32 | 26.67 |
| | | Medium | 52 | 43.33 |
| | | High | 36 | 30.00 |
| 9. | Achievement Motivation | | | |
| | | Low | 30 | 25.00 |
| | | Medium | 53 | 44.17 |
| | | High | 37 | 30.83 |
| 10. | Innovativeness | | | |
| | | Low | 34 | 28.33 |
| | | Medium | 58 | 48.33 |
| | | High | 28 | 23.34 |

With respect to age, more than half of the respondents (51.67%) were in the middle-age group (35–50 years), followed by the old-age group (25.00%) and the young-age group (23.33%). The predominance of middle-aged farmers in agricultural activities aligns with findings from Rao *et al.* (2021) and Prasad *et al.* (2019), who attributed this trend to the migration of youth to non-farm employment sectors. Regarding educational status, the majority had studied up to high school level (35.00%), followed by intermediate level (26.67%), reflecting a gradual improvement in literacy rates in rural Telangana (Census of India, 2011; NSSO, 2019).

Farm size distribution revealed that small farmers (1.1–2.0 ha) constituted the largest category (36.67%), consistent with the national trend of declining average land holdings (Singh, 2020). The prevalence of small and marginal landholdings (56.67% combined) underscores the importance of cost-effective, precision nutrient management approaches such as soil test-based fertilization. Regarding farming experience, a plurality of respondents (46.66%) had medium-level experience, suggesting a productive working-age farming population.

Concerning training undergone, about 48.34% had medium-level exposure to agricultural training, indicating partial penetration of extension training programs. Extension contact was medium for 52.50% of respondents, corroborating findings from Kumar and Singh (2018) that the reach of formal extension machinery in peninsular India remains uneven. Psychological attributes including scientific orientation (45.00%), economic motivation (43.33%), achievement motivation (44.17%) and innovativeness (48.33%) were predominantly at medium levels suggesting considerable potential for further enhancement through targeted extension interventions.

### 3.2 Knowledge of Farmers on Soil Sampling Procedures and SHC-Based Nutrient Management

Table 2 presents the item-wise distribution of respondents' knowledge on soil sampling procedures and SHC-based recommendations.

**Table 2: Distribution of respondents according to their level of knowledge on soil sampling Procedures and soil health card based recommendations**

**n=120**

| S. No. | | Frequency (n) | Percentage (%) |
|---|---|---|---|
| 1. | Acid soils can be reclaimed by the application of lime. | 79 | 65.83 |
| 2. | The recommended quantity of muriate of potash for paddy cultivation is 16 kg per acre. | 70 | 58.33 |
| 3. | Vermicompost is manure produced by using earthworms. | 94 | 78.33 |
| 4. | Nitrogenous fertilizers in hybrid cotton should be applied in three split doses. | 77 | 64.17 |
| 5. | Zinc deficiency in paddy can be corrected by spraying 5 grams of zinc sulphate per litre of water. | 68 | 56.67 |
| 6. | Soil testing services are provided by Soil Testing Laboratories, KVKs/Research Stations and private agencies. | 106 | 88.33 |
| 7. | Zinc is not a macro nutrient. | 88 | 73.33 |
| 8. | Gypsum is used as a soil amendment for reclaiming sodic (alkali) soils. | 78 | 65.00 |
| 9. | Soil samples should not be collected from abnormal areas such as bunds, manure heaps, irrigation channels or wet spots. | 96 | 80.00 |

| | | | |
|---|---|---|---|
| 10. | Soil samples should be collected in a zigzag manner from the field to obtain a representative sample. | 76 | 63.33 |
| 11. | Soil samples should be collected after harvest or before sowing of the crop. | 72 | 60.00 |
| 12. | About 8–10 soil cores should be collected from one acre to prepare a composite soil sample. | 95 | 79.17 |
| 13. | The Soil Health Card Scheme was started in the year 2015. | 86 | 71.67 |
| 14. | The major (macro) nutrients tested in soil are Nitrogen, Phosphorus and Potassium. | 92 | 76.67 |
| 15. | The secondary nutrients tested in soil include Sulphur, Calcium and Magnesium. | 73 | 60.83 |
| 16. | The micronutrients tested in soil include Zinc, Iron, Manganese, Copper and Boron. | 87 | 72.50 |
| 17. | The physical(chemical) parameters reported in the Soil Health Card include soil pH and Electrical Conductivity (EC). | 102 | 85.00 |
| 18. | The recommended fertilizer dose for paddy varies according to soil test values. | 69 | 57.50 |
| 19. | The recommended fertilizer dose for maize varies depending on soil fertility status. | 84 | 70.00 |
| 20. | Azolla is a suitable biofertilizer for rice cultivation. | 74 | 61.67 |
| 21. | In paddy, nitrogenous fertilizers should be applied in three split doses at basal, tillering and panicle initiation stages. | 105 | 87.50 |
| 22. | Phosphorus solubilizing bacteria enhance the availability of phosphorus in soil. | 94 | 78.33 |
| 23. | Phosphorus fertilizers in paddy should be applied as basal dose. | 101 | 84.17 |
| 24. | The commonly used nitrogenous fertilizer is urea. | 86 | 71.67 |
| 25. | The Soil Health Card provides crop-wise fertilizer recommendations based on soil test results. | 81 | 67.50 |
| 26. | Balanced fertilization helps in maintaining soil health and improving crop productivity. | 103 | 85.83 |

Among the 26 knowledge items assessed, the highest level of awareness was recorded for the availability of soil testing services at Soil Testing Laboratories, KVKs/Research Stations and private agencies (88.33%), followed by the application of nitrogenous fertilizers in paddy in three split doses (87.50%), the role of balanced fertilization in maintaining soil health and improving crop productivity (85.83%) and the physical parameters reported in SHCs i.e. soil pH and EC (85.00%). These high awareness levels for infrastructure-related and broadly communicated agronomic practices may be attributable to sustained mass media campaigns, group training programs and Kisan Melas conducted in the district (Reddy & Gayatri, 2020).

Relatively high knowledge was also observed for the need to avoid abnormal areas during soil sampling (80.00%), collection of 8–10 soil cores per acre for composite samples

(79.17%), the definition of vermicompost and the role of phosphorus-solubilizing bacteria (78.33% each) and the classification of zinc as a micronutrient (73.33%). These findings suggest that demonstration-oriented extension activities and exposure to organic farming training have adequately addressed certain technical concepts.

Conversely, significant knowledge gaps existed in areas directly linked to precision nutrient management. The correct dose of zinc sulphate for correcting zinc deficiency in paddy (56.67%), the recommended dose of muriate of potash for paddy (58.33%) and the variation of fertilizer dose for paddy with soil test values (57.50%) recorded the lowest percentages. Comparable gaps in micronutrient-specific and dose-specific knowledge have been reported in Andhra Pradesh (Subrahmanyam *et al*., 2018) and Madhya Pradesh (Tiwari *et al*., 2020). These findings highlight that while farmers possess general awareness of soil health concepts, quantitative and crop-specific details embodied in SHC recommendations remain poorly internalized.

Furthermore, only 60.00% of respondents correctly identified the appropriate timing of soil sampling (after harvest or before sowing) and 63.33% understood the zigzag transect method for collecting representative samples. These gaps are particularly consequential because incorrect sampling undermines the reliability of soil test results and the ensuing recommendations (Das *et al*., 2020). Encouraging results were noted for the paddy-specific basal application of phosphorus (84.17%) and awareness of the SHC scheme launch year (71.67%), suggesting good uptake of broadly communicated information.

### 3.3 Overall Knowledge Level

Table 3 presents the categorization of respondents by overall knowledge level.

**Table 3: Distribution of respondents according to their Knowledge level on soil sampling procedures and SHC based recommendations**

**n=120**

| S. No. | Category | Score Range | Frequency (n) | Percentage (%) |
|---|---|---|---|---|
| 01. | Low knowledge | Up to 8 | 19 | 15.83 |
| 02. | Medium knowledge | 9 – 17 | 72 | 60.00 |
| 03. | High knowledge | 18 – 26 | 29 | 24.17 |
| | **Total:** | | **120** | **100.00** |

The majority of respondents (60.00%) fell in the medium knowledge category followed by high knowledge (24.17%) and low knowledge (15.83%). The preponderance of medium-level knowledge is consistent with findings from similar studies conducted in Warangal district of Telangana (Ramaiah *et al*., 2022), in Karnataka (Patil *et al*., 2019), and in Odisha (Mohanty *et al*., 2021). The relatively small proportion with high knowledge underscores the need for intensive capacity-building efforts, especially regarding quantitative fertilizer recommendations, micronutrient management, and soil sampling methodology.

### 3.4 Correlation between Profile Characteristics and Knowledge Level

Table 4 summarises the Pearson correlation coefficients between farmer profile variables and knowledge level.

**Table 4: Correlation between profile characteristics of the farmers and their level of knowledge on soil sampling procedures and SHC based recommendations**

**n = 120**

| S. No. | Independent Variables | Correlation Coefficient (r) | Significance |
|---|---|---|---|
| 1 | Age | -0.112 | NS |
| 2 | Education | 0.462** | Significant |
| 3 | Farm size | 0.298* | Significant |
| 4 | Farming experience | 0.145 | NS |
| 5 | Training undergone | 0.518** | Significant |
| 6 | Extension contact | 0.487** | Significant |
| 7 | Scientific orientation | 0.436** | Significant |
| 8 | Economic motivation | 0.321* | Significant |
| 9 | Achievement motivation | 0.354* | Significant |
| 10 | Innovativeness | 0.401** | Significant |

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

Training undergone exhibited the strongest positive correlation with knowledge (r = 0.518**), confirming that structured learning experiences substantially enhance farmers' understanding of soil health management. This finding is consistent with Kumari *et al.* (2021), who reported a significant association between training participation and soil management knowledge across districts of Bihar, and with Sivakumar *et al.* (2020) in the Tamil Nadu context. Exposure to training programs appears to foster both the declarative knowledge (knowing what) and procedural knowledge (knowing how) essential for correct soil sampling and fertilizer application.

Extension contact was the second strongest predictor (r = 0.487**), affirming the indispensable role of extension systems – including public extension agents, KVK scientists and input dealers in knowledge dissemination. Singh and Rao (2019) and Yadav *et al.* (2020) similarly documented significant positive relationships between extension contact and farmers' technical knowledge across different Indian states. The digital extension modalities increasingly being deployed by PJTAU and the state extension machinery are expected to amplify this effect in the coming years.

Education (r = 0.462**) was positively and highly significantly correlated with knowledge, corroborating a large body of literature (Rashid *et al*., 2019; Meena *et al*., 2021).

Literate and better-educated farmers possess greater capacity to decode SHC recommendations, interpret scientific language in advisory literature, and critically evaluate extension messages. Innovativeness (r = 0.401**) also showed a significant relationship, suggesting that farmers with a higher propensity to adopt new ideas and technologies are more likely to seek out and retain information on soil health management, consistent with the diffusion of innovations framework articulated by Rogers (2003).

Scientific orientation (r = 0.436**) was significantly associated with knowledge, reflecting that farmers who approach agricultural problems analytically are better equipped to understand the scientific basis of soil testing and balanced fertilization. This finding aligns with Thiyagarajan *et al.* (2019), who found scientific orientation to be a significant predictor of technology adoption among paddy farmers in South India. Achievement motivation (r = 0.354*) and economic motivation (r = 0.321*) were significant at the 5% level, suggesting that goal-directed farmers who view agriculture as a commercial enterprise are more motivated to acquire knowledge that can enhance profitability.

Farm size showed a weakly but significantly positive correlation (r = 0.298*), consistent with the notion that farmers with larger holdings have greater exposure to diverse soil conditions and extension services, and higher economic stakes in precision nutrient management. However, the weak effect size suggests that size alone is insufficient; targeted outreach to small and marginal farmers remains imperative. Neither age (r = -0.112, NS) nor farming experience (r = 0.145, NS) exhibited significant relationships with knowledge, indicating that mere longevity in farming does not automatically translate into accurate understanding of scientific soil management practices. These non-significant relationships may reflect the persistence of traditional beliefs and heuristic decision-making among more experienced farmers, as noted by Bedi *et al.* (2020).

**4. Conclusions and Recommendations**

The study reveals that the majority of farmers in Karimnagar district possess a medium level of knowledge regarding soil sampling procedures and SHC-based nutrient management. While general awareness about soil testing infrastructure, the SHC scheme and broad fertilizer management principles is reasonably satisfactory, critical gaps persist in the domain of quantitative, crop-specific recommendations, particularly the recommended doses for micronutrients like zinc sulphate, secondary nutrients and potash and in the technical details of representative soil sampling. These gaps, if unaddressed, can compromise the scientific integrity of soil test results and the accuracy of crop-specific fertilizer recommendations derived from the SHC.

Training undergone, extension contact, education, scientific orientation, and innovativeness emerged as the most significant positive predictors of knowledge, collectively pointing toward a multi-pronged extension strategy. The following recommendations are advanced: (1) intensive soil sampling demonstrations and field visits should be organized at critical crop-stage periods to impart hands-on procedural knowledge; (2) SHC-based training modules should explicitly address micronutrient management and dose-specific recommendations using local crop case studies; (3) digital extension tools such as farmer-facing mobile applications, interactive voice response systems, and social media campaigns should be deployed to improve extension contact frequency and reach; (4) functionally literate farmers and innovators within villages should be trained as 'soil health champions' or lead farmers to facilitate peer-to-peer knowledge dissemination; and (5) extension programs should systematically target small and marginal farmers who may lack the social and economic capital to independently access information.

Future research should employ longitudinal designs to assess whether enhanced knowledge translates into behavioural change (actual adoption of soil sampling and SHC recommendations) and improved soil health and crop productivity outcomes. Multi-district comparative studies covering the entire Telangana state would generate more generalizable findings to guide state-level extension policy.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.



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