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Grain Size Distribution and Textural Classification of Soils in Malegaon Village, Baramati, Pune District, Maharashtra

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ABSTRACT:

The present study investigates the grain size distribution and textural characteristics of agricultural soils in Malegaon village, Baramati Tehsil, Pune District, Maharashtra, to assess their physical properties and depositional environment. Fifteen representative soil samples were collected from different agricultural locations and analyzed for sand, silt, and clay proportions using mechanical sieve and hydrometer methods. The results reveal that the sand fraction dominates, ranging from 46.14% to 90.40%, followed by silt (6.46-40.48%) and clay (1.01-13.38%), classifying most soils as sandy loam to loamy sand according to the USDA textural triangle. Statistical parameters derived from Folk and Ward's (1957) method show mean grain size values between –0.90ϕ and 2.10ϕ, indicating coarse to medium sand; sorting index values between 1.41ϕ and 2.55ϕ, suggesting moderate to poor sorting; positive skewness (average 0.28ϕ) implying fine-skewed distributions; and kurtosis values (0.58ϕ-1.99ϕ) reflecting mesokurtic to leptokurtic characteristics. These findings indicate that the soils were formed under variable energy conditions influenced by slope, parent basaltic material, and semi-arid climate. The dominance of coarse textures and moderate sorting suggests limited weathering and episodic sediment reworking. Overall, the study concludes that Malegaon's soils are geomorphologically controlled, texturally heterogeneous, and agriculturally significant, requiring site-specific management strategies to enhance moisture retention and fertility.

Keywords:
Grain size distribution, Soil texture, Textural classification, Agricultural soils, Malegaon village.

1. INTRODUCTION:

Soil texture is defined by the relative proportions of sand, silt, and clay which plays a fundamental role in determining the physical, chemical, and biological characteristics of the soil. It directly influences essential processes such as water infiltration, aeration, nutrient retention, and root penetration, thereby governing soil fertility and overall crop productivity (Brady & Weil, 2017; Hillel, 2004). Textural composition also affects soil structure, porosity, and permeability, which in turn regulate the movement and storage of air and water within the soil matrix (Azizi et al., 2023; Amirian-Chakan et al., 2019). Understanding the grain-size distribution of soils is therefore crucial for assessing land capability, irrigation efficiency, and sustainable agricultural practices in diverse agro-ecological regions (FAO, 2022).

Soil texture serves as a diagnostic indicator in soil classification and provides insight into soil genesis, parent material, and depositional environment (Jenny, 1994; Buol et al., 2011). The relative proportions of sand, silt, and clay reflect both pedogenic processes and geomorphological controls that shape landscape evolution. In addition to its fundamental scientific value, textural analysis has practical implications for agriculture, hydrology, and environmental management. Coarse-textured (sandy) soils generally promote infiltration but have poor nutrient-holding capacity, whereas fine-textured (clayey) soils retain water and nutrients but often suffer from poor aeration and drainage (Hilliard & Reedyk, 2020; Wang et al., 2023). Hence, a thorough understanding of soil texture supports the formulation of effective soil and water conservation measures and the mitigation of land degradation in agricultural landscapes (Keshavarzi et al., 2022; Swain et al., 2021).

Over the last decade, integration of laboratory-based particle-size analysis with geospatial techniques has enhanced our ability to interpret spatial variability in soil texture. Remote sensing and digital soil mapping approaches employing Sentinel-1 and Sentinel-2 imagery and machine learning algorithms have been successfully applied for predicting soil textural fractions at regional scales (Mandal et al., 2020; Mirzaeitalarposhti et al., 2022; Zheng et al., 2023). Such techniques complement traditional field and laboratory methods, enabling more accurate textural classification and supporting land-use planning at multiple scales.

The Deccan Plateau of western India offers an excellent natural laboratory to study texture landform relationships. The Baramati region of Pune District, located in the semi-arid zone of western Maharashtra, is characterized by diverse geomorphological features and basaltic parent material derived from the Deccan Traps. Malegaon village, within this region, represents a typical agricultural landscape where soil texture strongly influences crop selection, irrigation scheduling, and nutrient management. The area lies within the Western Maharashtra Scarcity Zone, receiving an average annual rainfall of approximately 500 mm and frequently experiencing drought conditions (Surwase et al., 2023; Virmani et al., 1982). The dominant soils are basalt-derived Vertisols, locally known as black cotton soils, which are rich in smectitic clays and exhibit high cation-exchange capacity and water-retention ability (Surwase et al., 2023; Britannica, 2024). While these properties are advantageous for dryland farming, the shrink–swell behavior of Vertisols causes deep cracking in dry seasons and poor drainage in wet periods, posing challenges for agricultural management (Hillel, 2004; Virmani et al., 1982). Consequently, evaluating the textural composition and variability of such soils is essential for optimizing crop performance and ensuring soil sustainability in this semi-arid basaltic terrain.

Accurate determination of soil texture typically involves laboratory grain-size analysis. Coarse fractions (sand) are measured by mechanical sieving, whereas finer fractions (silt and clay) are quantified through sedimentation methods based on Stokes' law (Bouyoucos, 1962; Gee & Or, 2002). Once the proportions of sand, silt, and clay are established, soils are classified according to the USDA soil-textural triangle, which delineates twelve principal textural classes (Soil Survey Staff, 2017). These classes provide a concise summary of soil behavior: for instance, a "sandy loam" indicates rapid drainage and low nutrient retention, while a "clay" denotes high water-holding capacity but slower infiltration.

Despite the agricultural importance of the Baramati region, detailed grain-size and textural studies at the village scale remain limited. Such micro-level investigations are vital for linking soil texture with topography, land use, and management practices. Against this backdrop, the present study entitled “Grain Size Distribution and Textural Classification of Soils in Malegaon Village, Baramati, Pune District, Maharashtra” aims to determine the relative proportions of sand, silt, and clay in the collected soil samples and classify the soils according to the USDA textural triangle

The findings of this research will provide baseline data on soil physical characteristics useful for sustainable land management, precision agriculture, and soil conservation planning in the Deccan basaltic region. Moreover, the results will enhance understanding of soil formation processes, resource potential, and management constraints of semi-arid agro-ecosystems typical of western Maharashtra.

2. STUDY AREA:

Malegaon is a prominent village situated in the Baramati Tehsil of Pune District, Maharashtra, approximately 5 km southeast of Baramati town and around 80 km from Pune city. The village encompasses a total geographical area of about 1,854.47 hectares, comprising agricultural lands, residential zones, small-scale industries, and educational institutions. This diverse land-use composition reflects a balanced blend of rural character and emerging urban development. Its strategic location along key regional routes ensures strong connectivity with surrounding towns and market centres, fostering both agricultural and socio-economic growth. Geographically, Malegaon lies at approximately 18.1460° N latitude and 74.6150° E longitude, within the semi-arid tract of western Maharashtra (Fig. 1). Owing to its proximity to Baramati a major agricultural and industrial hub the village serves as an important centre for regional trade, agricultural production, and rural development planning.

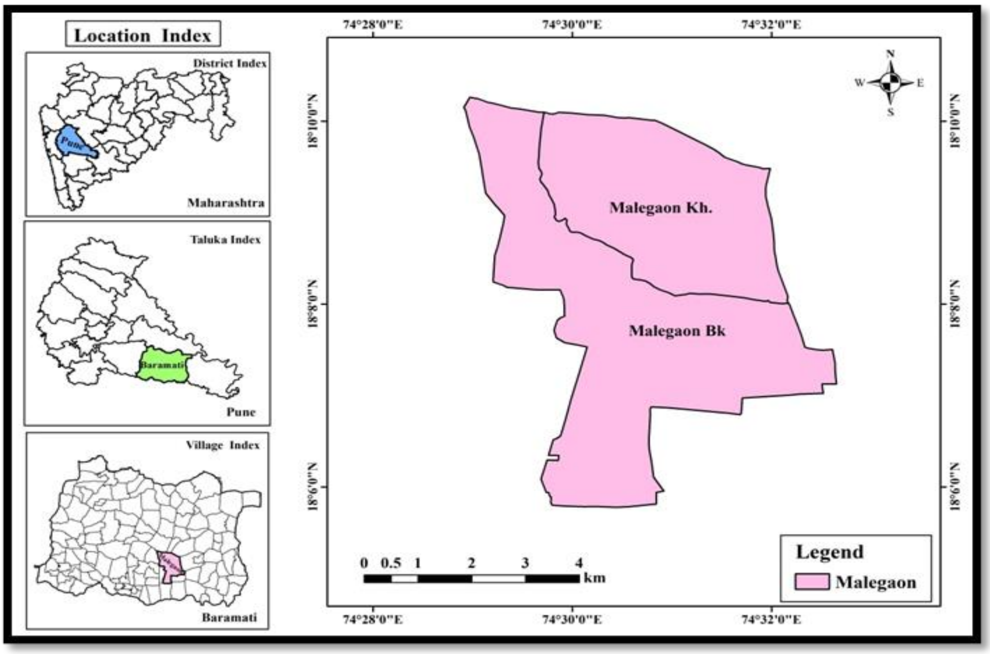


Fig. 1. Proportion of sand in the agricultural soil samples.

3. MATERIAL AND METHODS:

Soil samples were collected from agricultural fields in Malegaon village, Baramati, using a stratified random sampling method to ensure representative coverage of varying land-use and topographic conditions. Composite soil samples were obtained from the surface layer (0-15 cm), representing the active root zone, by collecting three to four subsamples in a zig-zag pattern using a stainless-steel auger. The subsamples were thoroughly mixed to form one composite sample per site. All fifteen samples were placed in labeled polyethylene bags after removing plant residues, roots, and stones, and the geographical coordinates of each location were recorded with a handheld GPS device. In the laboratory, the soils were air-dried, gently crushed, and sieved through a 2 mm mesh to obtain the fine-earth fraction.

For the textural analysis, about 150-200 g of each soil sample was oven-dried at 100-120°C for 48 hours to remove moisture. The dried samples were gently crushed with a pestle and mortar to break down aggregates without altering the natural grain size. From each sample, 100 g of soil was used for mechanical sieve analysis to separate different particle-size fractions. A sieve stack with mesh sizes ranging from -2 ϕ (4 mm) to 2 ϕ (0.25 mm), along with a base pan, was arranged in an automatic sieve shaker and operated for 10-15 minutes. After sieving, the soil retained on each sieve was carefully weighed, and the percentage of each size fraction (granules, sand, and silt-clay) was calculated. These data were then used to prepare a cumulative frequency curve on probability graph paper, from which the main grain-size parameters mean size, sorting, skewness, and kurtosis were computed. The calculations followed the Folk and Ward (1957) graphical method, as described by Pettijohn (1975), which helps to interpret the average grain size, degree of sorting, and symmetry of the soil's particle-size distribution (Table 1).

Table 1. Graphical measures and their descriptive terminology. After Folk and Ward (1957)

Mean	Standard deviation	Skewness	Kurtosis
$M_z = \frac{\phi_{16}+\phi_{50}+\phi_{84}}{3}$	$\sigma_I = \frac{\phi_{84}-\phi_{16}}{4} + \frac{\phi_{95}-\phi_5}{6.6}$	$Sk_I = \frac{\phi_{16}+\phi_{84}-2\phi_{50}}{2(\phi_{84}-\phi_{16})} + \frac{\phi_5+\phi_{95}-2\phi_{50}}{2(\phi_{95}-\phi_5)}$	$k_G = \frac{\phi_{95}+\phi_5}{2.44(\phi_{75}-\phi_{25})}$

Sorting (□*I*)		**Skewness (*SkI*)**		**Kurtosis (*KG*)**	
< 0.35	very well sorted	0.3 to 1.0	very fine skewed	< 0.67	very platykurtic
0.35-0.50	well sorted	0.1 to 0.3	fine skewed	0.67-0.90	platykurtic
0.50-0.71	moderately well sorted	0.1 to -0.1	symmetrical	0.90-1.11	mesokurtic
0.71-1.00	moderately sorted	-0.1 to -0.3	coarse skewed	1.11-1.50	leptokurtic
1.00-2.00	poorly sorted	-0.3 to -1.0	very coarse skewed	1.50-3.00	very leptokurtic
2.00-4.00	very poorly sorted			>3.00	extremely leptokurtic
> 4.00	extremely poorly sorted				

4. RESULTS AND DISCUSSION:

4.1 Grain size distribution of soil:

The results of the textural analysis of 15 agricultural soil samples from Malegaon village are presented in Table 1. The sand content ranges from 46.14 % to 90.40 % with an average of 71.21 %, indicating that most soils are dominantly sandy in nature. The silt fraction varies between 6.46 % and 40.48 %, with an average of 22.29 %, while the clay content is relatively low, ranging from 1.01 % to 13.38 % with a mean of 6.50 % (Table 2). This compositional pattern reveals that the majority of the samples fall within sandy loam to loamy sand textural classes according to the USDA classification system.

Table 2. Textural properties of agricultural soil samples

Sample No.	Sand (%)	Silt (%)	Clay (%)
1	77.3	17.85	4.85
2	71.92	22.19	5.89
3	47.63	39.44	12.93
4	55.6	34.35	10.05
5	57.43	35	7.57
6	50.22	38.07	11.71
7	46.14	40.48	13.38
8	81.89	14.9	3.21
9	89.1	8.15	2.75
10	90.4	8.59	1.01
11	88.19	6.46	5.35
12	76.3	12.78	10.92
13	82.99	15.94	1.07
14	72.01	23.68	4.31
15	81.05	16.52	2.43
Minimum	**46.14**	**6.46**	**1.01**
Maximum	**90.4**	**40.48**	**13.38**
Average	**71.21**	**22.29**	**6.50**

Samples 1, 2, 8, 9, 10, 11, 13, 14, and 15 exhibit high sand percentages (>70 %), reflecting well-drained soils with coarse texture, typical of upland agricultural fields formed on weathered basaltic regolith. These soils generally possess low water-holding capacity and limited nutrient retention, requiring frequent irrigation and organic matter addition for sustainable productivity. In contrast, samples 3, 4, 5, 6, and 7 show comparatively higher silt and clay contents (30–40 % silt and up to 13 % clay), suggesting moderate to fine textures such as loam or sandy clay loam (Table 2). These finer soils are likely located in lower slope or depositional zones, where sediment accumulation and limited drainage promote finer particle enrichment.

The overall dominance of sand indicates that the study area is characterized by coarse-textured soils, reflecting the influence of parent basaltic material, arid climate, and fluvial reworking within the Baramati basin. The moderate variation in silt and clay percentages across the samples implies a degree of textural heterogeneity controlled by micro-topography and land-use patterns. Soils with higher silt and clay proportions are expected to exhibit improved moisture retention and fertility potential, while highly sandy soils may be more prone to erosion and nutrient leaching.

Hence, the textural composition of Malegaon's agricultural soils reveals a gradient from sandy loam on uplands to loam and sandy clay loam in low-lying areas. Such variation has direct implications for irrigation scheduling, fertilizer management, and crop selection. The predominance of sand underscores the necessity of adopting organic amendments, mulching, and contour bunding to enhance soil structure and water conservation. Overall, these results demonstrate that the region's soils are relatively young and weakly developed, shaped by the semi-arid climate and basaltic geomorphic setting of the Deccan Plateau.

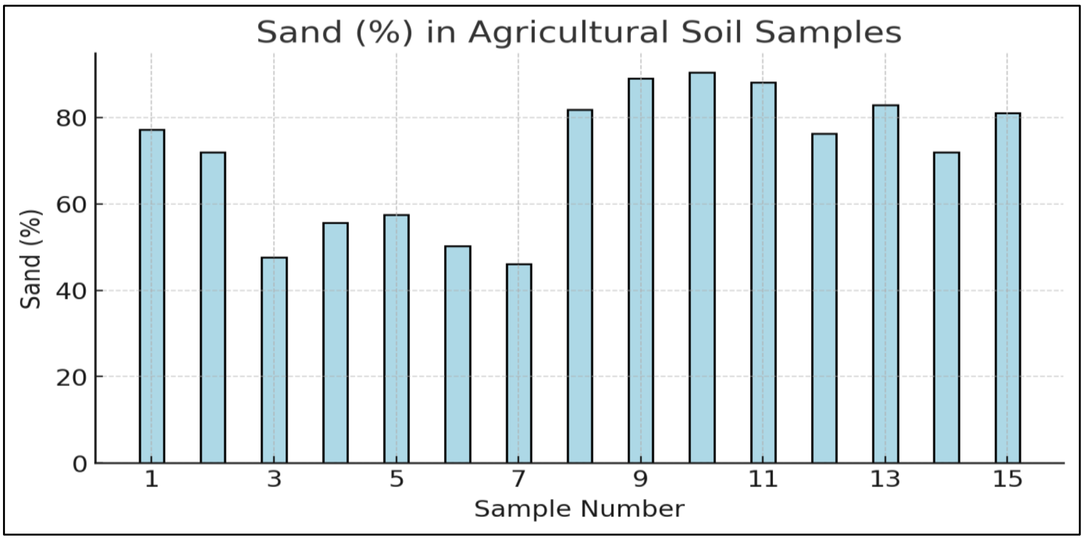


Fig. 2. Proportion of sand in the agricultural soil samples.

Fig. 2 illustrates the proportion of sand in the agricultural soil samples collected from Malegaon village, Baramati. The sand content shows a marked variation among the samples, ranging approximately from 46% to 90%, with an average of about 71%. The majority of the samples display high sand content (>70%), indicating that the soils are predominantly coarse-textured. Samples 1, 2, 8, 9, 10, 11, 13, 14, and 15 exhibit particularly high sand percentages, suggesting that these soils are well-drained and likely occur on upland or gently sloping terrains where finer particles such as silt and clay are prone to erosion or downward migration (Fig. 2).

In contrast, samples 3, 4, 5, 6, and 7 show relatively lower sand percentages (below 60%), reflecting a greater contribution of fine fractions and a transition towards loamy textures (Fig. 2). These sites are likely associated with lower slope or depositional zones that favour the accumulation of finer sediments. The dominance of sand across most samples signifies that the soils of Malegaon village have low water-holding capacity and nutrient retention potential, characteristics typical of semi-arid basaltic regions. Such soils require careful management practices, including organic matter addition and moisture conservation techniques, to sustain agricultural productivity. Overall, the observed sand distribution highlights the textural heterogeneity of the area and its close linkage to geomorphic position and surface processes.

Fig. 3. Proportion of silt in the agricultural soil samples.

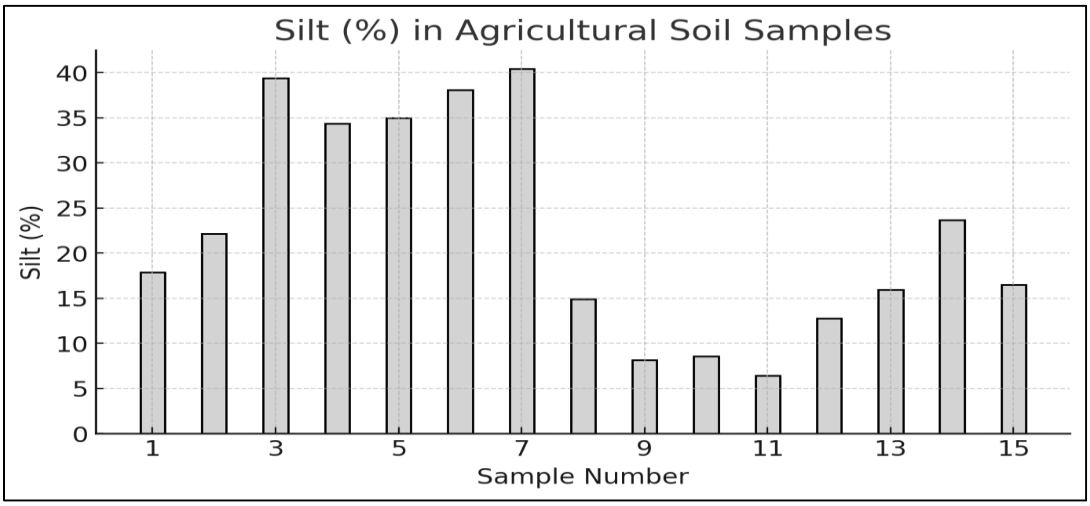


Fig 3 presents the proportion of silt in the agricultural soil samples from Malegaon village, Baramati, revealing noticeable variation across the study sites. The silt content fluctuates between 6.46% and 40.48%, with an overall average of around 22%, indicating a moderate contribution of fine particles to the soil texture. Samples 3, 4, 5, 6, and 7 exhibit relatively high silt percentages (above 30%), suggesting that these soils have undergone greater deposition of finer materials, likely due to runoff accumulation or reduced slope gradients (Fig 3). Such soils tend to possess better moisture retention capacity and improved nutrient availability, supporting favorable conditions for crop growth.

In contrast, samples 9, 10, 11, and 12 record noticeably lower silt contents (<10%), pointing to coarse-textured, well-drained soils typical of upland areas where finer sediments are removed by surface erosion. The intermediate silt values observed in samples 1, 2, 13, 14, and 15 reflect a transitional zone between upland and low-lying fields, where partial deposition of silt occurs (Fig. 3). The overall spatial pattern of silt distribution thus mirrors the geomorphological variability of the region, controlled by slope, drainage, and micro-topography. Soils with higher silt content are likely more productive under rainfed conditions, while sandy soils with low silt may require enhanced organic inputs and irrigation management to maintain soil fertility and water balance.

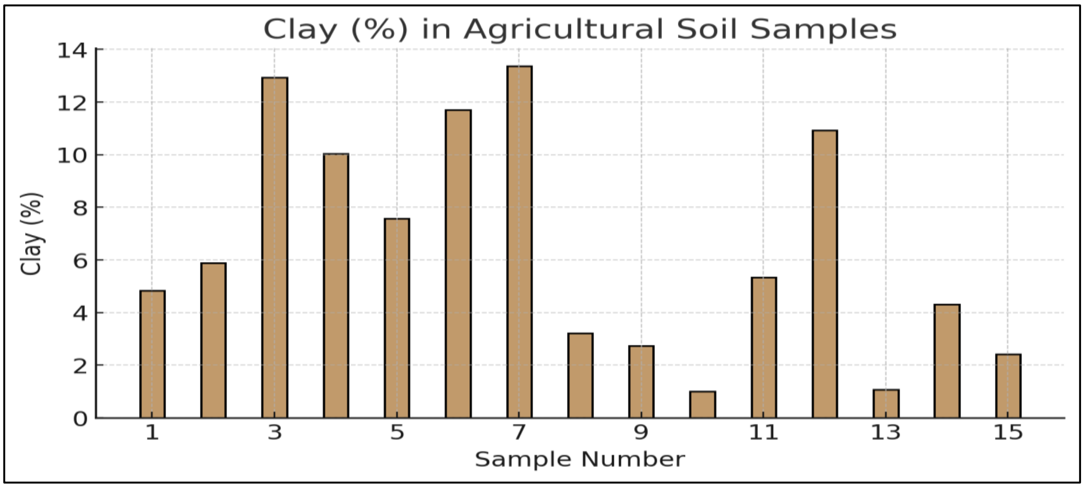


Fig. 4. Proportion of silt in the agricultural soil samples.

Fig. 4 illustrates the proportion of clay in the agricultural soil samples collected from Malegaon village, Baramati. The clay content ranges from 1.01% to 13.38%, with an average of approximately 6.5%, indicating a relatively low to moderate fine fraction in the study area. Samples 3, 4, 5, 6, and 7 show comparatively higher clay percentages (>10%), signifying their occurrence in depositional or lower slope zones where fine particles accumulate through surface runoff and sedimentation processes (Fig. 4). Such soils exhibit greater water-holding capacity and cation exchange potential, which are beneficial for nutrient retention and crop growth, especially under semi-arid climatic conditions.

In contrast, samples 9, 10, 13, and 15 have very low clay contents (<4%), corresponding to coarse-textured, well-drained soils typically found on upland positions or eroded surfaces. These soils are prone to rapid drying and nutrient leaching, making them less favourable for water-demanding crops unless supplemented with organic matter or irrigation. The moderate clay concentrations observed in samples 1, 2, 8, 11, 12, and 14 suggest transitional soil conditions between upland and valley zones, where both erosion and deposition processes influence soil formation (Fig. 4). Overall, the distribution pattern of clay reflects the geomorphic control on particle deposition and highlights the textural variability within Malegaon's agricultural landscape, which plays a critical role in determining soil fertility, structure, and management potential.

4.2 Statistical Parameters of Soil

Table 3. Statistical parameters of agricultural soil samples

Sample No.	Mean (ϕ)	Sorting Index (ϕ)	Skewness (ϕ)	Kurtosis (ϕ)
1	0.27	2.08	0.55	0.89
2	0.23	2.40	0.43	0.79
3	1.77	2.55	-0.40	0.63
4	1.30	2.53	0.10	0.66
5	1.30	2.37	0.10	0.82
6	2.10	2.12	-0.11	0.64
7	1.87	2.43	-0.35	0.58
8	0.23	1.98	0.59	1.99
9	-0.90	1.98	0.44	1.32
10	0.23	1.45	0.29	1.14
11	0.77	1.46	0.27	1.33
12	1.40	2.34	0.25	1.10
13	-0.20	2.05	0.38	1.23
14	1.60	1.41	1.22	0.82
15	0.07	2.01	0.51	1.33
Minimum	-0.90	1.41	-0.40	0.58
Maximum	2.10	2.55	1.22	1.99
Average	0.80	2.08	0.28	1.02

Table 3 presents the statistical parameters i.e. mean grain size (ϕ), sorting index (ϕ), skewness (ϕ), and kurtosis (ϕ) for fifteen agricultural soil samples collected from Malegaon village, Baramati. These parameters, computed following the graphical method of Folk and Ward (1957), provide insights into the textural maturity, depositional energy, and sedimentary processes influencing the agricultural soils of the study area.

The mean grain size varies from -0.90ϕ to 2.10ϕ, with an average of 0.80ϕ, indicating that the soils predominantly range from coarse sand to fine sand. Samples 9 and 13 exhibit negative mean values (coarser texture), suggesting high-energy depositional conditions or limited weathering, typical of upland soils. In contrast, higher mean values (e.g., samples 3, 4, 5, 6, and 7) denote finer particles associated with lower energy environments such as valley bottoms or depositional zones (Table 3).

The sorting index ranges between 1.41ϕ and 2.55ϕ, averaging 2.08ϕ, which classifies the soils as moderately to poorly sorted. This variability in sorting indicates a heterogeneous source material and fluctuating transport mechanisms, possibly resulting from alternating episodes of runoff, surface erosion, and sediment deposition in the semi-arid terrain. Poorly sorted samples (3, 4, 6, and 7) reflect inconsistent sediment supply or multiple depositional episodes, while relatively better-sorted samples (10, 11, and 14) suggest uniform particle-size distribution under more stable depositional conditions (Table 3).

Skewness values range from -0.40ϕ to 1.22ϕ, with an average of 0.28ϕ, indicating that the majority of the samples are positively skewed (fine-skewed). Positive skewness implies dominance of finer particles and a tendency toward gradual fining of sediments, which is typical of soils developed in low-energy agricultural plains. Negative skewness in samples 3, 6, and 7 denotes coarse asymmetry, reflecting erosional zones or well-drained upland fields where finer fractions have been removed.

The kurtosis values range from 0.58ϕ to 1.99ϕ, averaging 1.02ϕ, which classifies most soils as mesokurtic (normally peaked). A few samples, particularly sample 8 (1.99ϕ), exhibit leptokurtic distributions, implying concentration of particles around the mean size due to limited transport and sorting. Lower kurtosis values (<0.9ϕ) in samples 3, 4, and 7 suggest platykurtic tendencies, representing wider grain-size distributions and more variable sediment input (Table 3).

Overall, the statistical parameters reveal that the agricultural soils of Malegaon are predominantly coarse to medium sand, moderately sorted, and fine-skewed, signifying their formation under transitional depositional environments influenced by both erosional and fluvial processes. The results highlight the textural heterogeneity and geomorphic control on sediment deposition, consistent with the semi-arid climatic and basaltic lithological setting of the Baramati region.

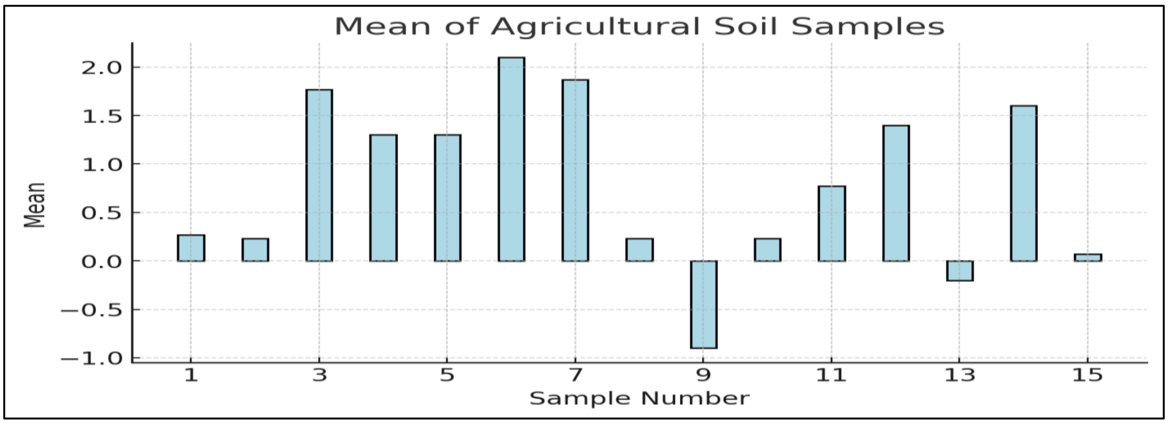


Fig. 5. Mean size (ϕ) of the particles in the agricultural soil samples.

The mean grain size (ϕ) of particles in the agricultural soil samples is displayed in Fig. 5. The mean values range from -0.90ϕ to 2.10ϕ, indicating a textural spectrum from coarse sand to fine sand across the study area. Samples 9 and 13 exhibit negative mean values, denoting coarser textures and suggesting deposition under high-energy conditions such as active runoff or erosion-dominated upland settings. Conversely, samples 3, 4, 5, 6, and 7 (Fig. 5) show relatively higher mean values (above 1.0ϕ), representing finer materials typical of low-energy depositional environments like gentle slopes or valley bottoms where fine sediments accumulate.

The intermediate mean values observed in samples 1, 2, 8, 10, 11, 12, 14, and 15 indicate moderate energy conditions, possibly corresponding to transitional zones between upland and lowland areas (Fig. 5). The spatial variation in mean grain size suggests that multiple geomorphic processes including surface erosion, fluvial transport, and sediment reworking have influenced soil development in the region. Overall, the predominance of fine to medium sand fractions reflects the semi-arid climate and basaltic parent material, which together contribute to the formation of weakly developed soils with limited clay enrichment but substantial textural variability across the agricultural landscape.

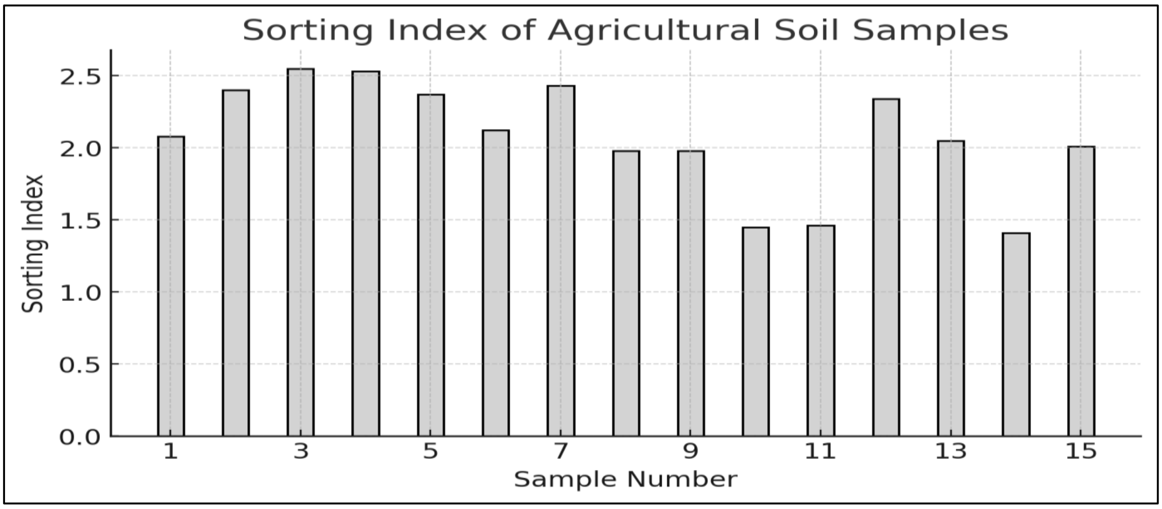


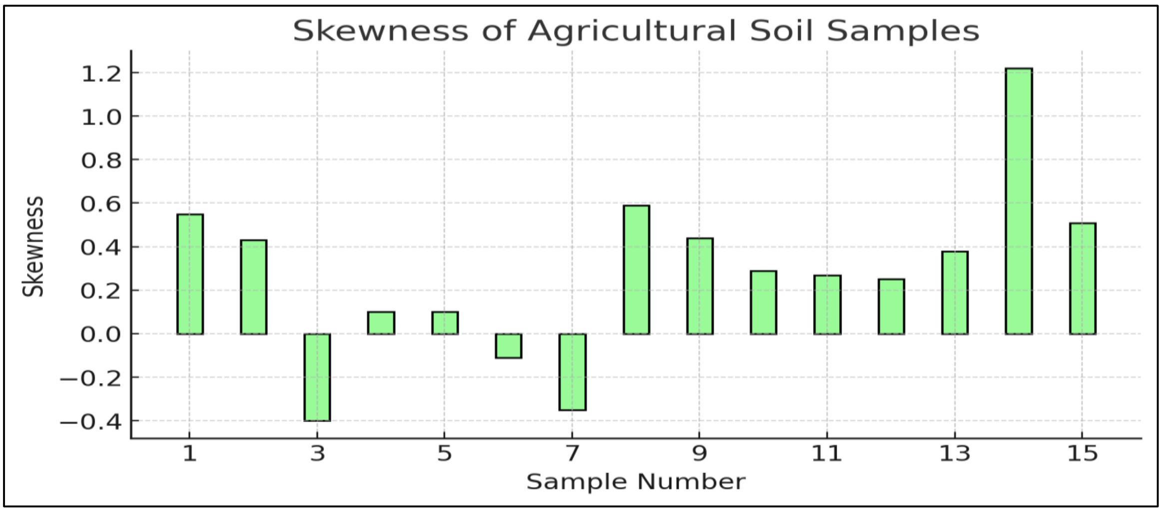
Fig. 6. Standard Deviation (ϕ) of the particles in the agricultural soil samples.

Fig. 6 illustrates the sorting index (standard deviation in ϕ units) of particles in the agricultural soil samples from Malegaon village, Baramati. The sorting values range between 1.41ϕ and 2.55ϕ, with an average of about 2.08ϕ, classifying the soils as moderately to poorly sorted according to Folk and Ward's (1957) scale (Fig. 6). This suggests that the soil particles are composed of a heterogeneous mix of grain sizes, reflecting variable transport and depositional conditions across the study area.

Samples 3, 4, 6, and 7 show the highest sorting index values (>2.4ϕ), indicating poorly sorted sediments that likely originated from fluctuating depositional energies or mixed sediment sources. Such conditions are typical of agricultural fields in lower slope or depositional areas, where runoff and sediment accumulation occur intermittently. On the other hand, samples 10, 11, 13, and 14 exhibit relatively lower sorting index values (<1.5ϕ), implying better sorting and more uniform grain-size distributions (Fig. 6). These better-sorted soils are generally found on upland or well-drained areas where erosion processes selectively remove finer fractions.

The observed spatial variation in sorting indicates that the soils of Malegaon have developed under complex geomorphic influences, where both erosional and depositional processes contribute to textural diversity. The predominance of moderate to poor sorting overall highlights episodic sediment transport and limited reworking, typical of semi-arid

Fig. 7. Skewness (ϕ) of the particles in the agricultural soil samples.



agricultural terrains derived from weathered Deccan basalt. This variability in sorting also affects soil permeability, infiltration, and root penetration—factors critical to sustainable land management and crop planning in the region.

The skewness (ϕ) values of particles in the agricultural soil samples from Malegaon village is shown in Fig. 7. The skewness values range from -0.40ϕ to 1.22ϕ, with an overall average of 0.28ϕ, indicating that most samples are positively skewed or fine-skewed. This pattern suggests a dominance of finer particles within the soil matrix and reflects low-energy depositional environments, where the settling velocity of fine sediments is reduced, allowing them to accumulate over time.

Samples 1, 2, 8, 9, 10, 11, 12, 13, 14, and 15 exhibit positive skewness, indicating that these soils have an excess of fine particles such as silt and clay. Such conditions are generally associated with stable agricultural lands in gently sloping or near-level areas, where depositional processes outweigh erosion. In contrast, samples 3, 6, and 7 display negative skewness (coarse-skewed), suggesting the predominance of coarse sand fractions (Fig. 7). These coarse-skewed samples are likely derived from upland fields or eroded surfaces, where high runoff energy removes finer sediments and leaves behind coarser grains.

The occurrence of both positive and negative skewness across the study area highlights the textural heterogeneity of Malegaon's soils and their sensitivity to topographic and hydrological variations. Positively skewed soils tend to retain more moisture and nutrients, enhancing their agricultural potential, whereas coarse-skewed soils are well-drained but nutrient-deficient, requiring organic amendments to improve productivity. Overall, the skewness distribution reflects the dynamic balance between erosional and depositional forces shaping the agricultural soils of the region.

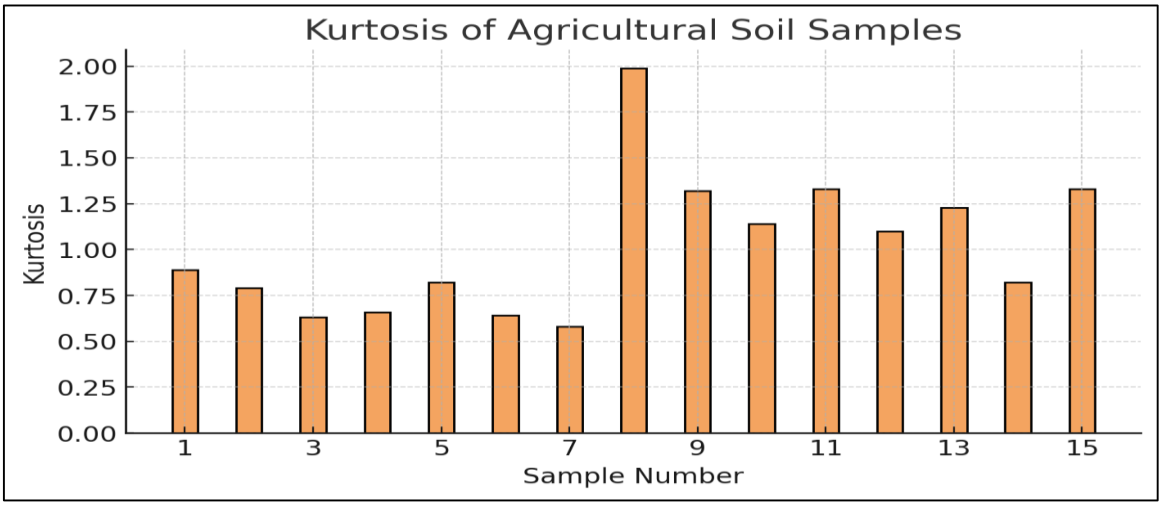


Fig. 8. Kurtosis (ϕ) of the particles in the agricultural soil samples.

Fig. 8 illustrates the kurtosis (ϕ) of particles in the agricultural soil samples from Malegaon village, Baramati. The kurtosis values range from 0.58ϕ to 1.99ϕ, with an average of approximately 1.02ϕ, classifying most samples as mesokurtic, or normally peaked. This indicates a relatively balanced distribution of grain sizes, where neither coarse nor fine fractions are excessively dominant. Such a distribution typically reflects moderate energy conditions during soil formation and sediment deposition.

A few samples, particularly sample 8 (1.99ϕ) and samples 9, 11, 12, and 15 (values between 1.1ϕ and 1.3ϕ) are leptokurtic, showing more sharply peaked grain-size distributions. This suggests a narrower range of particle sizes and indicates selective sediment deposition, likely due to localized fluvial processes or minimal post-depositional disturbance. Conversely, samples 3, 4, 6, and 7 display platykurtic tendencies (values below 0.8ϕ), denoting broader distributions and a higher degree of textural mixing, possibly resulting from variable sediment sources or repeated cycles of erosion and redeposition (Fig. 8).

Overall, the kurtosis distribution emphasizes the heterogeneous nature of Malegaon's agricultural soils, shaped by alternating episodes of erosion and deposition. The dominance of mesokurtic and leptokurtic soils suggests a relatively stable depositional regime, consistent with semi-arid climatic conditions and basaltic parent material, where fluvial reworking and slope dynamics have played key roles in determining soil texture and structure. These textural attributes are crucial for understanding soil permeability, aeration, and water-retention characteristics that directly affect crop performance in the region.

CONCLUSION:

The present study on the Grain Size Distribution and Textural Classification of Soils in Malegaon Village, Baramati, Pune District, Maharashtra provides valuable insights into the physical characteristics and depositional dynamics of the region's agricultural soils. The analysis of fifteen representative soil samples revealed that the soils are predominantly coarse-textured, with sand as the dominant fraction, ranging between 46.14% and 90.40%, followed by silt (6.46-40.48%) and clay (1.01-13.38%). Based on the USDA classification, the soils mainly fall under sandy loam and loamy sand textural classes, indicative of a semi-arid, well-drained environment derived from basaltic parent material of the Deccan Traps.

The statistical parameters further corroborate the dominance of coarse-grained sediments. The mean grain size (-0.90ϕ to 2.10ϕ) signifies the prevalence of course to medium sand, while the sorting index (1.41ϕ–2.55ϕ) indicates moderately to poorly sorted soils, reflecting heterogeneous sediment sources and variable depositional energy conditions. The predominance of positive skewness (0.28ϕ average) suggests that finer particles are retained in lower-energy zones such as depressions and gentle slopes, whereas negative skewness in some samples points to coarser materials in upland erosional areas. The kurtosis values (0.58ϕ-1.99ϕ) show that most soils are mesokurtic to leptokurtic, representing relatively stable depositional conditions with moderate textural uniformity.

In conclusion, the grain-size and textural analysis establishes that Malegaon's agricultural soils are geomorphologically controlled, texturally heterogeneous, and moderately developed under semi-arid climatic conditions. The findings serve as a baseline dataset for further geochemical, hydrological, and GIS-based soil quality assessments and will aid in formulating sustainable land management and precision agriculture strategies for the basaltic landscapes of the Deccan Plateau.

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COMPETING INTERESTS:

The authors declare no competing interests.

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