

# Soil Profile and Physical Properties of Soil of Research Field in Rajshahi, Bangladesh

Zakiya Yasmin<sup>1</sup>, Md Abul Kalam Azad<sup>1\*</sup>, Md Monirul Islam<sup>1</sup>, Most Nure Anzuman Ara<sup>1</sup>, Fatema Tuz Zohora<sup>1</sup>, Iftekharul Islam<sup>2</sup>, Ismail Hossain<sup>2</sup>

<sup>1</sup>Institute of Environmental Science, University of Rajshahi, Rajshahi, Bangladesh

<sup>2</sup>Department of Geology and Mining, University of Rajshahi, Rajshahi, Bangladesh

Email: \*akazad-ies@ru.ac.bd

**How to cite this paper:** Yasmin, Z., Azad, M. A. K., Islam, M. M., Ara, M. N. A., Zohora, F. T., Islam, I., & Hossain, I. (2025). Soil Profile and Physical Properties of Soil of Research Field in Rajshahi, Bangladesh. *Journal of Geoscience and Environment Protection*, 13, 36-46. <https://doi.org/10.4236/gep.2025.139003>

**Received:** June 24, 2025

**Accepted:** September 13, 2025

**Published:** September 16, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

Soil profile and physical properties of soil are important for crop cultivation and horticultural practices. This study was carried out to identify the soil profile of the research field of Institute of Environmental Science (IES) of University of Rajshahi during December 2024-February 2025. For getting the Soil Profile of Rajshahi University campus, two bores were dug in research field. The soil samples were collected from two sites at a considerable depth with possible variation of the horizons. A total 12 sediment samples from two soil profile sites were collected and analyzed in the laboratory of Department of Geology and Mining of University of Rajshahi. In 1<sup>st</sup> soil profile site (SP1), soil horizon A was found at 0 - 15 cm, E & B1: 15 - 60 cm, B2: 60 - 78 CM, C1: 78 - 100 cm and C2: 100 - 200 cm, whereas in the 2<sup>nd</sup> soil profile site (SP2), the soil horizon was found at different depths, A: 0 - 30 cm, E & B1: 30 - 58 cm, B2: 58 - 83 cm, C1: 83 - 163 cm and C2: 163 - 203 cm. From physical soil properties analysis, the particle size was found dominantly sands with almost identical silt and clay. Major soil textures of the studied profiles are sandy loam, sandy clay loam, loamy sand and medium loam, and most cases, soil order is mainly Entisols. The soil composition of IES research field of University of Rajshahi was found to suitable for diverse agricultural activities, however, challenges like water retention and soil fertility are problematic in some areas of this research field.

## Keywords

Soil Profile, Horizon, Physical Properties and Soil Fertility

## 1. Introduction

Understanding how soils react to agricultural practices is essential to achieving

soil management to preserve soil quality. Thus, growing knowledge, that soil is an essential part of the earth's biosphere and that it plays a dual role in maintaining environmental quality and producing food and fiber has sparked interest in assessing the quality of soil resources (Doran & Parkin, 1994). Soils of Bangladesh are mainly floodplains with some hills and terraces based on physiographical conditions of Bangladesh. In accordance with the country's division based on altitude and relief, Bangladesh is situated at the lowest points of three powerful river systems: the Ganges-Padma, Brahmaputra-Jamuna, and Surma-Meghna. The land can be classified into three main physical unit categories: Tertiary hills, Pleistocene uplands, and Recent plains. It is reported that nearly 70% of all land is made up of floodplain soils within Recent plains, which are widely distributed throughout the nation (Alam et al., 1994).

The agricultural production of Bangladesh is primarily dependent on both calcareous and noncalcareous soil types, which together make up approximately 87% of all floodplain soils, according to Alam et al. (1994), who identified 14 general soil types that fall under this category. Soils are classified into 20 General Soil Types based on their morphological appearance and mode of formation. These categories correspond to the USDA Soil Taxonomy and FAO-UNESCO classification systems (Saheed, 1984). Surprisingly, calcareous soils formed over the Ganges sediments have higher extractable bases and are more alkaline than noncalcareous soils of the Brahmaputra sediments. Aluminum rich soil is found in the hilly region of Chittagong Hill Tracts of Bangladesh. Aluminum is approximately 8.2% of the earth's crust and is considered a Lewis acid (Aide, 2022).

The authors' current effort is an attempt to conduct systematic investigations in order to characterize the soil profile of the alluvial floodplain soil types that make up the majority of Bangladesh. The main objectives of the study were to delineate soil profile of the area, to assess soil type or classes of the digging sites, and finally to characterize soil properties.

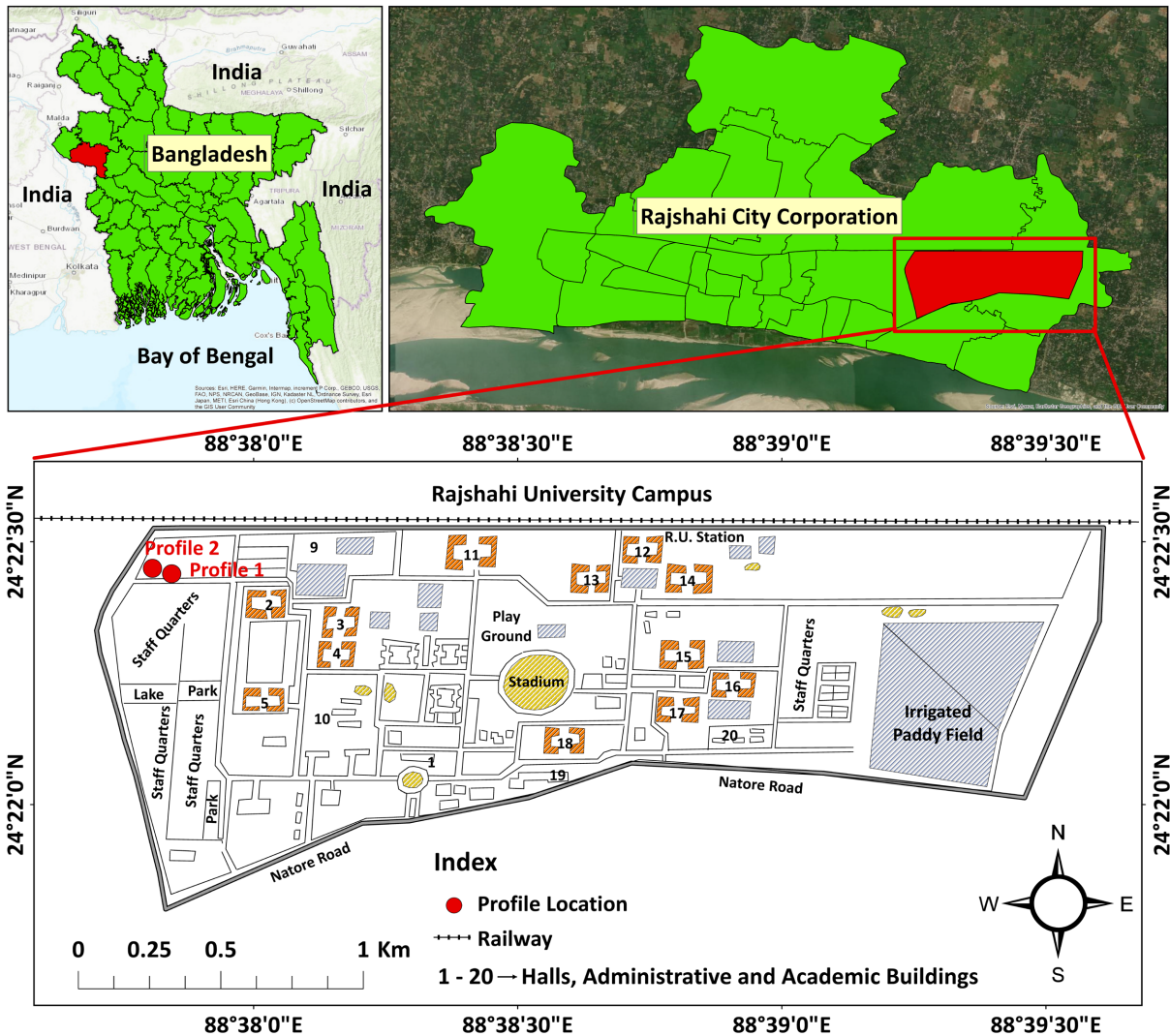
## 2. Study Site Description

### 2.1. Location

The study area of this research work comprises the western boundary of the Rajshahi University campus, Rajshahi city of Bangladesh (Figure 1). This area is situated in the central-western part of Bangladesh. For getting the soil profile of Rajshahi University campus area, two separate digging sites were selected. One of the profile sites is located in the latitude 24.37363 N and longitude 88.629888 E, another one is located in the latitude 24.373885 N and longitude 88.629568 E.

### 2.2. Geological Setting

The Bengal Basin, which spans a considerable area in Bangladesh, is an intricate sedimentary basin located between the Peninsular Indian Shield and the Shillong massif. It is located near the triple junctions of the Indian and Eurasian plates and the Burmese sub-plate. It contains the thickest sedimentary piles (>20 km) in the



Source: The Rajshahi University Map is modified from B. K. Saha; shapefile of Bangladesh Map is collected from <https://www.arcgis.com/home/item.html?id=4678466156d142478606baf3d6ace6d6>; our student created a Location Map of Study Site using ArcGIS 10.8.2.

**Figure 1.** Location map and soil profile positions of the study area.

world. Tectonically, the Rajshahi Division belongs to the Southern slope of Rangpur Saddle or Bogura Shelf and its sedimentary cover is about 700 m, while the thickness gradually increases in the southern part of the platform (Reimann, 1993; Hossain et al., 2009). The Ganges-Brahmaputra-Meghna River system carries these sediments primarily. Because of the elevation change, the Ganges River flows from downstream to the south in the basin, according to a grain size analysis of the river bed sediments.

### 3. Materials and Methods

For the purpose of this study, two separate digging sites were selected for getting the soil profile of the Rajshahi University campus area (Figure 1). The soil samples were collected from the soil profiles at a considerable depth with possible variation of the horizons. Raw and wet soil samples were preserved in the polyethylene bags and

brought to the laboratory for grain size analysis. A total of 12 sediment samples from two soil profiles were collected for laboratory investigation. The samples were dried in an electric oven at 45°C. 100 gm of each dried sample was taken and sieved by a sieving machine for 15 minutes using 35, 45, 60, 80, 120, 170, 230 and 325 standard meshes, and their size distributions were recorded. The samples were analyzed at the Department of Geology and Mining, University of Rajshahi, Rajshahi, Bangladesh.

## 4. Results and Discussion

A soil profile describes secondary weathering features related topsoil development (e.g., horizons, colors, and soil structure) and any primary features inherent to the parent material, such as sedimentary stratigraphy, grain size, or mineralogy (Eppes, 2009). Weathering, humification, and mineralization are essential components of the pedological system.

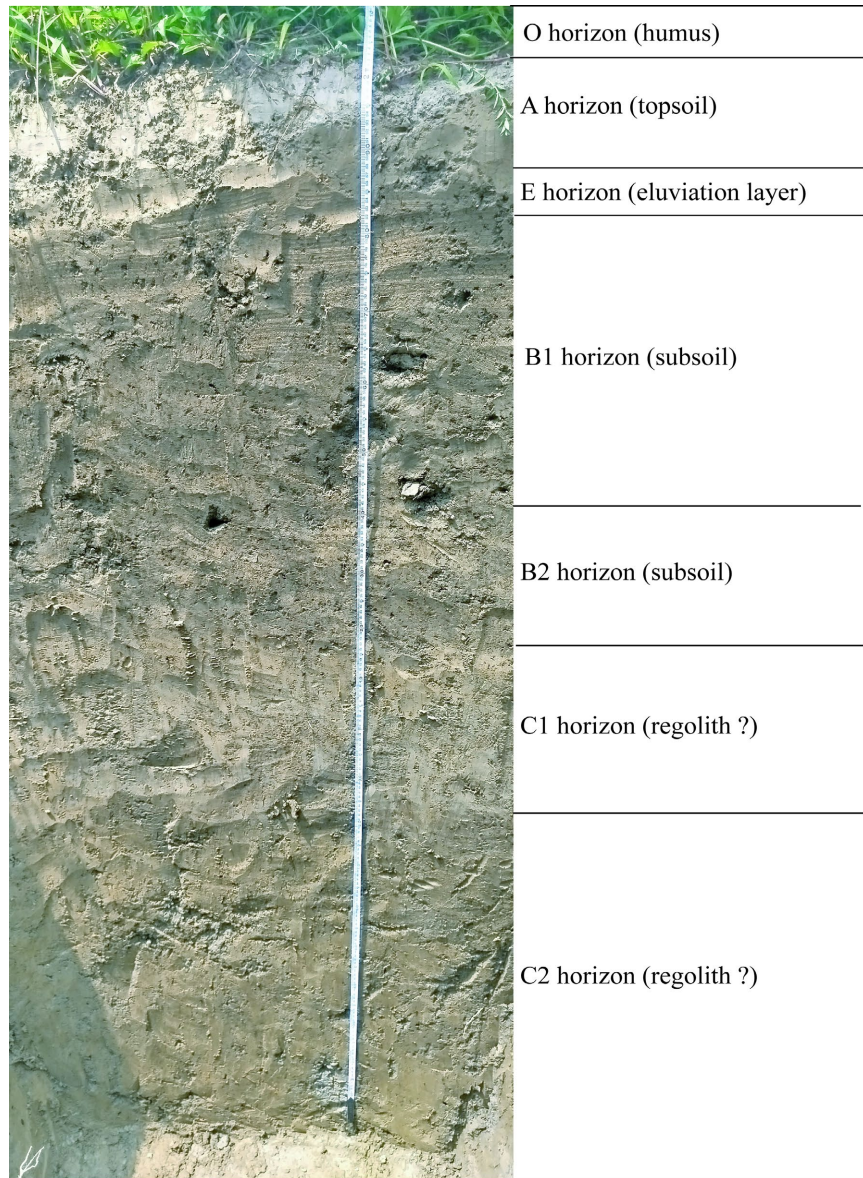
### 4.1. Soil Profile Description

The soil is the thin topmost layer of the earth's crust mainly composed of organic matters, minerals and rock particles that support life. A soil profile is a vertical cross-section of the soil, made of layers running parallel to the surface. These layers are also known as soil horizons. The top layer is generally fertile, with sandy clay or sandy loam and silty textures, which makes it suitable for agriculture. The soil is moderately rich in organic matter due to crop residues and the natural vegetation of the area. Below the topsoil, the subsoil layer of the studied profiles is typically loamy sand or medium sand in nature. It can sometimes become less compacted, having some root penetration. Lower layer of the profiles consists of weathered alluvial deposits, mainly derived from the sediments of the Ganges River. Main texture is slightly mixed sandy loam or loamy sand or medium loam, sandy clay loam, comparatively moist, locally oxidized spotted with light brown color or dark spot, slightly sticky when wet. The characteristics of soil profile-1 (SP1) are shown in **Table 1** and **Figure 2**.

The characteristics of soil profile-2 (SP2) are shown in **Table 2** and **Figure 3**.

**Table 1.** Characteristics of the soil profile-1 (SP1).

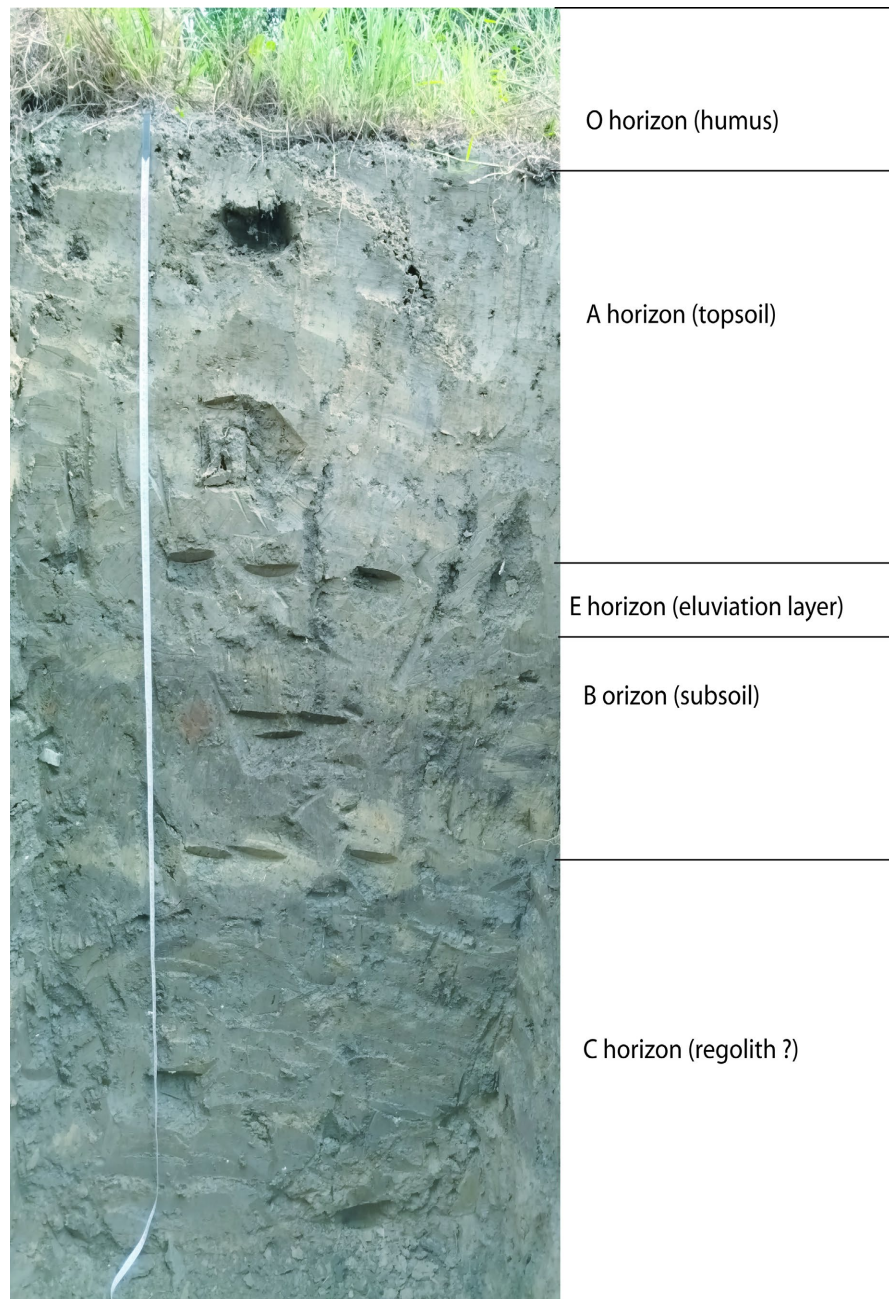
Horizon designation	Profile depth (cm)	Profile description
		(Latitude 24.37363 N, Longitude 88.629888 E)
A	0 - 15 cm	Topsoil, dry, white, slightly light yellow, limited visible organic matters, sandy clay loam, comparatively dry, some organic rich clots present.
E & B1	15 - 60 cm	Layer E and B1 are not so much clear to divide (subsoil). Overall, moist, slightly black, porous type, silty nature, dry and wet mixed area has some shells, loamy sand. Slightly sticky and slightly plastic when wet, friable when moist.
B2	60 - 78 cm	Medium loam, slightly silty, comparatively more yellowish-brown color than B1 layer, eluviated type.
C1	78 - 100 cm	Sandy loam, moist, oxidized spotted with light brown color, slightly sticky when wet.
C2	100 - 200 cm	Sandy loam or medium loam, moist, brown color, fine grained, still leached water, dark spot, oxidation rich, slightly sticky.



**Figure 2.** Photograph of soil profile-1 (SP1) with major horizons or layers.

**Table 2.** Characteristics of the soil profile-2 (SP2).

Horizon designation	Profile depth (cm)	Profile description (Latitude 24.373885 N, Longitude 88.629568 E)
A	0 - 30 cm	Topsoil, gray color, white, silty, limited visible organic matters, sandy loam, comparatively dry, some organic rich clots present, friable.
E & B	30 - 58 cm	Eluviated type, subsoil, light yellow color, dry, porous type, silty nature, sandy loam.
B	58 - 83 cm	Mixed of loamy sand or sandy loam, light brown or white color, slightly moist, few yellow spots present.
C	83 - 163 cm	Moist, oxidized spotted with gray color, slightly sticky, shell present, top layer sandy loam, lower part are more loamy sand type.
C	163 - 203 cm	Dark gray or black color, still leached water, dark spot, oxidation rich, slightly sticky, large size iron nodule present. Many shells visible. Slightly irregular textures, mixed of loamy sand or sandy loam.



**Figure 3.** Photograph of soil profile-2 (SP2) with major horizons or layers.

Analysis of the subgrade soil enables us to identify it as falling into classes S2 and S4 on the basis of their CBR of between 6 and 26 (CEBTP, 1984).

## 4.2. Soil Texture and Classification

### 4.2.1. Particle Size

The particle size classes are based on the particle size grades of the British Standards Institution and the Massachusetts Institute of Technology and the measured particle size data are shown in **Table 3**. Particle size data of a soil profile is very important for delineating the soil characteristics of a crop land. In the present

study, two representative soil profiles have been dug near the western boundary of the Rajshahi University campus to know the soil characteristics of the experimental crop land of the Institute of Environmental Sciences (IES), University of Rajshahi. According to size grade, sand particles are divided into coarse sand, medium sand, fine sand, very fine sand. In this case, overall profile samples show coarse sand (0.24 - 1.47 wt%), medium sand (8.51 - 23.98wt%), fine sand (11.26 - 30.26 wt%), very fine sand (17.14 - 44.12 wt%). On the other hand, silt (8.82 - 33.84 wt%) and clay (5.19 - 27.02 wt%) are comparatively identical. Overall, sands (55.05 - 82.30 wt%) are dominant particle size in both profiles.

**Table 3.** Grain size data of soil profile SP1 and SP2.

Profile Sample No. & Depth (cm)		Phi ( $\phi$ ) wt%	Lithology	Profile Sample No. & Depth (cm)		Phi ( $\phi$ ) wt%	Lithology		
SP1	SS1 (12 cm)	1.00	1.47	Coarse Sand	SP2	SS2 (50 cm)	1.00	0.06	Coarse Sand
		1.50	13.09				1.50	8.52	
		2.00	4.08	Medium Sand			2.00	4.77	Medium Sand
		2.50	8.62				2.50	11.17	
		3.00	11.51	Fine Sand			3.00	12.02	Fine Sand
		3.51	11.97				3.51	12.78	
		3.99	8.44	Very Fine Sand			3.99	8.36	Very Fine Sand
		4.51	12.56				4.51	26.59	
		4.76	27.02	Clay			4.76	15.34	Clay
SP1	SS-2 (40 cm)	1.00	0.62	Coarse Sand	SP2	SS3 (75 cm)	1.00	0.28	Coarse Sand
		1.50	10.12				1.50	12.42	
		2.00	2.19	Medium Sand			2.00	5.73	Medium Sand
		2.50	9.08				2.50	14.19	
		3.00	14.61	Fine Sand			3.00	14.41	Fine Sand
		3.51	21.58				3.51	15.57	
		3.99	22.54	Very Fine Sand			3.99	11.48	Very Fine Sand
		4.51	8.82				4.51	19.62	
		4.76	8.54	Clay			4.76	5.19	Clay
SP1	SS-3 (85 cm)	1.00	0.13	Coarse Sand	SP2	SS4 (100 cm)	1.00	0.54	Coarse Sand
		1.50	5.75				1.50	6.53	
		2.00	2.76	Medium Sand			2.00	3.13	Medium Sand
		2.50	4.18				2.50	9.18	
		3.00	7.08	Fine Sand			3.00	11.52	Fine Sand
		3.51	19.51				3.51	21.02	
		3.99	7.14	Very Fine Sand			3.99	9.47	Very Fine Sand
		4.51	33.84				4.51	24.61	
		4.76	18.62	Clay			4.76	12.67	Clay

Continued

SP1	SS-4 (110 cm)	1.00	0.75	Coarse Sand	SP2	SS5 (125 cm)	1.00	0.24	Coarse Sand
		1.50	12.41	Medium Sand			1.50	10.84	Medium Sand
		2.00	3.52				2.00	4.14	
		2.50	8.57	Fine Sand			2.50	10.59	Fine Sand
		3.00	9.88				3.00	13.83	
		3.51	17.91	Very Fine Sand			3.51	13.72	Very Fine Sand
		3.99	10.32				3.99	6.02	
		4.51	22.66	Silt			4.51	22.33	Silt
		4.76	12.67	Clay			4.76	17.22	Clay
SP1	SS-5 (160 cm)	1.00	0.28	Coarse Sand	SP2	SS6 (170 cm)	1.00	0.34	Coarse Sand
		1.50	9.94	Medium Sand			1.50	17.42	Medium Sand
		2.00	3.02				2.00	6.56	
		2.50	7.84	Fine Sand			2.50	13.22	Fine Sand
		3.00	10.80				3.00	14.90	
		3.51	13.72	Very Fine Sand			3.51	11.00	Very Fine Sand
		3.99	4.82				3.99	9.56	
		4.51	28.47	Silt			4.51	18.80	Silt
		4.76	20.82	Clay			4.76	7.22	Clay
SP2	SS1 (20 cm)	1.00	0.82	Coarse Sand	SP2	SS7 (205 cm)	1.00	0.31	Coarse Sand
		1.50	15.62	Medium Sand			1.50	7.59	Medium Sand
		2.00	7.16				2.00	2.60	
		2.50	16.04	Fine Sand			2.50	7.01	Fine Sand
		3.00	14.22				3.00	10.22	
		3.51	9.20	Very Fine Sand			3.51	16.83	Very Fine Sand
		3.99	7.94				3.99	9.66	
		4.51	16.94	Silt			4.51	28.26	Silt
		4.76	11.48	Clay			4.76	16.02	Clay

#### 4.2.2. Soil Texture Classification

The soil texture triangle and the ratios of sand, silt, and clay of two soil profiles SP1 and SP2 are shown in **Table 4**. We can learn about characteristics like permeability and water-holding capacity by understanding the texture of the soil. These attributes affect the kinds of plants that can grow there as well as the rates of erosion. Applications for using soil texture analysis include construction, agriculture, and conservation. This texture also influences the key characteristics such as drainage, water storage, workability, susceptibility to soil erosion and suitability for different uses. It also plays a major part in defining soil structure.

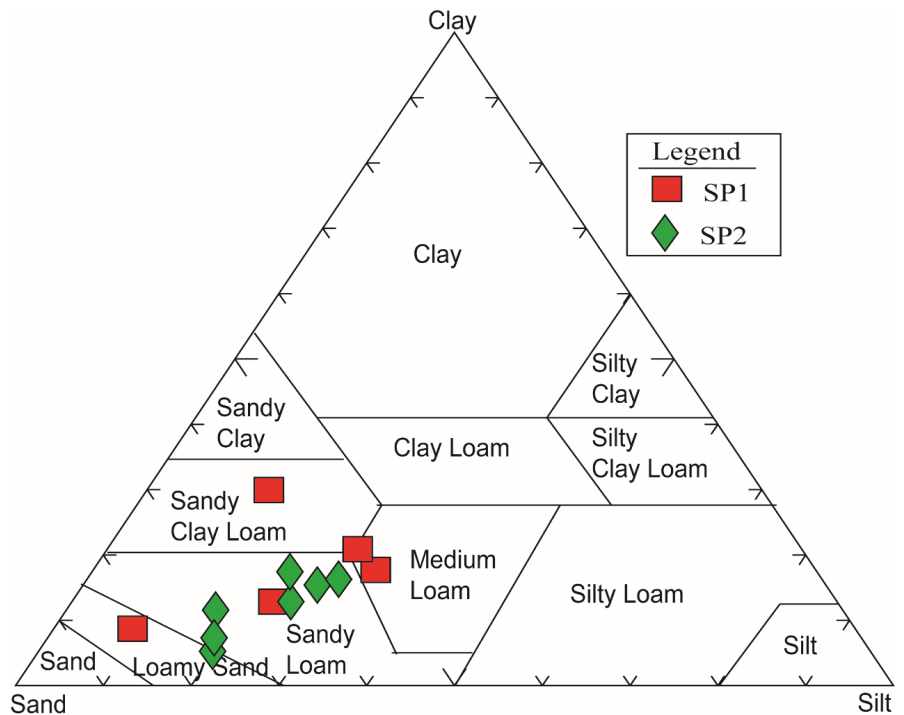
**Table 4.** Textural characteristics of soils of profile SP1 and SP2.

Sample No.	Site	Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Texture
SS1	Crop land (SP1)	AB	12	56.18	13.91	29.92	Sandy Clay Loam
SS2			40	82.30	8.99	8.71	Loamy sand
SS3			85	53.22	34.18	18.81	Medium Loam
SS4			110	64.20	22.96	12.84	Sandy Loam
SS5			160	50.57	28.55	20.88	Medium Loam/Sandy Clay Loam
SS1	Crop land near bushes (SP2)		20	71.41	17.04	11.55	Sandy Loam
SS2			50	57.91	26.69	15.40	Sandy Loam
SS3			75	74.91	19.84	5.25	Loamy sand/Sandy Loam
SS4			100	62.22	24.94	12.84	Sandy Loam
SS5			125	60.02	22.57	17.41	Sandy Loam
SS6			170	73.72	18.99	7.29	Sandy Loam/Loamy Sand
SS7			205	55.05	28.69	16.26	Sandy Loam

**4.2.3. Mineral Soil**

The texture class of a soil is defined on the relative proportions of sand, silt and clay. The relative amounts of clay, silt, and sand particles in the soil allow for the classification of mineral soils into 11 major classes (Figure 4).

Soil profile 2 (SP2) shows mostly sandy loam texture all over the profile length. However, soil profile 1 (SP1) has slightly heterogenous. It shows medium loam, sandy loam, sandy clay loam and loamy sand.



**Figure 4.** Soil textures of the study area.

All over the profile 2 consists of individual grains, which can be seen and felt. In dry condition, clods are easily break. During digging or wet condition (with moisture), soils were moderately gritty to gritty; forms ball and did not show ribbons or very poorly visible.

#### 4.2.4. Soil Orders

There are various levels in soil taxonomy, such as great group, subgroup, family, order, and suborder (Donovan, 1981). Soil order is the broadest classification level in the USDA (United States Department of Agriculture) Soil Taxonomy system. This system of classification primarily makes use of the quantitatively measured characteristics of the soil, such as its organic matter content, base saturation, texture, structure, moisture content, temperature, cation exchange capacity, and clay mineralogy (Banglapedia, 2021).

Based on a number of criteria, including parent materials, soil formation (the percentage of soil profile development), weathering (chemical and physical), and climate, the earth's soils are divided into several classes.

There are twelve different types of soil in the world: Mollisols, Alfisols, Entisols, Inceptisols, Vertisols, Spodosols, Ultisols, Oxisols, Histosols, Andisols, and Gelisols. Within this international group, Bangladesh is exposed to six of these types: Entisols, Inceptisols, Mollisols, Alfisols, Ultisols, and Histosols.

In these six types, the study area is prominently rich with Entisols. As the soil profiles of the studied bore logs show very weak development beyond the A-horizon and lack clear diagnostic horizons, they are almost unaltered sediments. This soil is dominantly sandy loam means sandy mineral-rich soil and comparatively low in organic matter, natural fertility and water holding capacity (Weil & Brady, 2016). Near the Ganges River system, the floodplain soil is more fertile due to the regular deposition of silt from flooding, which replenishes nutrients and enhances agricultural productivity. We also know very well that there are Entisols covering about sixteen percent of the Earth's land area that is free of ice. These occur where the rate of erosion or deposition is higher than the rate of soil formation, such as in dunes, steep slopes, and flood plains, or in areas that have recently been exposed to parent materials. Soil series depends on the geographical location of soil. Ten soil series under Alfisols are reported in Southeastern Missouri (Aide, 2024).

## 5. Conclusion

Particle size of the soils of the profiles is dominantly sand with almost identical silt and clay. Major soil textures of the studied profiles are sandy loam, sandy clay loam, loamy sand and medium loam, and most cases, soil order is mainly Entisols. The soil composition of research field of Rajshahi University campus supports diverse agricultural activities, however, it highlights challenges like water retention and soil fertility in specific areas.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

- Aide, M. (2022). Aluminum Soil Chemistry: Influence on Soil Health and Forest Ecosystem Productivity. *Agricultural Sciences*, *13*, 917-935. <https://doi.org/10.4236/as.2022.138057>
- Aide, M. (2024). Soil Profile Concentration Distributions of Aluminum, Gallium, Indium and Thallium across Southeastern Missouri. *Journal of Geoscience and Environment Protection*, *12*, 80-92. <https://doi.org/10.4236/gep.2024.121006>
- Alam, M. L., Miyauchi, N., & Shinagawa, A. (1994). Study on Clay Mineralogical Characteristics of Calcareous and Noncalcareous Soils of Bangladesh. *Clay Science*, *9*, 81-97.
- Banglapedia (2021). *Bangladesh Soil*. [http://en.banglapedia.org/index.php?title=Bangladesh\\_Soil](http://en.banglapedia.org/index.php?title=Bangladesh_Soil)
- CEBTP (1984). *Practical Guide to Pavement Design for Tropical Countries* (pp. 1-154).
- Donovan, A. (1981). Guy D. Smith, 73, USDA Soil Expert, Dies. *Washington Post*.
- Doran, J. W., & Parkin, T. B. (1994). Defining and Assessing Soil Quality. In J. W. Joran, D. C. Coleman, D. F. Bezdicek, & B. A. Stewart (Eds.), *Defining Soil Quality for Sustainable Environment* (pp. 1-21). SSSA Special Publ. No. 35.
- Eppes, M. C. (2009). Introducing Field-Based Geologic Research Using Soil Geomorphology. *Journal of Geoscience Education*, *57*, 11-22. <https://doi.org/10.5408/1.3544222>
- Hossain, I., Tsunogae, T., & Rajesh, H. M. (2009). Geothermobarometry and Fluid Inclusions of Dioritic Rocks in Bangladesh: Implications for Emplacement Depth and Exhumation Rate. *Journal of Asian Earth Sciences*, *34*, 731-739. <https://doi.org/10.1016/j.jseaes.2008.10.010>
- Reimann, K. U. (1993). *Geology of Bangladesh* (160 p.). Gebruder Borntraeger, Verlags, Science Publishers.
- Saheed, S. M. (1984). Soils of Bangladesh. In *Proceedings of International Symposium on Soil Test Crop Response Correlation Studies* (pp. 107-129). Bangladesh Agricultural Research Council and Soil Science Society of Bangladesh.
- Weil, R. R., & Brady, N. C. (2016). *The Nature and Properties of Soils* (15th ed.). Pearson Education, Inc.