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Characterization and classification of major coconut growing soils in South Eastern Ghats of Tamil Nadu, India

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Abstract

Six soil series representing major coconut growing soils of the Eastern Ghats in Krishnagiri district of Tamil Nadu state, India, were evolved from granite gneiss and alluvium parent materials. Characterization of different soil properties was done using a detailed soil survey at 1:10000 scale. The soils were neutral to moderately alkaline in reaction (7.31 to 9.19), non-saline, poor to moderately well-drained and moderately shallow (<75 cm) to very deep (>150 cm) in depth. The soils were sandy to clay in texture, sub-angular blocky to crumb in structure, dark reddish-brown to brown, very low to high in OC content (0.06 to 2.70%), low to medium in AWC (3.44 to 22.39%), low to high in CEC (4.70 to 54.0 cmol (p^+) kg^{-1}) and having high base saturation (77 to 100%). The soils also had sizable amounts of exchangeable sodium (4.29 to 33.46%), which was maximum in P5, P6 and P1, and high clay content in P5 and P2. The distribution of $CaCO_3$ in different depths was found to be maximum in P4 and P1. The soil orders identified in the coconut area were *Inceptisols, Entisols, Alfisols* and *Vertisols*. Assessment of soil resources and identification of yield-limiting soils factors on coconut could enable of better management and improved productivity.

Keywords: Classification, coconut, Eastern Ghats, soil characterization, sustainability

Introduction

Soil is a vital natural resource for the survival on the earth, and its assessment is a prerequisite for determining soil productivity and the sustainability of the ecosystem. Precise scientific information on characteristics, potentials, limitations, and management of different soils are indispensible for planning and developing soil resources and maintaining the productivity of different plantation crops like coconut (Lal, 2013).

In India, coconut cultivation is an indivisible implant of socio-historical culture as well as an ethnic identity. The livelihood and food security of the major population in Asia and other coastal countries depends mostly on coconut palm (Raghavi *et al.,* 2019). It is estimated that about 12 million people in India are dependent on the coconut sector through cultivation, processing and trading activities. With an annual production of around 17,000 million nuts, the contribution of coconut to the Indian GDP is about ₹ 15,000 crores and a major share of the world’s total production is from India, the Philippines and Indonesia (APCC, 2017).

In India, coconut is mainly cultivated in Kerala, Tamil Nadu, West Bengal, Odisha, Karnataka, Maharashtra, and Pondicherry. Of late, coconut cultivation has been introduced to suitable locations in non-traditional states, including Assam, Gujarat, Madhya Pradesh, Rajasthan, Bihar, Tripura, Manipur, and Arunachal Pradesh and the hinterland regions of the coconut growing states. In India, Tamil Nadu tops the list in the productivity of coconut, but production is high in Karnataka and Kerala tops in the area. Tamil Nadu has the highest

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yield among the major coconut growing states with 14,873 nuts, followed by Andhra Pradesh with 13,808 nuts (Singh*,* 2016).

Coconut is a tropical crop and grows well in hot climates. The palm adapts almost all types of well-drained soils, such as alluvial, red sandy loam, coastal sandy with slightly acidic to neutral soil reaction (Kannan *et al.,* 2017). A decline in soil qualities is primarily responsible for coconut palm's declining health and productivity in the different states (Nair *et al.,* 2018). Major soil parameters like poor drainage, depth, nutrients status and organic carbon had a role in deciding coconut growth and yield in Eastern Ghats. Root penetration and development, important for water uptake, depends on soil physical properties (Avinash *et al.,* 2019).

In Tamil Nadu, it is impossible to increase area-wise production in coconut because of water deficit, high labour cost, and utilization of agricultural land for other purposes. Therefore yield has to be increased within the area by using site-specific land resources information and adopting a scientific method of cultivation. A proper understanding of the soil characteristics of the coconut growing soils in Eastern Ghats will be a key indicator for sustainable productivity. Therefore, a case study was undertaken in the Eastern Ghats in Kaveripattinam block, Krishnagiri district of Tamil Nadu, to evaluate the soil properties for better management and productivity.

Materials and methods

Study area

The Eastern Ghats located along peninsular India extends over 1750 km between 77°22' to 85°20' E longitude and 9°95' to 20°74' N latitude covering states of Tamil Nadu, Karnataka Andhra Pradesh and Odisha. The study was confined to the southern portion of the Eastern Ghats located in Tamil Nadu state. The area lies between 11°47' & 12°33' N latitude and 77°27' & 78°38' E longitude covering Kaveripattinam block of Krishnagiri district (Fig. 1), which belongs to agro-ecological sub-region (AESR) of 8.2 and covers 29,839 ha. Landscape and soil characteristics are given in Table 1.

Field studies

A detailed soil survey was carried out on a 1:10,000 scale during 2017-2019. The base map was prepared using a survey of India toposheet (1:50000 scale) and IRS-P6 LISS IV remote sensing image merged with village cadastral map. Soil survey fieldwork was carried out based on imagery characteristics, geology, landform, slope and vegetation. Based on the slope variability, different transect and random observation were studied. Three hundred and fifteen soil profiles were studied in the Kaveripattinam block. Among them, six representative soils series (P1-Nedungal (NDG), P2- Pannanthur (PNT), P3- Papparapatti (PPT), P4- Arasampatti (ASP), P5- Puliyur (PLR) and P6- Kottapatti (KTP) were identified from a coconut growing soils. Soil pits/profiles were excavated on each landform for describing morphological characteristics (Soil Survey Staff, 2003).

Climatic condition

The study area receives rainfall under the influence of both southwest and northeast monsoons. The mean annual rainfall varied from 750 to 900 mm, and more than 60 to 70 per cent is received during the northeast monsoon (October-December).

Table 1. Site characteristics of study area

Pedons	Series	Area covering (ha)	Landform	MSL	Slope (%)	Runoff	Drainage	Nuts $tree^{-1}$ yr^{-1}	Management
P1	Nedungal (NDG)	1125	Valley floor	538	0-1	Slow	Poor	160	Good
P2	Pannanthur (PNT)	1768	Valley floor	431	1-3	Medium	Somewhat poorly	140	Moderate
P3	Papparapatti (PPT)	1323	Lower pediment	429	1-3	Medium	Moderate	165	Good
P4	Arasampatti (ASP)	814	Valley floor	417	0-1	Slow	Somewhat poorly	150	Good
P5	Puliyur (PLR)	342	Valley floor	418	0-1	Very slow	Poor	185	Very good
P6	Kottapatti (KTP)	3213	Valley floor	410	0-1	Slow	Somewhat poorly	150	Good

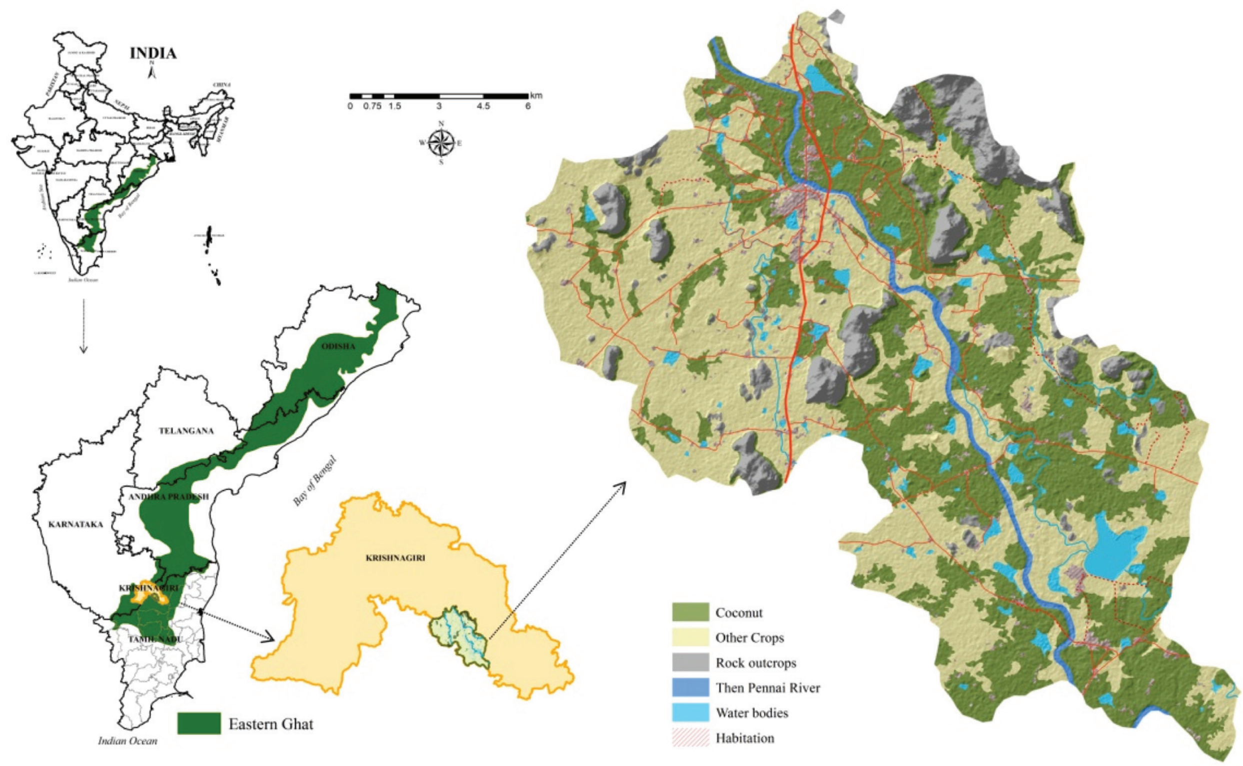

Fig. 1. Location map of the Study area

The mean maximum summer temperature was 37°C, and the mean minimum temperature was 25.5°C. The soil temperature class was *hyperthermic* and moisture regime, "*ustic*", which is Deccan Plateau, hot semiarid eco-region with mixed red loamy soils and LGP 150 to 180 days.

Soil analysis

The soil samples were collected from major coconut growing soils from different depths marked as the horizon and kept for air drying. Subsequently, samples were powdered and sieved using a 2 mm sieve to determine soil physical and chemical characteristics. Soil texture was determined by using the International Pipette Method (Day, 1965). While soil pH and EC were determined according to Jackson (1973) and Page *et al.* (1982), soil organic carbon (SOC) was estimated by the wet oxidation method (Walkley and Black, 1934). Available water capacity (AWC) was calculated as the water retained between suction 0.03 and 1.5 MPa using pressure plate apparatus (Klute, 1986). Cation exchange capacity (CEC) was determined using 1 N ammonium acetate at pH 7.0, whereas base saturation was calculated as the sum of bases divided by CEC and multiplied by 100. Exchangeable sodium percentage (ESP) is the sodium adsorbed on soil particles, and this was calculated as ESP = (exchangeable Na × 100) / cation exchange capacity. Land capability classes (LCC) and land irrigability classes (LIC) developed for coconut-based soil and site variability (AIS & LUS, 1970). The soils were classified as per the guidelines given in Keys to Soil Taxonomy (Soil Survey Staff, 2014).

Results and discussion

Soil morphology

Detailed morphological characteristics of different soil series are given in Table 2. The soil depth varied from moderately shallow (P4) to very deep (P5). The variations in topography and slope gradient have resulted in the variation in different depths (Srinivasan *et al.,* 2011). The soils are poorly to moderately drained. The surface soil matrix colour varied from dark brown (7.5YR 3/2) to very

Table 2. Morphological and physical characteristics of the coconut growing soils

Depth (cm)	Horizon	Colour (moist)	Sand	Silt (%)	Clay	Texture	Structure	Consistence		
Pedon 1: Nedungal series								D	M	W
0-18	Ap	10 YR 3/1	54.45	18.87	26.68	scl	m 2 sbk	sh	fr	ms/mp
18-29	Bw1	10 YR 3/2	50.23	20.26	29.51	scl	m 1 sbk	-	fr	ms/mp
29-42	Bw2	10 YR 3/2	59.09	17.91	23.00	scl	m 1 sbk	-	fr	ms/mp
42-91	Bw3	10 YR 5/2	64.41	12.27	23.31	scl	f 1 sbk	-	fr	ms/mp
Pedon 2: Pannanthur series										
0-18	Ap	7.5 YR 4/2	42.58	21.48	35.94	cl	f 1 sbk	s	vfr	s/p
18-32	A2	5 YR 4/3	61.76	15.60	22.64	scl	f 2 sbk	sh	fr	ms/mp
32-50	Bt1	2.5 YR 3/4	53.37	13.95	32.68	scl	m 1 sbk	-	fr	ms/mp
50-80	BC	2.5 YR 3/6	74.54	9.52	15.94	sl	m 1 sbk	-	fr	so/po
Pedon 3: Papparapatti series										
0-18	Ap	7.5 YR3/2	54.69	21.95	23.36	scl	f 2 sbk	s	vfr	ss/sp
18-42	A1	7.5 YR 3/4	68.27	17.60	14.12	sl	f 2 sbk	-	vfr	so/po
42-75	AC	7.5 YR 4/3	83.40	7.87	8.73	ls	f 1 cr	-	l	so/po
75-105	CA	7.5 YR 4/3	89.06	3.37	7.57	s	f 1 cr	-	l	so/po
Pedon 4: Arasampatti series										
0-17	Ap	10 YR 3/3	63.51	19.15	17.33	sl	f 2 sbk	l	vfr	so/po
17-42	Bw1	10 YR 3/2	43.07	32.35	24.58	sil	f 2 sbk	-	fr	so/po
42-73	Bk1	10 YR 6/1	40.23	29.57	30.20	cl	f 2 sbk	-	fr	ms/mp
Pedon 5: Puliyur series										
0-19	Ap	10YR 3/1	28.67	29.18	42.15	c	f 1 sbk	l	l	vs/vp
19-49	Bss1	10YR 3/1	27.98	25.24	46.77	c	f 2 sbk	-	vfr	vs/vp
49-75	Bss2	10YR 3/1	24.21	26.47	49.32	c	f 2 sbk	-	vfr	vs/vp
75-110	Bss3	10YR 2/1	17.57	25.25	57.18	c	f 2 sbk	-	vfr	vs/vp
110-158	Bss4	10YR 2/1	16.74	25.00	58.26	c	f 2 sbk	-	vfr	vs/vp
Pedon 6: Kottapatti series										
0-16	Ap	10 YR 4/2	38.85	41.38	19.77	sil	f 1 sbk	l	vfr	ss/sp
16-38	Bw1	10 YR 5/4	34.68	43.30	22.02	sil	f 2 sbk	-	fr	ss/sp
38-75	Bw2	10 YR 5/3	38.39	40.25	21.36	sil	f 2 sbk	-	fr	ss/sp
75-102	BC	10 YR 5/3	56.23	27.19	16.58	sl	f 1 sbk	-	fr	so/po
102-130	CB	10 YR 4/3	83.42	7.81	8.77	ls	f 1 sbk	-	vfr	so/po

Texture: s-sand, ls- loamy sandy, sl- sandy loam, sil- silt loam, scl - sandy clay loam; cl-clay loam, c-clay.
Structure: Size (S) - vf - very fine, f - fine, m - medium, c - coarse; Grade (G) - 0 - structure less, 1- weak, 2 - moderate, 3 - strong; Type (T) cr - crumb, sg - single grain, abk - angular blocky, sbk - sub-angular blocky; *Consistence*: Dry: s - soft, 1- loose, sh - slightly hard, h - hard; Moist: 1- loose, vfr- very friable, fr - friable, fi - firm, vfi - very firm; Wet: so - non-sticky, ss - slightly sticky, ms - moderately sticky, vs - very sticky; po - non-plastic, ps - slightly plastic, mp - moderately plastic, vp - very plastic

dark gray (10YR 3/1) and dark grayish brown (10YR 4/2), whereas subsoils were reddish-brown to dark red in P2, others were brown (7.5YR 4/3) and black (10YR 2/1). Reddish colour (P2) was attributed to the differential degrees of erosion, lesser content of organic matter and iron oxide content (Patil and Dasog, 1999) and intense leaching of bases resulting in sesquioxides at the surface. The dark colour of P1, P3, P4, P5 and P6 soils were due to different drainage systems, and influences of clay-humus complex and status of organic matter were responsible for colour change in deeper layers

Table 3. Physico-chemical characteristics of the coconut growing soils

Depth (cm)	pH (1:2.5) H_2O	EC (dS m^{-1})	AWC (%)	OC (%)	CEC cmol (p^+) kg^{-1}	CEC/ Clay ratio	BS	ESP (%)	$CaCO_3$ Eq
Pedon 1: Nedungal series									
0-18	7.31	1.38	12.05	2.70	13.59	0.51	100	10.68	6.74
18-29	8.60	0.55	12.89	0.34	20.97	0.71	100	9.32	7.10
29-42	8.75	0.50	11.94	0.18	16.35	0.71	100	13.96	6.37
42-91	8.73	0.56	12.70	0.08	16.37	0.70	100	9.25	6.37
Pedon 2: Pannanthur series									
0-18	8.35	0.41	10.96	0.87	21.07	0.59	100	4.83	4.56
18-32	8.31	0.49	9.04	0.56	14.70	0.65	100	5.58	4.08
32-50	7.91	0.66	8.03	0.45	14.11	0.43	100	5.72	1.20
50-80	8.03	0.53	6.74	0.21	11.47	0.72	100	8.23	0.84
Pedon 3: Papparapatti series									
0-18	7.86	0.47	10.55	0.87	15.09	0.65	100	4.29	3.12
18-42	7.56	0.10	9.40	0.56	9.80	0.69	100	8.47	0.84
42-75	7.54	0.77	5.10	0.16	6.96	0.80	100	7.40	0.72
75-105	7.55	0.37	3.44	0.06	4.70	0.62	100	5.41	0.48
Pedon 4: Arasampatti series									
0-17	8.42	0.88	10.24	1.08	12.84	0.74	100	4.84	9.84
17-42	8.54	0.65	10.59	0.21	21.85	0.89	100	7.53	4.20
42-73	8.74	0.46	11.56	0.25	22.15	0.73	100	6.35	24.60
Pedon 5: Puliyur series									
0-19	8.01	1.64	7.84	1.49	43.12	1.02	100	15.64	5.28
19-49	8.36	1.10	11.44	0.41	43.22	0.92	100	16.24	5.28
49-75	8.87	1.04	9.92	0.35	49.20	1.00	100	21.79	6.60
75-110	9.10	1.34	18.33	0.29	51.55	0.90	100	27.67	7.20
110-158	9.19	0.53	22.39	0.29	54.00	0.93	100	33.46	5.88
Pedon 6: Kottapatti series									
0-16	8.16	0.715	12.04	0.17	13.52	0.68	100	14.23	2.88
16-38	7.85	0.495	12.67	0.23	14.70	0.67	89	8.73	0.00
38-75	7.82	0.462	12.11	0.19	13.72	0.64	77	8.79	0.00
75-102	7.92	0.350	9.89	0.21	11.96	0.72	89	9.53	0.00
102-130	8.17	0.198	7.28	0.14	5.78	0.66	91	9.14	0.00

(Rao *et al.,* 1995). The different soil colour variations were attributed to different chemical properties (Fe and Mn), minerals influences, and textural makeup of soils conditioned by slope position and water movement (Walia and Rao, 1997; Somasundaram *et al.,* 2010). The texture of the soils varied from sandy to clay. This might be due to different combinations of weathering process and soil-forming factors (climate, parent material, topography, biota and vegetation) and processes caused at different times (Srinivasan *et al.,* 2016). The structure of soils was subangular blocky to crumb type. Different blocky structure formation is due to different clay content (Sharma *et al.,* 2004). The dry consistency varied from soft to slightly hard, moist consistency varied from friable to very friable and wet consistency varied from non-sticky/ plastic to very sticky to very plastic. The presence of various structures and consistency of the soils is because of influences of clay fraction and clay

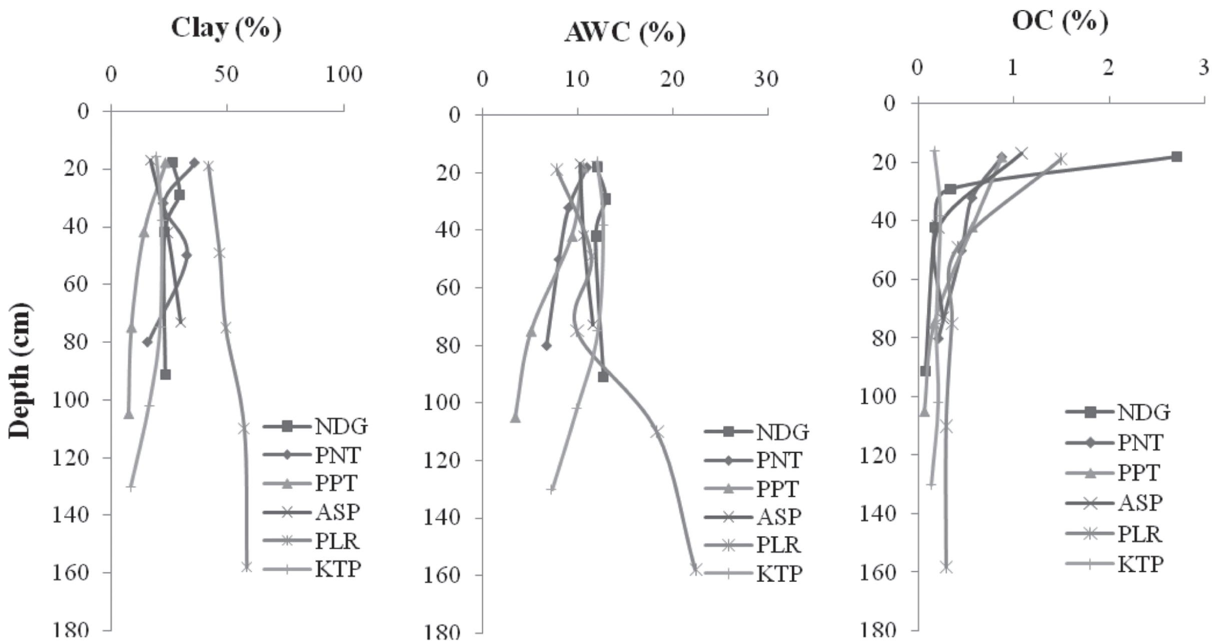

Fig. 2. Depth wise distribution of clay, AWC and OC contents

minerals (Thangasamy *et al*., 2005). Soil structure was better in all the coconut growing soils except the lower layer of P3, which are better aggregated due to higher organic carbon and relatively lower compaction.

Physical characteristics

The comprehensive soil physical properties are given in Tables 2 and 3. Particle-size distribution data revealed that the clay content varied from 7.57 to 58.26 per cent. Higher clay content was observed in subsoils of P5 and P1. Silt content in all the pedons showed irregular tendency with different depth, except P2 and P3, which might be due to variation of soil-forming process and action of different weathering process and highest silt content was recorded in P6 and P4 soils, which may be due to higher water fluctuations from different sources (canal, river and well) at different intervals (Srinivasan *et al.,* 2015). Sand distribution was maximum in P3 and P6 soils, ranging from 34.68 to 89.06 per cent sand contributing maximum in texture classes, which could be attributed to the siliceous nature of granite-gneiss parent material. Sandy soils exhibit limitations to coconut production due to poor nutrient retention and water holding capacity, limiting moisture availability to the palm (Arachchi and Somasiri, 1997). These soils have to be properly managed to improve coconut production. Water holding capacity (WHC) of different pedons varied from 3.44 to 22.39 per cent. These variations were due to the difference in depth, clay, silt and organic carbon content. Low WHC in coarse texture (P2 and P3) soils was due to high sand content. The irregular trend of WHC with depth was due to the clay and water movement from the surface to different lower horizons (Fig. 2). Pedons 5, 1 and 6 have a higher water holding capacity in the sub-surface horizon than in surface horizons, which might be due to excess clay content and organic matter in the soils (Satish *et al.,* 2018).

Chemical characteristics

All the series were neutral to moderately alkaline, with pH varying from 7.31 to 9.19. This extensive variation was attributed to the nature of the parent material, leaching, presence of $CaCO_3$ and exchangeable Na. Higher pH in soils of P4 and P5 were attributed to alkaline hydrolysis of carbonates and bicarbonates in the presence of a high amount of exchangeable Na (Srinivasan *et al.,* 2019). The presence of exchangeable bases brought by runoff water in surface horizons to subsurface and alternate wet and dry situations results in the

Table 4. Classification of major coconut growing soils in the study area

Pedons	Series	Soil taxonomy				
		Order	Sub order	Great group	Sub group	Family
P1	Nedungal	Inceptisols	Aquepts	Endoaquepts	Typic Endoaquepts	Fine-loamy
P2	Pannanthur	Alfisols	Ustalfs	Rhodustalfs	Typic Rhodustalfs	Fine-loamy
P3	Papparapatti	Entisols	Orthents	Ustorthents	Typic Ustorthents	Sandy
P4	Arasampatti	Inceptisols	Ustepts	Calciustepts	Aquic Calciustepts	Fine-loamy
P5	Puliyur	Vertisols	Aquerts	Natraquerts	Typic Natraquerts	Fine
P6	Selakuttapatti	Inceptisols	Ustepts	Haplustepts	Fluventic Haplustepts	Fine-silty

deposition of soluble salts in surface soils (Ram *et al.,* 2010). All the soil series had shown low EC values varying from 0.10 to 1.64 dS m^{-1}, indicating non-saline nature. The low EC may be due to excess water movement and frequently leaching of base cations by percolating water. This could also indicate the low status of cations and anions, which are important in coconut nutrition (Nair *et al*., 2018).

The organic carbon content of the soils was found low to high on the surface (0.17 to 2.70%) and low to medium in subsoils (0.06 to 0.56%). Surface soils recorded higher organic carbon content than sub-surface soils due to increased litter, crop residues, and the addition of manure and fertilizers to the surface soils. Organic carbon content decreased with depth in all the pedons (Fig. 2). Brown to dark brown surface colour in all these series compared to sub-surface horizons was due to deposition of organic matter. Further, the organic C was leached to lower layers and percolating water leading to its loss from the surface soils (Leelavathi *et al*., 2009). Cation exchange capacity (CEC) and base saturation (BS) varied from 4.70 to 54.0 cmol (p^+) kg^{-1} and 77 to 100 per cent, respectively, which corresponded to the clay content, organic C content and also type of clay mineral present in the different horizons of soils. The higher base saturation observed in almost all pedons might be due to the higher amount of Ca^{2+} occupying exchange sites on the colloidal complex. The differences in base saturation indicate the degree of leaching (Sharma *et al.,* 2011). CEC/clay ratio varied from 0.43 to 1.02, which indicated the nature of clay minerals in different pedons. The exchangeable sodium percentage (ESP) ranged from 4.29 to 33.46 per cent, with high ESP in lower layers of P5 and P1. This may be due to the occurrence of sodium ions enriched through runoff water and parent materials. The high $CaCO_3$ may be due to the climate responsible for the pedogenic processes resulting in the depletion of Ca^{2+} ions from the soil solution in $CaCO_3$ with the concomitant increase in ESP with different depths of soils. Free $CaCO_3$ percentage ranged from 0.0 to 24.6 per cent, and the highest $CaCO_3$ content was noticed in P4 soil, which might be due to river flow accumulation and climate change effect on pedogenic processes resulting in the depletion of Ca^{2+} ions from calcite parent materials (Khanday *et al.,* 2017).

Soil classification

Based on the variation in soil development and soil characteristics, different soil series were identified, and family level classification was carried out as per the keys to soil taxonomy (Table 4). These soils were classified in the order *Entisols* (P3), *Inceptisols* (P1, P4 and P6), *Alfisols* (P2) and *Vertisols* (P5). Pedon 3, without any diagnostic horizon, was classified as *Entisols*. Pedons 1, 4 and 6 have cambic (Bw) subsurface diagnostic horizons and were classified under *Inceptisols*. The P2 series having an *argillic* horizon with *ochric* epipedon and were classified under *Alfisols*. Pedons 5 was placed under *Typic Natraquerts* at sub-group level due to the presence of sodic horizon (ESP > 15) and showed intersecting slickensides, wedge-shaped aggregates, more than 30% clay in all the horizons and cracks (2-5 cm wide) in the B horizon resulting in the development of Bss horizon, were classified under *Vertisols*. The development of different kinds of soils in a single region may be influenced by variation in climatic condition, geology, sloping position, water movement and vegetation over time (Srinivasan *et al.,* 2013).

Table 5. Evaluations and management of coconut growing soils

Pedons	Series	LCC	LIC	Major limitations	Suitable management
1.	Nedungal	IIws	4ws	Leveled low land with moderately deep, slight erosion, slow runoff, poor drainage and low soil nutrients status and high sodium content.	Adopting suitable drainage system and deep pit plantation will be more sustainable. Addition of appropriate quantity of manures and fertilizers will get more yields.
2.	Pannanthur	IIse	2sw	Very gently slope with moderately deep depth, slight erosion, medium runoff and low AWC & poor nutrients status.	Improving soil quality by addition different manures and management systems. Adopting appropriate soil and water conservation measures and nutrient management techniques.
3.	Papparapatti	IIIse	2st	Very gently slope with deep depth, slight erosion, medium runoff and low AWC & poor nutrients status.	Adopting appropriate soil and water conservation measures. Application of organic manures and adopting integrated nutrient management (INM).
4.	Arasampatti	IIs	2w	Leveled low land with moderately shallow, slow runoff, somewhat poorly drainage and low soil nutrients status and high sodium content.	Adopting suitable drainage system and deep plantation techniques. Application of optimum dose of manures and fertilizers.
5.	Puliyur	IIsw	3wt	Leveled low land with very deep, slow runoff, poor drainage and low soil nutrients status and high sodium content.	High clay rich soils should add excess organic manures and suitable drainage system. Application of different organic manures and remediation of deficient nutrients.
6.	Kottapatti	IIsw	2wt	Leveled low land with very deep depth, slight erosion, slow runoff, somewhat poorly drainage and low soil nutrients status.	Addition of excess organic measures (FYM, vermicompost, coir pith and compost etc) improving the soil quality and fruiting yield. Application of balanced fertilizer in different age of the coconut system.

Interpretative groupings

Soils were interpreted and evaluated for land capability and irrigability for coconut plantation considering climatic conditions, soil depth, texture, drainage, slope, AWC, $CaCO_3$ and exchangeable sodium percent. The categorization of soils into capability classes and subclasses were done mainly based on the number and severity of several limitations *viz.,* erosion risk (e), wetness (w), rooting zone (soils) limitations (s) and climatic limitations (c). The major coconut growing soils placed in the land capability class of II, except P3, was grouped in IIIse (Table 5). Land irrigability assessment categorized different coconut growing soils into 2 to 4 with different subclasses wetness, topography and soil limitations. Major constraints encountered for coconut cultivation are shallow depth, poor drainage, high sodium salts, low AWC and poor soil fertility. Appropriate site-specific soil and water conservation measures and the addition of organic manures and fertilizers will overcome the limitations and improve the productivity of coconut plantations in the Eastern Ghat regions.

Conclusion

Extensive low soil depth, poor drainage, low soil organic matter, high sodium level and widespread nutrient deficiencies were major limitations of coconut production in the Eastern Ghat regions. Therefore, adopting appropriate site-specific technologies will be achieving sustainable productivity. The study will help identify potential areas and yield-limiting soil parameters for the scientific cultivation of coconut and ensure sustainable production in this region.

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