



MAPPING AND ASSESSMENT OF SOILS IN NAGARJUNASAGAR CATCHMENT, LINGASUGUR TALUK OF KARNATAKA

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Abstract- A detailed soil survey was carried out in the 4D5A2s, 4D5A2t, 4D5A2u and 4D5A3j Subwatersheds of Nagarjunasagar catchment, Lingasugur taluk of Raichur district, Karnataka, India covering an area of 22381 ha, spread over 47 villages. The survey area is represented by four major physiographic division namely subdued hills, upper pediplains, lower pediplains and alluvial plains developed over granite. Nine soil series were identified and mapped into 27 mapping units. The soils developed subdued hills is excessively drained, shallow, yellowish red to reddish brown, gravelly sandy loam to gravelly clay, mapped into a single mapping unit and classified under LCC VI. The soils is spread over 0.7 percent of the total area and classified into Lithic Ustorthents. The soils of upper pediplains are well drained, shallow to deep, reddish brown to dark yellowish brown, gravelly sandy loam to gravelly clay and mapped into 14 mapping units. These soils belong to LCC II, III and IV and classified into Typic Haplustalfs, Typic Ustorthents and Typic Haplustepts which represent the 18.7 percent of the total area. The soils of lower pediplains and alluvial plains are moderately well drained to well drained, moderately deep to very deep, dark brown to dark grayish brown, calcareous, gravelly clay loam to clay, mapped under 12 mapping units which belongs to land capability classes II, III and V and classified into Typic, Sodic and Fluventic Haplustepts which represents the 78.04 percent of the total area.

Keywords- Subdued hills, pediplains, alluvial plains, detailed soil survey, land capability classification

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Introduction

The modern agriculture requires precise information on various landuse and agro-climatic parameters like soil types and characteristics, rainfall, temperature, water resources etc. which influence directly the soil response to any specific use [1,2], however, the usefulness of a soil, is not solely due to its inherent qualities but the qualities which affect its capacity to respond to the inputs and management for a specific use or a combination of uses [3]. Soil survey is the only an effective array in the arsenal of planners and users to provides adequate information in terms of land form, terraces, vegetation as well as characteristics of soils (viz., texture, depth, structure, stoniness, drainage, acidity, salinity and so on) which can be utilized for the planning and development of modern agriculture. Likewise mapping and assessment of soils is the process of evaluation of a particular tract of land for specific purposes involving the execution and interpretation of data of natural resources and other related aspects of land in order to identify and make a comparison of the promising kind of land uses. To prepare a land resource inventory in terms of mapping units, its assessment and capability classification, a detailed soil survey work of the soils of Nagarju-

nasagar catchment, Lingasugur Taluk, Raichur district of Karnataka, India was undertaken by the Soil & Land Use Survey of India, Hyderabad centre, on 1:7920 scale.

Material and Methods

General Description of the Survey Area

The study area comprising 4D5A2s, 4D5A2t, 4D5A2u and 4D5A3j subwatersheds of Nagarjunasagar catchment, Lingasugur taluk of Raichur district, Karnataka lies between 16°03' to 16°21' N latitudes and 76°20' to 76°38' E longitudes and has a total geographical area of 22381 ha spread over 47 villages of entire taluka.

The physiography of the area has been divided into subdued hills, upper pediplains, lower pediplains and alluvial plains. The hills have strong to moderately steep (10-15%) side slope and have an altitude between 540 to 590 m above mean sea level whereas most of the area represents very gentle to gentle (1-5%) slopes of pediplains and alluvial plains and have an altitude between 480 to 540 m above mean sea level. All the subwatersheds are drained through Anehosur and Hirehalla stream which directly flowing into the Krishna River. The drainage pattern is dendritic to subdendritic

with moderate to severe soil erosion.

Granite is the main geologic formation in the survey area and alluvium landscape is encountered around major stream bank. The granite rocks are medium to coarse textured, dark coloured, possessing distinct petrological characters with rhombic pyroxene hypersthene and a high quality of the dark ferromagnesian compound which gives it dark colour.

The survey area is influenced by the semi-arid climate where evapotranspiration exceeds the precipitation for the major part of the year. The total annual rainfall is 740 mm, about 80.3 percent of which falling between June to October. The mean annual temperature is 30.5°C, whereas the mean summer soil temperature and mean winter soil temperature are 31.8°C and 26.5°C respectively. December is the coldest month (16.8°C) and April, May are hottest month (44.7°C). The soil moisture regime is 'ustic' and soil temperature regime is 'isohyperthermic' [4].

Soil Survey Methodology

Detailed soil survey of the area was carried out using cadastral map of 1:7920 based on grid system [5]. The soils of the area representing three physiographic divisions namely subdued hills, pediplains and alluvial plains were studied for their morphological characteristics [4] and the soil samples were collected from all the horizons and analyzed for their physico-chemical characteristics with standard procedures [6,7]. Mapping of soils [8] and land evaluation [9,10] procedure were adopted.

Result and Discussion

The area was represented by three major physiographic division namely subdued hills, Pediplains and alluvial plains developed over alluvium and granite. Nine soil series namely Bhupur, Chennampalli, Devergudda, Devsugur, Fatepur, Gabbur, Hembral, Mudgal and Tatikol were identified for mapping and assessment based on their physico-chemical and morphological properties.

Soil Morphology

Chennampalli series soils are excessively drained, shallow, yellowish red to reddish brown, gravely loamy sand to sandy loam representing pasture and grazing land use occur on strongly (10-15%) sloping, subdued hills [Table-1]. The surface layer is 18-22 cm thick, underlain by weathered granitic parent material. The lithic contact is encountered within 50 cm below the surface. Bhupur, Devergudda, Devsugur and Tatikol series soils of upper pediplains are well drained, shallow to deep, reddish brown to dark yellowish brown, gravely sandy loam to gravely clay occur on very gently to moderate (1-5%) sloping and suitable for rainfed crops. The surface layer is 7-25 cm thick which is underlain by 38-85 cm sub-surface soils and has weathered granitic parent material.

Fatepur, Hembral and Gabbur series soils of lower pediplains are moderately well drained to well drained, moderately deep to very deep, dark brown to dark grayish brown, calcareous, gravely clay loam to clay occur on very gently to gently (1-5%) sloping and suitable for rainfed crops. The surface layer is 6-12 cm thick which underlain by 21-125 cm. cracks with 2-5 cm width and well developed slickensides are present in the soils of Hembral series. Mudgal series soils are moderately deep, very dark grayish brown, calcareous, sandy clay loam to gravely clay occur on very gently to gently (1-5%) sloping, developed over alluvium. These soils are alkaline, suitable for pasture and grazing, but it can be utilized as agricultural lands adopting reclamation practices. The soil colour varies from

dark brown (7.5 YR 4/4) to reddish brown (5YR 3/4) in subdued hills, reddish brown (5YR 3/4) to dark reddish brown (5 YR 3/3) and dark yellowish brown (10 YR 4/4) in upper pediplains and dark grayish brown (10 YR 4/2) to very dark grayish brown (10 YR 3/2) in lower pediplains and alluvial plains. The variation of colour in uplands and hill slope is due to prevalence of well drained conditions, admixture of organic matter and occurrence of iron in oxidized ferric form [11,12]. The soils of the taluk showed wide textural variation and have been classified into coarse loamy to very fine textural class. This wide variation in soil texture is caused by topographic position, nature of parent material, weathering, translocation of clay and age of soils [13]. The structure of the soils is weak, fine, subangular blocky in subdued hills, very fine, single grains to moderate, medium, subangular blocky in upper pediplains and moderate, medium, subangular blocky to angular blocky in lower pediplains and alluvial plains. The variation in soil structure is a reflection of physiographic position of the pedons [14]. The consistence of the soils occurring on the subdued hills and upper pediplains varied from loose, very friable, slightly sticky and slightly plastic to slightly hard, friable, sticky and plastic whereas the soils of lower pediplains and alluvial plains varied from slightly hard, friable, slightly sticky and slightly plastic to very firm, very sticky and very plastic. The wide variation in consistence is due to variation in clay content of pedons situated on different topographic position [12]. The boundary of the soils on subdued hills varied from abrupt smooth to diffuse smooth whereas the boundary of the soils on upper pediplains, lower pediplains and alluvial plains varied from clear smooth to gradual smooth. Strong effervescence with dilute HCl were observed in the soils of Devergudda, Devsugur series on upper pediplains and Fatepur, Gabbur, Hembral and Mudgal series on lower pediplains and alluvial plains. The vertic properties such as 2-5 cm wide cracks extended upto 50 cm depth and developed slickensides in lower horizons were observed in Gabbur and Hembral soil series of lower pediplains.

Soil Characteristics

Physico-chemical characteristics of the soils are presented in [Table -2]. The clay content varied from 33 to 34% in subdued hills, 8-63% in upper pediplains, 49-63% in lower pediplains and 25-45% alluvial plains. The high clay content in the soils of lower pediplains and alluvial plains as compared to upper pediplains and subdued hills was due to deposition of finer fractions in the lower pediplains and alluvial plains from the upper pediplains and subdued hills. Thus in a topo-sequence, the soil texture could be chiefly be attributed to the transportation of finer soil particles down the slope through runoff and their deposition in lower physiographic position [15]. The increase in clay content in lower horizons could be attributed to vertical migration of clay [16,17]. Silt content of all the pedons are ranges from 7 to 34%. Silt content in the soils of subdued hills and upper pediplains are almost increases with the depth whereas soils of lower pediplains and alluvial plains have irregular trends. Sand constitutes the bulk of mechanical fractions which could be attributed to dominance of physical weathering. Sand content in subdued hills and upper pediplains are higher (22 to 84%) than the lower pediplains and alluvial plains (21 to 37%). The bulk density of soils is highly dependent on texture and ranges from 1.31 to 1.85 Mg m⁻³. The lower bulk density was noticed with clayey texture in lower pediplains and higher bulk density with Loamy texture in upper pediplains, which might be due to more compaction of finer particles in lower pediplains caused by overhead weight of the surface soils.

Table 1- Morphological characteristics of soils

Horizon	Depth (m)	Colour (moist)	Texture	Structure	Gravel (%)	Consistence			Cutans/ Slick-ensides/ cracks (cm)	Boundary	Pores	Roots	Effervescence
						Dry	Moist	Wet					
1. Subdued hills (10-15% slope)													
Chennampalli: Loamy skeletal, mixed, isohyperthermic, Lithic Ustorthents													
A1	0.00-0.08	7.5 YR 4/4	cl	sbk-1-f	25	ds	mfr	wss wps	-	as	c-vf-f	vf-f-p	-
Ac	0.08-0.18	5 YR 3/4	cl	sbk-1-m	25	dsh	mfr	wss wps	-	cs	c-vf-f	vf-f-p	-
C	0.18-0.48	weathered parent material of granite											
2. Upper Pediplains (1-5% slope)													
Bhupur: Fine, mixed, isohyperthermic, Typic Haplustalfs													
Ap1	0.00-0.07	7.5 YR 4/4	ls	sg-0-vf	-	dl	ml	wso wpo	-	cs	f-m	vf-f-f	-
A12	0.07-0.16	7.5 YR 4/4	sl	sbk-1-f	-	ds	mvfr	wss wps	-	gs	c-vf-f	vf-f-f	-
Bt1	0.16-0.31	5 YR 34/4	sc	sbk-1-m	-	dsh	mfr	ws wp	tn-py	gs	-	tn-py	-
Bt2	0.31-0.67	5 YR 34/4	sc	sbk-1-m	-	dsh	mfr	ws wp	tn-py	gs	-	tn-py	-
C	0.67-0.75	weathered parent materials of granite											
Devergudda: Fine loamy, mixed, isohyperthermic, Typic Haplustepts													
Ap1	0.00-0.14	5 YR 3/3	sl	sbk-1-m	8	dsh	mfr	wss wps	-	cs	c-vf-f	vf-f-f	-
Bw1	0.14-0.38	5 YR 3/3	scl	sbk-2-m	12	dsh	mfr	ws wp	-	cs	c-vf-f	vf-f-f	-
C	0.38-0.52	weathered parent material of granite											
Devsugur: Fine skeletal, mixed, isohyperthermic, Typic Ustorthents													
Ap1	0.00-0.09	10 YR 4/4	c	sbk-1-f	35	dsh	mfr	wss wps	-	cs	c-vf-f	vf-f-f	es
Ap2	0.09-0.18	10 YR 4/4	c	sbk-1-f	40	dsh	mfr	wss wps	-	cs	-	vf-f-f	ev
C	0.18-0.55	weathered parent materials of Granite											
Tatikol: Loamy skeletal, mixed, isohyperthermic, Typic Ustorthents													
Ap	0.00-0.07	5 YR 4/4	ls	sg-0-vf	35	dl	ml	wso wpo	-	cs	-	vf-f-f	-
Ac	0.07-0.18	5 YR 4/4	sl	sbk-1-f	37	ds	mvfr	wss wps	-	cs	c-vf-f	vf-f-f	-
C	0.18-0.55	weathered parent materials of granite											
3. Lower Pediplains (1-5% slope)													
Fatepur: Fine, montmorillonitic, isohyperthermic, Vertic Haplustepts													
Ap	0.00-0.08	10 YR 3/2	c	sbk-2-m	15	dsh	mfr	ws wp	-	cs	f-vf-f	vf-f-f	es
Bw1	0.08-0.16	10 YR 3/2	c	sbk-2-m	15	dsh	mfi	wvs wvp	pf	gs	vf-f	vf-f	es
Bwss2	0.16-0.27	10 YR 3/2	c	sbk-2-m	12	dsh	mfi	wvs wvp	ss	gs	vf-f	vf-f	es
C	0.27-0.68	weathered parent materials of granite											
Gabbur: Very Fine, montmorillonitic, isohyperthermic, Sodic Haplusterts													
Ap1	0.00-0.10	10 YR 3/3	c	sbk-2-m	8	dh	mfr	ws wp	-	cs	f-vf-f	vf-f-f	es
Bw1	0.10-0.32	10 YR 3/3	c	sbk-2-m	6	dvh	mvfi	wvs wvp	pf	gs	vf-f	vf-f	es
Bwss2	0.32-0.56	10 YR 3/3	c	sbk-2-m	6	dvh	mvfi	wvs wvp	ss	gs	vf-f	-	es
C	0.56-0.65	weathered parent materials of granite											
Hembral: Fine, montmorillonitic, isohyperthermic, Typic Haplusterts													
Ap1	0.00-0.08	10 YR 3/2	c	sbk-2-f	-	dh	mfr	ws wp	-	cs	f-vf-f	vf-f-f	es
A12	0.08-0.18	10 YR 3/2	c	sbk-2-m	-	dvh	mfi	wvs wvp	-	gs	f-vf-f	vf-f	es
Bw1	0.18-0.40	10 YR 3/2	c	sbk-2-m	-	dvh	mvfi	wvs wvp	pf	gs	f-vf-f	vf-f	es
Bwss2	0.40-0.81	10 YR 3/2	c	sbk-2-m	-	dvh	mvfi	wvs wvp	ss	gs	f-vf-f	-	es
Bwss3	0.81-1.10	10 YR 3/2	c	sbk-2-m	-	dvh	mvfi	wvs wvp	ss	-	f-vf-f	-	es
4. Alluvial plains (1-5% slope)													
Mudgal: Fine loamy, mixed, isohyperthermic, Fluventic Haplustepts													
Ap1	0.00-0.09	10 YR 3/2	scl	sbk-1-m	-	dsh	mfr	wss wps	-	cs	c-vf-f	vf-f-p	es
A12	0.09-0.22	10 YR 3/2	scl	sbk-2-m	-	dh	mfi	wv wp	-	gs	c-vf-f	vf-f-f	es
Bw1	0.22-0.41	10 YR 3/2	scl	sbk-2-m	-	dh	mfi	wv wp	-	gs	c-vf-f	vf-f	es
Bw2	0.41-0.95	10 YR 3/1	c	sbk-2-m	-	dh	mfi	wv wp	-	gs	c-vf-f	-	es
Bw3	0.95-1.05	10 YR 3/1	scl	sbk-2-m	-	dh	mfi	wv wp	-	-	c-vf-f	-	es

*Symbols used according to Soil Survey manual, (Soil Survey Staff, 2000 and AIS & LUS, 1970)

The WHC of soils is highly depends on depth, clay and organic carbon content of the pedons. The minimum WHC (15.3%) was noticed in Bhupur series of upper pediplains to maximum (62.5%) in Gabbur series of lower pediplains.

The pH of the soils varied from 6.4 to 9.2 being higher in Devsugur series of upper pediplains and Fatepur, Gabbur, Hembral and Mudgal series of lower pediplains and alluvial plains. It is due to more accumulation of exchangeable bases removed from subdued hills and upper pediplains. The EC of the soils of all the series varied from 0.1 to 1.62 dS m⁻¹. The organic carbon content is low to moderately high which ranges from 0.12 to 1.55 percent respective-

ly. The Chennampalli series of subdued hills represents pasture and grazing land use and are higher in organic carbon content whereas other series soils are low in organic carbon. It is due to addition of large amounts of leaf litter through leaf fall and also less intensive cultivation of field crops in subdued hills leading to low removal or depletion of organic carbon from the surface soils. The low CEC was noticed in the soils of Tatikol series of subdued hills followed by high CEC in the soils of Hembral series of lower pediplains which ranges from 2.5 to 47.1 cmol (P⁺) kg⁻¹. The lowest ESP was noticed in Bhupur series of upper pediplains and highest in Mudgal series alluvial plains.

Table 2- Physico-chemical characteristics of soils

Soil Depth (m)	Mechanical Analysis (%)			Textural Class	pH (1:2.5)	EC (dsm ⁻¹)	OC (%)	CaCO ₃ (%)	Exchangeable cations [cmol (p+) kg ⁻¹]				Sum	CEC	ESP	BS (%)	BD [Mg m ⁻³]
	Sand	Silt	Clay						Ex. Ca	Ex. Mg	Ex. Na	Ex. K					
1. Subdued hills (10-15% slope)																	
Chennampalli: Loamy skeletal, mixed, isohyperthermic, Lithic Usthorthents																	
0.00-0.08	34	32	34	cl	7	0.1	1.55	3.2	6.2	6	0.5	0.4	13.1	14.6	3.4	89.7	1.34
0.08-0.18	33	34	33	cl	7.1	0.1	1.28	3.5	7.2	6.2	0.6	0.3	14.9	14.3	4.2	104.2	1.39
2. Upper Pediplains (1-5% slope)																	
Bhupur: Fine, mixed, isohyperthermic, Typic Haplustalfs																	
0.00-0.07	82	10	8	ls	6.7	0.2	0.15	1.5	2.5	3.3	0.3	0.1	6.2	6.3	4.8	98.4	1.81
0.07-0.16	80	10	10	sl	6.6	0.2	0.12	0.2	0.5	2.3	0.3	0.1	3.2	4.1	7.3	78	1.85
0.16-0.31	50	10	40	sc	6.5	0.1	0.3	2.5	4.3	4.5	0.2	0.3	9.3	11.3	1.8	82.3	1.39
0.31-0.67	47	8	45	sc	6.5	0.1	0.28	2.2	4	3.5	0.4	0.3	8.2	11.2	3.6	73.2	1.33
Devergudda: Fine loamy, mixed, isohyperthermic, Typic Haplustepts																	
0.00-0.14	81	7	12	sl	9.2	0.2	0.39	8.8	24	7.1	9.2	0.8	41.1	41.7	22.1	98.6	1.8
0.14-0.38	52	14	34	scl	9.1	0.2	0.32	4.6	24.2	8.8	11.5	0.8	45.3	45.8	25.1	98.9	1.44
Devsugur: Fine skeletal, mixed, isohyperthermic, Typic Ustorthents																	
0.00-0.09	24	15	61	c	9.2	0.2	0.39	8.8	24	7.1	9.2	0.8	41.1	41.7	22.1	98.6	1.34
0.09-0.18	22	15	63	c	9.1	0.2	0.32	4.6	24.2	8.8	11.5	0.8	45.3	45.8	25.1	98.9	1.33
Tatikol: Loamy skeletal, mixed, isohyperthermic, Typic Ustorthents																	
0.00-0.07	84	8	8	ls	7.1	0.1	0.12	0.5	1	0.7	0.2	0.2	2.1	2.5	1	84	1.42
0.07-0.18	68	14	18	sl	7	0.1	0.28	1.1	3.8	2.3	0.4	0.3	6.8	7	5.7	97.1	1.51
3. Lower Pediplains (1-5% slope)																	
Fatepur: Fine, montmorillonitic, isohyperthermic, Vertic Haplustepts																	
0.00-0.08	37	14	49	c	8.3	0.1	0.53	21.1	31.5	2.5	4.3	0.8	39.1	40.1	10.7	97.5	1.4
0.08-0.16	35	14	51	c	8.4	0.1	0.51	21.8	32.5	3	4.6	0.8	40.9	41.4	11.1	98.8	1.4
0.16-0.27	32	15	53	c	8.5	0.1	0.47	22.3	30.8	3.5	5.7	0.7	40.7	41.1	13.9	99	1.37
Gabbur: Very Fine, montmorillonitic, isohyperthermic, Sodic Haplusterts																	
0.00-0.10	23	18	59	c	8	0.1	0.37	14	32.5	5.3	5.4	0.8	44	42.8	12.6	102.8	1.43
0.10-0.32	27	12	61	c	9	0.1	0.45	13.8	28.8	6	6.5	0.8	42.1	41.9	15.5	104.7	1.37
0.32-0.56	21	16	63	c	9	0.2	0.39	13.7	30	5.8	9.8	0.8	46.4	46.8	20.9	99.1	1.34
Hembral: Fine, montmorillonitic, isohyperthermic, Typic Haplusterts																	
0.00-0.08	29	16	55	c	8.6	0.1	0.59	13.7	28.3	8	4.6	0.9	41.8	42.8	10.3	97.7	1.42
0.08-0.18	27	16	57	c	8.6	0.1	0.5	13.2	30	9	4.6	0.8	44.4	44.6	10.3	99.6	1.39
0.18-0.40	29	15	56	c	8.6	0.1	0.5	13.6	31.8	8.5	5	0.7	46	47.1	10.6	97.7	1.39
0.40-0.81	25	22	53	c	8.5	0.1	0.5	12.9	27.5	9.3	5	0.7	42.5	42.3	11.8	100.4	1.4
0.81-1.10	21	22	57	c	8.5	0.1	0.48	11.4	24.8	8.8	5.9	0.8	40.3	40.9	14.4	98.5	1.31
4. Alluvial plains (1-5% slope)																	
Mudgal: Fine loamy, mixed, isohyperthermic, Fluventic Haplustepts																	
0.00-0.09	51	18	31	scl	8.5	0.1	0.35	13	15.8	7	2.4	0.4	25.6	26.9	8.9	95.2	1.7
0.09-0.22	55	16	29	scl	8.6	0.1	0.21	14.7	13.5	7.8	3	0.3	24.6	25.6	11.7	96.1	1.72
0.22-0.41	57	16	27	scl	9.3	0.2	0.32	12.1	14.3	7	6.1	0.4	27.7	28.3	21.5	97.8	1.75
0.41-0.95	29	26	45	c	9.1	0.5	0.24	10.6	11.5	12	17.4	0.4	41.4	42.9	40.5	96.5	1.6
0.95-1.05	57	18	25	scl	8.6	1.6	0.12	8	10.5	15	10.5	0.3	36.3	38.2	27.4	95	1.7

Land Evaluation

Land evaluation classification stating land capability class, soil irrigability classification, land irrigability classification, soil suitability for paddy and hydrological soil groupings are given in [Table-3].

Soil Mapping

Chennampalli series soils of subdued hills are excessively drained, shallow, yellowish red to reddish brown and coarse loamy which mapped under C2hE3SR mapping unit and spread over 0.7 percent of the total area. Bhupur, Devsugur, Tatikol and Devergudda series soils of upper pediplains are well drained, shallow to deep, reddish brown to dark yellowish brown and fine which mapped into B4dB2, B4dC2, B4cC3, D2rB2, D2rC2, D2rC3, DG3dB2, DG3dC2, DG3kC3, T2dB2, T2dC2, T2dC2S, T2cC3SR and T2dD3SR mapping units and represents 18.7 percent of the total area. Fatepur, Hembral and Gabbur series soils of lower pediplains are moderately well drained to well drained, moderately deep to very deep, dark brown to dark grayish brown, calcareous, gravelly clay loam to clay which mapped into F3hB2, F3rB2, F3rC2, G4rB2, G4rC2, H5rB2, H5rC2 and H5rC2S mapping units and represents 74.3 percent of

the total area. Mudgal series soils are moderately deep, very dark grayish brown, calcareous, sandy clay loam to gravelly clay occur on very gently to gently stream bank developed over alluvium. These soils are alkaline representing the 3.74 percent of the total area and mapped into M5kB2, M5kC2, M5rC2 and M5rC3 mapping units.

Land Capability Classification

The result on land capability classification shows that majority of soils belongs to class II (29.7), class III (32.0), class IV (8.3), Class V (26.7) and class VI (0.7) lands. Chennampalli series soils of subdued hills belong to land capability class VI and spread over 0.7 percent of the total area. These soils are suitable for permanent pasture and grazing. The surface layer of these soils are 18-22 cm thick which underlain by weathered granitic parent material. Soils of upper pediplains are well drained, shallow to deep, reddish brown to dark yellowish brown, gravelly sandy loam to gravelly clay belongs to land capability classes II, III and IV and represents the 18.7 percent of the total area. These soils are neutral to alkaline, suitable for agricultural practices with proper management whereas the soils of lower pediplains are moderately well drained to well drained,

moderately deep to very deep, dark brown to dark grayish brown, calcareous, gravelly clay loam to clay belongs to land capability classes II, III and V and represents 74.3 percent of the total area. The Fatepur and Hembral series soils are suitable for intensive cultivation with proper management and Gabbur series soils are suitable for permanent pasture and grazing. Mudgal series soils are

moderately deep, very dark grayish brown, calcareous, sandy clay loam to gravelly clay occur on very gently to gently slope, stream bank developed over alluvium. These soils are alkaline representing the 3.74 percent of the total area and belong to land capability class V. These soils are suitable for pasture and grassland. Similar studies were also made by [18,19].

Table 3- Mapping and evaluation of soils

Soil Mapping Unit	Description of mapping unit	Land Capability Classification	Soil irrigability Classification	Land irrigability Classification	Paddy soil group	Hydrological soil group
1. Subdued hills (10-15% slope)						
Chennampalli: Loamy skeletal, mixed, isohyperthermic, Lithic Ustorthents						
C2dE3SR	Chennampalli, shallow, gravelly sandy loam, strongly sloping (10-15%) slope, severe erosion, stony and rocky.	Vles-1	E	6st	4	D
2. Upper Pediplains (1-5% slope)						
Bhupur: Fine, mixed, isohyperthermic, Typic Haplustalfs						
B4dB2	Bhupur, deep, sandy loam, very gently sloping (1-3%) slope, moderate erosion.	IIes-1	B	2st	2	C
B4dC2	Bhupur, deep, sandy loam, gently sloping (3-5% slope), moderate erosion.	IIes-1	B	3st	3	C
B4cC3	Bhupur, deep, loamy sand, gently sloping (3-5% slope), severe erosion.	IVes-1	B	3st	3	C
Devergudda: Fine loamy, mixed, isohyperthermic, Typic Haplusteps						
DG3dB2	Devergudda, moderately deep, gravelly sandy loam, very gently sloping (1-3% slope), moderate erosion.	IIes-2	C	3st	3	C
DG3dC2	Devergudda, moderately deep, gravelly sandy loam, gently sloping (3-5% slope), severe erosion.	IIes-3	C	3st	3	C
DG3kC3	Devergudda, moderately deep, gravelly sandy clay loam, gently sloping (3-5% slope), severe erosion.	IVes-2	C	3st	3	C
Devsugur: Fine skeletal, mixed, isohyperthermic, Typic Ustorthents						
D2rB2	Devsugur, shallow, gravelly clay, very gently sloping (1-3% slope), moderate erosion.	Ves-4	D	5st	4	D
D2rC2	Devsugur, shallow, gravelly clay, gently sloping (3-5% slope), moderate erosion.	Ves-4	D	5st	4	D
D2rC3	Devsugur, shallow, gravelly clay, gently sloping (3-5% slope), severe erosion.	Ves-5	D	5st	4	D
Tatikol: Loamy skeletal, mixed, isohyperthermic, Typic Ustorthents						
T2dB2	Tatikol, shallow, gravelly sandy loam, very gently sloping (1-3% slope), moderate erosion.	IVes-3	D	4st	4	D
T2dC2	Tatikol, shallow, gravelly sandy loam, gently sloping (3-5% slope), moderate erosion.	IVes-3	D	4st	4	D
T2dC2S	Tatikol, shallow, gravelly sandy loam, gently sloping (3-5% slope), moderate erosion, stony phase.	IVes-3	D	4st	4	D
T2cC3SR	Tatikol, shallow, gravelly loamy sand, gently sloping (3-5% slope), severe erosion, stony and rocky phase.	IVes-4	D	4st	4	D
T2dD3SR	Tatikol, shallow, gravelly sandy loam, moderately sloping (5-10%) slope, severe erosion, stony and rocky phase.	IVes-5	D	4st	4	D
3. Lower Pediplains (1-5% slope)						
Fatepur: Fine, montmorillonitic, isohyperthermic, Vertic Haplusteps						
F3hB2	Fatepur, moderately deep, clay loam, very gently sloping (1-3% slope), moderate erosion.	IIes-2	C	3st	3	C
F3rB2	Fatepur, moderately deep, clay, very gently sloping (1-3% slope), moderate erosion.	IIes-2	C	3st	3	C
F3rC2	Fatepur, moderately deep, clay, gently sloping (3-5% slope), moderate erosion.	IIes-3	C	3st	3	C
Gabbur: Very Fine, montmorillonitic, isohyperthermic, Sodic Haplusterts						
G4rB2	Gabbur, deep, clay, very gently sloping (1-3% slope), moderate erosion.	Ves-1	D	5st	4	D
G4rC2	Gabbur, deep, clay, gently sloping (3-5% slope), moderate erosion.	Ves-2	D	5st	4	D
Hembral: Fine, montmorillonitic, isohyperthermic, Typic Haplusterts						
H5rB2	Hembral, very deep, clay, very gently sloping (1-3% slope),	IIes-1	B	2st	2	D
H5rC2	Hembral, very deep, clay, gently sloping (3-5% slope), moderate erosion.	IIes-1	B	3st	3	C
H5rC2S	Hembral, very deep, clay, gently sloping (3-5% slope), moderate erosion, stony.	IIes-1	B	3st	3	C
4. Alluvial plains (1-5% slope)						
Mudgal: Fine loamy, mixed, isohyperthermic, Fluventic Haplusteps						
M5kB2	Mudgal, very deep, gravelly sandy clay loam, very gently sloping (1-3% slope), moderate erosion.	Ves-1	D	5st	3	D
M5kC2	Mudgal, very deep, gravelly sandy clay loam, gently sloping (3-5% slope), moderate erosion.	Ves-2	D	5st	3	D
M5rC2	Mudgal, very deep, gravelly clay, gently sloping (3-5% slope), moderate erosion.	Ves-2	D	5st	3	D
M5rC3	Mudgal, very deep, gravelly clay, gently sloping (3-5% slope), severe erosion.	Ves-3	D	5st	3	D

* Symbols used according to Klingebiel and Montgomery 1961, FAO 1976 and Soil Survey manual, (AIS & LUS, 1970).

Soil Irrigability Classification

The soil irrigability classes are defined in terms of soil properties that express their degree of limitation for development and their requirement for irrigation management. Four soil irrigability classes are identified based on available WHC, effective soil depth, surface texture, infiltration, topography, drainage, quality of irrigation water and soil salinity and alkalinity [5]. Bhupur and Hembral soil series have moderate limitations for sustained uses under irrigation are grouped into "B" class. These soils are deep to very deep, moderately well drained, fine textured, moderately slow to slow permeable and have moderate erosion hazards. Devergudda and Fatepur soil series have severe limitations for sustained uses under irrigation are grouped into "C" class. These soils are moderately deep to very deep, moderately well drained, fine textured, moderately slow permeable and have moderate erosion hazards. Devsugur, Gabbur, Mudgal and Tatikol soil series are shallow, well drained, and loamy with moderate to severe erosion hazards. These soils are having severe limitations for sustained use under irrigation and grouped into class "D". Chennampalli series soils are shallow, coarse textured, excessively drained, developed over strongly sloping lands and having severe erosion hazards. These soils are not suitable for sustained uses under irrigation and grouped into class "E".

Land Irrigability Classification

The suitability of land for irrigation depends on physical and socio-economic factors in addition to the soil irrigability classes, quality of irrigation water, drainage pattern and other considerable factors. Bhupur, Devergudda, Fatepur and Hembral soil series have moderate to severe limitations of soils and topography for sustained uses under irrigation and classified under land irrigability sub-classes from 2st to 3st, whereas Tatikol (4st), Devsugur, Gabbur and Mudgal (5st) followed by Chennampalli (6st) with increasing limitations.

Soil Suitability for Paddy

Paddy soil group is a grouping of soils based on soil depth, pH, soil texture, puddling quality, permeability, slope and physiography. Insufficient precipitation for growing paddy needs irrigation in the survey area. Bhupur and Hembral soil series are highly suitable for paddy cultivation followed by Devergudda and Fatepur with increasing limitations. The paddy crops can be grown in the soils of Gabbur and Mudgal series adopting reclamation by gypsum. Chennampalli, Devsugur and Tatikol soil series are unsuitable for paddy cultivation.

Hydrological Soil Groupings

Hydrological Soil Groupings are suggestive of runoff generation capacity of soils from rainfall and useful for hydrological studies particularly in watershed management. Bhupur, Devergudda and Fatepur soil series have moderately high to high runoff potential and classified under class 'C' and rest are having high runoff potential and classified under class 'C'.

Soil Classification

Based on morphological, physical and chemical properties and climatic data, the soils were classified as Entisols, Inceptisols, Alfisols and Vertisols [4]. Soils of subdued hills and upper pediplains (except Bhupur and Devergudda series) do not have any diagnostic horizon, hence, classified as Entisols. Bhupur series soils were classified as Alfisols with argillic (Bt) sub-surface diagnostic horizon and Devergudda, Fatepur and Mudgal series soils having cambic

(Bw) sub-surface diagnostic horizon were classified as Inceptisols. Due to wide cracks and slickensides (Bss) in sub-surface diagnostic horizons, Gabbur and Hembral series soils of lower pediplains were classified as Vertisols. Chennampalli series of subdued hills and Devsugur and Tatikol series of upper pediplains are shallow in depth and have gravelly texture, hence, grouped under Orthents at suborder level and Ustorthents at great group level due to 'ustic' soil moisture regime. Further the Chennampalli series placed under Lithic Ustorthents at sub-surface level in the presence of lithic contact within 50 cm of the mineral soil surface whereas Devsugur and Tatikol series were placed under Typic Ustorthents in the absence of lithic contact within 50 cm of the mineral soil surface. The Bhupur series of upper pediplains showed the presence of argillic (Bt) sub-surface diagnostic horizon as evidenced by the fact that the illuvial horizon contained more clay than the eluvial horizon and also had base saturation more than 35% throughout the profile. However this series was classified as Ustalfs at sub-order level due the presence of 'ustic' soil moisture regime. Bhupur series did not have duripan, plinthite, kandic, natric, or petrocalcic horizons and hence classifies as Haplustalfs at great group level and Typic Haplustalfs at sub group level. Devergudda and Fatepur series of lower pediplains and Mudgal series of alluvial plain were grouped under Ustepts at sub-surface level due to 'ustic' soil moisture regime and Haplustepts at great group level because these soils did not have either duripan or calcic horizon. Further, Devergudda series did not have vertic properties and lithic contact within 50 cm from the surface, hence, this series was classifies as Typic Haplustepts at sub-group level. Fatepur series had vertic features like 2-3 cm wide cracks to a depth of 3-5 cm and slickensides in the lower horizons; hence, this series was classified as Vertic Haplustepts at sub-group level and due to irregular decrease or increase in organic carbon and clay content in lower horizons Mudgal series have been classified as Fluventic Haplustepts. Gabbur and Hembral series of lower pediplains were grouped under Usterts at sub-surface level due to 'ustic' soil moisture regime Haplusterts at great group level. Further, Gabbur series were grouped into Sodic Haplusterts whereas Hembral series grouped as Typic Haplusterts.

Conclusion

Chennampalli series soils of subdued hills are excessively drained, shallow, yellowish red to reddish brown, gravelly loamy sand to sandy loam mapped into one mapping unit which belongs to land capability class VI and spread over 0.7 percent of the total area. These soils are suitable for permanent pasture and grazing. Bhupur, Devsugur, Tatikol and Devergudda series soils of upper pediplains are well drained, shallow to deep, reddish brown to dark yellowish brown, gravelly sandy loam to gravelly clay mapped into 14 mapping units which belongs to land capability classes II, III and IV and represents the 18.7 percent of the total area. These soils are neutral to alkaline, suitable for agricultural practices with proper management. Fatepur, Hembral and Gabbur series soils of lower pediplains are mapped into 8 mapping units which belongs to land capability classes II, III and V and represents 74.3 percent of the total area. The Fatepur and Hembral series soils are suitable for intensive cultivation with proper management whereas Gabbur series soils are suitable for permanent pasture and grazing. Mudgal series soils are moderately deep, very dark grayish brown, calcareous, sandy clay loam to gravelly clay occur on very gently to gently slope stream bank developed over alluvium. These soils are alkaline representing the 3.74 percent of the total area and mapped into

4 mapping units which belongs to land capability class V and suitable for pasture and grassland. Though, the Gabbur and Mudgal series are alkaline and not suitable for agriculture but it can be improved by adopting soil reclamation measures.

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