

Soil-site suitability evaluation for commonly growing crops in Yerpedu mandal of Chittoor district, Andhra Pradesh

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Abstract : Seven typical pedons in Yerpedu Mandal of Chittoor district, Andhra Pradesh were evaluated for their suitability to groundnut, sorghum, maize, sugarcane, paddy and mango. The major limitations in Ultic Haplustalfs for different crops are soil texture, base saturation and organic carbon. In Typic Haplustepts and Typic Ustipsamments, the limitations are mainly due to soil texture, base saturation, pH and organic carbon whereas, soil texture, pH and organic carbon are the factors causing major limitations, in general, for all the crops in Typic Ustifluvents. The limitation levels of the land characteristics varied from crop to crop. The suitability classes can be improved if soil fertility characteristics are improved.

Additional key words : Land evaluation, soil taxonomy, limitations, potentials

Introduction

Indiscriminate use of land resources, in general, lead to their degradation and in-turn decline in productivity. They need to be used according to their capacity to satisfy the needs of its inhabitants. This can be achieved through proper investigations of land resources and their scientific evaluation. Land suitability evaluation is the process of estimating the potential of land for land use planning (Sys *et al.* 1991). Although, Satyavathi and Suryanarayan Reddy (2004) evaluated some soils of Telangana region of Andhra Pradesh for commonly growing crops but information on soil-site suitability for crops in Yerpedu mandal, in particular, and Chittoor district of Andhra Pradesh, in general, is virtually lacking and hence, an attempt has been made to evaluate the soil suitability for six major crops of the region viz. groundnut, sorghum, maize, sugarcane, paddy and mango.

Materials and Methods

Study Area

Yerpedu mandal lies in between 13°36' and 13°40' N latitude and 79° 18' and 79° 28' E longitude. The climate is semi-arid monsoonic type. The mean annual rainfall is 1204 mm of which 90 per cent is received during June to December. The mean annual temperature is 27°C with mean summer temperature of 31°C and the mean winter temperature of 27°C. The maximum temperature is in May that rises to 39°C and the minimum temperature is 25°C in the month of December. The soil moisture regime is 'ustic' and soil temperature regime is 'isohyperthermic'. The natural vegetation comprises *Tridax procumbens*, *Parthenium hysterophorus*, *Prosopis juliflora*, *Calotropis gigantea*, *Acacia auriculiformis*, *Commalina bengalensis*, *Cynodon dactylon*, *Cyprus rotundus*, *Pongamia pinnata* and *Azadirachta indica*, etc.

Table 1. Relevant characteristics of the selected pedons

Depth (cm)	Sand (2- 0.05)	Silt (0.05- 0.002)	Clay (<0.002)	CaCO ₃ (%)	CEC (cmol(p ⁺) kg ⁻¹ soil)	BS (%)	Sum of basic cations (cmol(p ⁺) kg ⁻¹ soil)	pH (1:2.5) H ₂ O	OC (g kg ⁻¹)	ECe (dSm ⁻¹)	ESP
-----% of <2 mm soil---											
P1 (Isukatagali) Fine-loamy, mixed, isohyperthermic Ultic Haplustalf											
0-20	50.2	32.5	17.3	0.5	17.4	67.5	11.2	7.1	3.0	0.08	2.9
20-53	65.3	16.3	18.4	0.5	17.0	68.0	10.8	7.1	3.9	0.09	4.5
53-70	71.4	2.1	26.5	1.0	16.9	67.3	10.9	7.6	2.9	0.10	2.6
70-104	55.3	16.2	28.5	2.5	15.9	67.6	10.2	7.8	2.1	0.16	3.2
104-150+	45.6	14.7	39.7	2.5	17.4	66.3	10.9	8.0	2.1	0.33	3.8
P2 (Pallam) Fine, kaolinitic, isohyperthermic Typic Haplustepts											
0-25	69.1	2.4	28.5	3.0	20.3	60.9	12.0	7.7	3.0	0.6	1.8
25-50	61.7	12.1	26.2	3.5	19.1	85.0	15.8	7.6	3.2	0.7	1.8
50-85	47.4	2.1	50.5	4.5	36.2	64.5	16.2	7.3	3.2	0.2	2.2
85-117	42.0	6.2	51.8	3.0	36.9	60.9	14.3	7.2	2.4	0.2	1.9
117-151	55.0	21.2	23.8	1.5	20.7	73.0	14.7	6.6	2.7	0.2	1.9
151-190+	77.7	4.4	17.9	3.5	16.9	55.6	8.9	7.8	1.1	0.2	3.1
P3 (Gudimallam) Fine-loamy, mixed, isohyperthermic Ultic Haplustalf											
0-12	84.2	8.9	6.9	0.5	20.7	42.8	8.5	6.8	2.4	0.1	1.5
12-25	79.9	12.6	7.5	2.0	20.2	47.1	9.2	7.0	1.8	0.5	1.4
25-49	73.8	11.9	14.3	2.6	18.7	52.6	9.2	7.0	1.4	0.0	3.4
49-78	61.6	15.4	23.0	3.0	22.9	46.3	9.8	6.6	1.1	0.1	3.4
78-111	67.8	8.1	24.1	4.5	23.2	51.9	11.4	6.5	1.2	0.1	2.6
111-140	59.9	26.7	13.4	4.5	17.8	52.5	9.7	6.8	0.8	0.1	3.1
P4 (Merlapak) Fine, smectitic, isohyperthermic Typic Haplustept											
0-22	66.3	25.3	8.4	3.0	16.9	67.8	10.8	7.8	4.4	0.2	3.4
22-56	52.0	4.2	43.8	3.5	20.2	79.0	15.4	8.0	3.6	0.8	2.7
56-78	58.9	4.6	36.5	12.5	23.3	81.2	18.2	8.5	2.9	0.9	3.1
78-96	64.3	2.1	33.6	9.5	26.7	61.9	15.8	8.7	2.6	0.9	2.6
96-120+	65.3	13.9	20.8	10.5	17.4	78.5	12.8	8.3	1.8	0.8	4.8
P5 (Pennagadam) Sandy, isohyperthermic Typic Ustipsamment											
0-22	77.8	4.0	18.2	4.0	16.4	46.2	7.3	8.3	3.0	0.1	1.6
22-40	93.6	2.1	4.3	4.0	11.5	43.9	4.9	8.1	2.0	0.1	1.5
40-71	92.7	2.1	7.2	3.5	10.9	40.6	4.1	8.1	1.5	0.1	3.1
71-110+	91.8	4.1	4.1	3.5	08.8	37.7	2.99	8.1	1.1	0.1	3.8
P6 (Papanaidupeta) Fine-loamy, mixed, isohyperthermic Typic Haplustept											
0-15	74.2	4.7	21.1	2.5	24.2	92.2	21.5	8.6	3.2	0.4	2.7
15-39	53.1	14.9	32.0	4.5	28.4	73.2	20.0	9.0	2.6	0.7	2.7
39-66	39.8	50.2	10.0	5.5	13.0	87.6	20.1	8.4	2.1	1.2	2.5
66-110	35.2	19.2	45.6	5.5	30.6	69.1	20.5	8.2	2.9	1.1	2.3
110-134+	42.6	2.1	55.3	5.0	37.2	60.0	21.6	8.1	1.9	1.0	2.3
P7 (Minagalapalem) Fine-loamy, mixed, isohyperthermic Typic Ustifluvent											
0-20	67.8	24.2	8.0	1.5	16.4	88.1	14.1	7.2	2.1	0.1	2.3
20-46	69.5	12.2	18.3	2.0	21.3	72.3	14.9	7.6	1.7	0.1	2.4
46-70	57.4	15.0	27.6	5.5	21.4	67.8	14.0	7.6	1.4	0.1	2.2
70-103	64.5	22.8	12.7	4.0	16.4	76.9	12.1	7.8	0.5	0.1	3.0
103-137	65.8	17.1	17.1	4.0	14.8	73.1	10.5	7.9	0.6	0.1	2.6
137-190+	61.0	26.0	13.0	3.5	13.3	79.5	10.1	7.2	0.9	0.1	3.8

Methodology

After traversing the Yerpedu mandal, seven typical pedons were studied on two landforms (plains and uplands) for their morphological characteristics following the procedure outlined in Soil Survey Staff (1951). Horizon-wise soil samples collected from the typifying pedons were analysed for their physical, physico-chemical and chemical properties following the standard procedures and classified according to Soil Taxonomy (Soil Survey Staff 1999). These pedons were evaluated for their suitability using limitation method regarding number and intensity of limitations (Sys *et al.* 1991).

The landscape and soil requirements for these crops were matched with generated data at different limitation levels: no (0), slight (1), moderate (2), severe (3), very severe (4). The number and degrees of limitations suggested the suitability class of pedon for a particular crop (Sys *et al.* 1991). The potential land suitability (Table 3) sub-classes were determined after considering the improvement measures to correct these limitations (Sys *et al.* 1991).

Results and Discussion

The relevant soil characteristics are given in table 1 and the site and weighted means of soil characteristics are given in table 2. These soils are developed from granite-gneiss and alluvial deposits. The kind and degree of limitations of the soils for the six crops are presented in table 3. The soils with no or only four slight limitations were grouped under highly suitable class (S1); the soils with more than four slight limitations, and/or with more than three moderate limitations under moderately suitability class (S2); the soil with more than three moderate limitations, and/or one or more severe limitation(s) under marginally suitable class (S3); the soils with very severe limitations which can be corrected under N1 (currently not suitable); the soils with very severe limitations which cannot be corrected were grouped under unsuitable class N2 (Sys *et al.*, 1991). This method also identifies the dominant limitations that restrict the crop growth in the sub-class symbol such as climatic (c), topographic (t), wetness (w), physical soil characteristics (s), soil fertility (f) and soil salinity/alkalinity (n). The suitability classes and sub-classes were decided by the most limiting soil characteristics (Table 3).

Table 2. Site and soil characteristics of pedons

Pedon	Land form	Wetness (w) Drainage	Soil depth (cm)	CaCO ₃ (%)	Apparent CEC (cmol (p ⁺) kg ⁻¹ clay)	BS (%)	pH (1:2.5)	OC (g kg ⁻¹)	ECe (dSm ⁻¹)	ESP
P1	upland	Mod. well drained	150+	0.50	92.4	67.3	7.1	3.2	0.1	3.4
P2	upland	Imperfectly drained	190+	3.00	92.9	65.9	7.7	3.0	0.4	1.9
P3	upland	Well drained	140	1.76	99.6	49.8	6.9	2.1	0.1	2.8
P4	Plain	Mod. well drained	120+	3.06	46.1	74.7	7.9	4.3	0.7	3.1
P5	Plain	Excessively drained	110+	4.00	84.3	41.2	8.3	2.9	0.1	2.7
P6	Plain	Imperfectly drained	134+	3.30	98.3	71.2	8.8	2.9	0.9	2.5
P7	Plain	Well drained	190+	1.60	77.7	76.3	7.3	2.0	0.1	2.5

Topography (slope) (t) : <3%

Flooding : F0 ; Climate (c) : Semi-arid monsoonic

Table 3. Limitation levels of the land characteristics and land suitability classes

Pedon	Crop	Wetness (w) Drainage	Physical soil characteristics (s)					Soil fertility characteristics (f)				Salinity / Alkalinity (n)		Actual land suitability subclass	Potential land suitability subclass
			Texture	Coarse fragments (vol. %)	Soil depth (cm)	CaCO ₃ (%)	Apparent CEC (cmol (p ⁺) kg ⁻¹ clay)	BS (%)	pH (1:2.5)	OC (g kg ⁻¹)	ECe (dSm ⁻¹)	ESP			
P1	Groundnut	0	0	0	0	0	0	0	1	2	0	0	S2f	S1	
	Sorghum	0	1	0	0	0	0	0	1	2	0	0	S2f,s	S1s	
	Maize	0	1	0	0	0	0	1	1	2	0	0	S2s,f	S1s	
	Sugarcane	0	1	0	0	0	0	1	1	2	0	0	S2f,s	S1s	
	Paddy	1	2	0	0	0	0	1	1	3	0	0	S3f,s,w	S2s,w	
	Mango	0	1	0	0	0	0	0	1	3	0	0	S3f	S1	
P2	Groundnut	0	1	0	0	0	0	0	2	2	0	0	S2s,f	S1s	
	Sorghum	0	0	0	0	0	0	0	1	2	0	0	S2f	S1	
	Maize	0	1	0	0	0	0	1	1	2	0	0	S2s,f	S1s	
	Sugarcane	0	1	0	0	0	0	1	2	2	0	0	S2s,f	S1s	
	Paddy	0	2	0	0	1	0	1	1	3	0	0	S3s,f,w	S2s,w	
	Mango	3	1	0	0	0	0	0	1	3	0	0	S3s,f	S3s	
P3	Groundnut	0	0	0	0	0	0	1	0	2	0	0	S2s,f	S1s	
	Sorghum	0	2	0	0	1	0	1	0	2	0	0	S2s,f	S2s	
	Maize	0	2	0	0	0	0	2	0	2	0	0	S2s,f	S2s	
	Sugarcane	0	2	0	0	0	0	2	0	2	0	0	S2f	S1	
	Paddy	2	4	0	0	0	0	2	0	3	0	0	N1s,w,f	-	
	Mango	1	0	0	1	0	0	1	1	3	0	0	S3s,f,w	S1s,w	
P4	Groundnut	0	0	0	0	0	0	0	2	2	0	0	S2f	S1	
	Sorghum	0	1	0	0	0	0	0	1	2	0	0	S2s,f	S1s	
	Maize	0	1	0	0	0	0	1	2	2	0	0	S2s,f	S1s	
	Sugarcane	0	1	0	1	0	0	1	2	1	0	0	S2s,f	S1s	
	Paddy	1	2	0	0	1	0	1	1	3	0	0	S3s,f,w	S2s,w	
	Mango	0	1	0	1	1	0	0	2	3	0	0	S3s,f	S1s	
P5	Groundnut	0	3	0	0	0	0	1	4	2	0	0	N2s,f	-	
	Sorghum	0	3	0	0	0	0	1	3	2	0	0	S3s,f	S3s	
	Maize	0	3	0	0	0	0	2	3	2	0	0	S3s,f	S3s	
	Sugarcane	0	4	0	1	0	0	2	3	2	0	0	N2s,f	-	
	Paddy	2	4	0	0	1	0	2	2	3	0	0	N2s,f,w	-	
	Mango	1	3	0	1	1	0	1	4	3	0	0	N2s,f,w	-	
P6	Groundnut	0	1	0	0	0	0	0	4	2	0	0	N2s,f	-	
	Sorghum	0	0	0	0	0	0	0	4	2	0	0	N2s,f	-	
	Maize	0	1	0	0	0	0	1	4	2	0	0	N2f	-	
	Sugarcane	0	1	0	0	0	0	1	4	2	0	0	N2f	-	
	Paddy	0	3	0	0	1	0	1	3	3	0	0	S3s,f	S3s	
	Mango	3	1	0	1	1	0	0	4	3	0	0	N2s,f,w	-	
P7	Groundnut	0	0	0	0	0	0	0	1	2	0	0	S2f	S1	
	Sorghum	0	2	0	0	1	0	0	1	2	0	0	S2s,f	S2s	
	Maize	0	2	0	0	0	0	1	1	2	0	0	S2f	S1	
	Sugarcane	0	2	0	0	0	0	1	1	2	0	0	S2s,f	S2s	
	Paddy	2	4	0	0	0	0	1	1	3	0	0	N2s,f	-	
	Mango	1	0	0	1	0	0	0	1	3	0	0	S3s,f	S1s	

Limitations : 0 – no slight; 1 – slight; 2 – moderate; 3 – severe; 4 – very severe

Suitability subclasses : f-soil fertility limitations; s-physical soil limitations; w-wetness limitations;
n-salinity (and/or alkalinity) limitations

Pedon P1 is moderately suitable for groundnut, sorghum, maize and sugarcane but marginally suitable for paddy and mango (Table 3). The major limitations are wetness (drainage), physical soil characteristics (texture) and soil fertility characteristics (base saturation, pH and organic carbon). Drainage is a major limiting factor for paddy cultivation because it does not allow to maintain standing water and requires irrigation at frequent intervals. For all the six crops, organic carbon is a major limiting factor and so, the organic carbon status in soils can be improved by the application of farmyard manure, green manuring and inclusion of legumes in rotation.

Pedon P2 is moderately suitable for groundnut, sorghum, maize and sugarcane and marginally suitable for paddy and mango. These soils showed limitations of wetness (drainage), physical soil characteristics (texture) and soil fertility characteristics (base saturation, pH and organic carbon). Pedon P3 is currently not suitable for paddy due to its coarse texture (sandy loam). These soils are moderately suitable for groundnut, sorghum, maize and marginally suitable for mango (Table 3). The limitations include drainage, texture, base saturation and organic carbon.

Pedon P4 is moderately suitable for groundnut, sorghum, maize and sugarcane and marginally suitable for paddy and mango. The major limitations include drainage for paddy and texture, soil depth, CaCO_3 , base saturation, pH and organic carbon for all other crops. Pedon P5 is not suitable for crops (groundnut, sugarcane, paddy and mango) due to its sandy texture, very low base saturation and poor organic carbon status. However, this soil is marginally suitable for sorghum and maize with limitations of texture, base saturation, pH and organic carbon.

Pedon P6 is permanently not suitable for growing groundnut, sorghum, maize and sugarcane due to very high pH (8.1 to 9.0) and not suitable for mango due to limitations of high pH and drainage. Pedon P7 is moderately suitable for groundnut, sorghum, maize and sugarcane but marginally suitable for mango. These soils are permanently not suitable for paddy. The major limitations are drainage, texture, soil depth,

base saturation pH and organic carbon.

The pedons P1, P2, P3 and P7 are moderately suitable for groundnut whereas the pedons P4, P5 and P6 are marginally suitable for groundnut. Satyavathi and Suryanarayan Reddy (2004) also reported that the soils of Telangana region of Andhra Pradesh are marginally to moderately suitable for growing groundnut crop. The pedons P1, P2, P3 and P5 were moderately suitable whereas the pedons P4, P6 and P7 are marginally suitable for growing sugarcane. These findings are in conformity with the findings of Naidu and Hunsigi (2001) who noticed that the soils of Mandya and Bhadravathi were moderately suitable but Jharkhandi soils were marginally suitable for growing sugarcane in Karnataka. Ashokkumar and Jagdish Prasad (2010) also reported that sodicity and hydraulic conductivity of soils limit the productivity and suitability of sugarcane in Central India.

Pedons 1,2,3,4 and 7 are moderately suitable for growing maize and sorghum but P5 is marginally suitable. The soils of P6 were permanently not suitable for growing groundnut, sorghum, maize and sugarcane due to very high pH (8.1 to 9.0). These findings are corroborated with the findings of Kadu *et al* (2003) who indicated that the alkalinity in central India causes poor hydraulic conductivity and thereby limits the growth of rice, sugarcane and groundnut. But the alkalinity can be improved by applying gypsum to replace sodium on exchange complex with calcium.

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