



## Soil-site Suitability Evaluation for Commonly Growing Crops in Vadamalapeta Mandal of Chittoor district, Andhra Pradesh

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### ABSTRACT

The soils of Vadamalapeta Mandal of Chittoor district, Andhra Pradesh were evaluated for their suitability to groundnut, rice and sugarcane crops. The major limitations in Typic Haplustalfs are pH, organic carbon, texture, soil depth and alkalinity. In Typic Ustifluvents pH, organic carbon, texture and alkalinity are the factors causing limitation for crop growth. Organic carbon, pH and texture are the limitations for the crop growth in Vertic Haplustepts and Typic Haplustepts. However, wetness, texture, pH, organic carbon and alkalinity are the major limitations for all the three crops in Typic Ustortents.

**Key words :** Land evaluation, Limitations, Potentials, Soil taxonomy.

The information on soil-site suitability to crops is believed to improve the usefulness of soil survey data. The land suitability evaluation for field crops forms a pre-requisite for land use planning (Sys *et al.*, 1991). However, each plant species requires specific soil and climatic conditions for its optimum growth. Information on soil constraints for crop growth and soil suitability for major crops in Vadamalapeta Mandal, in particular and Chittoor district, in general, is very much lacking. Keeping these facts in view, the soil survey data collected in Vadamalapeta Mandal was evaluated for suitability to commonly cultivated crops (groundnut, rice and sugarcane).

### MATERIAL AND METHODS

#### Study Area

The study area lies in between 13°34' and 13°56' N latitude and 79° 31' & 79° 52' E longitude. The climate is semi-arid, monsoonic type with distinct summer, winter and rainy seasons. The mean annual rainfall is 1257 mm of which 90 per cent was received during June to December. The mean annual temperature is 29°C with a mean summer and winter soil temperatures of 34°C and 29°C, respectively. The mean maximum temperature is in May that raises to 39°C and the mean minimum temperature is 24°C in the month of December. The soil moisture regime is ustic and soil temperature is iso-hyperthermic. The natural vegetation of the study area is *Parthenium hysterophorus*, *Lantana camera*, *Cyprus rotundus*, *Cynodon dactylon*, *Eucalyptus robusta* and *Lucas aspera*.

#### Methodology

After traversing through foot the Vadamalapeta Mandal, seven typical pedons were selected, dug and 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 analyzed for their physical, physico-chemical and chemical properties following the standard procedures and classified according to Soil Taxonomy (Soil Survey Staff, 2010). These areas are evaluated for their suitability using limitation method regarding number and intensity of limitations (Sys *et al.*, 1991) based on the field and laboratory data..

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 presented in table 1 while the site and weighted means of soil characteristics are indicated in Table 2. These soils are developed from granite-gneiss and alluvial materials. The kind and degree of limitations of the soils for the three crops are presented in table 3. The soils with no or only four slight limitations are

grouped under 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 can not be corrected are grouped under unsuitable class N2 according to Sys *et al.* (1991). This method also identifies the dominant limitation that restrict the crop growth in the sub-class symbol such as climate (c), topography (t), wetness (w), physical soil characteristics (s), soil fertility (f) and soil salinity/alkalinity (n). The suitability classes and sub-classes are derived by the most limiting soil characteristics (Table 3).

Pedon 1, which is grouped under Typic Haplustalfs is marginally suitable (S3) for rice and moderately suitable (S2) for groundnut and sugarcane. Soil fertility characteristics *viz.*, pH, alkalinity and organic carbon, physical soil characteristics like texture and soil depth are the limitations. For all three crops organic carbon is a major limiting factor. Texture (sandy clay loam) is not a limitation for groundnut while alkalinity is not a limiting factor for rice. So the organic carbon status in these soils can be improved by the application of farm yard manure, green manure and inclusion of legumes in crop rotation. Satyavathi and Suryanarayan Reddy (2004) reported that Typic Haplustalfs of Telangana region of Andhra Pradesh were moderately suitable for growing groundnut crop as they exhibited similar limitations of soil fertility and physical soil characteristics.

Pedons 2 and 3 which are grouped under Typic Ustifluvents are marginally suitable (S3) for rice and moderately suitable (S2) for groundnut and sugarcane. These soils showed limitations *viz.*, physical soil characteristics (texture), soil fertility characteristics (pH and organic carbon) and alkalinity. The texture can be improved by mixing the soil with tank silt year after year. Alkalinity can be reclaimed by applying gypsum to replace sodium on the exchange complex with calcium ions and the replaced sodium can be leached out of the root zone.

Pedon 4 which is grouped under Vertic Haplustepts is marginally suitable (S3) for the crops studied due to very severe limitation of wetness (drainage) and physical soil characteristics (texture, pH and organic carbon). The soil characteristics such as depth and fertility status are in favourable range to suit crop requirements. However, heavy

texture and improper drainage are found to be important soil related constraints in growing these crops. These results were in accordance with the findings of Satyavathi and Suryanarayan Reddy (2004) who reported that Vertic Haplustepts in Telangana region of Andhra Pradesh were marginally suitable (S3) for growing groundnut.

Pedon 5, which is grouped under Typic Ustorthents is marginally suitable (S3) for crops rice and groundnut. But the crops suffer from the constraints like wetness, texture, soil depth, pH and organic carbon. However, this soil is moderately suitable (S2) for sugarcane. The soil characteristics *viz.*, texture and neutral reaction are found to be congenial for sugarcane crop. Further, the pedon 6 also grouped under Typic Ustorthents, is marginally suitable (S3) for the crops studied due to very severe limitations of wetness (drainage), physical soil characteristics (texture, pH and organic carbon) and alkalinity. Previous studies of Kadu *et al.*, (2003) indicated that alkalinity in the soils of central India, limits the growth of crops (rice, sugarcane and groundnut) causing low availability of soil water as affected by poor hydraulic conductivity. Alkalinity can be minimised by applying gypsum to replace sodium on the exchange complex with calcium.

Though the pedons 5 and 6 were classified under Typic Ustorthents, they differ in their suitability to sugarcane *i.e.* pedon 5 is moderately suitable (S2) while pedon 6 is marginally suitable (S3) for growing sugarcane crop. This difference in suitability is mainly due to alkalinity in pedon 6. The alkalinity can be managed by addition of gypsum so as to achieve sustainable yields.

Pedon 7, which is classified under Typic Haplustalfs is moderately suitable for groundnut (S2) whereas marginally suitable (S3) for rice and sugarcane. The major limiting factors for the growth of rice and sugarcane in this soil are pH (8.42) and organic carbon. They can be improved by reducing soil pH through application of organic manures and amendments like sulphur. The other limiting factors are the texture and alkalinity.

Though the pedons 1 and 7 are classified under Typic Haplustalfs, they differ in their suitability to sugarcane crop. Pedon 1 is moderately suitable (S2) whereas pedon 7 is marginally suitable (S3) for growing sugarcane crop. The difference in suitability for growing sugarcane crop between these two pedons is higher pH (8.40) in pedon 7. Hence, the pH can be controlled by application of organic manures and sulphur. These findings were in agreement with those of Leelavathi *et al.*, (2010), who reported that Ultic Haplustalfs, Typic Haplustepts,

Table 1. Relevant soil characteristics of the pedons

Depth (cm)	Physical characteristics			CaCO <sub>3</sub> (%)	Fertility characteristics				Salinity and alkalinity		
	Mechanical composition				CEC [cmol (p+) kg <sup>-1</sup> soil]	BS (%)	Sum of basic cations [cmol (p+) kg <sup>-1</sup> soil]	pH (1:2.5 H <sub>2</sub> O)	OC (%)	ECe (dSm <sup>-1</sup> )	ESP
	Sand (2-0.05)	Silt (0.05 - 0.002)	Clay (<0.002)								
P1 Kayampeta : Fine-loamy, Kaolinitic, iso-hyperthermic, Typic Haplustalfs											
0-10	56.01	20.86	23.13	1.04	20.18	90.93	17.24	7.65	0.54	0.01	0.50
10-40	58.94	20.45	20.61	1.05	18.80	77.03	13.45	7.65	0.50	0.02	5.48
40-75	54.03	20.32	25.65	1.01	19.50	86.92	15.64	7.68	0.41	0.02	6.72
75-95	47.98	25.22	26.80	1.06	19.33	88.20	15.89	7.53	0.36	0.03	6.00
95-110	49.34	22.17	28.49	1.08	18.47	93.18	15.82	7.88	0.34	0.04	7.53
P2 Kadirimangalam: Fine-loamy, siliceous, iso-hyperthermic, Typic Ustifluvents											
0-12	60.19	19.73	20.08	1.40	25.47	88.34	21.09	7.83	0.41	0.02	5.54
12-46	48.31	22.60	29.09	1.21	24.38	85.85	19.30	7.94	0.33	0.04	6.69
46-84	46.63	22.15	31.22	1.06	23.86	89.95	19.53	7.50	0.38	0.04	8.09
84-101	67.51	17.30	15.19	0.64	17.81	84.28	13.92	7.62	0.32	0.05	6.12
101-140	79.16	14.59	6.25	0.48	15.78	79.97	11.61	7.80	0.28	0.06	6.40
140-180+	90.04	5.76	4.20	0.41	10.81	74.75	7.02	7.51	0.13	0.04	9.80
P3 Vadamalapeta: Fine-loamy, siliceous, iso-hyperthermic, Typic Ustifluvents											
0-14	66.77	21.42	11.81	1.38	15.98	75.41	11.12	6.23	0.28	0.04	5.82
14-53	75.44	16.26	8.30	0.86	14.24	73.81	9.76	6.71	0.21	0.05	5.27
53-70	88.22	6.22	5.56	0.42	6.62	84.74	4.80	7.52	0.14	0.02	12.24
70-104	49.62	43.90	6.48	0.74	15.55	87.85	12.95	7.54	0.26	0.04	4.56
104-131	24.98	50.56	24.46	0.88	18.76	76.01	13.24	7.33	0.24	0.06	5.44
131-170+	51.80	38.45	9.75	1.01	19.65	87.48	16.33	7.45	0.23	0.06	4.38
P4 Vadamala: Fine, Smectitic, iso-hyperthermic, Vertic Haplustepts											
0-15	50.05	23.39	26.56	0.85	24.98	79.58	18.74	8.08	0.60	0.10	4.56
15-70	46.12	14.61	39.27	1.36	37.90	77.23	27.48	8.58	0.56	0.12	4.72
71-100	47.25	12.41	40.34	1.61	50.71	87.14	42.42	8.87	0.45	0.15	3.49
100-123	43.52	12.62	43.86	1.84	49.68	83.41	39.83	8.84	0.38	0.17	3.24
123-158	43.47	13.14	43.39	1.42	53.32	89.37	45.64	8.75	0.33	0.18	3.77
P5 S.B.R. Puram: Fine-loamy, Smectitic, iso-hyperthermic, Typic Haplustepts											
0-15	69.19	11.57	19.24	1.26	17.40	85.23	14.11	7.33	0.51	0.04	4.71
15-35	48.36	17.46	34.18	1.18	18.02	90.57	14.95	7.08	0.43	0.06	7.60
35-55	27.79	43.99	28.22	1.34	28.76	76.29	20.96	7.01	0.36	0.09	3.41
P6 Seetharamapuram: Sandy, siliceous, iso-hyperthermic, Typic Ustorthents											
0-18	63.16	16.94	19.90	1.36	17.71	87.01	14.44	6.85	0.54	0.04	5.48
18-30	62.62	17.26	20.12	1.28	14.33	86.88	11.05	7.41	0.48	0.05	9.77
30-47	81.03	11.94	7.03	1.31	12.30	87.80	9.56	7.33	0.46	0.05	10.08
47-65	74.45	22.35	3.20	1.24	12.18	78.57	8.34	7.44	0.38	0.06	10.10
65-86	69.84	27.42	2.74	1.18	14.65	61.02	7.47	7.42	0.34	0.10	10.03
P7 Pattiputtur: Fine-loamy, Kalonitic, iso-hyperthermic, Typic Haplustalfs											
0-23	66.06	19.20	14.74	1.41	19.33	86.91	15.44	8.44	0.36	0.03	7.03
23-59	57.46	22.64	19.20	1.37	20.41	88.14	16.45	8.19	0.35	0.04	7.54
59-72	48.98	21.85	29.18	1.28	24.81	91.78	21.09	8.22	0.34	0.04	6.77
72-85	41.53	21.53	36.94	1.30	29.25	91.01	23.80	8.18	0.31	0.08	9.64
85-113	41.09	16.19	42.72	1.26	33.18	91.95	27.98	8.28	0.40	0.12	7.62

Table 2. Site and soil characteristics of pedons (weighted mean)

Pedon No.	Land form	Wetness (w) drainage	Physical soil characteristics (s)			Soil fertility characteristics (f)				Salinity and alkalinity (n)	
			Texture	Soil depth (cm)	CaCO <sub>3</sub> (%)	Apparent CEC [c mol (p+) kg <sup>-1</sup> soil]	BS(%)	pH 1:2.5	OC	ECe (dSm <sup>-1</sup> )	ESP
1	Plain	Well drained	scl	110	1.04	19.22	84.92	7.65	0.52	0.02	6.72
2	Plain	Well drained	scl	180+	1.08	24.60	79.03	7.89	0.37	0.03	8.09
3	Plain	Well drained	scl	170+	0.82	14.73	80.10	6.44	0.25	0.04	12.24
4	Plain	Imperfectly drained	sc	158	1.36	34.02	80.56	8.28	0.58	0.13	4.72
5	Gently sloping	Moderately well drained	cl	055	1.26	21.06	83.92	7.23	0.48	0.07	7.60
6	Gently sloping	Moderately well drained	sl	086	1.27	14.73	79.04	7.01	0.52	0.06	10.10
7	Plain	Well drained	scl	113	1.34	19.91	89.27	8.42	0.36	0.05	9.64

Topography (Slope) : 0-1%, 3-8%  
 Flooding : Fo

Ultic Haplustalfs, Typic Haplustepts and Typic Ustifluvents were moderately suitable (S2) for groundnut and sugarcane while Ultic Haplustalfs and Typic Haplustepts were marginally suitable (S3) for growing paddy crop in Yerpedu mandal of Chittoor district, Andhra Pradesh. Ashok Kumar and Jagdish Prasad (2010) also reported that sodicity and hydraulic conductivity of soils limit the productivity and suitability of sugarcane in central India.

In conclusion, the interpretation of soil survey data revealed that pedons 1, 2 and 3 are moderately suitable for growing sugarcane and groundnut and marginally suitable for growing rice. Pedons 4 and 6 are marginally suitable for growing groundnut, rice and sugarcane crops. Pedon 5 is moderately suitable for growing sugarcane and marginally suitable for growing ground nut and rice crops, whereas pedon 7 is moderately suitable for growing groundnut and marginally suitable for growing rice and sugarcane. The soil-site suitability for different crops (rice, sugarcane and groundnut) revealed that

shallow depth in pedons 5 and 6 and low organic carbon in all the pedons (1, 2, 3, 4, 5, 6 and 7) are the major limitations for growing these crops on these soils. By correcting the above limitations sustainable yields can be achieved in rice, sugarcane and groundnut crops.

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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) ECe (dSm <sup>-1</sup> )	Actual land suitability sub-class	Potential land suitability sub-class	
			Texture	Coarse fragments (Vol. %)	Soil depth (cm)	CaCO <sub>3</sub> (%)	Apparent CEC [cmol (p+) kg <sup>-1</sup> ]	BS (%)	pH 1:2.5	OC (g kg <sup>-1</sup> )				ESP
P1	Rice	0	2	0	0	0	0	0	0	0	0	0	S3fs	S2s
	Groundnut	0	0	0	0	0	0	0	0	0	0	0	S2f	S1
	Sugarcane	0	1	0	0	0	0	0	0	0	1	0	S2fn	S1
P2	Rice	0	2	0	0	0	0	0	0	0	0	0	S3fs	S2s
	Groundnut	0	0	0	0	0	0	0	0	0	1	0	S2fn	S1
	Sugarcane	0	1	0	0	0	0	0	0	0	1	0	S2fn	S1
P3	Rice	0	2	0	0	0	0	0	0	0	0	0	S3fn	S2
	Groundnut	0	0	0	0	0	0	0	0	0	2	0	S2fsn	S2s
	Sugarcane	0	1	0	0	0	0	0	0	0	2	0	S2fns	S1s
P4	Rice	2	2	0	0	0	0	0	0	0	0	0	S3fsn	S1sw
	Groundnut	3	1	0	0	0	0	0	0	0	0	0	S3fsw	S1sw
	Sugarcane	2	1	0	0	0	0	0	0	0	0	0	S3ffw	S1sw
P5	Rice	1	1	0	0	0	0	0	0	0	0	0	S3fsw	S1sw
	Groundnut	2	1	0	0	0	0	0	0	0	0	0	S3fsw	S2sw
	Sugarcane	1	0	0	0	0	0	0	0	0	1	0	S2fswn	S1sw
P6	Rice	1	3	0	0	0	0	0	0	0	0	0	S3fswn	S2sw
	Groundnut	2	0	0	0	0	0	0	0	0	2	0	S3fswn	S2sw
	Sugarcane	1	2	0	0	0	0	0	0	0	2	0	S3fswn	S2sw
P7	Rice	0	2	0	0	0	0	0	0	0	0	0	S3fs	S2s
	Groundnut	0	0	0	0	0	0	0	0	0	1	0	S2sn	S1s
	Sugarcane	0	1	0	0	0	0	0	0	0	1	0	S3fsn	S2s

Limitations: 0- No; 1-Slight; 2-Moderate; 3-Severe, 4-Very severe  
 Suitability classes: f-Soil fertility limitations; s-Physical soil limitations; w-Wetness limitations; n-Salinity (and / or alkalinity) limitations.

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