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COMPARISON OF SOIL TEXTURE OF PADDY AND FINGER MILLET CULTIVATED FIELDS

Anjana Sinha¹ and A S Ravikumar²

¹Research Scholar, Department of Civil Engineering, UVCE, Bangalore University, Jnanabharathi, Bengaluru, 560056, India

²Professor, Department of Civil Engineering, UVCE, Bangalore University, Jnanabharathi, Bengaluru, 560056, India.

ABSTRACT

One of the key physical characteristics of soil that determines its quality and health is its texture. It establishes the soil's ability to hold air, water, and nutrients. This study presents the results of soil texture analysis which have been conducted on samples collected from agricultural fields under paddy and finger millet cultivation. The physical properties of soil have been determined using sieve and hydrometer analyses. The collected samples are analyzed to estimate the proportion of gravel, sand, silt, and clay. The results indicate textural differences between the two cropping systems. Particle size distribution curves and hydrometer readings have been interpreted to classify the soil texture, which is critical in assessing the water retention and nutrient dynamics of the cultivated fields. The sieve analysis revealed a dominant presence of sand in both locations. The paddy field soil had 65.5% sand, 6.8% gravel, and 28% fines (silt and clay combined), while the finger millet field soil showed a higher gravel content (15%) and a slightly lower sand percentage (63.2%). Hydrometer analysis further partitioned the fines into silt and clay. The paddy soil consisted of 24.4% silt and 3.3% clay, while the finger millet soil had 19.9% silt and only 1.9% clay. Soil texture analysis is crucial for selecting the right crop, managing inputs, and ensuring

sustainable productivity in fields cultivated with paddy and finger millet. It empowers farmers to maximize yield, conserve resources and reduce risks.

Keywords: Soil texture, Sieve analysis, Hydrometer analysis, Paddy, Finger millet

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1. Introduction

The basic building blocks of soil minerals are soil particles, which are divided into three categories according to their size: sand, silt, and clay found in a certain ratio i.e. (5:3:2 ratio). This is an unchangeable and permanent feature of the soil. Soil categorization is based on the distribution of soil particles in each size group, which reveals the mechanical composition of the soil (Juma, 1993). One of the primary factors used for soil categorization, both domestically and internationally, is soil texture (Richer-de-Forges et al., 2022). Soil texture is a vital physical property that influences water infiltration, retention, aeration, and root development. In agricultural land management where different crops have distinct texture requirements, it is particularly crucial. Varied nations and groups have varied standards for defining the size and texture of soil particles leading to a variety of soil texture classification schemes. The International Society of Soil Science system (ISSS system) and the United States Department of Agriculture system (USDA system) are currently one of the most extensively used soil texture classification standards (Takahashi et al., 2020). The USDA system uses 2 μm , 50 μm , and 2000 μm as the size boundaries for soil clay, silt, and sand and subdivides the sand into five categories: very fine, fine, medium, coarse, and very coarse. The USDA approach classifies soil texture using a triangle coordinate map that separates it into four categories: sand, loam, clay loam, and clay. These groupings are based on the properties of soil aeration, soil water, and fertilizer-holding ability. The physical characteristics of soil such as permeability, specific surface area and water-holding capacity are influenced by soil texture. These changes in the microenvironment of soil microbial activity result in variations in the distribution and cycling of nutrients in the soil (Dobarco et al., 2019 and Rudiyanto et al., 2021). Twelve different forms of soil texture are represented by the triangular structure known as a texture triangle. It is employed in the research of India's various soil types.

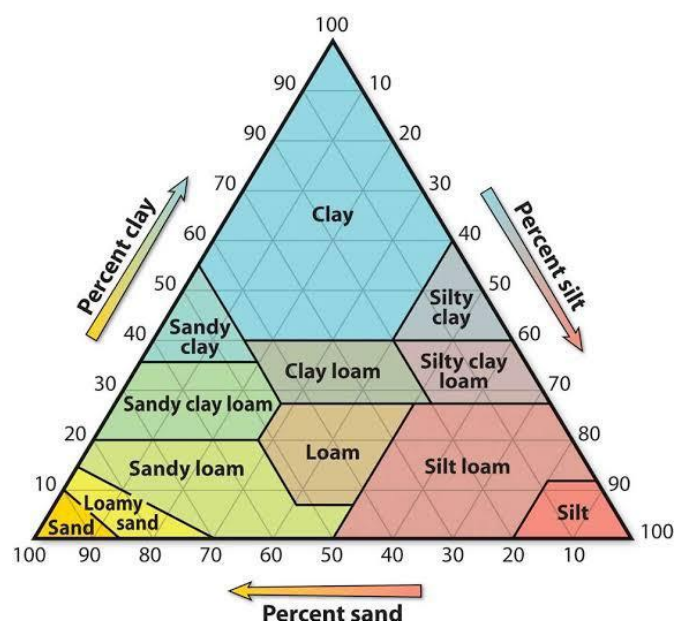


Fig. 1 Determination of textural classes in the laboratory.

Three grades which primarily preserve the soil's texture are sandy, loamy, or clay-based. There are two types of sandy soil: sandy soil and loamy soil. There are seven types of loamy soil: sandy loam, loam soil, silt loam, silt, clay loam, silty clay loam, and sandy clay loam. However, loamy soil can be separated into three categories: clay, silt clay, and sandy clay. The feel, structure, drainage, aeration, and water-holding ability of the soil are all influenced by these particles. Particle size analysis determines the soil structure by determining the relative amount of sand, silt and clay in the soil by the laboratory method.

This study aims to analyze the soil texture in selected locations cultivated with paddy and finger millet using standardized laboratory techniques, including sieve and hydrometer analysis. Also, Sentinel-2 satellite data has been used to create soil map of Hemavathi Command Area.

2. MATERIALS AND METHODOLOGY

2.1 Study area and data used

Hemavathi river origin at Western Ghats at an elevation of 1,219 m above mean sea level near Ballala Rayana Durga in Chikmangalur District, Karnataka. Hemavathi confluence with river Cauvery after travelling a distance of 245 km through Chikkamagaluru, Hassan, Kodagu and Madikeri. Hemavathi Left Bank Canal (HLBC) off takes from Gorur dam constructed across Hemavathi river in Hassan District at 76° 03'0" E longitude and 12° 45'0" N latitude with live storage of 32.731 TMC. The Hemavathi command area has longitude from

75° 58' 25" E and 77° 58' 48" E and latitude from 12° 38' 14" N and 13° 30' 0" N and has an area of 4481.81 km². It has covered four districts i.e., Hassan, Mandya, Mysuru and Tumkuru. Taluks under Hassan district are Arkalgud, Chennarayapatna, Hassan and Holenarsipur. Taluks under Mysuru district is K.R.Nagar taluk. Taluks under Mandya district are Krishnaraj Pete, Mandya, Nagamangala and Pandavapura. Taluks under Tumkuru district are Gubbi, Kunigal, Tiptur, Tumkur and Turuvekere. The land use is distinguished by agricultural lands, plantation and forests. In the study area, the cultivation of large variety of crops is achievable due to the presence of loamy structured red soils. The free lateral and downward penetration of water is permitted by shallow soils. Fig. 2 shows the location map of the study area. For the present study, the watershed which comes under Nagamangala taluk, Mandya district has been considered.

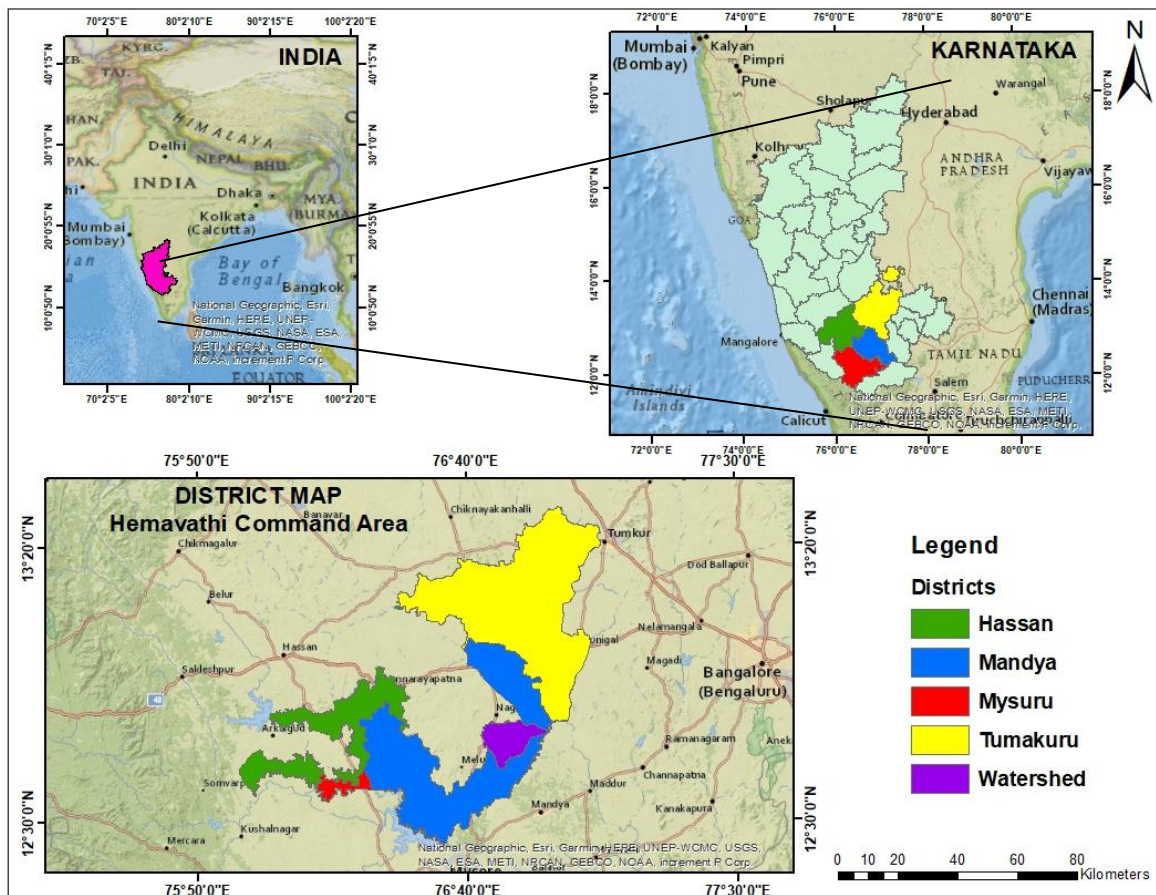


Fig. 2 Location map of study area

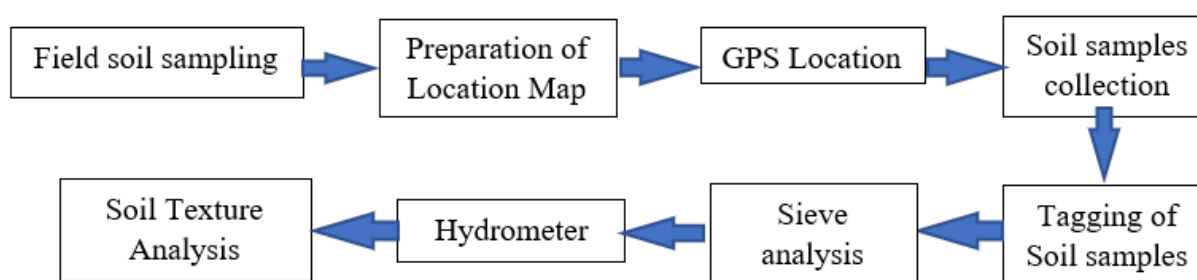
Following are the data products and softwares which are used in this present study.

Table 1 Data Products

Sl. No.	Data	Details	Source
1	SOI Toposheets on 1:50,000 scale	No.- 57C/16, 57C/15, 57C/11, 57C/8, 57C/12, 57C/16, 57D/5, 57D/1, 57D/9, 57D/14, 57D/13, 57D/11, 57D/10, 57D/7, 57D/6, 57D/2, 57G/4, 57G/3, 57H/1, 48P/13, 48P/14.	Survey of India (2022) https://surveyofindia.gov.in
2	Satellite Data	Sentinel -2 (10 m resolution) (2022)	European Space Agency https://dataspace.copernicus.eu/
3	Soil Samples	Year 2024	Ground

2.2 Methodology

The flow chart shows the soil texture analysis for the study area is displayed in Fig.3.

**Fig. 3** Methodology for soil texture analysis

Soil collection and preparation

Soil samples were collected from two agricultural locations of Hemavathi command area which falls under Nagamangala taluk of Mandya district, Karnataka, India. Each locations are cultivated with either paddy or finger millet. The core cutter method was employed to extract undisturbed soil samples. The geographic coordinates of the sampling points are listed in Table 2.

Table 2 Soil sampling locations

Sl. No.	Geological Coordinates (Decimal Degree)		Type of crop	Depth below ground level (cm)
	Longitude (N)	Latitude (E)		
1	76.7269	12.7248	Finger Millet	26
2	76.7213	12.7923	Paddy	26

2.3 Soil Texture Analysis

The percentages of sand, silt, and clay composition in each soil sample were determined by analyzing their texture using conventional laboratory techniques.

2.4 Hydrometer Analysis

The soil texture was examined using the hydrometer method. The initial reading was collected to determine the amount of silt and clay after the entire lab process was completed. A second reading was made expressly to ascertain the clay concentration following a four-hour interval. The calculations we made to ascertain the soil texture using equations (1) through (4) are shown below.

$$\%Clay + \%Silt = \frac{\text{Corrected Hydrometer Reading at 40 Sec}}{\text{Weight of Sample}} * 100 \quad (1)$$

$$\%Clay = \frac{\text{Corrected Hydrometer Reading at 4 hours}}{\text{Weight of Sample}} * 100 \quad (2)$$

$$\%Silt = (\%Clay + \%Silt) - \%Clay \quad (3)$$

$$\%Sand = 100 - (\%Clay + \%Silt) \quad (4)$$

3. RESULTS

3.1 Soil Map

Soil map prepared using Sentinel-2. The soils in the Hemavathi command area are loamy skeletal, clayey skeletal, fine and fine loamy and isohyper thermic and the group of soils are based on their differentiating morphological, physical and physio-chemical characteristics. There are 12 classes of soil textures found in the command area. Fig. 4 shows the soil map of Hemavathi Command Area. Table 3 depicts the spatial distribution of soil and its percentage of area within the command area.

Comparison of Soil Texture of Paddy and Finger Millet Cultivated Fields

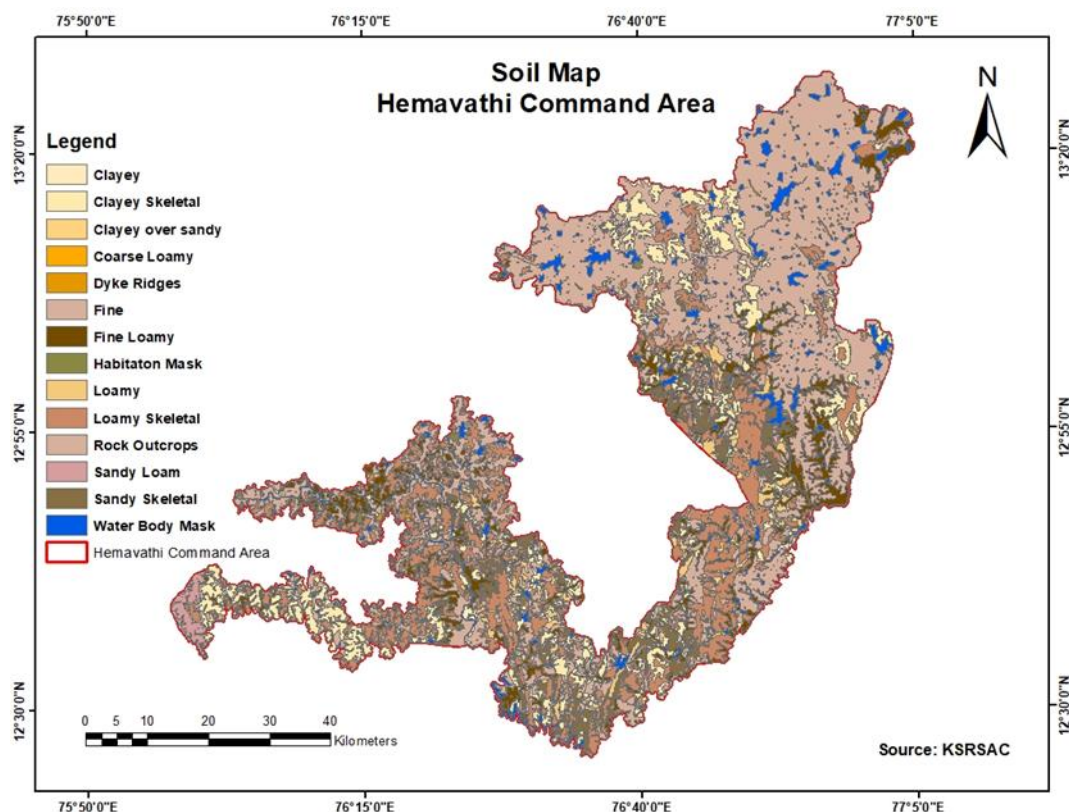


Fig. 4 Soil map of Hemavathi Command Area

Table 3 Spatial distribution of different soil texture in the Hemavathi Command Area

Sl. No	Soil texture	Area (km ²)	% of Area
1	Clayey	40.47	0.91
2	Clayey Over Sandy	21.38	0.48
3	Clayey Skeletal	488.89	10.96
4	Coarse Loamy	2.514	0.06
5	Dyke Ridges	9.07	0.20
6	Fine	1923.80	43.13
7	Fine Loamy	455.56	10.21
8	Habitation Mask	39.63	0.89
9	Loamy	108.94	2.44
10	Loamy Skeletal	862.15	19.33
11	Rock Outcrops	40.31	0.90
12	Sandy Loam	28.53	0.64
13	Sandy Skeletal	162.07	3.63
14	Water Body Mask	276.59	6.20
Total		4459.92	100

Fig. 5 and 6 shows the images of soil sampling locations where core cutter was driven.



Fig. 5 Soil Sample location (Paddy field)

Fig. 6 Soil Sample location (Finger millets field)

3.2 Sieve analysis

1 kg of oven dried soil sample is washed with running water under a 75-micron sieve until the water runs clear. The soil retained on the 75-micron sieve is then oven dried again and then the sample is used to conduct the sieve analysis for the particle size distribution.

Fig.7 and 8 shows the particle size analysis of the samples

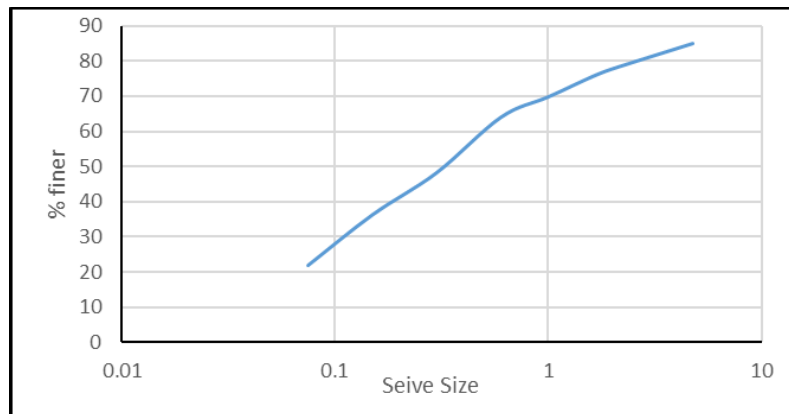


Fig. 7 Particle size distribution of Finger millet field soil sample

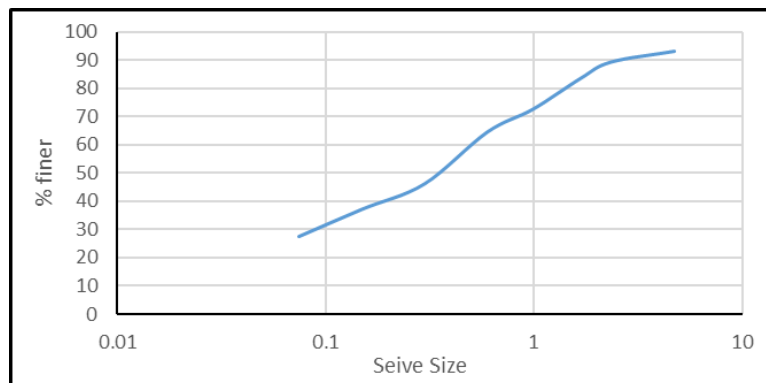


Fig. 8 Particle size distribution of Paddy field soil sample

Hydrometer analysis

Sieve analysis gives the total percentage of sand, gravels and fines, to further differentiate fines into silt and clay hydrometer analysis is necessary. 50 gm of 75 micron passed soil is collected and hydrometer analysis is conducted. Fig.9 and 10 shows the Grain size distribution chart potted after hydrometer analysis of the samples.

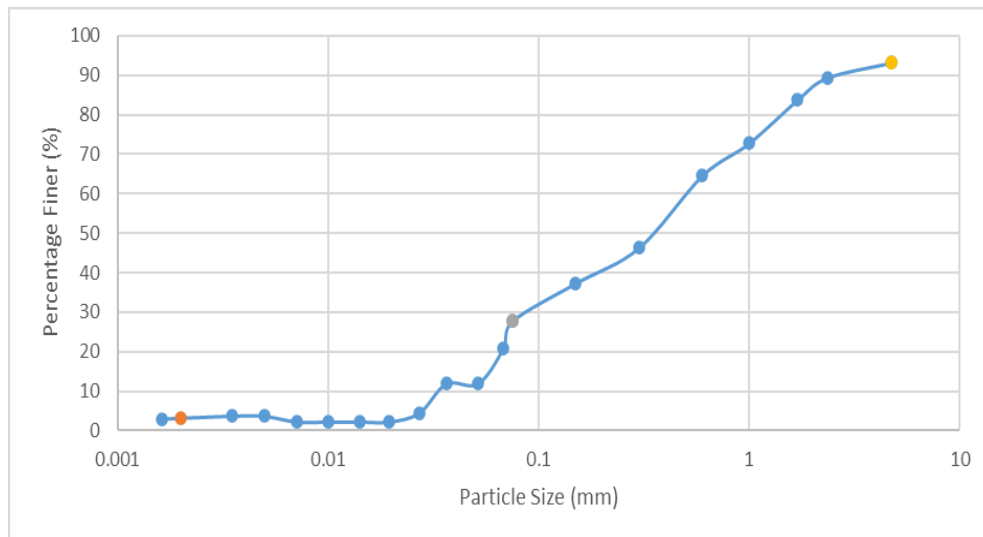


Fig. 9 Hydrometer analysis of Paddy field soil sample

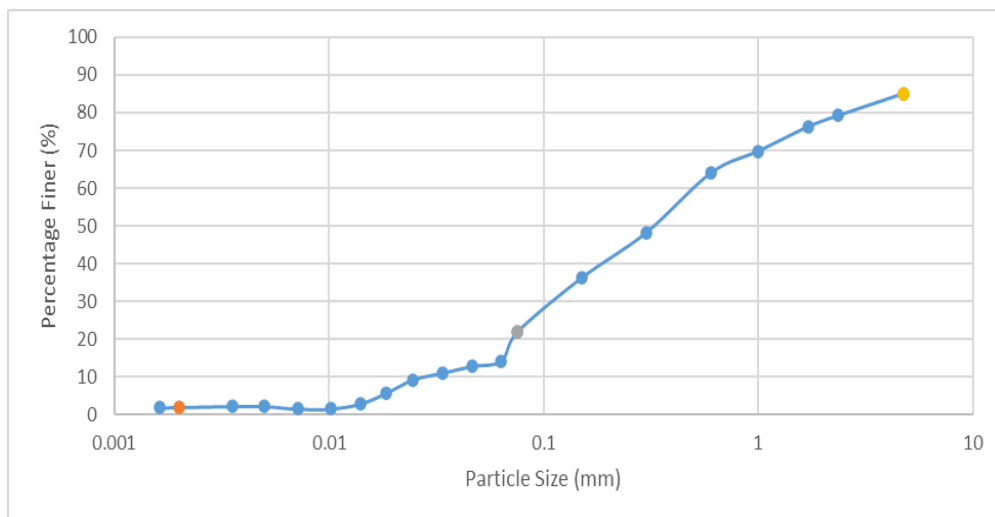


Fig. 10 Hydrometer analysis of Finger Millets field soil sample

The Table 4 shows the results of soil texture analysis.

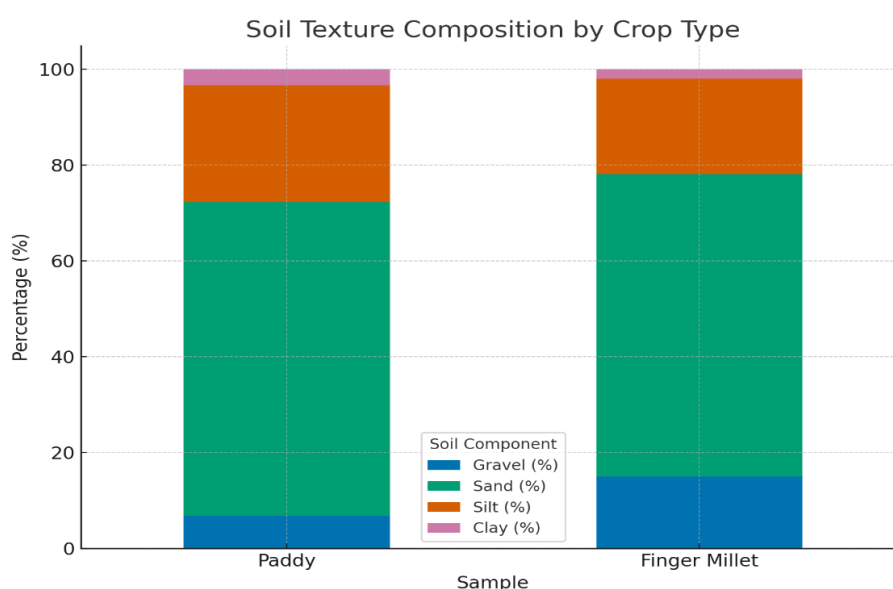
Table 4 Soil Texture Analysis

Sl No.	Geological coordinates (Decimal Degrees)		Type of crop	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	longitude	latitude					
1	76.72°	12.79°	Paddy	6.8	65.5	24.4	3.3
2	76.73°	12.72°	Finger Millet	15	63.2	19.9	1.9

The sieve analysis revealed a dominant presence of sand in both locations. The paddy field soil had 65.5% sand, 6.8% gravel, and 28% fines (silt and clay combined), while the finger millet field soil showed a higher gravel content (15%) and a slightly lower sand percentage (63.2%).

Hydrometer analysis further partitioned the fines into silt and clay. The paddy soil consisted of 24.4% silt and 3.3% clay, while the finger millet soil had 19.9% silt and only 1.9% clay. The relatively low clay content in both samples suggests better drainage properties, though the silt content in the paddy field indicates higher water retention capacity suitable for flooded crops.

Based on USDA soil texture triangle, the soil in both fields falls under the sandy loam category, with the paddy field showing slightly finer characteristics due to higher silt content.



Analysis has been done for the cultivation of paddy and finger millet. Soil texture analysis is vital in agriculture because it influences water management, nutrient availability, soil health, and ultimately crop productivity. For crops like paddy and finger millet that have

contrasting water and soil needs, understanding soil texture ensures better planning and resource management. Paddy requires high water retention (best in clayey soils), while finger millet prefers well-drained soils. Clay soils retain nutrients, ideal for paddy. Sandy soils require frequent fertilization, suitable for finger millet. Clayey soils facilitate puddling for paddy. Finger millet needs friable loamy soils. Heavy soils reduce water loss for paddy while light soils benefit finger millet's drought resistance. Texture analysis helps reduce erosion (important for finger millet) and waterlogging (critical for paddy). Texture analysis allows matching crop needs with site conditions, improving yield. Texture data supports soil maps, variable input application and smart farming decisions.

4. CONCLUSIONS

The analysis highlights distinct differences in soil texture between fields cultivated with paddy and finger millet. The relatively higher silt content in the paddy field supports its suitability for water-intensive cultivation while the finger millet field's higher gravel content suggests greater porosity and drainage. Soil texture shows how much power is needed to plough the soil. Heavy soil requires more power & energy for ploughing. Optimum soil texture is necessary for better plant stand, optimum growth, efficient water and nutrient supply of the plants. Soil texture analysis is crucially important in agriculture because it directly affects key physical and chemical properties of the soil that influence crop growth and productivity. It helps determine irrigation schedules and water management strategies, influences fertilizer application and nutrient management plans, influences crop selection and yield potential, helps in planning soil conservation measures, guides land use planning, zoning, and crop zoning and enhances data-driven decision-making. These findings are useful for crop-specific soil management and irrigation planning.

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REFERENCES

- [1] Baver, L. D., Gardner, W. H., & Gardner, W. R. (1972). *Soil Physics* (4th ed.). Wiley.

- [2] Dobarco, M. R., Bourennane, H., Arrouays, D., Saby, N. P. A., Cousin, I., & Martin, M. P. (2019). Uncertainty assessment of Global Soil Map predictions in France. *Geoderma*, 337, 1209–1220. <https://doi.org/10.1016/j.Geoderma.2018.11.027>
- [3] Eshel, G., Levy, G. J., Mingelgrin, U., & Singer, M. J. (2004). Critical evaluation of the use of laser diffraction for particle-size distribution analysis. *Soil Science Society of America Journal*, 68(3), 736–743. <https://doi.org/10.2136/sssaj2004.7360>
- [4] Hillel, D. (1998). *Environmental Soil Physics*. Academic Press.
- [5] Juma, N. G. (1993). Interrelationships between soil structure/texture, soil biota/soil organic matter and crop production. *Geoderma*, 57(1–2), 3–30.
- [6] Kozak, J., Niedzielski, T., & Sobieraj, J. (2021). Soil texture prediction using machine learning and satellite imagery. *Geoderma*, 382, 114760.
- [7] Mulder, V. L., de Bruin, S., Schaepman, M. E., & Mayr, T. R. (2011). The use of remote sensing in soil and terrain mapping—A review. *Geoderma*, 162(1–2), 1–19.
- [8] Pathak, H., Aggarwal, P. K., Roetter, R., Kalra, N., Bandyopadhyay, S. K., Prasad, S., & van Keulen, H. (2010). Soil fertility management for sustaining productivity of rice–wheat and rice–finger millet cropping systems in South Asia. *Journal of Crop Improvement*, 24(3), 286–303
- [9] Rawls, W. J., Brakensiek, D. L., & Saxton, K. E. (1982). Estimation of soil water properties. *Transactions of the ASAE*, 25(5), 1316–1320.
- [10] Richer-de-Forges, A. C., Arrouays, D., Chen, S. C., Dobarco, M. R., Libohova, Z., Roudier, P., Minasny, B., & Bourennane, H. (2022). Hand-feel soil texture and particle-size distribution in central France: Relationships and implications. *Catena*, 213, 106196.
- [11] Rudiyanto, Minasny, B., Chaney, N. W., Maggi, F., Giap, S. G. E., Shah, R. M., Fiantis, D., & Setiawan, B. I. (2021). Pedotransfer functions for estimating soil hydraulic properties from saturation to dryness. *Geoderma*, 403, 115194.
- [12] Sharma, P. K., & De Datta, S. K. (1985). Effect of puddling on soil physical properties and processes. *Advances in Soil Science*, 2, 139–178.

- [13] Singh, G., & Mishra, D. (2021). Assessment of soil texture and fertility for rice and finger millet cultivation in eastern India. *Journal of Soil Science and Plant Nutrition*, 21(2), 986–998.
- [14] Soil available water capacity products: A French case study. *Geoderma*, 344, 14–30.
- [15] Soil Survey Staff. (2017). *Soil Survey Manual*. USDA Handbook No. 18.
- [16] Sreenivas, K., & Dadhwal, V. K. (2007). Assessment of soil texture using IRS P6 LISS-III and field data in part of Indo-Gangetic plains. *Journal of the Indian Society of Remote Sensing*, 35(2), 143–151.
- [17] Takahashi, T., Nakano, K., Nira, R., Kumagai, E., Nishida, M., & Namikawa, M. (2020). Conversion of soil particle size distribution and texture classification from ISSS system to FAO/USDA system in Japanese paddy soils. *Soil Science and Plant Nutrition*, 66(3), 407–414.

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