

**Research Article****Soil-site suitability for major crops in Renigunta mandal of Chittoor district in Andhra Pradesh**

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**Summary**

A reconnaissance soil survey was undertaken in Renigunta mandal of Chittoor district, Andhra Pradesh to evaluate the suitability of soils for paddy, groundnut, redgram, sugarcane vegetables and mango. The soil belongs to Inceptisols, Entisols and Alfisols. More than 60 per cent base saturation, texture was finer and regular decrease in organic carbon with depth in Typic Haplustepts. Organic carbon, base saturation are major limitation in Typic Ustipsamments and Typic Ustifluvents. However, organic carbon and base saturation did not show limitation in Typic Haplustalfs. In general, texture, base saturation, pH and organic carbon are the major limitation for crop growth in all the soil. The limitation level of the land characteristics varied from crop to crop. The suitability classes can be improved if the corrective limitations (soil fertility characteristics) are altered through soil amelioration measures.

**Key words :** Soil-site suitability, Renigunta mandal, Groundnut, Paddy, Sugarcane, Vegetables, Mango

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**Introduction**

Land evaluation is the ranking of soil units on the basis of their capabilities (under given circumstances including levels of management and socio-economic conditions) to provide highest returns per unit area and conserving the natural resources for future use. The land suitability evaluation for field crops forms a pre-requisite for land use planning (Sys *et al.*, 1991). Performance of any crop is largely influenced by soil-site parameters as conditional by climate and topography and management level (Sehgal, 1991). Thus, it is essential to interpret the soil-site suitability for major crops grown in the area. However, each plant species requires specific soil and climatic conditions for its optimum growth. Production oriented crop cultivation on appropriate soils (taxonomic unit) appeared to be more beneficial (Bhaskar *et al.*, 1988 and Naidu *et al.*, 1988). Information on soil site suitability for crops in Renigunta mandal in particular and Chittoor district of Andhra Pradesh in general is very much lacking. Hence, in this study an attempt has been made to evaluate the soil suitability for major crops *viz.*, for paddy, groundnut, redgram, sugarcane,

vegetables and mango on Inceptisols, Entisols and Alfisols in Renigunta mandal of Chittoor district, Andhra Pradesh.

**Resources and Research Methods****Study area :**

The study area comprising of 12,397 ha, lies in between 13° 32' and 13°53' N latitude and 79° 29' and 79°59' E longitude (Fig.A). It represents semi-arid monsoonic climate with distinct seasons. The soils were developed from granite-gneiss and alluvium parent material. The annual precipitation is 1286 mm of which 90 per cent is received during June to December. The mean annual soil temperature is 31°C with mean summer and winter soil temperatures of 31° and 27°C, respectively. The soil moisture regime is *ustic* and soil temperature regime is *iso-hyperthermic* (Soil Survey Staff, 1999). The natural vegetation comprised of *Azadirachta indica*, *Mangifera indica*, *Pongamia glabra*, *Cynodon dactylon*, *Cyprus rotundus*, *Lantana camera*, *Parthenium hysterophorus* and *Lucas aspera*.

### Methodology :

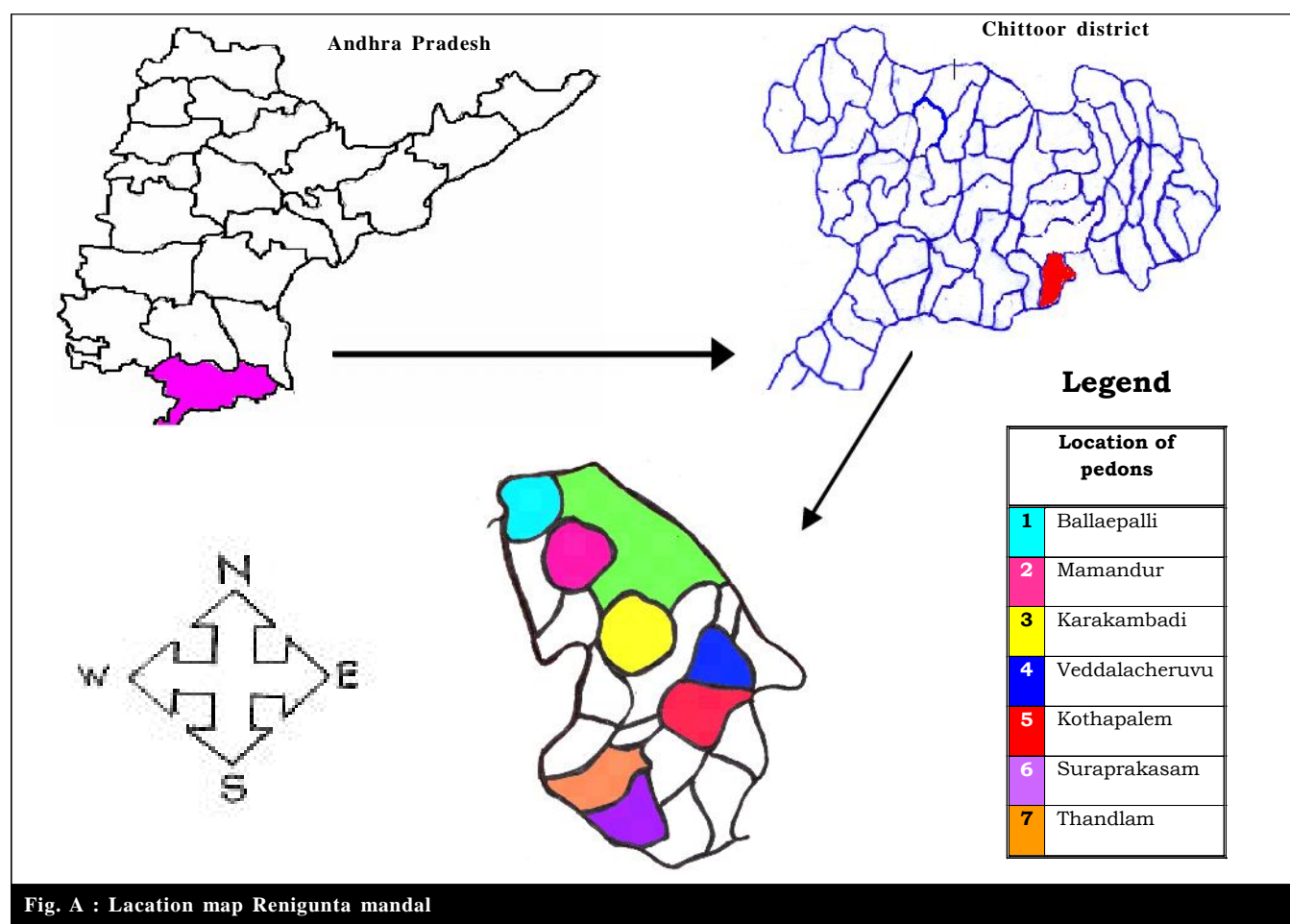
A reconnaissance soil survey was conducted in Renigunta mandal as per the procedure outlined by AIS and LUS (1970) on 1:50,000 scale toposheets. The pedons were studied on defined land forms (plains and uplands) in the Renigunta mandal for their morphological characteristics following the procedure given in Soil Survey Staff (1951). The soil correlation exercise yielded 7 soils. Horizon-wise soil samples were collected from the typifying pedon of these soils were analysed for their physical, physico-chemical and chemical properties following the standard procedures (Table B). The soils were classified according to soil taxonomy (Soil Survey Staff, 1999).

These seven soils were selected for evaluation (Fig.A) and their suitability assessed using limitation method regarding number and intensity of limitations (Sys *et al.*, 1991). This evaluation procedure consisted of three phases.

In phase I, the data has been collected in terms of characteristics (Table A). The following landscape and soil characteristics were used to evaluate soil suitability: topography (% slope), wetness (flooding and drainage), physical soil characteristics (texture/structure, CaCO<sub>3</sub>), soil

fertility characteristics [% base saturation, pH (H<sub>2</sub>O), % organic carbon, salinity (EC<sub>e</sub>, dSm<sup>-1</sup>) and alkalinity (ESP)]. The study locations are almost nearly level (0-1%) to very gently sloping (3-8%) and never been flooded (F<sub>0</sub>). The drainage conditions (Table A) were compared with regard to texture: a) fine and medium textured soils and b) coarse textured soils as per guidelines given in Sys *et al.* (1991).

In phase II the landscape and soil requirements for these major crops were taken from the tables (Sys *et al.*, 1993). In phase III the land suitability under rainfed conditions has been assessed by comparing the landscape and soil characteristics with crop requirements at different limitation levels: no (0), slight (1), moderate (2), severe (3), very severe (4) (Table B). Limitations are deviations from the optimal conditions of a land characteristic / land quality, which adversely affect the kind of land use. If a land characteristic is optimal for plant growth, it has no limitation on other hand, when the same characteristic is unfavourable for plant growth; it has severe limitation for particular land evaluation type. Thus the evaluation was done by comparing the land characteristics with the limitation levels of the crop requirement tables (Sys *et al.*, 1993). The number and degrees of limitations



**Table A: Site and soil characteristics of studied profiles**

Pedons	Soil	Parent material	Wetness (w) Drainage	Physical characteristics		Soil fertility characteristics (f)				Salinity and alkalinity	
				Texture	CaCO <sub>3</sub>	Apparent CEC (cmol (p+) kg <sup>-1</sup> clay)	BS (%)	pH (1:2.5)	OC (g kg <sup>-1</sup> )	FCe (dSm <sup>-1</sup> )	ESP
1.	Fire loamy, illitic, iso-hyperthermic, Typic Haplustalfs	granite-gneiss	well drained	CL	160+	96.36	75.23	7.11	3.10	0.18	2.85
2.	Fire-loamy, siliceous, iso-hyperthermic, Typic Ustifluvents	granite-gneiss	well drained	L	150	98.25	72.13	6.98	4.81	0.10	3.01
3.	Fire loamy, siliceous, iso-hyperthermic, Typic Ustorthents	granite-gneiss	well drained	L	58	89.43	80.46	6.56	3.22	0.07	1.75
4.	Fire, illitic, iso-hyperthermic, Typic Haplustepts	calcareous	moderately	CL	140+	73.15	79.84	8.11	1.01	0.19	1.98
5.	Fire, illitic, iso-hyperthermic, Typic Haplustepts	Murrum	Well drained	Ls	130+	83.12	83.12	7.88	1.92	0.56	1.02
6.	Fire, illitic, iso-hyperthermic, Typic Haplustepts	granite-gneiss	well drained	SCL	170+	75.42	80.12	8.22	2.54	0.29	1.62
7.	Coarse-loamy, siliceous, iso-hyperthermic, Typic Ustipsarments	alluvium	moderately	Ls	200	88.14	78.27	8.02	1.21	0.08	2.08

 Topography, t (slope): <8%; Flooding: F<sub>0</sub> and Climate, c: Semi-arid monsoonic

suggested the suitability of class of each soil for a particular crop (Sys *et al.*, 1991).

The present suitability classes can be improved if the correctable limitations such as pH, organic carbon and sodicity are altered through soil amelioration measures. The potential land suitability sub-classes were determined after considering the improvement measures to correct these limitations (Sys *et al.*, 1991).

## Research Findings and Discussion

The results of the present study as well as relevant discussions have been presented under following sub heads:

### Soil characterization :

The data pertaining to soil characteristics of different landforms of the pedons P<sub>1</sub> to P<sub>7</sub> (village names mentioned) are presented in Table 1.

### Soil-site suitability for major crops :

The kind and degree of limitations of the studied soils for the major crops are presented in Table 1. The soils with no or only four slight limitations are grouped under suitability class (S<sub>1</sub>) (very suitable); the soils with more than four slight limitations, and/or with more than three moderate limitations under moderately suitability class (S<sub>2</sub>); the soil with more than three moderate limitations, and/or one or more severe limitations(s) under marginally suitable (S<sub>3</sub>) class; the soils with very severe limitations which can be corrected under N<sub>1</sub> (currently not suitable); the soils with very severe limitations which cannot be corrected grouped under unsuitable class N<sub>2</sub> (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.

The studied soils varied in their suitability for different crops according to the criteria for the determination of the land suitability classes (Table 2).

Pedon 1, which is grouped under Typic Haplustalfs was moderately suitable for paddy, groundnut, redgram and sugarcane whereas it is marginally suitable for vegetables and mango. The major limitations were wetness (drainage), physical soil characteristics (texture) and soil fertility characteristics (base saturation, pH and organic carbon). Wetness (drainage) was a major limiting factor for paddy cultivation because it does not allow to maintain standing water and requires irrigation at frequent intervals. For all six crops organic carbon was a major limitation factor so, the organic carbon status in soils can be improved by the application of farm yard manures, green manuring and inclusion of legumes in rotation.

Pedon 2, which is grouped under Typic Ustifluvents

Table 1: Depth-wise soil characteristics used in assessing suitability

Pedon and Location	Horizon	Depth (cm)	Physical characteristics (s)				Fertility characteristics (s)					Salinity and alkalinity (n)		
			Sand (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)	CaCO <sub>3</sub> (%)	CEC (cmol (p+)-kg <sup>-1</sup> soil)	BS (%)	pH (1:2.5)	OC (g kg <sup>-1</sup> )	ECe (dSm <sup>-1</sup> )	ESP		
Balaepalli	Ap	0.00-0.20	31.25	46.75	22.00	2.00	20.2	84	7.80	3.2	0.17	6.00		
	Al	0.20-0.48	22.50	52.75	24.75	2.50	19.2	88	7.33	2.8	0.15	7.00		
	E	0.48-0.71	37.25	42.75	20.00	3.20	22.8	76	7.00	1.9	0.06	7.00		
	Bt1	0.71-0.96	32.35	38.00	29.15	3.00	22.3	76	7.46	1.5	0.12	9.00		
	Bt2	0.96-1.18	33.38	38.75	27.87	4.50	20.1	78	7.87	1.1	0.21	9.90		
Mamandur	C	1.18-1.60	29.35	45.25	24.90	4.50	25.1	78	7.27	1.3	0.22	10.00		
	Ap	0.00-0.23	35.52	42.03	22.35	0.50	16.7	79	6.49	5.2	0.11	7.00		
	Al	0.23-0.47	38.33	35.46	25.71	3.00	19.9	76	6.86	1.6	0.07	9.00		
	A2	0.47-0.67	36.21	40.89	22.90	2.00	19.9	84	6.73	1.5	0.05	9.00		
	A3	0.67-0.88	37.54	36.21	26.25	2.50	12.6	91	6.16	2.2	0.20	7.00		
Karakampadi	A4	0.88-1.07	39.74	46.95	13.31	2.50	13.1	81	7.01	1.3	0.11	7.00		
	A5	1.07-1.50	36.98	37.12	25.90	3.20	13.3	80	7.17	0.6	0.08	8.00		
	Ap	0.00-0.16	26.16	48.71	25.13	1.50	21.54	86	6.79	4.3	0.06	5.90		
	Al	0.16-0.33	32.19	41.97	25.84	2.50	23.91	76	6.58	2.3	0.08	5.20		
	A2	0.33-0.58	33.54	38.63	27.73	2.60	25.27	86	6.57	1.7	0.09	6.70		
Veddalacheruvu	Ap	0.00-0.17	40.58	30.21	29.11	4.50	43.63	90	7.22	1.9	0.16	12.10		
	Al	0.17-0.32	45.73	22.16	32.11	2.00	37.37	77	7.76	1.3	0.10	9.10		
	Bw1	0.32-0.54	29.14	28.19	42.67	2.50	34.71	70	8.56	0.9	0.18	15.0		
	Bw2	0.54-0.75	30.99	27.15	41.86	2.40	33.71	78	8.49	1.0	0.16	12.5		
	Bw3	0.75-0.94	32.57	26.86	40.57	2.30	39.74	77	8.46	0.7	0.21	12.3		
Kothapalem	Bw4	0.94-1.18	33.08	26.35	40.57	3.60	39.64	81	8.33	0.4	0.16	12.10		
	Bw5	1.18-1.40	34.79	27.73	37.48	3.60	32.51	96	8.94	0.7	0.14	11.50		
	Ap	0.00-0.23	82.73	08.11	9.15	1.00	13.82	82	7.43	2.6	0.37	8.00		
	Al	0.23-0.43	80.73	11.15	8.67	1.30	11.34	83	7.80	1.2	0.20	8.00		
	Bw1	0.43-0.69	23.73	29.69	46.58	1.40	10.04	78	7.36	1.1	0.34	8.33		
Surapiakasam	Bw2	0.69-0.89	23.80	30.49	45.71	1.20	32.18	77	6.41	1.7	0.28	8.90		
	Bw3	0.89-1.10	28.54	38.71	32.76	1.30	37.80	73	6.23	1.6	0.40	9.80		
	Bw4	1.10-1.30	28.58	36.89	34.53	2.50	19.22	93	6.20	1.1	0.68	9.90		
	Ap	0.00-0.29	20.58	58.27	21.05	0.40	21.06	73	7.82	3.3	0.37	9.90		
	Al	0.29-0.57	19.42	56.71	23.87	2.50	20.52	74	8.48	1.7	0.14	11.10		
Thandam	Bw1	0.57-0.86	37.55	34.89	27.56	1.50	20.09	82	8.16	1.1	0.10	9.50		
	Bw2	0.86-1.09	24.32	47.97	27.71	3.00	35.00	81	8.96	1.3	0.20	9.80		
	B3	1.09-1.33	18.59	55.66	25.75	3.10	28.94	84	8.43	3.1	0.33	12.50		
	Bw4	1.33-1.70	17.64	52.89	29.47	1.70	31.64	80	8.22	2.5	0.03	14.50		
	Ap	0.00-0.28	13.71	49.13	37.16	0.40	23.22	85	8.69	0.6	0.11	8.10		
Thandam	Al	0.28-0.55	68.55	21.05	10.30	1.50	18.47	81	8.68	1.3	0.07	5.90		
	A2	0.55-0.87	79.40	11.67	08.93	3.50	15.62	77	8.28	0.4	0.05	7.10		
	A3	0.87-1.00	72.89	10.50	16.61	2.50	21.71	78	8.30	1.3	0.05	7.00		
	A4	1.00-1.26	85.16	5.03	9.81	3.00	5.83	77	7.85	1.2	0.03	1.10		
	Cl	1.26-1.53	87.86	6.71	5.43	2.50	6.91	87	7.87	0.7	0.03	7.60		
C2	1.53-2.00	88.51	7.65	3.74	4.50	2.16	88	8.66	1.1	0.01	1.80			

**Table 2: Limitations levels of the land characteristics and land suitability classes**

Soil	Crop	Wetness (w)		Soil physical characteristics (s)			Soil fertility characteristics (f)			Salinity / Alkalinity (n)		Actual land suitability subclass	Potential land suitability subclass
		Drainage	Texture	CaCO <sub>3</sub> (%)	DS (%)	pH (1:2.5)	OC (g kg <sup>-1</sup> )	ECe (dSm <sup>-1</sup> )	ESP				
Typic Haplustalfs	Paddy	1	2	0	0	1	3	0	0	0	S3f,s,w	S2 s,w	
	Groundnut	0	1	0	1	1	2	0	0	0	S2,f	S1s	
	Redgram	0	1	0	0	1	1	0	0	0	S2s,f	S2s	
	Sugarcane	0	1	0	0	1	2	0	0	0	S2f,s	S1s	
Typic Ustifluvents	Vegetables	1	0	0	0	1	1	0	0	0	S2f	S1w	
	Mango	1	1	0	1	1	1	0	0	0	S3f	S1	
	Paddy	1	2	0	0	1	3	0	0	0	S3f,s,w	S2 s,w	
	Groundnut	0	1	0	1	1	2	0	0	0	S2,f	S1s	
Typic Ustorthents	Redgram	0	1	0	0	1	1	0	0	0	S2s,f	S2s	
	Sugarcane	0	1	0	0	1	2	0	0	0	S2f,s	S1s	
	Vegetables	1	0	0	0	1	1	0	0	0	S2f	S1w	
	Mango	1	1	0	1	1	0	0	0	0	S3f	S1	
Typic Haplustepts	Paddy	2	3	0	2	1	0	0	0	0	S2,s,w	S1s	
	Groundnut	0	2	0	1	1	0	0	0	0	S2f,s	S1s	
	Redgram	0	2	1	0	2	0	0	0	0	S2s,f,w	S2f	
	Sugarcane	0	2	0	2	1	0	0	0	0	S2s,f	S1s	
Typic Haplustepts	Vegetables	0	1	0	1	1	1	0	0	0	S3s,f	S1f	
	Mango	0	0	0	0	0	1	0	0	0	S3s,w	S2w	
	Paddy	1	2	0	1	3	1	0	0	0	S3f,s	N2s	
	Groundnut	0	1	0	1	2	0	0	0	0	N1s,f	N2s	
Typic Haplustepts	Redgram	1	1	0	0	4	1	0	0	0	N1s,f	N2s	
	Sugarcane	0	0	0	2	3	0	0	0	0	S2s,f	N1s	
	Vegetables	0	1	0	0	2	1	0	0	0	S3f,w	N1s,w	
	Mango	1	0	0	0	3	1	0	0	0	S2s,w	N1s	
Typic Haplustepts	Paddy	2	1	1	1	1	0	0	0	0	S2s,f	S2f	
	Groundnut	0	1	1	1	1	0	0	0	0	S3s,f	S1s	
	Redgram	1	1	0	0	0	0	0	0	0	S3s,f	S1s	
	Sugarcane	0	2	0	0	0	1	0	0	0	S2s,f	S2f	
Typic Haplustepts	Vegetables	0	1	1	0	0	1	0	0	0	S2s,f	S1s	
	Mango	1	3	1	0	2	1	0	0	0	S2s,f,w	S2	
	Paddy	1	1	0	1	3	1	0	0	0	S3s,f	N2s	
	Groundnut	0	2	0	1	2	0	0	0	0	S3s,f	N2f	
Typic Haplustepts	Redgram	0	1	0	0	4	1	0	0	0	N1w,f	N2f	
	Sugarcane	0	1	1	2	3	0	0	0	0	N1s,f	N2s	
	Vegetables	2	1	1	0	2	1	0	0	0	S3w,f	N1s	
	Mango	2	1	0	0	3	1	0	0	0	S3f,w	N1s	
Typic Ustipsammments	Paddy	1	1	1	1	1	1	0	0	0	S3w,s	N2w	
	Groundnut	1	1	1	2	1	0	0	0	0	S3s	S2s	
	Redgram	2	1	0	1	1	1	0	0	0	S2f,s	S1w,s	
	Sugarcane	1	2	0	3	0	0	0	0	0	S3s,f	S2s	
Typic Ustipsammments	Vegetables	0	1	0	1	0	0	0	0	0	S3s,w	N2w	
	Mango	2	2	0	1	1	0	0	0	0	S3s,f,w	S2s,w	

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

was moderately suitable for paddy, groundnut, redgram and sugarcane and marginally suitable for vegetables and mango. These soils showed limitations *viz.*, wetness (drainage), physical soil characteristics (texture) and soil fertility characteristics (base saturation, pH and organic carbon).

Pedon 3, which is grouped under Typic Ustorthents was currently suitable for vegetables due to its loamy texture. The texture can be improved by mixing with farmyard manure mixing with green manure year after year. Further, these soils were moderately suitable for paddy, groundnut and redgram and marginally suitable for mango. The limitations included drainage under wetness, texture under physical soil characteristics and base saturation and organic carbon under soil fertility characteristics.

Pedon 4, which is grouped under Typic Haplustepts was moderately suitable for paddy, groundnut, redgram and sugarcane while, marginally suitable for vegetables and mango. However, the major limitations includes wetness (drainage) for paddy and physical soil characteristics such as texture, soil depth and CaCO<sub>3</sub> and soil fertility characteristics *viz.*, base saturation, pH and organic carbon for all other crops.

Pedon 5, which is grouped under Typic Haplustepts was suitable for major crops like sugarcane, paddy and mango due to its very loamy sandy texture and very low soil fertility characteristics such as very low base saturation and poor organic carbon status. However, this soil was marginally suitable for groundnut and redgram with limitations of texture due to very coarse sandy texture under physical characteristics and base saturation, pH and organic carbon under soil fertility characteristics. Similar findings were reported by Satyavathi and Suryanarayan Reddy (2004).

The study further indicates that Typic Haplustepts (Pedon 6) was permanently not suitable for growing crops like paddy, groundnut, redgram and sugarcane due to very high pH (8.13 to 8.99). However, this soil was also not suitable for growing mango orchards due to limitations of high pH and wetness (drainage).

In case of pedon 7, which is classified under Typic Ustipsamments was moderately suitable for crops like paddy, groundnut, redgram and sugarcane while marginally suitable for mango. However, these soils were permanently not suitable for vegetables. The major limitations were wetness (drainage), physical soil characteristics (texture and soil depth) and soil fertility characteristics (base saturation pH and

organic carbon).

### Conclusion :

The soil-site suitability evaluation study revealed that the major limitations of the area were texture, base saturation, pH and organic carbon. The coarser texture can be improved by mixing the soil with tank silt whereas the fine texture can be improved by addition of organic matter. The soil fertility properties such as base saturation, pH and organic carbon can be improved by addition of organic matter through farm yard manure or compost or green manuring. Hence, judicious use of organic manures in combination with inorganic fertilizers in these soils not only paves the way to achieve sustainable yields of crops but also sustains the soil fertility without deterioration for future generations.

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