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Soils of Thotapalli Major Irrigation Project of North-Coastal Andhra Pradesh: Characterization and Classification

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Abstract: Six representative pedons from Devarapalli (P_1), Gujjangivalasa (P_2), Patikivalasa (P_3), Gangada (P_4), Aamiti (P_5) and Maddivalasa (P_6) villages belonging to ayacut of Thotapalli major irrigation project of North-Coastal Andhra Pradesh were studied. Pedons 1, 2 and 5 were developed from granite-gneiss, while pedons 3, 4 and 6 had their parent legacy with granite-gneiss mixed with calcareous murrum. The soils of P_1 and P_2 were moderately deep to very deep having argillic horizon while cambic sub-surface diagnostic horizon was noticed in P_3, P_4 and P_5. Deep and wide surface cracks and slickensides close enough to intersect were observed in P_4 and P_6. The pedons P_1, P_2, P_3 and P_5 had sandy loam to sandy clay loam texure and it was clay loam to clay in cultivated plains (P_4 and P_6). The soils were low to medium in organic carbon content. The CEC ranged from 6.4 to 32.5 cmol (p+) kg^{-1} and the soil exchange complex was dominated by calcium followed by magnesium, sodium and potassium. The ratio of CEC/ clay was low in P_2, medium in P_1, P_3 and P_5 and high in P_4. Devararapalli pedon was classified as Typic Haplustalfs, Gujjangivalasa as Typic Haplustults, Patikivalasa and Amiti as Typic Haplustepts, Gangada as Vertic Haplustepts and Maddivalas as Chromic Haplusterts.

Keywords: *Soil characterization, classification, argillic horizon, cambic horizon, Vertisol, Inceptisol*

Introduction

The knowledge of soils with respect to their extent, distribution, characteristics and potential use are important for optimising land use. The study of soils today has assumed an increased importance due to rapidly declining land area under agriculture, declining soil fertility and increasing soil degradation through unbridled population increase, urbanisation, improper land use policies and irrational use of inputs (Kanwar 2004). It is always required to create soil database on any ayacut area of proposed irrigation project which is lacking for Srikakulam and Vizianagaram district under Thotapalli reservoir to maximise. The irrigation use efficiency for sustainable crop production and hence present investigation was carried out.

Materials and Methods

The study area comprises parts of Srikakulam and Vizianagaram districts of north coastal region of Andhra Pradesh under Thotapalli reservoir. It is located between 18°12' to 18°33' N latitude and 83°29' to 83°38' E longitude. The location map of the area and site of representative pedons is presented in figure 1. The geology of the area is granite-gneiss with calcareous murrum (Table 1). The climate is semi-arid to sub-humid monsoonic type. The mean annual temperature and rainfall were 28.34 °C, 950.8 mm and 26.48 °C, 1108.7mm in Vizianagaram and Srikakulam districts, respectively. The soil moisture is *ustic* and soil temperature regime is iso-hyperthermic. The natural vegetation in the area comprises of *Borasus*

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falabellifera, Azadirachata indica, Cocas nucifera, Palmyrah spp, Cyprus spp, Cynodon spp, Euphorbia spp, Tridax procumbens, Calotropis spp, Lucas spp. and Typha spp.

Reconnaissance soil survey was conducted in the ayacut area of Thotapalli major irrigation canal during April to June, 2018 using Survey of India toposheets of 1: 50,000 scale as per the procedure outlined by AIS&LUS (1970). Auger bores, mini pits, road cuts and 15 pedons located on uplands and plains were studied for their morphological properties. Six representative pedons were included in the present study (Table 2). Horizon-wise samples were collected and processed following standard procedures. These pedons were classified according to Soil Survey Staff (2014). Land capability classification up to subclass level was done based on limitations and potentials of soils (Klingebiel and Montgometry 1966) and land use plans were suggested.

Table 1. Soil-site characteristics of different pedons

Pedon	Profile location	Mandal	District	Slope %	Physiography	Drainage	Parent material
P_1	Devarapalli	Ranastalam	Srikakulam	1-3	Uplands	Moderate to well drained	Granite-gneiss
P_2	Gujjangi-valasa	Gurla	Vizianagaram	1-3	Uplands	well drained	Granite-gneiss
P_3	Patikava-lasa	Cheepuru-palli	Vizianagaram	1-3	Uplands	Moderate to well drained	Granite-gneiss mixed with calcareous murrum
P_4	Gangada	Balijipeta	Vizianagaram	0-1	Plains	Poorly drained	Granite-gneiss mixed with calcareous murrum
P_5	Amity	Therlam	Vizianagaram	1-3	Uplands	Moderate to well drained	Granite-gneiss
P_6	Maddiva-lasa	Vangara	Srikakulam	0-1	Plains	Poorly drained	Granite-gneiss mixed with calcarious murrum

Results and Discussion

Soil morphology

Pedon P_1, P_2 and P_6 are more than 120 cm deep while P_3 and P_4 had calcareous murrum after 90 cm. Hard gravel layer was found after 80 cm in P_5. These pedons had their colour in 10YR but in lower horizon colour was in 7.5 YR or 5YR. The Pedons P_1, P_4, P_5 and P_6 had variable texture ranging from coarse to fine with depth while P_2 and P_3 exhibited uniform texture throughout the profile. These variations are due to nature of parent material, *in situ* weathering, and translocation of clay and age of soils (Geethasireesha and Naidu 2013). Pedons P_1 and P_2 had granular structure at surface and sub-angular blocky in lower layers. Pedons P_4 and P_6 had angular blocky to blocky structure. Pedon P_3 and P_5 exhibited sub-angular blocky structure throughout the profile. The variation in structural development could be due to movement of clay and soluble material to lower layers as well as over burden pressure.

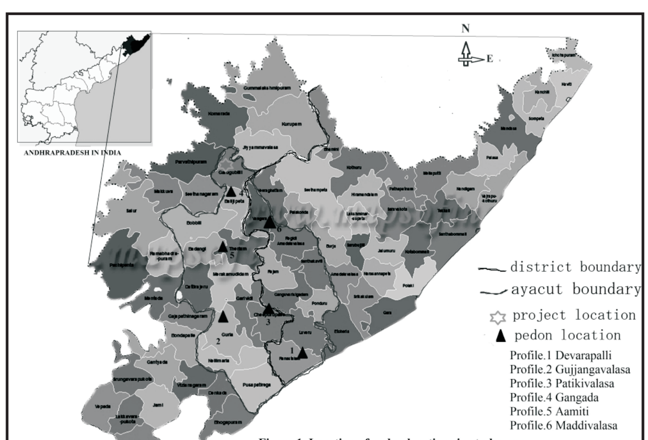

Figure 1. Location of pedon locations in study area

Table 2. The Morphological characteristics of the soils

Profile no. and horizon`	Depth (m)	Colour		Texture	Structure			Consistence			Effe rves cenc e	Pores		Conca conir	Concretions		Roots		Bou nda ry	Other features
		Dry	Moist		S	G	T	Dry	Moist	Wet		Size	Qty.		size	Qty	Size	Qty.		
1. Devarapalli (P_1)																				
Ap	0.00-0.10	7.5YR 4/3	7.5YR 4/4	sl	f	1	gr	sh	vfr	ss & ps	-	m	m	-	-	-	c	c	gw	
Bw	0.10-0.25	7.5YR 4/3	7.5YR 3/3	scl	m	1	sbk	sh	fr	ss & ps	-	f	c	-	-	-	f	c	gw	
Bt_1	0.25-0.58	7.5YR 5/4	7.5YR 4/3	scl	m	2	sbk	sh	fi	ss & ps	-	f	c	conir	-	-	f	c	dw	Continuous and thick argillians observed in subsurface horizons.
Bt_2	0.58-0.70	5YR 5/4	5YR 3/6	scl	m	2	sbk	h	fi	s & p	-	f	f	conir	-	-	f	c	dw	
Bt_3	0.70-0.90	5YR 4/6	75YR 4/6	scl	m	2	sbk	h	fi	s & p	-	f	f	conir	-	-	f	f	dw	
Bt_4	0.90-1.19+	5YR 4/6	5YR 4/6	scl	m	3	sbk	h	vfi	s & p	-	f	f	conir	-	-	-	-	-	
2. Gujjangivalasa (P_2)																				
Ap	0.00-0.10	7.5YR 5/4	7.5YR 4/4	sl	f	1	gr	l	l	so & po	-	m	c	-	-	-	c	c	gw	
Bw	0.10-0.22	7.5YR 5/4	7.5YR 5/4	sl	m	1	sbk	sh	fr	ss & ps	-	m	c	conir	F	f	f	c	gw	Patchy and thin argillans observed in subsurface horizons
Bt_1	0.22-0.40	7.5YR 4/6	7.5YR 4/3	scl	m	2	sbk	h	fi	s & p	-	f	f	conir	F	f	f	c	dw	
Bt_2	0.40-0.70	7.5YR 5/6	7.5YR 4/6	scl	m	2	sbk	h	fi	s & p	-	f	f	conir	F	f	f	c	dw	
Bt_3	0.70-0.98+	7.5YR 5/6	7.5YR 4/7	scl	m	2	sbk	h	vfi	s & p	-	f	f	conir	C	f	f	f	-	
3. Patikvalasa (P_3)																				
Ap	0.00-0.10	7.5 YR 4/3	7.5 YR 3/2	scl	m	1	rbk	sh	fr	s & p	-	c	c	-	F	f	c	c	cw	
Bw_1	0.10-0.30	7.5 YR 5/3	7.5 YR 5/4	scl	m	2	rbk	sh	fi	ss & ps	es	c	c	conca	F	f	c	c	gw	-
Bw_2	0.30-0.50	10 YR 5/3	10 YR 5/5	scl	m	2	rbk	sh	fi	s & p	es	f	f	conca	C	f	f	c	dw	
Bw_3	0.50-0.80	10 YR 5/4	10 YR 4/4	scl	m	2	rbk	h	fi	s & p	es	f	f	conca	C	f	f	f	dw	
Bw_4	0.80- 0.95+	10 YR 4/2	10 YR 3/2	scl	m	2	rbk	h	vfi	s & p	ev	f	f	conca	C	f	f	f	-	

Contd....

Profile No. and horizon`	Depth (m)	Colour		Texture	Structure			Consistence			Effervescence	Pores		Concreations			Roots		Boundary	Other features
		Dry	Moist		S	G	T	Dry	Moist	Wet		Size	Qty.	Conir conca	Size	Qty	Size	Qty.		
4. Gangada (P_4)																				
Ap	0.01-0.09	10YR 4/4	10YR 3/4	scl	m	2	sbk	h	fi	vs & vp	es	m	c		f	f	c	m	gw	
Bw_1	0.09-0.40	10YR 3/2	10YR 3/2	sc	m	3	sbk	vh	vfi	vs & vp	es	f	c	conca	c	f	f	m	gw	Surface cracks of 1.0 cm wide upto depth of 35 cm were observed. Pressure faces observed in lower horizons.
Bw_2	0.40-0.62	10YR 4/4	10YR 3/4	sc	m	3	abk	vh	vfi	vs & vp	ev	f	c	conca	c	f	f	f	dw	
Bw_3	0.62-0.82	10YR 5/4	10YR 4/4	scl	m	2	abk	vh	vfi	vs & vp	ev	f	c	conca	c	f	f	f	dw	
Bw_4	0.82-1.02+	10YR 4/4	10YR 3/5	scl	m	2	abk	vh	vfi	vs & vp	ev	f	c	conca	c	f	-	-	-	
5. Amity (P_5)																				
Ap	0.00-0.16	7.5YR 5/4	7.5YR 4/4	scl	m	2	sbk	sh	fr	ss & sp	-	m	c	-	-	-	c	m	cs	
Bw_1	0.16-0.30	7.5YR 3/2	7.5YR 2/3	scl	m	2	sbk	h	fi	ss & sp	-	m	f	conir	f	f	m	c	cw	Patchy and thin argillans observed in subsurface horizons
Bw_2	0.30-0.48	7.5YR 5/4	7.5YR 4/2	scl	m	3	sbk	h	fi	ss & sp	-	f	c	conir	c	c	f	f	dw	
Bw_3	0.48-0.70	5YR 5/5	5YR 4/3	scl	m	1	sbk	h	fi	ss & sp	-	f	c	conir	c	c	f	f	dw	
Bw_4	0.70-0.90+	5YR 5/6	5YR 4/4	sl	m	1	sbk	h	fi	ss & sp	-	f	f	conir	c	c	m	f	-	
6. Maddivalasa (P_6)																				
Ap	0.00-0.13	10YR 5/3	10YR 4/3	scl	m	2	sbk	h	fi	vs& vp	-	m	c	-	-	-	c	c	gw	Surface cracks more than 2 cm wide and extended upto more than 50 cm. Prominent intersecting slickensides and wedge shaped aggregates and pressure faces observed in lower horizons
Bw	0.13-0.32	10YR 4/5	10YR 3/3	c	m	3	abk	vh	vfi	vs & vp	-	f	c	-	-	-	c	f	gw	
Bss_1	0.32-0.55	10YR 4/3	10YR 3/3	c	m	3	abk	vh	vfi	vs & vp	-	f	f	-	-	-	c	c	dw	
Bss_2	0.55-0.74	10YR 3/2	10YR 2/3	c	m	3	abk	vh	vfi	vs & vp	-	f	f	-	-	-	c	c	dw	
Bss_3	0.74-1.15+	10YR 3/2	10YR 2/2	c	m	3	abk	vh	vfi	vs & vp	-	f	f	-	-	-	c	c	-	

Texture : sl – sandy loam; scl- sandy clay loam; cl- clay loam ; sc sandy clay ; c-clay
Structure : S-size: f- fine; m-medium; c- coarse; G-grade 1-weak ; 3- strong; T-type gr- granular; sbk-sub angular blocky; abk-angular blocky;
Consistence : Dry: l- loose, sh- slightly hard; h- hard; vh-veryhard; Moist: s-soft; fr-friable fi-firm ; vfi-very firm; Wet: sopo – non sticky& non plastic; ss sp – slightly sticky & slightly plastic; sp-sticky& plastic : vsvp-very sticky & very plastic
Effervescence : e-slight effervescence ; es-strong effervescence ev- violent effervescence
Pores and roots : S- size : vf-very fine; f-fine; m-medium; c-coarse ; Qty: vf-very few : f-few; c-common; m-many;
Boundary : c-clear ; s-smooth; d-diffuse ; g-gradual ; w-wavy

Physico-chemical properties

The clay content in the soil ranged from 12.6 to 45.2 per cent (Table 3) and increased with depth, which might be due to translocation of clay from surface to sub-surface horizons with percolating water in coarse textured soils (P_1, P_2, P_3, P_5) and intense chemical weathering in sub-surface layers of fine textured soils (P_4, P_6). These findings are in accordance with the results reported by Sreedharreddy and Naidu (2016). The sand content in different horizons of the pedons varied from 37.3 to 76.5 per cent. In general, the sand content decreased with depth except in P_3, wherein it did not follow any trend of distribution with depth. Pedon P_1, P_2, P_3 had relatively higher sand content owing to intense physical weathering. The silt content varied from 10.9 to 18.9 per cent and it showed irregular trend of distribution with depth.

Table 3. Physical and physico-chemical properties of soils

Profile No. & horizon	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	pH	E.C (dSm^{-1})	Organic carbon (%)	$CaCO_3$ (%)	CEC	Exchangeable bases				Base saturation (%)
											Ca^{2+}	Mg^{2+}	Na^+	K^+	
										cmol (p^+) kg^{-1} soil					
P_1 : Devarapalli															
Ap	0.00-0.10	4.5	62.2	18.6	19.2	6.23	0.13	0.534	-	13.50	3.96	1.02	0.28	0.04	39.26
Bw	0.10-0.25	3.1	58.0	17.5	24.5	6.61	0.17	0.301	-	15.40	5.85	0.67	0.35	0.07	45.06
Bt1	0.25-0.58	4.0	53.5	17.5	29.0	7.34	0.17	0.231	-	17.00	6.01	1.05	0.63	0.11	45.88
Bt2	0.58-0.70	2.3	56.0	16.0	28.0	7.41	0.21	0.215	-	15.40	5.90	1.00	0.24	0.09	46.95
Bt3	0.70-0.90	2.3	60.5	15.5	24.0	7.35	0.23	0.220	-	14.20	5.76	0.52	0.22	0.08	46.34
Bt4	0.90-1.19+	3.0	58.0	17.0	25.0	7.48	0.23	0.205	-	14.20	5.72	0.60	0.21	0.10	46.69
P_2 : Gujjangivalasa															
Ap	0.00-0.10	5.0	76.5	10.9	12.6	4.87	0.11	0.376	-	6.40	0.88	0.22	0.10	0.06	23.33
A2	0.10-0.22	5.1	68.0	14.8	17.2	5.43	0.13	0.256	-	7.10	1.25	0.36	0.13	0.08	25.63
Bt1	0.22-0.40	6.9	69.1	10.4	20.5	5.51	0.15	0.250	-	9.63	1.75	0.45	0.11	0.05	24.51
Bt2	0.40-0.70	6.9	67.8	11.0	21.2	5.96	0.20	0.135	-	8.15	1.57	0.42	0.10	0.06	26.38
Bt3	0.70-0.98+	19.1	68.0	11.5	20.5	5.50	0.26	0.123	-	8.15	1.72	0.48	0.14	0.05	29.33
P_3 : Patikavalasa															
Ap	0.00-0.10	5.43	61.3	14.4	24.3	7.23	0.19	0.330	1.3	15.30	8.35	1.05	0.25	0.10	63.73
Bw1	0.10-0.30	5.64	60.5	13.0	26.5	7.48	0.20	0.226	3.4	17.20	8.86	1.01	0.72	0.12	62.27
Bw2	0.30-0.50	5.13	58.2	16.1	25.7	7.54	0.22	0.196	3.0	14.20	7.36	1.31	0.28	0.09	63.66
Bw3	0.50-0.80	6.01	59.9	13.6	26.5	7.91	0.23	0.180	7.0	11.70	6.90	1.22	0.33	0.06	72.74
Bw4	0.80-0.95+	8.03	63.2	12.5	24.3	8.28	0.31	0.135	9.5	13.50	8.23	1.38	0.41	0.03	74.44
P_4 : Gangada															
Ap	0.00-0.09	5.1	55.2	15.8	29.1	7.88	0.39	0.450	3.15	27.35	20.80	2.18	0.71	0.13	87.09
Bw1	0.09-0.40	5.6	51.0	14.1	34.9	8.04	0.43	0.316	6.30	31.80	24.70	2.24	0.80	0.11	87.58
Bw2	0.40-0.62	6.3	48.1	15.0	36.9	8.26	0.44	0.291	7.10	29.50	20.30	3.82	1.17	0.09	86.03
Bw3	0.62-0.82	7.1	53.4	13.2	33.4	8.50	0.47	0.253	9.8	30.10	20.20	3.50	1.19	0.13	83.12
Bw4	0.82-.02+	21.5	54.3	14.1	31.6	8.71	0.58	0.213	13.8	28.80	20.50	3.61	1.18	0.15	88.33
P_5 : Amiti															
Ap	0.00-0.16	5.1	65.3	13.7	21.0	6.53	0.24	0.520		16.80	4.83	1.12	0.35	0.14	38.33
A2	0.16-0.30	5.6	63.2	13.6	23.2	7.20	0.26	0.376	-	14.90	4.83	1.61	0.32	0.17	44.60
Bw2	0.30-0.48	6.3	58.1	16.6	25.3	7.61	0.31	0.226	-	14.90	4.10	1.50	0.48	0.09	42.40
Bw3	0.48-0.70	7.1	56.4	18.4	25.2	7.14	0.39	0.110	1.1	16.10	4.10	1.80	0.52	0.08	40.37
Bw4	0.70-0.90+	26.3	61.4	15.0	23.6	7.10	0.45	0.110	1.35	15.25	4.28	1.48	0.16	0.02	39.61
P_6 : Maddivalasa															
Ap	0.00-0.13	0.8	43.0	18.9	38.1	7.80	0.48	0.619	-	29.10	18.90	2.18	0.50	0.10	74.50
Bw	0.13-0.32	0.8	41.5	17.0	41.5	8.16	0.56	0.302	1.1	32.50	20.10	3.04	1.32	0.18	75.82
Bss1	0.32-0.55	0.4	39.0	17.0	44.0	8.12	0.45	0.231	1.1	32.50	20.00	3.35	1.25	0.12	76.06
Bss2	0.55-0.74	0.5	39.0	18.9	42.1	8.04	0.53	0.110	1.5	28.90	19.80	3.25	1.15	0.12	84.15
Bss3	0.74-1.15+	1.1	37.3	17.5	45.2	7.91	0.60	0.110	2.9	31.10	21.60	3.46	1.05	0.10	84.28

Pedons P_3, P_4, P_6 were slightly alkaline to alkaline; P_2 had acid pH while P_1 and P_5 were neutral. The pH of these pedons increased with depth which could be due to continuous removal of basic cations by crop plants and/or leaching of basic cations to deeper layers along with percolating water and as release of organic acids in surface layers during decomposition of organic matter. The pH of P3, P_4 and P_6 are in consonance with $CaCO_3$ Content (Visalakshidevi *et al*. 2015). These pedons were non-saline. The organic carbon in different horizons of the pedons ranged from 0.11 to 0.62 per cent and decreased with depth, which could be due to enriched surface horizon with crop residue, left over roots mass and farm yard manure application. Calcium carbonate ranged from 1.3 to 9.5 per cent in P_3, 3.15 to 13.8 in P_4 and in general increased with depth in all the pedons. The increase in calcium carbonate content could be attributed to the leaching of bicarbonate from upper layer during rainy season and their subsequent precipitation as carbonate in the lower layer (Leelavathi *et al.* 2009). The cation exchange capacity varied from 5.40 to 32.5 cmol (p^+) kg^{-1} soil and it was irregularly distributed with depth. Pedons P_4 and P_6 recorded higher CEC due to high clay content and expanding nature of clay. The exchangeable complex of the soils was dominated by Ca^{+2}. Exchangeable sodium was relatively higher in P_4 and P_6.

Soil classification

Pedons P_3, P_4 and P_5 with cambic subsurface diagnostic horizon were classified as Inceptisols at order level and Ustepts at suborder level owing to ustic soil moisture regime. At greatgroup level these three pedons were classified as Haplustepts. At subgroup level pedon P_3 and P_5 were classified as Typic Haplustepts due to absence of lithic contact within 50 cm from surface. However, pedon P_4 was classified at subgroup level as Vertic Haplustepts due to presence of surface cracks of more than 5.0 mm wide within 125 cm and presence of wedge shaped aggregates in sub surface.

Pedon P_1 was classified as Alfisol at order level due to the presence of argillic sub-surface diagnostic horizon with more than 35 per cent base saturation. At suborder level it was placed under Ustalf owing to Ustic soil moisture regime. At greatgroup level, it was classified as Haplustalf. At subgroup level the pedon was classified as Typic Haplustalf.

Pedon P_2 was grouped to the order Ultisol because of presence of argillic sub-surface diagnostic horizon with less than 35 per cent base saturation and low active clay (low ratio of CEC/clay). At suborder level these soils were placed in Ustults due to ustic soil moisture regime. At greatgroup, this pedon was grouped as Haplustult and Typic Haplustult at sub group level with fine-loamy textural family class

Pedon P_6 was classified as Vertisol at order level because of more than 30 per cent clay, more than 25 cm thick slickenside zone with in 100 cm. At greatgroup level, the pedon was grouped as Haplusterts since it does not have properties of salic, gypsic or calcic horizon with in 100 cm depth. At sub group level it was classified as Chromic Haplustert because of the colour value moist were 4 in surface horizon. At family level the pedon was placed under fine textural family class with smectitic mineralogy.

Land capability classification

The grouping of soils into capability classes and subclasses is done mainly based on the severity of limitations *viz*., erosion risk, wetness limitation, soil limitation, slope and climate limitation. These limitations can be improved by the addition of organic manures, addition of tank silt, providing drainage facilities, soil fertility management, adopting irrigation methods *etc.*

Table 4. Land capability classification and interpretation of soils for their sustainable use

Profile No.	Land capability class	Description and present land use	Potentialities	Major limitations	Suggested land use
P_1	IIs	Good cultivable land for sustainable agriculture. Presently under cultivation irrigated rice followed by maize pulses	Good internal drainage, relatively good water and nutrient retention capacity good soil depth, neutral soil pH, suitable climate. Options for different cropping systems,	Gentle slope, moderate erosion hazard, low organic carbon status.	Suitable climate for double cropping including legume in rotation under INM Maize, groundnut, mesta, red gram, sugarcane may be grown. Erosion control measures may be adopted.
P_2	IVse	Fairly good cultivable land for sustainable agriculture. Presently under mango orchard	Good internal drainage, good soil depth, suitable climate	Coarse texture, excessive drainage, gentle slope, low CEC, low base status, low water holding capacity, low organic matter and poor nutrient status, acidic soil pH, moderate erosion .	Addition of tank silt (pond mud) is recommended, application of lime based on lime requirement value suitable soil and water management practices could be followed. Although climate suits for double cropping, agricultural crops like groundnut, maize, mesta and fruit crops like mango, guava, and cashew can be grown under specific soil and water management practices.
P_3	IIIse	Moderately good cultivable land for sustainable agriculture. Presently under rice followed by maize/ pulses	Relatively good water and nutrient retention capacity good soil depth, suitable climate, moderate internal drainage.	Gentle slope, moderate erosion, low organic carbon. Slight to moderately alkaline pH, nutrient imbalance.	Climate suitable for double cropping including legume in rotation under normal soil and water management practices. Suitable crops are sugarcane, Rice, maize can be grown under INM
P_4	IVsw	Fairly good cultivable land for sustainable agriculture. Presently under Rice followed by pulses	High CEC, high water and nutrient retention, good base saturation, suitable climate	Poor internal drainage, low organic carbon moderately alkaline pH, nutrient imbalance, wetness limitation	Addition of organic manures, green manuring soil test based fertiliser management for phosphorous and micronutrients. Double cropping involving rice –pulses or rice- maize can be adopted.
P_5	IIIs	Moderately good cultivable land for sustainable agriculture. Presently under Rice followed by maize/ pulses	Relatively good water and nutrient retention capacity, good soil depth, suitable climate, good, internal drainage.	Poor drainage, low organic matter and water holding capacity	Climate suitable for double cropping including legume in rotation with normal soil and water management practices. Suitable crops are sugarcane, Rice, maize and pulses
P_6	IVsw	Fairly good cultivable land for sustainable agriculture. Presently Rice followed by Maize is grown.	High CEC, high water and nutrient retention, Good base saturation, suitable climate	Very poor internal drainage, low organic carbon slight alkaline nutrient imbalance, wetness	Addition of organic and green manuring soil test based fertiliser management, for phosphorous and micronutrients. Double cropping involving rice –pulses or rice- maize can be grown.

Note: s- soil limitation, w- wetness limitation, e- erosion limitation.

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