

Soil resources inventory using remote sensing and GIS - A case study in Kangeyam tract, Erode district, Tamil Nadu

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Abstract : Visual interpretation of IRS 1C LISS III FCC of Kangeyam tract of Erode district, Tamil Nadu was carried out to delineate different physiography units. These physiographic units were further sub-divided based on slope classes. The sample strips were selected in each physiographic unit for developing physiography-soil relationship. Based on the morphological, physical, chemical and exchangeable properties, the soils were classified into Inceptisols, Alfisols and Entisols. The soils, in general, are very shallow to deep, poor to moderately well drained with varied colour and texture. Three land capability classes viz., IIIItwf (21%), IVtsf (10 %) and VIItsef (70 %) were identified.

Additional key words : *Soil classification, land capability*

Introduction

Remote sensing has ushered a new era by way of augmenting the efficiency of natural resource survey programmes and has become the most efficient tool for geological, geomorphological and soil resource mapping with respect to their nature, spatial distribution, potential and limitations for optimal utilization of natural resources (Sharma 2004). Soil survey information could be utilized in combination with other information such as climatic data, socio-economic profile of the farmers, etc to delineate priority areas for various land use. Keeping these factors in view, an attempt has been made to characterize and classify the soils of Kangeyam tract, district Erode, Tamil Nadu using remote sensing techniques and evaluate their land capability classes for different land use plan options.

Materials and Methods

Study area

The study area (Kangeyam taluk) lies between

77° 25' and 77° 48' E longitude and 10° 51' and 11° 8' N latitude and covers an area of 90806 ha in Erode district of Tamil Nadu. The soil temperature and moisture regimes are 'isohyperthermic' and 'ustic', respectively. The area is subjected to different degrees of erosion resulting in varied depth of soils. Sorghum and pulses are cultivated under rainfed conditions and coconut, rice and vegetables under irrigated conditions.

Remotely sensed data (IRS- 1C LISS III on 1: 50,000 scale, Date of pass 28.02.2002) was used for pre-field interpretation in conjunction with Survey of India Toposheets (1 : 50,000 scale). The physiography map was prepared by visually interpreting the False Colour Composites (FCC) based on the image characteristics. Physiographic units were further sub-divided on the basis of slope classes and the same was used for field investigation for developing physiography-soil relationship. Representative pedons of each unit were studied and soils were classified as per keys to Soil Taxonomy (Soil Survey Staff 2006). Land capability classification was done as outlined by Klingebiel and Montgomery (1961).

Results and Discussion

Soil Morphology

The morphological characteristics of the soils occurring on different landforms are given in table 1. In general, soils were very shallow to deep, poor to moderately well drained with varied colour. The variations in soil colour might be due to nature and type of soil forming process and nature of parent material (Mohekar and Challa 2000). The increase in redness with depth in soils might be due to decrease in organic matter and increase in iron oxides and also due to oxidation and reduction process (Nayak *et al.* 2002). The structure was granular in surface horizon of pedons 5, 7 and 9, while in others it was sub-angular blocky. Weak structure was observed in most of the pedons in surface horizons whereas it was medium to strong in sub-surface soil. The soil structural variations appear to be due to textural differences of these pedons (Patil and Jagdish Prasad 2004).

Physical characteristics

The data pertaining to particle-size distribution and available water holding capacity (AWHC) of soils are shown in table 1. The relatively high amount of gravel (13.3 to 65.9 %) reflects the resistance of gravels to weathering and lack of favourable environment for hydrolysis and other weathering processes (Krishnan 1997). The increase of clay content with depth in some pedons could be due to the combined effect of *in-situ* clay formation and illuviation (Kharche *et al.* 2000). The available water holding capacity (AWHC) of different pedon ranged from 3.67 to 37.07 cm³cm⁻³ (Table 1). There was positive and significant correlation of water holding capacity with clay ($r=0.65^{**}$)

Chemical Characteristics

The chemical properties of the soils are given in table 2. The soils were neutral (pH 6.6) to moderately alkaline (pH 8.3) might be due to the parent material, calcium carbonate, leaching, accumulation or loss of bases from upper layers by precipitation (Walia and Rao 1997). The electrical conductivity ranged from

0.014 to 0.19 dS m⁻¹. Organic carbon content of the soils was generally low (< 0.55) and, in general, decreased with depth might be due to retention of plant residues on the surface horizons (Saha *et al.* 2000). The cation exchange capacity varied from 9.1 to 28.6 cmol (p+) kg⁻¹ and exhibits a positive and significant correlation with clay content (0.807^{**}). Relatively low CEC was observed in pedon P 12 and P14. The exchangeable cations followed the trend of Ca⁺⁺ > Mg⁺⁺ > Na⁺ > K⁺. The base saturation percentage ranged from 94.9 to 99.1.

Soil map

Based on physiography-soil relationship, soil map of Kangeyam tract was prepared on 1:50,000 scale and depicted in figure 1. The soil map showed the association of two soil series.

Land capability classification

Three land capability classes viz., III, IV and VI have been identified in the Kangeyam tract (Fig. 2). The study indicates that more than 20.6 per cent areas is under the land capability sub-class III_{twf} indicating severe limitations of topography, wetness and soil fertility with respect to organic carbon (Table 3). About 9.6 per cent area falls under the capability sub-class of IV_{tsf} with limitations of topography, soil depth and organic carbon, erosion and wetness. The remaining area of 69.7 per cent is under sub-class VI_{tsef} with limitation of slope, soil depth, erosion, drainage and organic carbon. The soils occurring on very gentle slope had constraint of undulating topography, soil depth, low organic carbon and wetness and that of gently sloping land had constraint of moderate erosion, calcareousness and wetness. Similarly soils of gentle to moderately sloping land had problem of undulating topography, moderate erosion, soil depth, excessive drainage, surface and sub-surface stoniness/gravelliness, wetness and that of moderately sloping land had constraints of soil depth, excessive drainage, severe erosion organic carbon. The moderately steeply sloping lands had constraints of severe erosion, soil depth, surface and sub-surface stoniness/gravelliness.

Table 1. Morphological and physical characteristics of soils

Horizon	Depth (cm)	Colour (Dry)	Structure			Particle-size distribution (%)			Gravel (%)	AWHC cm ³ cm ⁻³	
			S	G	T	Sand	Silt	Clay			
1	2	3	4	5	6	7	8	9	10	11	12
Gently sloping upland: P 1 (Nattakadaiyur series)- Mixed Lithic Ustipsamments											
Ap	0- 18	10YR 5/4	f	1	sbk		83.6	7.4	9.0	13.9	4.61
C	18-30	10YR 5/2	m	1	sbk		83.8	6.0	10.2	14.4	4.29
Very gently sloping upland: P 2 (Velakaundanpalayam series)- Loamy-skeletal, mixed Lithic Ustorthents											
Ap	0-13	5YR3/4	f	1	sbk		76.6	17.4	16.0	26.1	8.28
C	13-34	5YR3/4	m	1	sbk		81.6	4.6	13.8	24.5	6.20
Nearly level plain: P 3 (Chettipalayam series)- Loamy-skeletal, mixed, Typic Ustifluvents											
Ap	0-13	10YR4/4	f	1	sbk		70.6	17.8	11.6	28.9	4.67
2C1	13-23	10YR3/6	m	1	sbk		66.2	5.6	28.2	33.5	7.60
2C2	23-57	10YR3/6	m	2	sbk		66.8	5.6	27.6	38.6	27.33
3C3	57-76	10YR3/6	m	2	sbk		66.0	11.0	23.0	33.9	10.89
3C4	76-90	10YR4/4	m	3	sbk		74.4	17.4	18.2	34.8	9.30
3C5	90-105	10YR4/2	m	3	sbk		75.0	14.0	11.0	37.7	10.62
Very gently sloping upland: P 4 (Thayampalayam series) - Loamy-skeletal, mixed, Typic Haplustepts											
Ap	0-14	7.5YR4/6	f	1	sbk		72.4	8.6	19.0	31.2	3.79
Bw	14-75	7.5YR5/6	f	1	sbk		65.4	17.4	17.4	36.5	15.17
Moderately steep sloping land: P 5 (Pannadipudur series)- Loamy-skeletal, mixed Typic Haplustepts											
Ap	0-9	10YR6/1	f	1	gr		67.2	24.2	8.2	26.9	14.40
Bwk	9-38	10YR6/3	f	1	gr		75.8	16.8	7.4	35.2	37.07
C	38-64	10YR7/4	f	1	gr		80.4	12.6	7.0	23.5	26.52
Nearly level plain: P 6 (Salapudur series)- Loamy-skeletal, mixed Typic Haplustepts											
Ap	0- 18	10YR3/4	f	1	sbk		87.8	3.6	8.6	19.8	8.06
Bw	18-39	10YR3/4	m	2	sbk		63.4	11.0	25.6	27.1	19.53
2C1	39-62	7.5YR3/4	f	1	sbk		87.6	2.6	9.8	32.9	12.07
2C2	62-92	7.5YR3/4	m	2	sbk		78.2	9.8	12.0	40.5	20.50
Moderately sloping land: P 7 (Velayudanpalayam series).-Loamy, mixed Lithic Ustorthents											
Ap	0-16	10YR4/6	f	1	gr		68.7	22.1	9.2	19.2	6.93
C	16-27	10YR4/4	f	1	sbk		82.3	10.8	6.8	32.34	3.67
Gently sloping upland: P 8 (Kangeyam series)- Sandy-skeletal, mixed Lithic Ustorthents											
Ap	0-22	10YR3/4	f	1	sbk		85.0	6.4	8.6	42.4	25.73
C	22-34	10YR4/4	f	1	sbk		82.8	8.0	9.2	65.9	12.00
Gently sloping upland: P 9 (Kambliyampatti series)- Fine-loamy, mixed Typic Haplustepts											
Ap	0-25	10YR4/4	f	1	gr		72.6	3.6	23.8	28.6	27.11
Bwk	25-58	10YR6/2	m	2	sbk		70.2	13.2	16.6	30.3	18.98
Very gently sloping upland: P 10 (Kurukathi series)- Loamy- skeletal, mixed Lithic Haplustepts											
Ap	0-14	10YR3/3	f	1	sbk		76.4	8.4	15.2	25.0	6.53
Bwk	14-28	10YR6/3	m	2	sbk		70.5	14.6	14.9	35.9	6.17

contd.

1	2	3	4	5	6	7	8	9	10	11	12
Very gently sloping upland: P 11 (Vanchipalayam series)- Coarse-loamy, mixed Typic Haplustepts											
Ap	0-19	10YR3/6	scl	f	1	sbk	49.4	26.8	23.8	18.9	13.34
Bw	19-36	10YR3/4	sl	m	2	sbk	74.8	13.4	11.8	30.0	8.59
BC	36-60	10YR4/6	ls	m	2	sbk	83.8	7.4	8.8	44.9	8.37
Very gently sloping upland: P 12 (Salaiyur series)- Loamy-skeletal, mixed Fluventic Haplustepts											
Ap	0-18	10YR3/4	ls	m	2	sbk	81.2	6.8	12.0	27.3	14.88
Bw1	18-40	10YR3/4	scl	m	2	sbk	68.8	6.8	24.4	37.9	27.84
Bw2	40-61	7.5YR3/4	scl	m	2	sbk	68.2	7.6	24.2	44.9	27.57
Bw3	61-82	7.5YR3/4	scl	m	2	sbk	66.3	9.6	24.1	41.9	28.00
Bw4	82-102	5YR3/4	scl	m	2	sbk	66.3	9.5	24.2	54.4	28.51
Bw5	102-128	5YR3/4	scl	m	2	sbk	67.6	8.3	24.1	60.9	36.69
Nearly level plain: P 13 (Dasanaickanpatti series)- Loamy-skeletal, mixed Typic Rhodustalfs											
Ap	0-15	5YR3/4	sl	f	1	sbk	70.4	11.4	18.2	23.1	7.68
Bt	15-40	2.5YR3/4	scl	m	2	sbk	67.0	8.8	24.2	25.1	11.76
BC	40-60	2.5YR3/4	sl	m	2	sbk	75.0	12.8	12.2	55.3	4.37
Nearly level plain : P 14 (Kiranur series)- Fine -loamy, mixed Typic Rhodustalfs											
AP	0-19	5YR3/4	sl	f	1	sbk	77.6	3.8	18.6	18.3	8.61
Bt	19-30	2.5YR3/6	scl	m	2	sbk	60.6	4.2	35.2	35.2	5.28
BC	30-66	2.5YR4/8	sl	m	2	sbk	75.8	10.2	14.0	31.0	8.65
Nearly level plain P: 15 (Mudalipalayam series)- Loamy-skeletal, mixed Typic Haplustalfs											
A	0-16	10YR3/4	sl	f	1	sbk	79.8	11.2	9.0	13.3	8.37
Bt	16-30	7.5YR3/4	scl	m	2	sbk	68.2	4.4	27.4	30.6	19.01
BC1	30-46	7.5YR4/4	sl	m	2	sbk	74.2	13.4	12.4	46.5	11.58
BC2	46-101	7.5YR4/6	ls	m	1	sbk	84.2	6.0	9.8	34.7	29.83
Moderately steep sloping: P 16 (Udiyur series)- Fine- loamy, mixed Typic Haplustalfs											
Ap	0-18	10YR3/4	sl	f	1	sbk	70.4	9.2	20.4	22.2	10.85
Bt	18-33	10YR4/4	scl	m	2	sbk	64.6	8.0	27.4	28.0	14.02

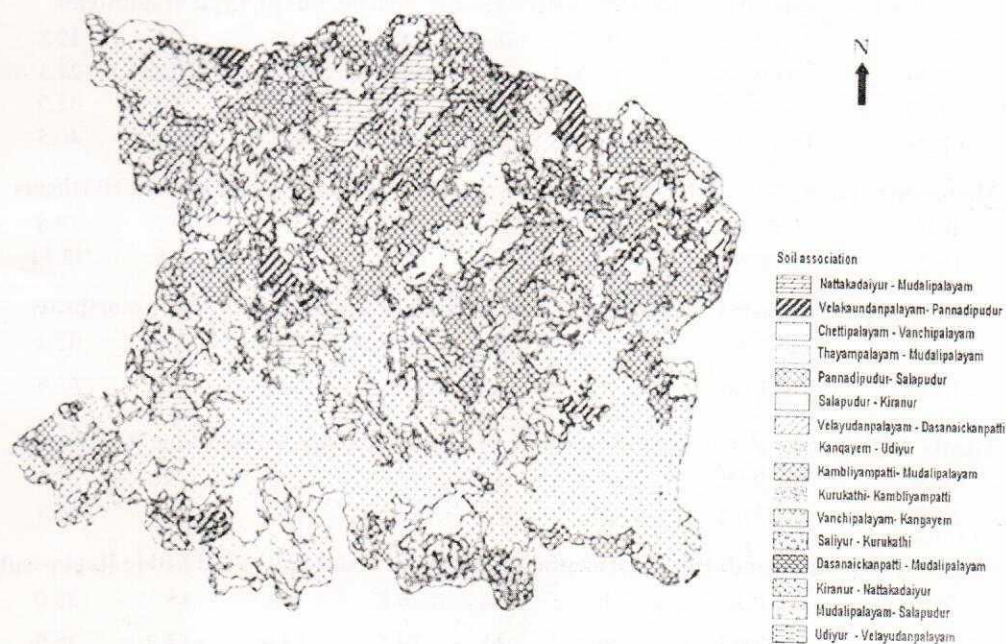


Fig. 1. Soil series association map of Kangeyam taluk

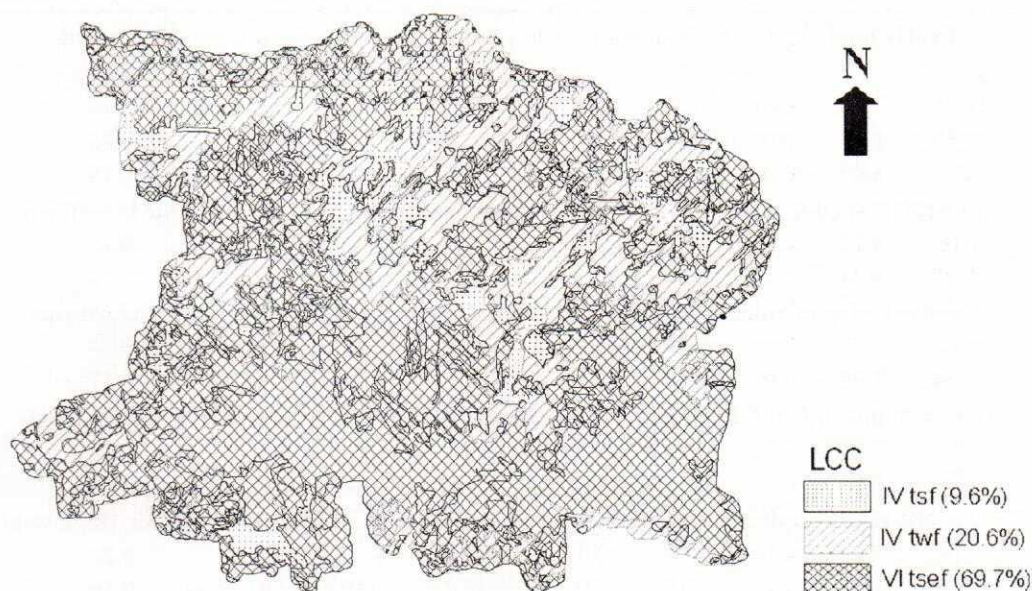


Fig. 2. Land capability classification map of Kangeyam taluk

Table 2. Chemical properties of soils

Horizon	Depth (cm)	pH	EC (dSm ⁻¹)	OC (%)	CaCO ₃ (%)	CEC cmol (p+)kg ⁻¹	Exchangeable bases cmol (p+) kg ⁻¹				Base saturation (%)
							Ca	Mg	Na	K	
1	2	3	4	5	6	7	8	9	10	11	12
Gently sloping upland: P 1 (Nattakadaiyur series)- Mixed Lithic Ustipsamments											
Ap	0-18	7.93	0.08	0.11	0.0	15.3	5.9	4.5	3.22	0.19	90.3
C	18-30	7.86	0.15	0.28	0.0	11.2	5.2	3.0	1.26	0.17	86.0
Very gently sloping upland: P 2 (Velakaundanpalayam series)- Loamy-skeletal, mixed Lithic Ustorthents											
Ap	0-13	7.23	0.15	0.43	0.00	14.9	8.3	3.5	1.61	0.14	90.9
C	13-34	7.44	0.02	0.33	0.50	11.4	6.1	2.0	1.50	0.23	86.4
Nearly level plain: P 3 (Chettipalayam series)- Loamy-skeletal, mixed Typic Ustifluvents											
Ap	0-13	8.11	0.09	0.21	2.00	12.7	8.0	1.5	0.89	0.31	84.3
2C1	13-23	8.21	0.08	0.18	2.50	23.1	14.1	5.0	0.11	0.28	84.4
2C2	23-57	8.24	0.08	0.22	2.75	20.2	13.4	1.5	1.22	0.15	80.5
3C3	57-76	8.22	0.08	0.17	3.25	21.3	13.8	4.0	1.20	0.19	90.1
3C4	76-90	8.18	0.06	0.11	3.50	13.4	8.7	1.0	1.43	0.14	84.1
3C5	90-105	8.20	0.06	0.09	3.75	13.8	8.4	1.5	1.24	0.15	81.8
Very gently sloping upland: P 4 (Thayampalayam series) - Loamy-skeletal, mixed Typic Haplustepts											
Ap	0-14	8.11	0.14	0.21	5.00	11.8	6.0	1.0	2.87	0.15	84.9
Bw	14-75	8.19	0.15	0.14	2.50	14.6	7.7	2.0	3.22	0.17	89.7
Moderately steep sloping land: P 5 (Pannadipudur series)- Loamy-skeletal, mixed Typic Haplustepts											
Ap	0-9	8.05	0.11	0.34	6.50	16.6	9.6	2.0	2.96	0.15	88.6
Bwk	9-38	8.09	0.08	0.21	7.50	14.8	8.5	2.0	2.28	0.17	87.5
C	38-64	8.18	0.11	0.14	11.50	13.4	8.0	1.0	2.41	0.19	86.6

contd.

1	2	3	4	5	6	7	8	9	10	11	12
Nearly level plain: P 6 (Salapudur series)- Loamy-skeletal, mixed Typic Haplustepts											
Ap	0-18	7.98	0.06	0.49	0.25	12.2	5.3	4.0	1.22	0.65	91.6
Bw	18-39	7.94	0.01	0.39	0.50	24.2	11.6	8.0	3.07	0.14	94.3
2C1	39-62	8.02	0.07	0.44	5.00	12.2	5.5	3.0	2.72	0.22	93.8
2C2	62-92	8.07	0.06	0.39	6.50	16.8	10.3	2.0	2.83	0.15	91.0
Moderately sloping land: P 7 (Velayudanpalayam series)-Loamy, mixed Lithic Ustorthents											
Ap	0-16	8.22	0.10	0.10	2.50	12.3	7.6	1.0	2.39	0.15	90.6
C	16-27	8.34	0.14	0.08	5.50	10.4	7.3	0.6	1.00	0.10	86.5
Gently sloping upland: P 8 (Kangayam series)- Sandy-skeletal, mixed Lithic Ustorthents											
Ap	0-22	8.03	0.04	0.21	2.25	12.9	7.5	1.5	2.46	0.24	90.7
C	22-34	7.92	0.05	0.17	5.25	11.5	7.9	1.0	1.37	0.17	90.8
Gently sloping upland: P 9 (Kambliyampatti series)- Fine-loamy, mixed Typic Haplustepts											
Ap	0-25	7.44	0.02	0.21	3.25	24.9	14.6	5.0	3.37	0.18	93.0
Bw	25-58	7.98	0.03	0.15	5.75	14.4	8.9	1.5	2.37	0.21	90.1
Very gently sloping upland: P 10 (Kurukathi series)- Loamy- skeletal, mixed Lithic Haplustepts											
Ap	0-14	7.89	0.12	0.28	1.50	12.3	7.9	1.0	1.70	0.22	88.0
Bw	14-28	7.90	0.10	0.11	5.50	15.7	10.0	2.0	2.17	0.16	91.3
Very gently sloping upland: P 11 (Vanchipalayam series)- Coarse-loamy, mixed Typic Haplustepts											
Ap	0-19	8.02	0.11	0.24	0.25	13.1	7.3	2.0	2.61	0.22	92.6
Bw	19-36	8.11	0.07	0.38	4.25	28.6	17.5	3.5	5.61	0.18	93.7
BC	36-60	8.08	0.08	0.29	6.00	15.9	10.3	1.0	2.98	0.23	91.3
Very gently sloping upland: P 12 (Salaiyur series)- Loamy-skeletal, mixed Fluventic Haplustepts											
Ap	0-18	7.72	0.19	0.34	5.25	11.0	7.9	1.0	0.52	0.18	87.3
Bw1	18-40	7.78	0.13	0.28	5.50	19.6	11.1	4.0	2.02	0.18	88.3
Bw2	40-61	7.80	0.06	0.34	4.00	23.7	15.4	4.3	1.68	0.34	91.6
Bw3	61-82	7.80	0.08	0.32	5.00	21.5	13.7	4.0	1.5	0.26	90.5
Bw4	82-102	7.80	0.18	0.20	4.00	20.6	14.5	2.0	1.2	0.18	86.8
Bw5	102-128	7.84	0.10	0.11	5.25	20.5	15.9	1.5	0.7	0.29	89.7
Nearly level plain: P 13 (Dasanaickanpatti series)- Loamy-skeletal, mixed Typic Rhodustalfs											
Ap	0-15	6.89	0.09	0.32	3.25	13.8	7.5	4.5	0.37	0.19	91.0
Bt	15-40	7.09	0.11	0.24	3.25	24.9	17.5	5.0	0.28	0.24	92.4
B3	40-60	7.12	0.11	0.22	4.50	11.9	6.2	3.5	0.76	0.22	89.7
Nearly level plain: P 14 (Kiranur series)- Fine -loamy, mixed Typic Rhodustalfs											
AP	0-19	6.62	0.07	0.49	2.25	10.0	5.8	2.0	1.13	0.15	90.8
Bt	19-30	6.94	0.02	0.51	2.00	21.4	16.8	1.5	1.41	0.19	93.0
BC	30-66	7.00	0.01	0.60	1.50	9.1	4.0	2.5	1.17	0.19	86.4
Nearly level plain :P 15 (Mudalipalayam series)- Loamy-skeletal, mixed Typic Haplustalfs											
A	0-16	8.17	0.12	0.34	0.0	12.9	6.2	4.0	1.57	0.17	92.6
Bt	16-30	8.24	0.09	0.28	0.0	21.9	9.8	7.5	3.04	0.15	93.6
BC1	30-46	8.10	0.11	0.30	0.0	16.3	11.1	1.5	1.91	0.19	90.2
BC2	46-101	8.24	0.15	0.21	0.50	11.9	8.1	1.0	1.14	0.15	87.3
Moderately steep sloping: P 16 (Udiyur series)- Fine- loamy, mixed Typic Haplustalfs											
Ap	0-18	7.26	0.17	0.24	0.25	11.4	6.1	3.0	0.74	0.32	89.1
Bt	18-33	7.32	0.18	0.18	0.0	22.7	14.8	5.0	1.02	0.17	92.5

Table 3. Landscape and soil characteristics

Characteristics	Soil series															
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Slope (%)	3-5	1-3	0-1	1-3	10-15	0-1	5-8	3-5	3-5	1-3	1-3	1-3	0-1	0-1	0-1	15-30
Erosion	Moderate	Slight	None to very slight	Slight	Very severe	None to very slight	Very severe	Moderate	Moderate	Slight	Slight	Slight	Very slight	Very slight	Very slight	Very severe
Flooding	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Drainage	E	E	W	W	E	MW	E	W	E	W	W	MW	MW	W	MW	E
Texture/structure	ls	sl	sl	sl	sl	ls	sl	ls	sl	sl	ls	ls	sl	sl	sl	sl
Coarse fragments (%)	14.2	25.3	34.6	33.9	28.5	30.1	25.8	54.2	29.5	30.5	31.3	44.6	34.5	28.2	31.3	25.1
Soil depth (cm)	30	34	105	>75	30	92	27	34	58	28	60	128	60	66	101	64
Soil fertility characters (f)																
Apparent CEC [cmol (p+) kg ⁻¹ clay]	32.85	24.28	45.59	78.13	50.14	55.24	24.99	34.03	80.22	29.24	55.18	63.09	52.18	36.82	55.36	39.84
Base saturation (%)	88.1	88.7	84.2	87.3	87.6	92.6	88.6	90.7	91.6	89.6	92.5	89.0	91.1	90.1	90.9	90.8
Organic carbon (%)	0.43	0.70	0.44	0.85	0.71	0.89	0.58	0.34	0.82	0.45	0.76	0.63	0.71	0.88	0.84	0.54
EC (dSm ⁻¹)	0.26	0.16	0.19	0.82	0.36	0.21	0.17	0.29	0.14	0.16	0.27	0.40	0.29	0.18	0.36	0.38
Class	IV t,s,w,f	IV t,s,w,f	IV t,s,f	IV t,s,f	VI t,s,w,f	VI t,s,w,f	VI t,s,w,f	VI t,s,f	VI t,s,f	VI t,s,w,f	VI t,s,f	VI t,s,w,f	III t,w,f	III t,w,f	IV s,w,f	VI t,s,w,f

E- Excessively drained, W- Well drained, MW- Moderately well drained, ls- loamy sand, sl- sandy loam, t - topography; s - soil characters, w - wetness

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