



## Effects of slope aspect on soil moisture classification and organic matter on beach ridge soil in Akwa Ibom state, Nigeria

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### Abstract

Research was carried out to examine effect of slope aspect on soil moisture classification and the distribution of organic carbon in beach ridge soils in Akwa Ibom State, Nigeria. The direction a slope faces can significantly impact soil characteristics by exposure to sunlight, temperature, and moisture levels. The findings indicate that NF slopes, primarily composed of sandy soils, with high total sand content of 931 g/kg and porosity of 0.50 m<sup>3</sup>/m<sup>3</sup>, also with a lower bulk density of average of 1.33 Mg/m<sup>3</sup>. Moisture classification results revealed that field water capacity recorded mean value of 0.20, permanent wilting point of 0.08 and available water capacity of 0.03. Conversely, SF slopes contain a high clay content of 58.50 g/kg, and increased compaction with bulk density of 1.44 Mg/m<sup>3</sup>. Moisture classification result shows that field water capacity recorded mean value of 0.30, permanent wilting point of 0.15 and available water capacity of 0.04. The result of chemical properties indicated that NF slopes recorded a high organic matter content of 1.17% and a moderate acidic pH of 5.49, whereas SF slopes recorded low organic matter content of 1.00% and acidic pH of 5.31. Additionally, SF soils showed high effective cation exchange capacity of 12.43 cmol/kg and base saturation of 62.50 %, compared to NF slopes with 9.07 cmol/kg and 44.05 %, respectively. These variations indicate that slope had significant influence on moisture classification and organic matter dynamics. To improve fertility on SF slopes, it is recommended to apply organic amendments to boost organic matter content and enhance soil structure. These insights offer practical suggestions for sustainable land use management and agricultural productivity in beach ridge soils of Akwa Ibom state, Nigeria.

**Keywords:** Slope aspect, soil properties, moisture classification, organic matter, beach ridge soil

### Introduction

Slope aspect is the direction a slope faces in relation to the compass direction. It influences sunlight exposure, moisture levels, and organic matter distribution. Understanding these factors is vital for effective soil management, especially in areas prone to climatic changes and human activities Ogban *et al.* (2022)<sup>[24]</sup> and Ogban and Essien (2016)<sup>[22]</sup>.

Soil moisture is the water held within soil pores, is a critical element of the terrestrial ecosystem. It supports plant growth, regulates hydrological cycles, and influences agricultural productivity. Soil moisture plays a key role in physical, biological and chemical processes essential for soil health and ecosystem stability (Essien *et al.*, 2019<sup>[11]</sup>; Simeon and Essien, 2023<sup>[12, 30]</sup>; Mark *et al.*, 2024)<sup>[13, 19]</sup>. Understanding its dynamics is fundamental for effective land and water resource management, particularly in agricultural systems (Essien *et al.*, 2023; Akpan *et al.*, 2024a)<sup>[5]</sup>. Slope aspect has a significant effect on soil moisture distribution by influencing the amount and intensity of solar radiation received. In the Northern Hemisphere, south-facing slopes are typically warmer and drier due to higher solar exposure, while north-facing slopes are cooler and retain more moisture. This difference is particularly important in tropical regions like Akwa Ibom State (Sam *et al.*, 2025<sup>[28]</sup> a; Sam *et al.*, 2025<sup>[29]</sup> b; Essien *et al.*, 2025), where moisture availability directly impacts vegetation, microbial activity, and soil fertility. Ogban and Okon (2020) found that high moisture availability on north-facing slopes in Akwa Ibom State leads to better soil quality.

Soil organic carbon (SOC) is a vital element of soil quality and fertility, significantly contributing to the global carbon

cycle, nutrient provision, and ecosystem stability. Its distribution is shaped by diverse environmental factors such as climate, slope, land usage, and soil characteristics. The determinants of SOC distribution is importance in agriculture and environmental sustainability (Akata *et al.*, 2025<sup>[5]</sup>; Akata *et al.*, 2024<sup>[1]</sup>; Akpan *et al.*, 2021)<sup>[4]</sup>.

Slope aspect also affects the distribution of soil organic carbon (SOC). Cooler, shaded slopes with high moisture retention promote the accumulation of organic matter and slow decomposition rates, resulting in higher SOC levels (Ben *et al.*, 2024<sup>[6]</sup>; Akata *et al.*, 2024b)<sup>[2]</sup>. On the other hand, warmer slopes experience faster decomposition, lower organic carbon levels, and reduced soil fertility. These dynamics are evident in Akwa Ibom State, where slope aspect plays a vital role in SOC distribution and overall soil functionality.

Although slope aspect's influence on soil properties is globally recognized, limited studies have focused on beach ridge soils in Nigeria. Existing research highlights the vulnerability of these soils to climatic and topographical influences. However, a comprehensive understanding of how slope aspect affects soil moisture and organic matter distribution, particularly in Akwa Ibom State, is still lacking. The findings of Ogban and Okon (2020) emphasize the need for such studies, showing that slope aspect can inform soil and agricultural management strategies in tropical environments.

The beach ridge soils in Akwa Ibom State are formed through sediment deposition and coastal processes. These soils are mostly sandy and highly porous, characterized by low nutrient retention, limited organic matter, and high susceptibility to erosion. Researchers like Fitzgerald *et al.*

(2008) [16] and Udo and Sobulo (1981) [34] have described these characteristics. Ogban and Okon (2020) further highlighted that north-facing slopes in Akwa Ibom State tend to have high infiltration rates, greater soil porosity, and better organic matter retention compared to south-facing slopes, illustrating the critical role of slope aspect in soil quality and resilience. Therefore, there is need to examine effect of slope aspect on soil moisture classification and organic matter distribution on beach ridge sands of Akwa Ibom State, Nigeria.

**Materials and Methods**

**Location of the Study Area**

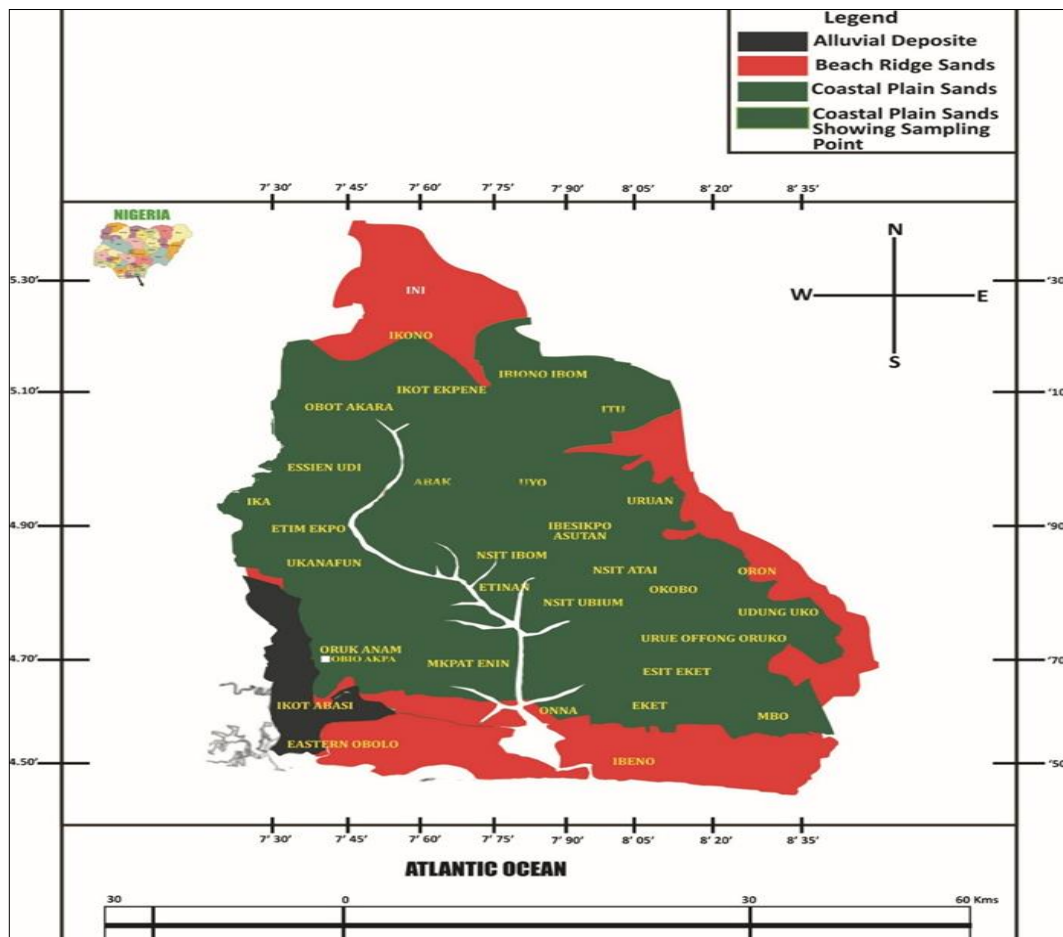
The study was conducted on soils formed on beach ridge sand in Akwa Ibom State, Nigeria. Akwa Ibom state is located between latitudes 4o30' and 5o30'N and longitudes 7o27' and 8o27'E (Petters *et al.*, 1989) [26].

The climate of Akwa Ibom State is humid tropical, with high temperatures and high humidity throughout the year.

The state experience two main seasons: the rainy season,

which lasts from March to October, and the dry season, which lasts from November to February. The average annual rainfall in Akwa Ibom State is approximately 2,500 mm, with the highest rainfall occurring in July and August (Petters *et al.*, 1989) [26].

Akwa Ibom State is underlain by a sedimentary geological formation and is made up of the coastal plain sands, beach sand, sandstone/shale and alluvial deposits. Apart from the northern corner northeastern parts where the land is intensely dissected the land scope of Akwa Ibom State comprising a generally low-lying plain with no portion exceeding 175 m above the sea level. The soils vary in texture from sand to loamy sand and mostly brownish in colour. The soil has low water retention capacity and low content of organic matter (Petters *et al.*, 1989) [26]. The beach ridge sand is derived from marine deposits associated with the Holocene transgressions and regressions of the Atlantic Ocean (Petters *et al.*, 1989) [26]. The areas topography ranges from hilly to undulating land possibly derived by erosion with the causal agent been rainfall.



**Fig 1:** Map of akwa ibom satate showing different parent materials

**Field Methods**

The study was conducted in beach ridge sands in Akwa Ibom State, two local government areas were selected for the study namely Ikot Abasi, and Eket, also two slope aspects were considered for the study (north and south facing slopes). The slopes were of uniform length of 100m, in each of the slope, four soil samples were collected at a distance of 25m apart, bulked, given a representative soil sample of each slope. The sampling points were identified as IK1, IK2, EK1, and EK2. Soil samples were taken from

North facing and South facing slopes given a total of samples for physical and chemical analyses. Again, 8 core samples were collected using core cylinders measuring 7.5cm long and 6.5cm internal diameter. The core samples were used for the determination of saturated hydraulic conductivity, bulk density and total porosity was calculated.

**Laboratory Analysis**The bulked samples were air-dried, crushed and sieved through a 2mm sieve for particle size distribution and selected chemical analyses.

### Particle Size Analysis

Particle size analysis was determined using Bouyoucos Hydrometer method after dispersing the soil with sodium hexametaphosphate solution, as described by Dane and Topp (2002) [9]. The soil textural classes were determined using the textural triangle.

### Saturated Hydraulic Conductivity

Saturated hydraulic conductivity (Ksat) was determined using the constant head permeameter method as described by Dane and Topp (2002) [9]. The saturated hydraulic conductivity was calculated using the equation below:

$$K_{sat} = QL/\Delta hAt$$

Where;

Ksat = saturated hydraulic conductivity (cm/hr-1)  
 Q = discharge rate (cm<sup>3</sup>)  
 L = length of soil column (cm)  
 Δh = change in hydraulic head (cm)  
 (L + h) (L = length of soil containing cylinder, h = height of water above soil containing cylinder)  
 A = cross-sectional area through which the flow takes place  
 t = time taken to collect Q (min)

### Bulk Density

Bulk density was determined by the method described by Dane and Topp (2002) [9]. Soil samples were oven-dried at a temperature of 105°C to a constant mass and bulk density was calculated using the equation below:

$$\rho_b = M_s/V_t$$

Where;

$\rho_b$  = bulk density (Mgm-3)  
 M<sub>s</sub> = dry soil mass (kg)  
 V<sub>t</sub> = total volume of soil (m-3); this was calculated from the internal dimensions of the cylinder.

### Total Porosity

Total porosity was calculated from particle size and bulk density relationship as follows;

$$T_p = [1 - [B_d/P_d]] \times 100$$

Where;

T<sub>p</sub> = Stotal porosity (m-3/m-3)  
 B<sub>d</sub> = bulk density (Mgm-3)  
 P<sub>d</sub> = particle density, which is assumed to be 2.65m-3/m-3

### Soil pH

Soil pH was determined using a glass electrode pH meter and 1NKCl at 1:2.5 soil water ratio (Udo *et al.*, 2009) [35].

### Organic Carbon

Organic carbon was determined by Walkley and Black wet digestion method (Nelson and Sommers, 1996) [21], while organic matter was obtained by multiplying the result from organic carbon with the Van Bemmelen factor of 1.724.

### Exchangeable Cations

The amount of Potassium (K) and Sodium (Na) were determined using flame photometer with appropriate filters while magnesium (Mg) and Calcium (Ca) were determined by atomic absorption spectrometer (AAS) (Thomas, 1982) [33].

### Effective Cation Exchangeable Capacity (ECEC)

Effective cation exchangeable capacity (ECEC) was obtained by summation of exchangeable acidity and exchangeable bases (Udo *et al.*, 2009) [35].

### Base Saturation

Base saturation was calculated by the summation of exchangeable basic cations divided by ECEC and multiplied by 100% (Udo *et al.*, 2009) [35].

$$\% BS = \text{TEB}/\text{ECEC} \times 100$$

Where;

TEB = Total exchangeable bases  
 BS = Base Saturation  
 ECEC = Effective cation exchange capacity

### Exchangeable Acidity

Exchangeable acidity was determined by titration using KCl extraction method (Peech *et al.*, 1962) [25].

### Cation Exchange Capacity

Cation exchange capacity was determined by the summation of all the exchangeable bases Mg, Ca, K and Na (Udo *et al.*, 2009) [35].

### Statistical Analysis

The data generated for physical and chemical properties of the soil were summarized using the mean, standard deviation and coefficient of variation. Pearson correlation analysis was used to establish relationships between soil properties, soil moisture classification and organic carbon.

### Results and Discussion

#### Effect of Slope Aspect on Physical Properties of Soil

The effects of slope aspect on soil physical properties are shown in Table 1. The results indicate that North-Facing Slope (NF): total sand (T<sub>s</sub>) values ranged from 916–946 g/kg (mean = 931 g/kg), with low variability (CV = 1.39%). Silt (S<sub>i</sub>): Ranged from 24–34 g/kg (mean = 29 g/kg). Clay (C<sub>l</sub>): Ranged from 30–50 g/kg (mean = 40 g/kg) with higher variability (CV = 28.88%). Bulk Density (B<sub>d</sub>): Mean value of 1.33 Mg/m<sup>3</sup>, indicating good porosity with a moderate range (1.18–1.50 Mg/m<sup>3</sup>). Hydraulic Conductivity (K<sub>sat</sub>): ranged from 2.69–5.41 cm/min (mean = 3.95 cm/min). High variability (CV = 32.41%) suggests localized permeability differences. Total Porosity (T<sub>p</sub>): had mean value of 0.50 m<sup>3</sup>/m<sup>3</sup>, reflecting favorable aeration.

South-Facing Slope (SF): total Sand (T<sub>s</sub>) was lower with mean values 906 g/kg, indicating higher clay content compared to NF. Silt (S<sub>i</sub>): Mean = 35.50 g/kg, with moderate variability (CV = 16.82%). Clay (C<sub>l</sub>): Ranged from 50–80 g/kg (mean = 58.50 g/kg). Bulk Density (B<sub>d</sub>): showed higher compaction (mean = 1.44 Mg/m<sup>3</sup>). Hydraulic Conductivity (K<sub>sat</sub>) values were lower (mean = 2.50 cm/min), reflecting restricted permeability due to higher clay content. Total Porosity (T<sub>p</sub>) mean = 0.45 m<sup>3</sup>/m<sup>3</sup>, indicating reduced aeration.

Texture and Porosity: The north-facing slope has higher sand content, promoting better porosity (T<sub>p</sub> = 0.50 m<sup>3</sup>/m<sup>3</sup>) and hydraulic conductivity (K<sub>sat</sub> = 3.95 cm/hr), bulk density, the slope had Lower B<sub>d</sub> on NF (1.33 Mg/m<sup>3</sup>) implies less compaction, supporting better root penetration. In contrast, SF has higher B<sub>d</sub> (1.44 Mg/m<sup>3</sup>), limiting root

growth. The higher sand content on the north-facing slope contributes to better porosity and infiltration, consistent with findings by Udo *et al.* (2012) that sandy soils improve aeration and reduce water retention. Conversely, the south-facing slope, with higher clay content, aligns with the results of Gupta and Larson (1979) [18], who noted clay's restrictive effects on water movement.

**Bulk Density:** The lower bulk density on NF indicates reduced compaction, a factor attributed to the protective

microclimatic conditions of shaded slopes, as observed in the work of Zang *et al.* (2019) on soil structure and porosity in sloped terrains.

**Hydraulic Conductivity:** Variability in hydraulic conductivity reflects the influence of slope aspect on soil water dynamics, which corresponds to findings by Vargan and Csiszer (2020) [38] on soils under varying slope gradients.

**Table 1:** Effect of slope aspect on soil physical properties

	SAMPLE ID	Ts	Si gkg <sup>-1</sup>	Cl	Bd Mgm <sup>-3</sup>	Ksat Cm/min	Tp m <sup>3</sup> m <sup>-3</sup>
<b>North Facing Slope</b>							
1		916	34	50	1.42	3.08	0.44
2		936	34	30	1.21	5.41	0.52
3		926	24	50	1.50	2.69	0.48
4		946	24	30	1.18	4.60	0.55
Min		916	24	30	1.18	2.69	0.44
Max		946	34	50	1.50	5.41	0.55
$\bar{x}$		931	29	40	1.33	3.95	0.50
SD		12.91	5.77	11.55	0.16	1.28	0.05
CV (%)		1.39	19.90	28.88	12.03	32.41	10.00
<b>South Facing Slope</b>							
1		876	44	80	1.55	1.84	0.55
2		916	30	54	1.41	2.33	0.45
3		916	34	50	1.38	3.14	0.42
4		916	34	50	1.41	2.69	0.39
Min		876	30	50	1.38	1.84	0.39
Max		916	44	80	1.55	3.14	0.55
$\bar{x}$		906	35.50	58.50	1.44	2.50	0.45
SD		20	5.97	14.46	0.08	0.55	0.07
CV (%)		2.21	16.82	24.72	5.56	22.00	15.56

Ts = Total sand; Si = Silt; Cl = Clay; Bd = Bulk density; Tp = Total porosity; Ksat = Hydraulic Conductivity.

**Effect of Slope Aspect on Selected Chemical Properties of Soil**

The effects of slope aspect on soil chemical properties are presented on Table 2.

**North-Facing Slope (NF):** organic matter (OM) mean value of 1.17% was higher than that of SF. pH was slightly acidic (mean = 5.49), suitable for most crops. Exchangeable Bases (Ca, Mg, Na, K): Ca = 2.70 cmol/kg, Mg = 0.90 cmol/kg, with moderate effective cation exchange capacity (ECEC = 9.07 cmol/kg). Base Saturation (Bsat): Mean = 44.05%.

**South-Facing Slope (SF)** organic matter (OM) was lower (mean = 1.00%), indicating faster decomposition rates. pH was slightly acidic (mean = 5.31). Exchangeable Bases (Ca, Mg, Na, K): Ca = 5.50 cmol/kg, Mg = 1.83 cmol/kg, with higher ECEC (12.43 cmol/kg). Base Saturation (Bsat): was higher (mean = 62.50%).

The NF slope retains more organic matter and enhanced moisture retention. The lower organic matter on SF results

from high temperature and exposure and accelerated decomposition. Both slopes are within the acidic range, but NF offers a better environment for nutrient availability. SF, despite its high ECEC and Bsat, may require organic matter addition to improve soil fertility.

The higher organic matter content on the north-facing slope agrees with studies by Gessler *et al.* (2000) [17], who demonstrated that shaded slopes typically have reduced decomposition rates due to cooler microclimatic conditions. Acidity of the soil across both slopes align with tropical soil studies (Simeon and Essien (2023) [12, 30]; Essien *et al.*, (2019) [11], which highlighted the leaching of basic cations in high rainfall areas. The high base saturation on the south-facing slope may be linked to slow organic matter accumulation, a relationship discussed in Sweeney *et al.* (2020) [31]. Similar nutrient dynamics were noted by Tellen and Yerima (2018) [32] in their research on tropical soils under varying slopes.

**Table 2:** Effects of slope aspect on soil chemical properties

	SAMPLE ID	Ph (H <sub>2</sub> O)	OM (%)	Av. P (mgkg <sup>-1</sup> )	Ca	Mg	Na	K cmolkg <sup>-1</sup>	EA	ECEC	Bsat (%)
<b>North Facing Slope</b>											
1		5.33	1.33	3.73	3.2	1.07	0.12	0.39	3.2	7.98	56.8
2		5.24	1.18	2.80	1.6	0.53	0.06	0.18	4.0	6.37	37.21
3		5.38	1.01	6.57	2.4	0.80	0.80	0.33	9.1	12.17	28.43
4		6.02	1.16	6.53	3.6	1.20	0.10	0.34	4.5	9.75	53.74
Min		5.24	1.01	2.80	1.60	0.53	0.06	0.18	3.20	6.37	28.43
Max		6.02	1.33	6.57	3.60	1.20	0.80	0.39	9.10	12.17	56.80
$\bar{x}$		5.49	1.17	4.91	2.70	0.90	0.27	0.31	5.20	9.07	44.05
SD		0.36	0.13	1.93	0.89	0.30	0.35	0.09	2.65	2.49	13.51

CV (%)		6.56	11.11	39.31	32.96	33.33	129.63	29.03	50.96	27.45	30.67
<b>South Facing Slope</b>											
1		5.24	0.86	8.87	5.2	1.73	0.15	0.63	6.4	14.11	54.64
2		5.43	0.92	6.53	6.0	2.00	0.06	0.15	4.0	12.21	67.24
3		5.26	1.20	6.57	7.2	2.40	0.10	0.09	5.1	14.89	65.75
4		5.32	1.01	8.87	3.6	1.20	0.09	0.41	3.2	8.50	62.35
Min		5.24	.86	6.53	3.60	1.20	0.06	0.09	3.20	8.50	54.64
Max		5.43	1.20	8.87	7.20	2.40	0.15	0.63	6.40	14.89	67.24
$\bar{x}$		5.31	1.00	7.71	5.50	1.83	0.10	0.32	4.68	12.43	62.50
SD		0.09	0.15	1.34	1.51	0.50	0.04	0.25	1.39	2.85	5.62
CV (%)		1.69	15.00	17.38	27.45	27.32	40.00	78.13	29.70	22.93	8.99

OM = Organic Matter; K = Potassium; Ca = Calcium; Mg = Magnesium; Na = Sodium; EA = Exchangeable Acidity; ECEC = Effective Cation Exchange Capacity; Bsat = Base Saturation.

**Soil Moisture Characteristics**

North-Facing Slope (NF): field water capacity (FWC) ranged from 0.14–0.25 (mean = 0.20), reflecting limited water retention, permanent wilting point (PWP) had a mean value of 0.08, indicating moderate water retention at critical levels and available water capacity (AWC) mean = 0.03, suggesting limited water available for plant use.

On the South-Facing Slope (SF), field water capacity (FWC) had higher values ranging from 0.16–0.39 and mean = 0.30, permanent wilting point (PWP) mean = 0.15, indicating significant moisture held at critical levels while available water capacity (AWC) mean = 0.04, slightly better than NF. Field Water Capacity: The higher FWC on SF is due to its higher clay content, allowing more water

retention. North facing slope, with sandy soils, retains less water, making it prone to faster drainage. Available Water Capacity: AWC on both slopes is low, but SF has a marginally better capacity due to its finer texture. The higher FWC on the south-facing slope is consistent with findings by Essien and Ogban (2018) [10], who observed increased water retention in clay-dominated soils. The high PWP on SF reflects the effect of finer particles in holding water under tension, similar to observations by Qin *et al.* (2021) [27] on soil moisture characteristics. The slightly better AWC on the SF slope matches findings by Brouwer *et al.*, (1985) [8] on the role of texture in water availability for crops.

**Table 3:** Effect of slope aspect on soil moisture classification

	FWC ←	PWP (%)	→ AWC
<b>North Facing Slope</b>			
1	0.22	0.08	0.01
2	0.18	0.07	0.01
3	0.14	0.08	0.04
4	0.25	0.09	0.05
Min	0.14	0.07	0.01
Max	0.25	0.09	0.05
$\bar{x}$	0.20	0.08	0.03
SD	0.05	0.01	0.02
CV (%)	25.00	12.50	66.67
<b>South Facing Slope</b>			
1	0.38	0.19	0.01
2	0.27	0.11	0.02
3	0.39	0.18	0.08
4	0.16	0.1	0.06
Min	0.16	0.10	0.01
Max	0.39	0.19	0.08
$\bar{x}$	0.30	0.15	0.04
SD	0.11	0.05	0.03
CV (%)	36.66	33.33	75.00

FWC = field water capacity, PWP = permanent wilting point, AWC = Available water capacity.

The result in Table 4a and 4b shows the relation between soil physical properties, organic matter and soil moisture characteristics on North and South facing slopes, respectively.

**Correlation matrix between soil physical properties, organic matter and soil moisture characteristic on North facing slope**

Results in Table 4a shows that Total sand and Total porosity (r = 0.998, p < 0.01), a strong positive relationship between

total sand (Ts) and total porosity (Tp) means sandy soils on the NF slope allow water to move quickly through large pores. This is similar to findings by Ogban and Okon (2020); Essien *et al.*, (2023) [13], who noted that sandy soils generally have good aeration and infiltration but struggle with holding water. Clay and bulk density (r = 0.975, p < 0.05), and hydraulic conductivity (r = -0.958, p < 0.05). Clay (Cl) had a noticeable negative effect on saturated hydraulic conductivity (Ksat), showing that soils with more clay hold water tightly, making it harder for water to flow. This agrees with studies that suggest clay-rich soils can get compacted, reducing their permeability (Udom *et al.*, 2023)

[37]. Silt and AWC ( $r = -0.980, p < 0.05$ ), the weak contribution of silt (Si) to water retention, seen in the negative correlation with available water capacity (AWC), shows that silt does not improve soil's ability to store water compared to clay or organic matter (Amanze *et al.*, 2024)<sup>[7]</sup>.

**Correlation matrix between soil physical properties, organic matter and soil moisture characteristic on South facing slope**

Organic matter (OM) vs. available water capacity (AWC) ( $r = 0.953^*, p < 0.05$ ), highlighting the influence of organic matter on moisture retention. Organic matter is crucial for improving AWC, emphasizing the need for OM-rich amendments. The significant correlation between organic matter and available water capacity ( $r = 0.953^*$ ) aligns with research by Hudson (1994), emphasizing the role of OM in improving soil water retention. Clay (Cl) vs. bulk density

(Bd) ( $r = -0.983^*, p < 0.05$ ), indicating clay's impact on compaction. Clay (Cl) vs. Total Porosity (Tp):  $r = 0.968^*, p < 0.05$ . Clay particles can create micro pores despite reducing macro pores. This reflects the dual role of clay in soil structure, as explained by Ogban and Essien (2016), who noted that clay improves water retention but limits aeration.

The properties of NF slopes are mainly influenced by soil texture, with sandy soils allowing water to drain quickly. However, the high clay content can lead to compaction and waterlogging if not managed properly. On SF slopes, organic matter plays a more important role in water retention, especially because these slopes experience more sunlight and heat, which increase evaporation. Maintaining high organic matter levels is crucial for managing soil moisture in such areas.

**Table 4 a:** Correlation matrix between soil physical properties, organic matter and soil moisture characteristic on North facing slope

	Ts	Si	Cl	Bd	Ksat	Tp	OM	FWC	PWP	AWC
Ts	1.000									
Si	-0.447	1.000								
Cl	-0.894	0.000	1.000							
Bd	-0.831	-0.092	0.975*	1.000						
Ksat	0.736	0.271	-0.958*	-0.940	1.000					
Tp	0.998**	-0.422	-0.905	-0.831	0.758	1.000				
OM	-0.335	0.750	0.000	-0.203	0.140	-0.356	1.000			
FWC	0.351	0.060	-0.422	-0.600	0.335	0.302	0.644	1.000		
PWP	0.316	-0.707	0.000	-0.078	-0.259	0.256	-0.062	0.597	1.000	
AWC	0.564	-0.980*	-0.140	-0.075	-0.145	0.532	-0.642	0.127	0.792	1.000

Ts = Total sand; Si = Silt; Cl = Clay; Bd = Bulk density; Tp = Total porosity; Ksat = Hydraulic Conductivity OM = Organic matter, FWC = field water capacity, PWP = permanent wilting point, AWC = Available water capacity. \*\*. Correlation is significant at the 0.01 level (2-tailed). \*. Correlation is significant at the 0.05 level (2-tailed).

**Table 4 b:** Correlation matrix between soil physical properties, organic matter and soil moisture characteristic on South facing slope

	Ts	Si	Cl	Bd	Ksat	Tp	OM	FWC	PWP	AWC
Ts	1.000									
Si	-0.949	1.000								
Cl	-0.991**	0.900	1.000							
Bd	-0.983*	0.903	0.986*	1.000						
Ksat	0.799	-0.600	-0.857	-0.885	1.000					
Tp	-0.936	0.791	0.968*	0.920	-0.842	1.000				
OM	0.618	-0.401	-0.689	-0.745	0.962*	-0.665	1.000			
FWC	-0.494	0.475	0.487	0.344	-0.094	0.609	0.162	1.000		
PWP	-0.645	0.707	0.599	0.493	-0.129	0.634	0.147	0.935	1.000	
AWC	0.656	-0.397	-0.743	-0.750	0.963*	-0.788	0.953*	-0.093	-0.033	1.000

Ts = Total sand; Si = Silt; Cl = Clay; Bd = Bulk density; Tp = Total porosity; Ksat = Hydraulic Conductivity OM = Organic matter, FWC = field water capacity, PWP = permanent wilting point, AWC = Available water capacity. \*\*. Correlation is significant at the 0.01 level (2-tailed). \*. Correlation is significant at the 0.05 level (2-tailed).

**Conclusion and Recommendation**

**Conclusion**

Slope direction plays a significant role in soil properties. North-facing slopes, are characterized by sandy textures, they provide larger pore space for drainage and aeration, but retain less moisture. South-facing slopes, have high clay content, they retain more water but experience challenges with compaction, reduced aeration, and faster organic matter decomposition. These differences underscore the importance of slope-specific land management strategies to optimize soil moisture and high productivity.

**Recommendations**

To improve soil conditions, adding organic matter to the south-facing slope can boost water retention and nutrient availability. The north-facing slope is more suitable for crops production that prefer well-drained soils, while the

south-facing slope is better for water-demanding crops. Water management practices should align with each slope's specific water retention capabilities to maximize efficiency and support sustainable agriculture.

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