Vol. 47, No. 3, pp 255-262, 2019
Indian Journal of Soil Conservation
Online URL : http://indianjournals.com/ijor.aspx?target=ijor:ijsc&type=home

Fertility capability classification of semi-arid upland soils of Palani block, Tamil Nadu for sustainable soil management

B. Kalaiselvi[1, *], M. Lalitha[1], S. Dharumarajan[1], R. Srinivasan[1], Rajendra Hegde[1], K.S. Anil Kumar[1] and S.K. Singh[2]

[1]*ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Bangalore - 560 024, Karnataka;* [2]*ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur - 440 033, Maharshtra.*

**Corresponding author:*
E-mail: kalaimitra15@gmail.com (B. Kalaiselvi)

ARTICLE INFO

Article history:
Received : July, 2019
Revised : November, 2019
Accepted : December, 2019

Key words:
Condition modifier
Crop productivity
Fertility capability
Soil and crop fertility
Tamil Nadu uplands

ABSTRACT

Fertility capability classification (FCC) is a technical soil classification system that focuses quantitatively on the physical and chemical properties of soils that are important towards soil fertility management. The present study is an attempt to classify soils of Palani block located leeward down of Palani hill ranges representing semi-arid region of Tamil Nadu uplands. Fifteen soils were identified at 1:10000 scale, out of which typifying pedons were analyzed and taxonomically classified. FCC classification was applied for these identified major soils. Condition modifiers in FCC system illustrate the soil fertility related constraints. The major limitations are dry soil moisture (d), gravelliness (r+), basic reaction (b), vertic clay (v), low soil organic matter (m), low nutrient retention (k), and low cation exchange capacity (e). The condition modifier d (100%) dominates in most of the soils followed by m (71%), k (50%), b (50 %), r+ (43%), and e (33%). Among the soils identified, Kk Fine *Typic Haplustalfs* (KkFTH), Kvp Coarse loamy *Typic Rhodustalfs* (KvpCTR), Ayk Fine *Vertic Haplusterts* (AykFVHrt) and AnP Coarse Loamy *Typic Haplustepts* (AnPCLTHt) soils have high soil constraints or conditional modifiers like low cation exchange capacity (e), low nutrient reserve (k), low organic carbon content (m) and gravelliness (r). Thus, FCC helps in rectifying the limitations of these different soil types by adopting appropriate management options considering the extent and severity of each limitation to achieve better soil and crop productivity of upland system.

1. INTRODUCTION

To feed the augmenting population and their demands, the food production should be increased through increasing soil productivity as the chance of increasing cultivable lands is not feasible. Simultaneously day by day, soils are being deteriorated by intensive cropping and indiscriminate use of high analysis fertilizers devoid of secondary and micro-nutrients (Kalaiselvi, 2016). In India, per capita land availability has decreased from 0.39 ha in 1951 to 0.12 ha in 2011, mainly due to increased population from 359 million in 1951 to 1.21 billion in 2011 (Ministry of Agriculture, Government of India 2012). Identification of soil limiting factors for agricultural production through capability classification enables decision makers to develop crop management strategies, such as manure and fertilizer management, appropriate soil and water conservation measures, suitable crop cultivations etc. to increase the productivity (Rahman *et al*., 2016). The need for soil surveys, land capability, land evaluation and nutrient status reports prior to crop cultivation and other agricultural land uses have been emphasized by many researchers (Dickson *et al*., 2002; Orimoloye, 2016; Lalitha *et al*., 2018). Land Resource Inventory mapping (1:10000 or larger scale) assists in planning of land use because it assesses the land resource and its potential for sustainable agricultural production. The optimal management of these resources with minimum adverse environmental impact is essential, not only for sustainable development but also for human survival (Kalaiselvi *et al*., 2017). According to Sanchez *et al*. (2003), the problem with soil taxonomy derived from soil survey is that it quantifies permanent soil parameters, most of which are located in the subsoil. Soil taxonomy ignores many dynamic parameters crucial to crop productivity, which are mostly in the topsoil where the majority of plant roots are located, both in natural and agricultural systems. To overcome this limitation, a fertility capability soil classification system (FCC) was developed to interpret soil taxonomy, and soil physical and chemical properties in a quantitative manner that is relevant to growing plants (Buol *et al*., 1975). The FCC System consists of three categorical levels; type (topsoil texture), substrata type (sub-soil texture), and 15 modifiers (Sanchez *et al*., 1982). Management of surface soil characteristics is relatively easier than manipulation of sub-surface layer properties, especially in rainfed production systems (Adhikary *et al*., 2010). Ultimately, the FCC groups the soils of similar fertility related production constraints (Jasper, 2004 and Minh, 2010). This kind of knowledge enables the farmer to make informed choices of technically feasible crops to be raised. The present study is an attempt of FCC prescribed by Sanchez *et al*. (2003) on soils of Palani block, Dindigul district, Tamil Nadu representing Tamil Nadu uplands (AESR 8.1).

2. MATERIALS AND METHODS

Study Area

The study area Palani block (Fig. 1) lies between 77°18'50" and 77°37'17"E longitudes and 10°21'18" and 10°32'27"N latitudes and has a total area of 40000 ha. The block is located in leeward down direction of Palani hill ranges and comes under Tamil Nadu uplands (AESR 8.1). The average annual rainfall is around 760 mm and the LGP ranges from 90-120 days. Since Palani is located in rain shadow area, north-east monsoon contributes more rainfall (600 mm) than south west monsoon (200 mm) (Rathod and Aruchamy, 2010). The area comes under iso-hyperthermic temperature regime. The major crops of the study area are sorghum, maize, paddy, sugarcane, coconut, guava and mango plantations, and vegetable crops like tomato, onion, drumstick, cabbage, radish, etc.

Land Resource Mapping

Detailed soil survey was conducted to generate information on different kinds and extent of land forms, land use and soil. Sentinal-2 imagery (10 m resolution) in conjunction with Survey of India toposheets (1:50000 scale) was used as base map for delineation of initial legends. Based on slope, land use and physiography, the study area is divided into different landforms *viz*., foot hills, upper pediplain and lower pediplain. It exhibits significant variability in geology and parent materials *viz*., granitic gneiss, calcic gneiss, charnockite and alluvium. Fifteen (15) soil profiles were selected representing various types of landforms and parent material for the assessment of fertility capability classification. Morphological examination of soil

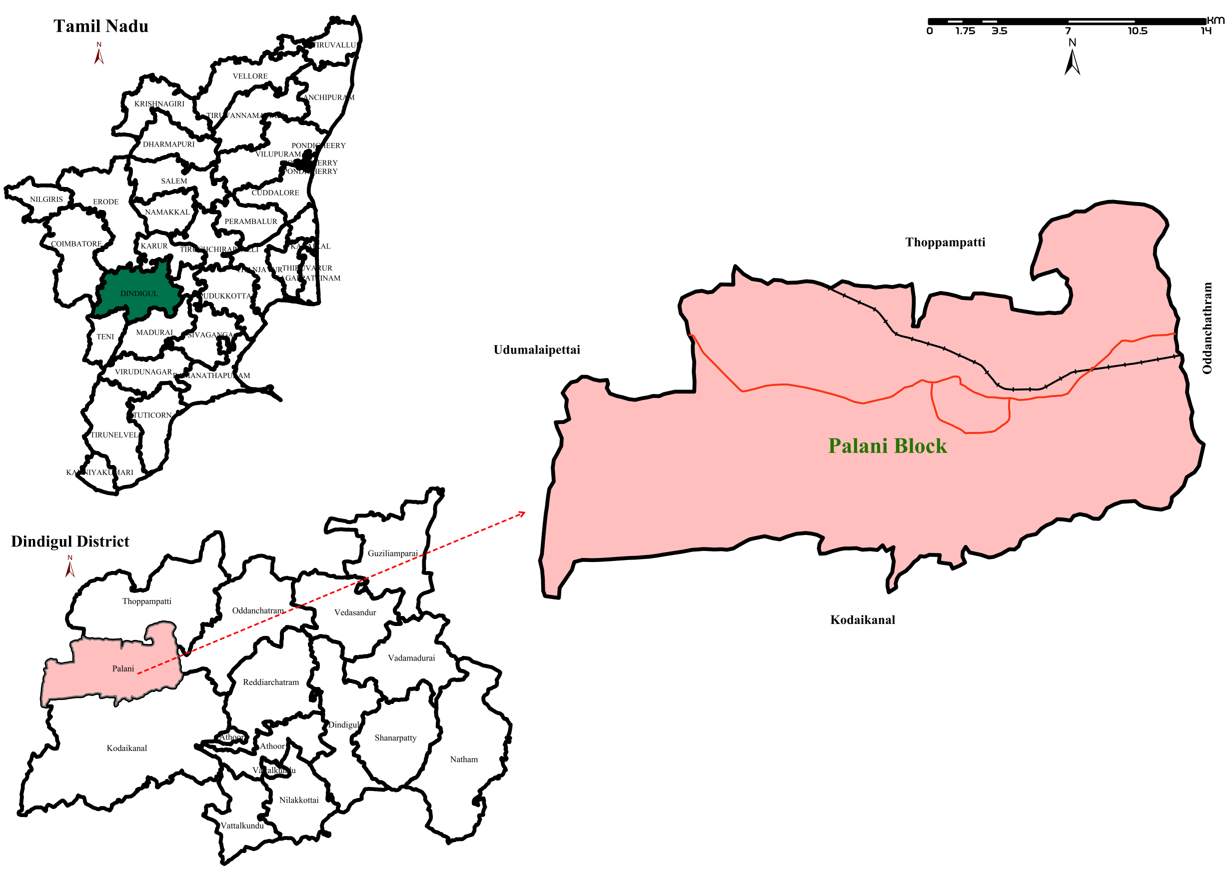

Fig. 1. Location map of Palani block, Dindigul district, Tamil Nadu

profiles was carried out in the field as per procedures laid out in the Soil Survey Manual (Soil Survey Staff, 2003[a]). Horizon-wise soil samples were collected from each typifying profiles.

Laboratory Analysis

Collected soil samples were air-dried and passed through 2 mm sieve and analyzed for particle-size distribution following International Pipette method (Richards, 1954), pH and electrical conductivity (EC) in 1:2.5 soil : water suspension (Piper, 1966). Organic carbon (OC) was estimated by Walkley and Black (1934) method. The cation exchange capacity (CEC) and exchangeable cations were determined as described by Jackson (1973). $CaCO_3$ equivalent (%) was determined by Piper method (Piper, 1966). Exchangeable sodium percentage (ESP) was estimated as the ratio of exchangeable sodium to CEC. Based on morphological, physical and physico-chemical properties, the typifying pedons were classified according to Soil Taxonomy (Soil Survey Staff, 2003[b]). Descriptive statistical analysis was done using IBM-SPSS package 20.0.

Fertility Capability Classification

FCC version 4 (Sanchez *et al*., 2003) was used to classify the soils based on surface (0-20 cm depth) and subsurface (20-50 cm depth) soil properties. The FCC system consists of three categorical levels: type, substrata type and 15 modifiers (Table 1). The first two categories *i.e.* type and sub-strata type indicate top soil and sub-soil texture, respectively. The third category *i.e.* condition modifiers were identified to indicate major soil fertility limitations/constraints. The superscripts + or – were used to express the magnitude of condition modifiers.

3. RESULTS AND DISCUSSION

Soil Properties

The typifying pedons were classified according to Soil Taxonomy (Soil Survey Staff, 2003[b]) into the orders of Alfisols, Vertisols, Inceptisols and Entisols. Taxonomical classification of the identified soil series is given in Table 2. The soils of Palani block are very shallow (0-25 cm) to very deep (>150 cm) depending on the geomorphologic positions and topography (Bhattacharyya *et al*., 2016). The particle size analysis of the soil indicated that sand is the dominant soil particle followed by clay and silt. The dominant surface soil texture is sandy loam. The descriptive statistics of the soil properties used to develop FCC are given in Table 3. The soil reaction (pH) ranged between very strongly acidic (<4.5) to strongly alkaline (8.4-9.0) depending on the parent material, leaching of bases, presence of calcium carbonate, exchangeable sodium and land management (Devi and Kumar, 2010). The soils are non-saline. OC content ranged from 0.21% to 1.64%. Some soils have the

Table: 1
Identifying criteria for fertility capability classification version 4

Identifying criteria	Symbol
Fertility capability class	
Surface soil texture (Type)	S, L, C, O
Subsurface soil texture (Substrata type)	S, L, C, O, R, R-
Identifying criteria of modifiers	
1. Aluminum toxicity (pH in 1:1 H2O < 5.0)	a
2. Basic reaction (pH in 1:1 H2O > 7.3)	b
3. Dry (soils has ustic, aridic or xeric moisture regimes)	d
4. Low cation exchange capacity (sum of bases extracted by NH4OAc <7 cmol kg^{-1})	e
5. Low K reserve (soil has weatherable minerals < 10% in silt fraction)	k
6. Natric (exchangeable sodium percentage of 15%)	n
7. Vertisols (soil has > 35% clay and more than 50% of clay is smectite)	v
8. Slope (slope limitation indicated by slope range)	%
9. Gravels by volume r+ = 10-35% (by volume), r+ +=>35% (by volume) of gravel size coarse fragments (2-25 cm in diameter) anywhere in the top 50 cm of the soil, r +++ = more than 15% rock outcroppings	r+, r++, r+++
10. < 80% total organic C saturation in the topsoil	m

Note:- S = sandy texture, L = loamy texture (<35% clay but not loamy sand and sand), C= clayey texture (>35% clay) , O = organic soil (>12% of organic carbon), R= rock or other hard root-restricting Layer, R- = as R, but layer can be ripped, plowed or blasted to increase rooting depth (Source: Sanchez et al.,2003)

Table: 2
Taxonomical classification of identified soil series

S.No.	Soil Series	Taxonomic classification
1.	RuCLTUent	Coarse loamy *Typic Ustorthents*
2.	AmCLTR	Coarse loamy *Typic Rhodustalfs*
3.	ThLTR	Loamy skeletal *Typic Rhodustalfs*
4.	ThCLTH	Coarse loamy *Typic Haplustalfs*
5.	CgpLTH	Loamy skeletal *Typic Haplustalfs*
6.	KkFTH	Fine mixed *Typic Haplustalfs*
7.	KvpCTR	Clayey skeletal *Typic Rhodustalfs*
8.	ChCLTH	Coarse Loamy *Typic Haplustalfs*
9.	AnPLTHt	Loamy skeletal *Typic Haplustepts*
10.	KkpFTHrt	Fine smectitic *Typic Haplusterts*
11.	AykFVHrt	Fine smectitic *Vertic Haplusterts*
12.	KmpFLTHt	Fine loamy Na-Saturated *Typic Haplustepts*
13.	VpCLTH	Coarse loamy *Typic Haplustalfs*
14.	AnPCLTH	Coarse loamy *Typic Haplustalfs*
15.	AnPCLTHt	*Typic Haplustepts*

calcium carbonate equivalent (7.8%) and ESP (8.2%) closer to the critical limit. CEC was found to be low (<32 cmol (+) / kg clay) except in Vertisols (>50%). High CEC of Vertisols might be due to the usual dominance of 2:1 type clay (Virmani *et al*., 1982). CEC increased in sub-surface (20-50 cm) ranging between 8.31 and 74.0 cmol (+) / kg clay substantially higher than surface (0-20 cm) ranging between 3.89 and 67.8 cmol (+) / kg clay soils, irrespective of the soil types.

Fertility Capability Classification and Management Options

The taxonomically classified soils were further classified into fertility capability units based on the prevailing fertility constraints into type, sub-strata and condition modifiers (Sanchez *et al.,* 2003). Type and substrata indicate the texture of the surface soil and textural change in sub-surface (20-50 cm), respectively. The types of soils are mostly loamy (L), sandy (S) and clay (C). While the substrata were loamy (L) and clay (c), most of the soils do not exhibit any textural change in sub-surface (20-50 cm). The condition modifiers of the soils were basic in reaction (b; pH>7.3), dry condition (d; ustic moisture regime), low CEC (e; CEC <7 cmol (p+) kg^{-1}, high P fixation by Fe and Al oxides (i; hues redder than 5YR), low nutrient capital reserve/ K deficiencies (k; exchangeable K < 0.20 cmol (p+) kg^{-1} soil), low organic carbon saturation (m; SOC < 5 g C kg^{-1} soil in top soil), ESP of 15% (n), cracking clays/vertic properties (v; >35% clay), and gravel content by volume 10–35% (r+), >35% (r++) of gravel size coarse fragments (2-25 cm in diameter) in the top 50 cm of the soil. The FCC units varied for each soil taxonomic unit in one or more soil condition modifier (Table 4). The variations might be due to the difference in slope, parent material and land management practices which influence soil properties (Rao and Jose, 2003).

The type, substrata and condition modified of the identified soils and their recommendations are given in Table 5. As a whole, soils of Palani block have constraint of soil moisture stress (d) due to uneven distribution of rainfall as it lies in the rain shadow region. Dry soil moisture regime can be effectively managed by following soil water conservation measures as well as crop water budgeting (Lalitha *et al*., 2016). Low organic carbon is the next major constraint of the soil (m) (71% of the collected samples), which might be attributed to the prevalence of tropical condition that accelerates the decomposition of organic matter, and leaves less residues in the soil (Nayak *et al*., 2002). But maintenance of quantitative and qualitative Soil Organic Carbon in the soil is critical for soil health (Lal, 2014). SOC in soil can be maintained and improved through application of different crop residues and implementation of practices (reduced tillage). The foot hill soils recorded low nutrient reserve (k) and low cation exchange capacity (e), which might be because of high leaching loss. Acidic soils of Charnockite parent material have low cation exchange capacity due to sandy texture and kaolinitic clay (Jawahar *et al*., 1999). Organic matter application is recommended to increase soil cation exchange capacity because of its high surface area and charge density, and it reacts with clay and minerals to form organo–mineral complexes (Lal, 2016). About 43% of the soils have gravelliness (r+) as a major constraint because it reduces soil water retention, nutrient storage and hinders plant growth by impeding root growth. Soils with high gravel content have high risk of soil erosion (Mustafa, 2016). Proper soil and water conservation measures like contour bunding, terracing, trench cultivation can be adopted to reduce soil loss due to erosion and reduce further increase of gravel content. Fine loamy Na-saturated *Typic Haplustepts* (KmpFLTHt) soils of calcic gneiss parent material evidenced that the potential sodic condition and accumulation of base cations due to leaching in sub-surface layer enhances the development of sub-soil sodicity with the presence of $CaCO_3$. It induces deficiency of phosphorus by forming Ca-P compounds and micronutrients (Prasad, 2000). Reclamation requires the replacement of Na^+ on the exchange complex by Ca^{2+} and leaching of Na^+ out of the root zone. Soil permeability and internal drainage must also be improved, so the displaced sodium ions can be leached out of the root zone (Minh, 2010). Soil application of gypsum may not be advocated to these sodic soils due to calcareousness, and foliar spray of micro-nutrients can be recommended to correct their deficiency (Vasu *et al.,* 2016). The soils, Fine smectitic *Typic Haplusterts* (KkpFTHrt) and Fine smectitic *Vertic Haplusterts* (AykFVHrt) recorded

Table: 3
Descriptive statistics of soil parameters used for FCC

Parameters	Surface soil (0-20 cm)						Sub-surface soil 20-50 cm					
	Average	Max	Min	SD	Skewness	Kurtosis	Average	Max	Min	SD	Skewness	Kurtosis
Sand (%)	69.78	87.55	15.01	19.39	-2.03	3.80	62.55	86.23	16.42	18.37	-1.46	1.89
Silt (%)	12.60	29.67	6.38	6.01	1.60	2.82	12.64	25.72	6.20	5.29	1.29	1.11
Clay (%)	17.62	55.31	5.24	14.11	2.12	3.89	24.81	57.86	7.57	14.21	1.47	1.50
pH	7.15	8.74	4.27	1.36	-0.83	-0.69	7.73	10.29	4.64	1.51	-0.60	-0.32
EC (dS m^{-1})	0.18	0.65	0.03	0.16	1.68	3.37	0.18	0.94	0.03	0.22	2.88	9.69
OC(%)	0.55	1.64	0.21	0.37	1.75	3.49	0.34	0.71	0.11	0.19	1.16	0.42
CEC (cmol (p+) kg^{-1})	17.24	67.82	3.89	17.12	2.08	4.33	24.49	73.99	8.31	17.28	2.00	3.97
Exch.K (cmol (p+) kg^{-1})	0.37	1.66	0.08	0.41	2.39	6.03	0.29	1.96	0.07	0.45	3.73	14.41
Exch.Na (cmol (p+) kg^{-1})	0.25	1.12	0.01	0.35	1.61	1.47	2.00	24.19	0.01	5.95	3.93	15.59
$CaCO_3$ Equivalent (%)	1.85	7.80	0.00	2.52	1.08	0.16	2.39	8.20	0.00	3.29	0.89	-1.07
ESP (%)	1.79	8.24	0.12	2.36	1.81	2.56	8.54	91.42	0.07	22.38	3.84	15.04

Table: 4
Relevant weighted average value of soil properties of identified upland soils for FCC

Pedon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Gravelliness (%)	pH	EC (dS m^{-1})	OC (%)	CEC (cmol (p+) kg^{-1})	Exchangeable bases (cmol (p+) kg^{-1})		$CaCO_3$ Equivalent (%)	ESP (%)
										K	Na		
Coarse loamy *Typic Ustorthents* (RuCLTUent)	0-20	80.71	6.38	12.91	0	5.38	0.036	0.21	5.15	0.16	0.01	0	0.23
Coarse loamy *Typic Rhodustalfs*	0-20	83.75	7.54	8.70	15	4.27	0.041	0.21	3.89	0.08	0.04	0	1.12
(AmCLTR)	20-50	66.29	10.80	22.91	18.5	4.64	0.050	0.16	8.31	0.15	0.01	0	0.07
Loamy skeletal *Typic Rhodustalfs*	0-20	83.54	8.33	8.13	27.2	5.66	0.032	0.39	3.94	0.11	0.01	0	0.12
(ThLTR)	20-50	74.44	7.92	17.64	53.3	5.74	0.025	0.21	18.68	0.14	0.05	0	0.50
Coarse loamy *Typic Haplustalfs*	0-20	72.47	12.82	14.71	14	7.95	0.099	0.31	9.95	0.51	0.03	1.08	0.34
(ThCLTH)	20-50	74.34	9.79	15.87	16.0	8.55	0.134	0.19	11.74	0.18	0.17	0.90	1.36
Loamy skeletal *Typic Haplustalfs*	0-20	67.49	16.43	16.07	46.6	7.87	0.645	1.64	22.48	1.66	1.12	4.61	8.24
(CgpLTH)	20-50	67.56	11.05	21.38	66.2	8.56	0.306	0.64	18.43	1.96	1.64	2.73	11.35
Fine mixed *Typic Haplustalfs*	0-20	72.86	9.93	17.21	0	8.35	0.167	0.82	18.38	0.28	0.43	0	3.40
(KkFTH)	20-50	74.56	9.51	15.92	0	8.65	0.182	0.23	22.59	0.13	1.54	0	9.00
Clayey skeletal *Typic Rhodustalfs*	0-20	80.97	12.63	6.40	15	5.80	0.050	0.37	3.92	0.20	0.02	0	0.26
(KvpCTR)	20-50	50.93	9.70	39.37	17	6.06	0.050	0.33	18.73	0.16	0.12	0	0.90
Coarse Loamy *Typic Haplustalfs*	0-20	75.15	10.27	14.58	0	7.73	0.230	0.37	11.35	0.24	0.07	0	0.65
(ChCLTH)	20-50	74.51	9.80	15.69	0	8.50	0.141	0.33	19.85	0.22	0.57	0	5.22
Loamy skeletal *Typic Haplustepts*	0-20	79.67	9.17	11.16	0	8.19	0.182	0.55	11.95	0.18	0.13	3.29	1.28
(AnPLTHt)	20-50	67.83	15.62	16.55	0	8.70	0.169	0.27	13.64	0.07	0.14	8.06	1.01
Fine smectitic *Typic Haplusterts*	0-20	15.01	29.67	55.31	0	7.88	0.247	0.56	47.38	1.00	0.36	3.84	0.78
(KkpFTHrt)	20-50	16.42	25.72	57.86	0	8.40	0.247	0.36	53.44	0.37	1.58	6.04	2.86
Fine smectitic *Vertic Haplusterts*	0-20	30.68	18.54	50.77	0	8.14	0.330	0.95	67.82	0.62	0.15	5.00	0.23
(AykFVHrt)	20-50	28.33	17.36	54.31	0	8.46	0.154	0.71	73.99	0.17	0.30	6.65	0.44
Fine loamy Na-Saturated *Typic Haplustepts*	0-20	63.09	19.57	17.35	0	8.74	0.260	0.54	16.16	0.22	0.78	4.00	4.84
(KmpFLTHt)	20-50	48.73	21.01	30.26	0	10.29	0.935	0.36	32.39	0.17	24.19	8.20	91.42
Coarse loamy *Typic Haplustalfs*	0-20	81.02	9.06	9.92	0	8.06	0.108	0.63	10.41	0.18	0.08	0	0.79
(VpCLTH)	20-50	86.23	6.20	7.57	0	8.66	0.076	0.31	13.49	0.15	0.18	0	2.41
Coarse loamy *Typic Haplustalfs*	0-20	75.64	9.52	14.83	0	5.36	0.078	0.30	10.42	0.16	0.03	0	0.35
(AnPCLTH)	20-50	64.95	10.31	24.74	0	5.89	0.031	0.24	13.06	0.13	0.09	0	0.73
Coarse loamy *Typic Haplustepts*	0-20	77.90	9.80	12.30	27.8	7.42	0.102	0.23	14.13	0.09	0.07	0	0.56
(AnPCLTHt)	20-50	77.38	9.08	13.54	68.3	7.21	0.025	0.11	16.02	0.07	0.02	0	0.14

Table: 5
Type, substrata and condition modifiers for fertility capability classification (FCC)

Landform	Soil series	Type/Substrata	Modifiers	Check list								Slope (%)	FCC unit	Management options / practices recommended
				b	d	e	k	m	n	r	v			
Lower Pediplain	Soil RuCLTUent	L+ R-	dekm	-	X	X	X	X	-	-	-	0-1%	L+R-dekm	• Application of K fertilizer • Application of organic amendments • Suitable irrigation method and timing for crop establishment • Annual and short rooted crops should be cultivated
	Soil AmCLTR	SL	dr+ekm	-	X	X	X	X	-	X	-	1-3%	SL dr+ekm	• Gravelliness is inherent • Application of organic substitutions can encourage water holding in sandy soils and increase CEC
	Soil KkFTH	L+	bd	X	X	-	-	-	-	-	-	1-3%	L+bd	• Unavailability of nutrients in alkaline condition can be managed through fertilizer management • Soil moisture constraint can be managed temporarily by irrigation
	Soil KvpCTR	SC	dr+emk	-	X	X	X	X	-	X	-	3-5%	SCdr+emk (3-5%)	• Impact of gravelliness can be managed by contour bunding across the slopes • Less cation exchange capacity, nutrient reserve and organic matter can be managed by application of organic and inorganic fertilizers
	Soil AnPLTHt	L+ R-	bdk	X	X	-	X	-	-	-	-	1-3%	L+R-bdk	• Split application of potassic fertilizer • Appropriate irrigation and drainage can alleviate salinity
	Soil KkpFTHrt	C+	bdvm	X	X	-	-	X	-	-	X	0-1%	C+bdvm	• Tillage is difficult when too dry and too moist • Appropriate tillage and drainage facilities can make the soil highly productive
	Soil AykFVHrt	C	bd	X	X	-	-	-	-	-	-	0-1%	Cbdv	• Suitable tillage and crop cultivation
	Soil KmpFLTHt	L	bdkmn	X	X	-	X	X	X	-	-	(0-1%)	Lbdkmn	• Low nutrient reserve due to Na-rich soil can be managed by usage of gypsum and drainage provision
Upper pediplain	Soil ThLTR	SL	dr++km	-	X	-	X	X	-	X	-	3-5%	SLdr++km (3-5%)	• Gravelliness is inherent • Application of organic amendments can encourage water holding of sandy soils
	Soil ChCLTH	L+	dm	-	X	-	-	X	-	-	-	1-3%	L+dm	• Provision of supplemental irrigation can encourage crop germination and growth
Foot hills	Soil ThCLTH	L+	bdr+m	X	X	-	-	X	-	X	-	0-1%	L+bdr+m	• Cultivation of suitable crops for gravelly nature of the soil
	Soil CgpLTH	L+	bdr++	X	X	-	-	-	-	X	-	3-5%	L+bdr++ (3-5%)	• High slope and gravel-Suitable perennial crops can be cultivated
	Soil VpCLTH	S +	bdk	X	X	-	X	-	-	-	-	0-1%	S+bdk	• Due to sandy texture, the water and nutrient holding is poor. Organic matter application and frequent irrigation can help in crop production
	Soil AnPCLTH	L+	dkm	-	X	-	X	X	-	-	-	3-5%	L+dkm (3-5%)	• Application of organic and inorganic fertilizers
	Soil AnPCLTHt	L+	dr++km	-	X	-	X	X	-	X	-	3-5%	L+dr++km (3-5%)	• Gravelliness is inherent • Contour bunding across the slope will reduce the chances of soil loss and gravelliness

high clay content (>50%) and showed vertic properties which reduces the workability when they are wet and dry (Prasad, 2000). However, the high moisture-storage capacity will also allow crops to sustain for several weeks after the rain. Palani block was differentiated into different land-forms like Hill ranges, foot hills, upper pediplain and lower pediplain based on the variation in physiography and elevational differences. The major constraints in foot hill landform is erosion and gravelliness, yet the nutrient availability is comparatively high which might be due to minimal exploitation of the land, high CEC and accumulation of leached material from the Palani hill ranges. Upper pediplain is the intermediate landform between foot hills and lower pediplain, and has gravelliness, low OC content due to higher decomposition rate in the prevalent dry climatic conditions. Lower pediplain landform has soils differentiated into entisols, inceptisols, vertisols and alfisol based on their horizon development, soil depth, clay accumulation, CEC, base saturation and organic carbon content. Compared to other landforms, lower pediplain has clay enriched soils with vertic properties. The major limitations in this landform are low K reserve in the sandy and loamy soils. Though the landforms influence the fertility capability, the land use management, cultivational activities and fertility management also alter the landform potentials. FCC can be used to prioritize the major productivity constraints related to soil fertility based on its extent and severity and it helps in finding suitable options for better management.

4. CONCLUSIONS

The study revealed that soils of the study area has major limitations of climatic condition, organic carbon, low nutrient reserve, basic conditions in particular sodicity (Kmp series) and calcareousness in lower pediplain landform. Based on the identified condition modifiers of FCC system, optimal management practices like irrigation management, addition of organic substitutes, application of appropriate fertilizers and suitable crop cultivations may be practiced to increase soil productivity and sustainability. As a whole, this study facilitates the outcome of detailed Land resource inventory to be utilized in a legible way by the farmers of the specific region.

REFERENCES

Adhikary, P.P., Biswas, H., Trivedi, S.M. and Chandrasekharan, H. 2010. Soil Fertility Capability Classification in a Semi-arid Region in Haryana with Special Reference to Soil Biological Condition Modifier. *J. Indian Soc. Soil Sci.,* 58(4): 428-435.

Bhattacharyya, R., Ghosh, B.N., Dogra , P. Mishra, P.K., Santra, P., Kumar, S., Fullen, M.A., Mandal, U.K., Anil, K.S., Lalitha, M., Sarkar, D., Mukhopadhyay, D., Das, K., Pal, M., Yadav, R., Chaudhary, V.P. and Parmar, B. 2016. Soil conservation issues in India. *Sustainability,* 8: 565.

Buol, S.W., Sanchez, P.A., Cate, Jr, R.B. and Granger, M.A. 1975. *Soil fertility capability classification.* In: Soil Management in Tropical America (ed. Bornemisza, E. and Alvardo, A.) Proceedings of seminar held at CIAT Cali Columbia, pp 126-141.

Devi, G.M.S. and Kumar, K.S.A. 2010. Characterization and classification of coffee growing soils of Karnataka. *J. Indian Soc. Soil Sci.,* 58: 25-131.

Dickson, A.A., Allison-Oguru, E.A. and Isirimah, N.O. 2002. Fertility capability classification based land evaluation in relation to socio-economic conditions of small holder farmers in Bayelsa state of Nigeria. *Indian J. Agric. Res.,* 36(1): 10-16.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 498 p.

Jasper. 2004. Using the fertility capability classification system in soil survey reports. *Soil Sur. Horiz.,* 45: 137-143.

Jawahar, D., Arunachalam, G., Velu, V. and Paramasivam, P.P. 1999. Fertility capability classification of *Theri* soils of Tamil Nadu. *J. Indian Soc. Soil Sci.,* 47(3): 570-573.

Kalaiselvi. B. 2016. Effect of TNAU customized fertilizer on sustaining soil fertility and enhancing the maize yield. *Madras Agric. J.,* 103(10-12): 320-326.

Kalaiselvi, B., Rajendra Hegde, Vasundhara, R., Dharumarajan, S. and Singh, S.K. 2017. Assessment of Land Suitability of Bilalgodu Micro-Watershed, Chikkamagaluru district, Karnataka for Optimal Agriculture Use Planning. *Int. J. Curr. Microbiol. App. Sci.,* 6(11): 1146-1155.

Lal, R. 2014. Societal value of soil carbon. *J. Soil Water Cons.,* 69: 186A-192A.

Lal, R. 2016. Soil Health and Carbon Management. *Food Ener. Secur.*, 5(4): 212-222.

Lalitha, M., Mani, S. and Sivasamy, R. 2016. Crop water budgeting for rainfed cotton for crop planning and management in Coimbatore. *J. Agrometeo.,* 18: 265-269.

Lalitha, M., Dharumarajan, S., Anil Kumar, K.S., Shivanand, Kalaiselvi, B., Arti Koyal, Parvathy, S., Rajendra Hegde and Singh, S.K. 2018. Application of fertility capability classification in Kangayam grasslands representing dry semi arid climate of Tamil Nadu. *Range Manage. Agrofor.,* 39(1): 1-7.

Minh, V.Q. and Tri, L.Q. 2010. Rice soil fertility classification and constraints in Mekong Delta. *Int. J. Environ. Rural Dev.,* 1(1): 91-97.

Ministry of Agriculture, Government of India. 2012. Agricultural statistics at a glance. New Delhi (India): Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. [cited 2012 Jul 10]. Available from:http://eands.dacnet.nic.in/latest_2006.htm.

Mustafa. A. 2016. Remote Sensing and Geographic Information System for Optimizing Land Use Base on Fertility Capability Classification. *Int. J. Plant Soil Sci.*, 12(2): 1-14

Nayak, D.C., Sarkar, D. and Das, K. 2002. Forms and distribution of pedogenic iron, aluminum and manganese in some Benchmark soils of West Bengal. *J. Indian Soc. Soil Sci.,* 50: 89-93.

Orimoloye, J.R. 2016. Fertility Capability Classification of Some Flood Plain Soils in Kogi State, Central Nigeria. *Life Sci. J.,* 13(1s).

Piper, C.S. 1966. Soil and Plant Analysis. Hans Publishers, Bombay, India.

Prasad, J. 2000. Application of Fertility Capability Classification system in soils of a watershed in semi-arid tropics. *J. Indian Soc. Soil Sci.*, 48(2): 329-338.

Rahman, M.A.E.A., Natarajan, A. and Rajendra Hegde. 2016. Assessment of land suitability and capability by integrating remote sensing and GIS for agriculture in Chamarajanagar district, Karnataka, India. *Egyptian J. Remote Sens. Space Sci.,* 19(1): 125-141.

Rao, D.V.K.N and Jose, A.I. 2003. Fertility capability classification of some soils under Rubber in Kerala. *J. Indian Soc. Soil Sci.,* 51: 183-188.

Rathod. I.M. and Aruchamy, S. 2010. Spatial Analysis of Rainfall Variation in Coimbatore District Tamil Nadu using GIS. *Int. J. Geomat. Geosci.*, 1(2):106-118.

Richards, L.A. 1954. *Diagnosis and Improvement of Saline and Alkali Soils*. USDA Handbook No. 60, Washington, USA. 159p.

Sanchez, P.A., Couto, W. and Buol, S.W. 1982. The fertility capability soil classification system: interpretation, applicability and modification. *Geoderma,* 27: 283-309.

Sanchez, P.A., Palm, C.A. and Buol, S.W. 2003. Fertility capability soil classification: A tool to help assess soil quality in the tropics. *Geoderma,* 114: 157-185.

Soil Survey Staff. 2003[a]. Soil Survey Manual. Agriculture Handbook No. 18, USDA, Washington, DC.

Soil Survey Staff. 2003[b]. Keys to Soil Taxonomy. 9th Edition, United States Department of Agriculture, Natural Resources Conservation services. Washington, DC.

Vasu, D., Singh, S.K., Karthikeyan, K. and Duraisami, V.P. 2016. Fertility Capability Classification (FCC): A case study in rainfed soils of semi-arid Deccan plateau. *Agropedology,* 26(1): 22-28.

Virmani, S., Sahrawat, M.K.L. and Burford, J. 1982. *Physical and chemical properties of vertisols and their management.* In: 12th International congress of Soil Science, India.

Walkley, A. and Black. I.A. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Sci.,* 37: 29–38.