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Land Capability and Land Irrigability Classification of Major Soil Types of Agricultural College Farm, Naira, Andhra Pradesh

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ABSTRACT

Four representative soil pedons located in red, black and associated soils of Agricultural college farm, Naira were studied morphology and horizon wise soil samples were collected and analysed in the laboratory for physical and chemical characteristics. The red and associated soils of upland soils were moderately sloping while black and associated soils were nearly level cultivated low lands. The gravel content of rainfed uplands ranged from 0.8 to 28.1. The soil texture ranged from sandy loam to clay, moderately deep to deep in depth, slight to moderate erosion and good to poor drainage. Low land black soils were subjected for flooding during monsoon season. The soils were low to medium in organic carbon, the CEC values ranged from 10.20 to 34.30 cmol (p+) kg^{-1} and base saturation was 43.05 to 87.6 percent. Free calcium carbonate (1.2 to 3.8%) was found in lower layers of pedons 2, 3 and 4. The ESP was low and EC was non saline. Red sandy loam soils on rainfed uplands (pedon1) fall under land capability class (LCC) of II with limitations of land form, soil physical properties and fertility; Reddish yellow soils on irrigated middle lands were grouped to LCC- III with wetness, soil physical properties and soil fertility as limitations. The black soils on middle lands and low lands classified to LCC-IV with limitations of wetness, soil physical properties and soil fertility. The land irrigability classes of the pedon-1 was identified as S1, soils of pedon-2 as S2 and soils of pedonss 3 and 4 as S3 with distinct limitations of wetness (w) and soil physical properties (s).

Key words: *Erosion, Land capability classification, Land irrigability classification, Wetness.*

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). Land capability and land irrigability classification is an interpretative grouping of soils mainly based on the inherent soil characteristics, external land features and existing climate nature. The classification points out the potentialities and limitations of soils. The Agricultural College Farm has an area of 250 acres, located north-west of the Srikakulam mandal, about 5 kilometers away from national highway-5. The land was moderately sloppier terrain comprising of red, black and associated soils, however, information is lacking on the aspects of land capability and land irrigability classes for the said a soils. Keeping the above facts in view, present study of land capability and irrigability classification of soil of Agricultural College Farm, Naira was taken up to suggest optimum land use plans for sustainable agricultural production.

MATERIAL AND METHODS

The study area was located in north-west part of Srikakulam mandal. The location map of study area and representative profiles was given in Fig 1. The details of study area viz., physiographic, slope, drainage, erosion, mean annual rainfall and mean annual temperature was presented in Table 1. The climate of the study area was characterised by plotting Ombrothermic graph using mean annual rainfall against mean annual temperature from the past decade weather data (2007 to 2016). A detailed soil survey was conducted in the study area during June, 2016 using village map of 1: 5,000 scale as per the procedure outlined by AIS&LUS (1971).

Auger bores, mini pits, road cuts of 8 profiles located on uplands and plains were studied. Soil correlation exercise resulted in four typical pedons *i.e*. one in rainfed red soils of uplands, one in associated red soils in mid lands, one in associated black soils in mid lands and one in low land black soils were identified for the study. Horizon-wise soil samples were collected and characterized for soil properties *viz*., soil reaction (pH) and soluble salt concentration (EC) were estimated by adopting procedure outlined by Jackson (1973), organic carbon content of the soil samples was estimated by Walkley and Black (1934) wet digestion method. Calcium carbonate content of soil samples was determined by titrimetry of Piper (1966). Exchangeable sodium and cation exchange capacity (CEC) were determined by centrifuge extraction procedure using neutral normal

Table 1. Site characters of study area used for land evaluation for land capability and irrigability classification

Pedon No	Slope %	Soil type & Physiography	Drainage	Erosion	Mean annual rainfall (mm)	Mean annual temperature (^{0}C)
1	03-Jan	Red sandy loams on Rainfed uplands	Moderate to well drained	Moderate	982.7mm	26.48^{0}C
2	03-Jan	Reddish yellow soils on Irrigated middle lands	Moderately drained	Moderate to severe		
3	03-Jan	Medium black soils on irrigated middle lands	Poorly drained	Moderate to severe		
4	0-1	Deep black soils on irrigated low lands	Very poorly drained	Slight		

ammonium acetate as described by Bower *et al*. (1952). Land capability classification was evaluated up to subclass level based on the guidelines by Klingebiel and Montgomery (1966). The land irrigability classes for irrigation were determined as per the guidelines proposed by AIS & LUS (1971).

RESULTS AND DISCUSSION

Climate

The climate of the study area was characterized using past one year meteorological data from 2007 to 2016. The average annual rainfall in the study area was 982.7 mm, out of which as much as 73 per cent was received during June to October months. The mean annual temperature of study area was 26.48 ^{0}C. It was semi arid climate with distinct monsoons. The soil moisture regime determined as *ustic* and soil temperature regime identified was *iso-hyperthermic*.

Soil inherent characters

Inherent soil characters were presented in Table 2. The soils were moderately deep to very deep with moderate slope in pedon 1, gentle slopes in pedons 2 and 3 and near leveled plain in pedon 4. Among the four pedons studied in red, black and associated soils of Agricultural College, Farm, Naira, pedon 1 had shown sandy loam texture at surface and sandy clay loam texture in the lower horizons, while profile 2 and 3 exhibited sand clay loam to sandy clay texture. Profile 4 was observed with sandy clay loam to clayey texture. These variations in soil texture were caused by topographic variations, nature of parent material, *in-situ* weathering, translocation of clay and age of soils (Sireesha and Naidu,2013). The soil reaction of various horizons of all four pedons studied ranged from 6.03 to 8.35. Pedon 1 exhibited slightly acidic to slightly alkaline pH, pedons 2 and 3 exhibited neutral to moderately alkaline, while pedon 4 was slightly alkaline to moderately alkaline in reaction. The soluble salt concentration (EC) of these soil pedons ranged from 0.13 to 1.35 dS m^{-1}. All the profiles studied were non saline in nature and showed a trend of increase soluble salt content with depth due to leaching of salts during monsoon season (Satyavathi and Reddy 2004).

The lower electrical conductivity in pedons 1and 2 could be due to relatively coarse texture, which encouraged leaching of soluble salts, while in pedon 3 finer texture caused poor drainage and subsequent accumulating of salts (Jayaramarao, 2012). The organic carbon content in different horizons of all the four pedons ranged from 0.12 to 0.75 per cent. The organic carbon status was medium in surface layers and low in sub- surface layers. Warm climatic conditions of the study area caused rapid decomposition of organic matter resulting low to medium organic carbon content (Niranjana *et al*. (2011). The organic carbon content showed a decreasing trend with soil depth, which could be due to surface layer enriched with crop residue like left over roots mass and added FYM to the surface soil due to cropping activity (Vijayakumar *et al*., 2011). Notable calcium carbonate content was recorded in lower horizons of pedons 2, 3 and 4, which ranged from 1.2 to 5.3 per cent. The presence of $CaCO_3$ in deeper soil layers was 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).

Table 2. Inherent soil pedons characters of Agricultural College Farm, Naira

Profile No. & horizon	Depth (m)	Coarse fragments (%)	Sand (%)	Silt (%)	Clay (%)	pH	E.C (dS m^{-1})	Organic carbon (%)	$CaCO_3$ (%)	CEC	Base saturation (%)	CEC/ clay	ESP	Infiltration rate ($cmhr^{-1}$)
Profile 1 Red sandy loams on Rainfed uplands with moderate slope														
Ap	0.00-0.13	9.5	66.20	16.50	17.30	6.03	0.13	0.53	-	10.20	43.05	0.58	2.55	3.42
Bt_1	0.13-0.32	6.1	59.00	17.50	23.50	6.51	0.17	0.30	-	13.50	48.30	0.55	2.59	-
Bt_1	0.33-0.50	4.0	56.50	17.50	26.00	7.04	0.17	0.13	-	15.30	49.61	0.53	3.20	-
Bt_2	0.51-0.64	16.3	59.00	16.00	25.00	7.41	0.31	0.12	-	15.85	49.40	0.57	3.47	-
Bt_3	0.65- 0.86+	28.1	60.50	15.50	24.00	7.73	0.39	0.12	-	14.50	50.69	0.59	3.45	-
Profile 2 Associate red soils on Irrigated middle lands with gentle slope														
Ap	0.01-0.10	6.1	59.20	16.50	24.30	6.63	0.39	0.45	-	16.35	52.48	0.67	3.06	2.13
Bw_1	0.11-0.38	4.6	56.80	17.10	26.10	7.14	0.43	0.37	-	17.50	58.09	0.65	3.14	-
Bw_2	0.39-0.53	3.3	54.80	16.70	28.50	7.36	0.40	0.29	-	18.30	61.64	0.62	3.72	-
Bw_3	0.54-0.80	4.1	56.55	16.20	27.25	7.68	0.47	0.25	-	19.80	64.80	0.65	4.04	-
Bw_4	0.80-0.95+	7.5	59.60	14.10	26.30	8.09	0.58	0.21	1.20	20.65	61.99	0.66	3.63	-
Profile 3 Associate black soils on irrigated middle lands with gentle slope														
Ap	0.01-0.18	3.68	54.10	14.10	31.80	7.33	0.43	0. 50		23.60	56.06	0.73	3.90	1.47
Bw_1	0.19-0.41	2.50	50.85	15.00	34.15	7.65	0.49	0.29		25.40	60.63	0.74	4.65	-
Bw_2	0.42-0.78	2.15	53.40	13.20	33.40	8.26	0.97	0.25		24.90	77.11	0.75	3.90	-
Bw_3	0.78- 1.05+	4.20	51.30	14.10	34.60	8.31	1.22	0.18	2.60	26.50	78.23	0.77	5.28	-
Profile 3 Deep black soils on irrigated low lands with nearly level plains														
Ap	0.00-0.14	1.4	46.00	18.90	35.10	7.81	0.48	0.75	-	29.60	78.48	0.84	3.21	0.91
Bss_1	0.15-0.38	0.8	45.50	17.00	37.50	8.16	0.65	0.30	-	30.50	81.44	0.81	4.33	-
Bss_2	0.39-0.72	1.0	44.40	17.00	38.60	8.12	0.81	0.23	-	33.50	83.19	0.87	5.52	-
Bss_3	0.73-1.06	0.8	40.85	18.90	40.25	8.04	1.04	0.18	1.50	32.50	87.60	0.81	3.54	-
Bss_4	1.06-1.35	2.0	40.70	17.50	41.80	8.26	1.20	0.18	3.80	34.30	84.64	0.82	5.98	-
Bss_5	1.35-1.48+	4.6	41.50	16.00	42.50	8.35	1.35	0.15	5.30	32.50	85.75	0.79	5.54	-

Table 3. Land capability classification of soil in Agricultural College Farm, Naira.

Pedon No	Soil type	Land form / topography (t)		Wetness (w)		Soil physical properties (s)				Chemical properties and fertility status (f)				LCC
		slope	erosion	drainage	flood	depth	Surface stoniness	texture	Coarse fragments	EC	OC	CEC	BS	
Profile 1	Red sandy loam soil in rain fed uplands	II	II	I	I	II	I	II	II	I	III	III	IV	II* (t,s,f)
Profile 2	Reddish yellow soils in irrigated middle lands	II	II	III	II	I	I	II	I	I	III	II	III	III** (w,s,f)
Profile 3	Medium black soils in irrigated meddle lands	II	II	IV	IV	II	I	III	I	I	III	I	II	IV(w,s,f)
Profile 4	Deep black soils in irrigated low lands	I	I	IV	V	I	I	III	I	I	III	I	I	IV (w,s,f)

*Indicates manageable organic carbon limitation; **indicates manageable organic carbon and base saturation limitation
Class I – no limitations; Class II – slight limitations; Class III – moderate limitations; Class IV – strong limitations.

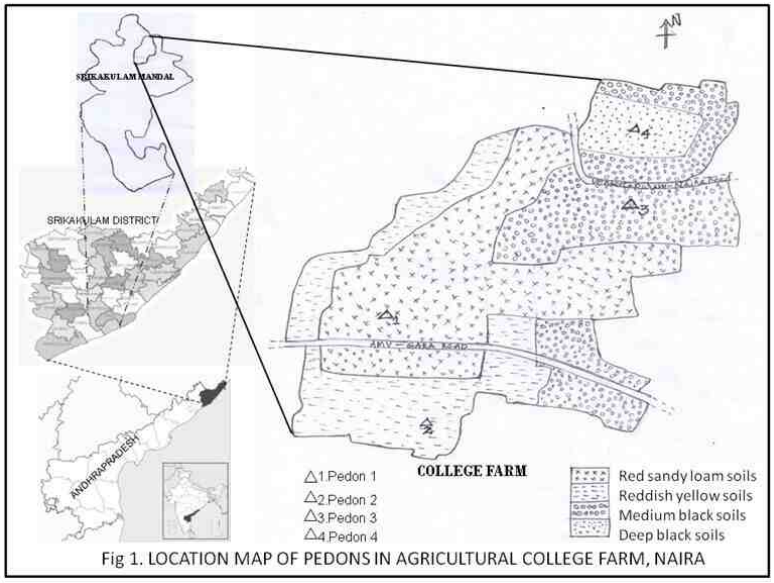

Fig 1. Location map of Pedons in Agricultural College Farm, Naira

Table 4. Land irrigability classification of soil in Agricultural College Farm, Naira.

Pedon No	Soil type	Land form / topography (t)		Wetness (w)		Soil physic properties (s)				Chemical properties and fertility status (f)			Land irrigability classification	Suitability for irrigation
		slope	erosion	drainage	Drainage outlets	depth	Rock out crops	texture	Coarse fragments	EC	ESP	$CaCO_3$		
Profile 1	Red sandy loam soil in rain fed uplands	II	II	I	II	II	I	I	II	I	I	I	II (t,w,s)	S1 (t,w,s)
Profile 2	Reddish yellow soils in irrigated middle lands	II	II	II	III	II	I	I	II	I	I	I	III (w,t,s)	S2 (w,t,s)
Profile 3	Medium black soils in irrigated meddle lands	II	II	IV	IV	II	I	II	I	I	I	I	IV (w,s)	S3 (w,s)
Profile 4	Deep black soils in irrigated low lands	I	I	IV	IV	I	I	III	I	I	I	I	IV (w,s)	S3 (w,s)

S1- suitable, S2 – moderately suitable, S3 – marginal suitable.
Class I – no limitations; Class II – slight limitations; Class III – moderate limitations; Class IV – strong limitations

The cation exchange capacity of the soil horizons varied from 10.2 to 34.3 cmol (p^+) kg^{-1} soil. All four pedons exhibited an increasing trend of CEC with depth. The analytical data revealed that, although there was not much variation in CEC among the horizons of each profiles, wider variations exhibited among the profiles, which was attributed to variation in nature and amount of clay particles. Pedon 4 recorded higher CEC which may be due to high clay content and expanding nature of clay, as evidenced by wide and deep surface cracks observed during summer and high CEC/ clay ratio (Tripathi *et al*., 2006). The percent base saturation ranged from 43.05 to 87.60, highest base saturation was registered in pedon 4 and lowest in pedon 1. Infiltration rate was highest in pedons 1 (3.4 cm hr^{-1}) and lowest in profile 4 (0.9 cm hr^{-1})

Land capability classification

Classification of study area in to distinct land capability classes was presented in Table 3. Based on the climate and inherent soil characters, soils of pedon 1 (rainfed uplands) was classified to Class II lands with limitations of land form (t), soil physical properties (s) and fertility (f). Soils of pedon 2 (associate red soils in mid lands) were classified as Class III lands with limitations of wetness (w), soil physical properties (s) and fertility (f); soils of pedon 3 (associate black soils) and pedon 4 (black soils) was classified as Class IV lands with limitations of wetness (w), soil physical properties (s) and fertility (f).

Land irrigability classification

The pedon 1 was also grouped to Land irrigability class S1 with limitations of land form (t), wetness (w) and soil physical properties, lands of pedon 2 was classified to S2 irrigability class with limitations of wetness (w), land form (t) and soil physical properties (s). The lands of pedons 3 and 4 were classified as S3 irrigability class with specific limitations of wetness (w) and soil physical properties (s). The detail description of land capability classes and land irrigability classes with potentials, limitations and suggestion for sustainable land use are given Table 5.

Table 5. Suggested land use of the soils of Agricultural College Farm, Naira according to land capability classes.

Pedon No.	Land capability class	Description and present land use	Potentialities	Major limitations	Suggested land use
1	II (t,s,f)	Moderately good cultivable land for sustainable agriculture. Presently using for cultivation orchards and irrigated dry crops like pulses.	Suitable climate for variety of crops. Good internal drainage, fairly good water and nutrient retention characters, good soil depth, neutral to slightly alkaline soil pH, non saline and suitable climate.	Moderate erosion hazard, low organic carbon, low CEC and low base status.	Orchard crops like Mango, Cashew, Sapota, Guava can be crown. With proper irrigation sources, Maize, groundnut, mesta, red gram, sugarcane and pulses can be grown with soil test based fertilizers and manures additions. Suitable erosion control measures may be adopted. Double cropping is possible by providing irrigation facilities.
2	III (w,s, f)	Moderately good cultivable land for sustainable agriculture. Presently Rice followed by pulses are grown.	Climate suitable for major crops like sugarcane, Maize, Rice, pulses etc. Moderately internal drainage, relatively good water and nutrient retention characters, good soil depth, suitable climate.	Moderate erosion hazard, moderate drainage hazard, low organic carbon and base status and, moderate soil hazard	Irrigated dry crops like Sugarcane, Maize, groundnut, pulses can be grown with certain soil and water management practices. Rice also can be grown with ample irrigation facility. Soil test based fertility management and providing moderate drainage network may be adopted.
3	IV (w,s,f)	Fairly good cultivable land for sustainable agriculture. Presently Rice followed by pulses are grown.	Good climate suitability for crops. High CEC, high water and nutrient retention, Good base saturation, good climate suitability.	Poor internal drainage, wetness limitation, low organic carbon status. Moderately alkaline pH, nutrient imbalance.	Rice followed by Maize/groundnut/ pulses may be grown. Addition of organic manures including green manuring with sesbania, soil test based fertiliser management, particularly phosphorous and micronutrient management.

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

CONCLUSION

The soils of Agricultural College Farm, Naira were classified to II, III and IV land capability classes duly identifying the limitation of land use such as erosion (e), wetness (w), soil (s), climate (c) and soil fertility (f). These soils also were classified as S1, S2 and S3 irrigability classes with specific limitations under each class viz., landform (t), wetness (w), soil (s) and fertility (f).

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