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Characterization, classification and management needs of soils of Indo-Gangetic Plains in Karnal District of Haryana

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Land resources are under an intense pressure due to ever-increasing human and livestock population as well as over exploitation of land resources resulting in acceleration of soil degradation (Velayuthum and Bhattacharyya 2000). The exploitation of land is more acute in Haryana state because of continued rice-wheat cropping system, imbalance use of fertilizers and over-exploitation of ground water. Thus, maintaining soils in a state of high productivity is important for providing people with basic needs on a sustainable basis. The soils differ in their morphology, physico-chemical characteristics, inherent productivity and fertility and their responses to management practices vary accordingly. Thus, it is imperative to study the soils of a particular area for sustainable land use. With this objective, detailed soil survey was conducted to characterize, classify soils of Sirsi village, a representative of Indo-Gangetic alluvial plains in Karnal district, Haryana.

The study area is located in tehsil and district Karnal of Haryana state and lies in between 29°41'39" to 29°42'29" N latitude and 76°54'25" to 76°55'54" E longitude with an area of 260 ha at an elevation of 226 m above MSL. The climate is semi-arid subtropical with mean annual temperature of 24.5°C and mean annual rainfall of 720 mm out of which 70% occurs during monsoon season (June to September). The estimated mean annual summer temperature (MAST) is 26°C and mean annual winter temperature (MAWT) is 14°C. The area qualifies for '*Hyperthermic*' temperature regime. Mean annual potential evapo-transpiration (PET) ranges between 1200-1400 mm. The soils of the area have developed on nearly level to gently sloping old alluvial Yamuna plains (Trans-Gangetic Plains). Majority of area (86.5%) is under irrigated agriculture barring forest (3%) and miscellaneous use. Rice-wheat is the major cropping system followed by sugarcane, mustard, vegetables and fodder crops like sorghum (summer) and berseem *etc.* A detailed soil survey of area was carried out as per procedure outlined in Soil Survey Manual (Soil Survey Division Staff 2000; AIS&LUS 1970) by using the cadastral map on 1:2640 scale as base map. Pedons and auger observations were studied as per the heterogeneity of the terrain. Morphological features were studied and horizon-wise soil samples from representative pedons were collected for laboratory characterization. The soil samples were analyzed for physico-chemical properties as per the standard laboratory procedures (Black 1965; Jackson 1973; Sarma *et al.* 1987). The soils were correlated, classified (Soil Survey Staff 2003) and evaluated for land capability (Kligebiel and Montgomery 1961) and land irrigability (AIS&LUP 1970). Considering the potentials and limitations of the soils, suitable management practices and conservation measures were suggested.

Based on field observations, laboratory characterization and correlation, six soil series (Sirsi A to Sirsi F) were tentatively identified and mapped into eighteen phases of soil series (Fig. 1).

The soils of different series were ≥150 cm deep with the colour of pedons of Sirsi-A to D series is in hue 10YR, value 4 to 5 and chroma 2 to 4 and had fine to medium, weak to moderate sub-angular blocky structure. The soils of Sirsi-A and B had clay loam texture in series control section while that of Sirsi-C and D possessed sandy loam texture throughout the

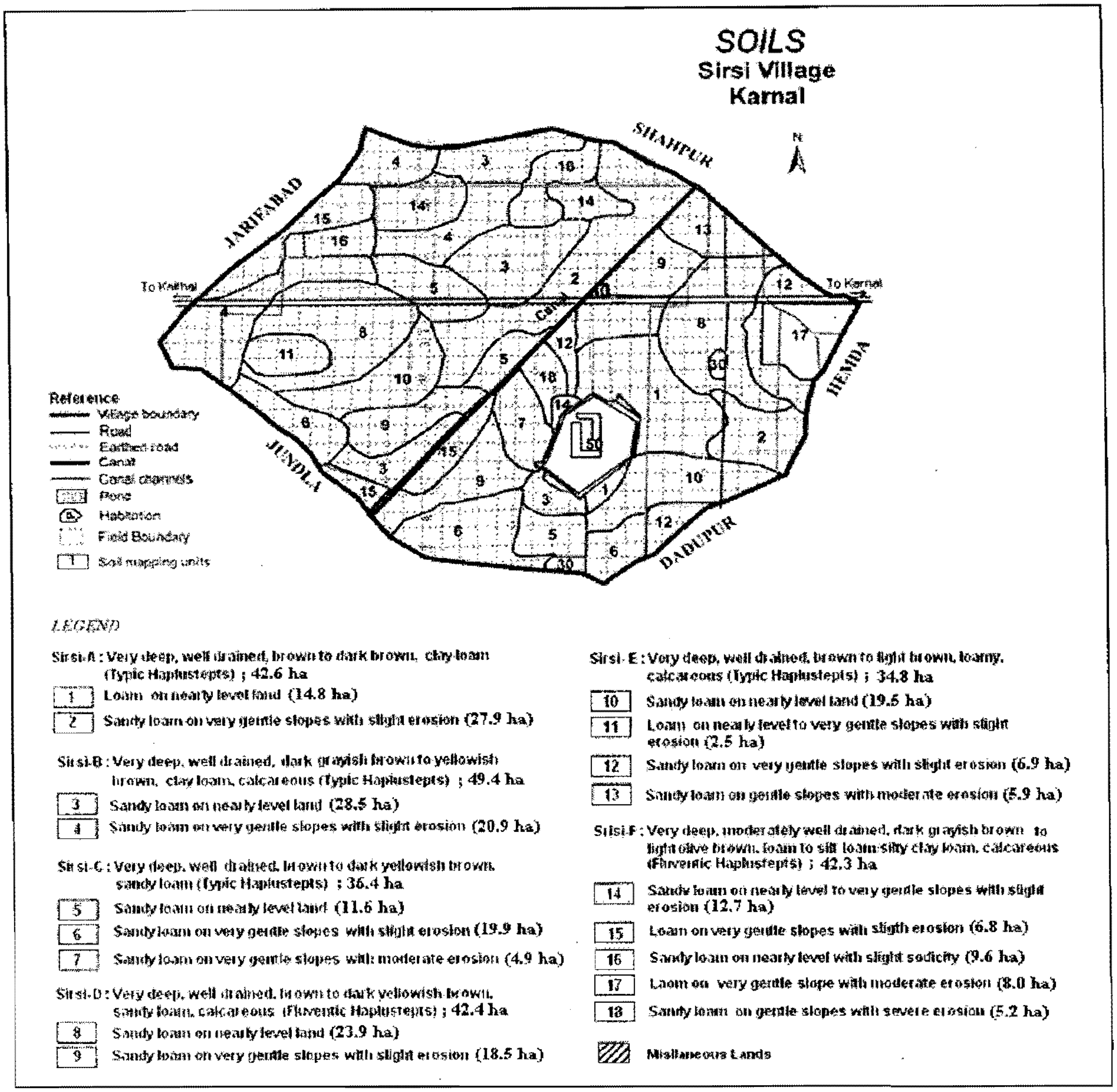

Fig.1. Soil Map of Sirsi, Karnal, Haryana

pedon. The soils belonging to Fluventic Haplustepts (Sirsi-F and E showed variability in their texture (loam to silty clay loam) through depth. These soils had dominantly moderate medium subangular blocky structure barring surface and sub-surface horizons. These calcareous soils (Sirsi-B, D, E and F) had $CaCO_3$ ranging from 0.5 to 27.1% in different horizons. These soils had their colour in 10YR and 2.5YR (sub-soils) which indicate their drainage condition.

Physico-chemical characteristics of the soils (Table 1) indicated that the pH and EC of Sirsi E and F soils are relatively higher than the other soils. The soils of series F had problem of salinity/sodicity (in pockets). In general, organic carbon content is relatively high in surface soils but decreased with depth indicating that these soils are well developed (Mahapatra *et al.*1996). The clay content of the soils

Table 1. Morphological, physical and chemical properties of soils

Horizon	Depth (Cm)	Munsell colour (Moist)	Structure	Sand (%)	Silt (%)	Clay (%)	pH (1:2.5)	EC (1:2.5) (dSm^{-1})	OC (%)	$CaCO_3$ (%)	CEC (cmol(p+) kg^{-1})
Sirsi-A: Fine-loamy, mixed, hyperthermic Typic Haplustepts											
Ap	0-14	10YR 4/3	m1sbk	34.8	39.4	25.7	8.2	0.10	0.48	-	8.9
Bw1	14-33	10YR 4/3	m2sbk	41.3	29.5	29. 2	7.9	0.07	0.29	-	9.2
Bw2	33-56	10YR 4/3	m2sbk	40.3	27.9	31.8	7.7	0.05	0.29	-	10.5
Bw3	56-82	10YR 4/3	m2sbk	34.7	26.1	39.2	7.9	0.04	0.23	-	12.1
Bw4	82-102	10YR 4/3	m2sbk	36.1	24.4	39.5	8.0	0.10	0.22	-	12.5
Bw5	102-122	10YR 5/3	m2sbk	40.3	28.6	31.0	8.1	0.08	0.20	-	8.6
BC	122-158	10YR 5/3	m2sbk	44.6	23.2	32.2	8.6	0.08	0.12	0.5	7.7
Sirsi-B : Fine-loamy, mixed, hyperthermic Typic Haplustepts											
Ap	0-18	10YR 5/2	m1sbk	47.6	37.9	14.5	8.5	0.14	0.64	2.0	8.9
BW1	18-41	10YR 4/2	m2sbk	36.9	32.6	30.5	8.4	0.07	0.43	0.5	10.8
BW2	41-61	10YR 4/2	m2sbk	40.7	22.1	37.2	8.1	0.08	0.29	0.7	10.1
BW3	61-84	10YR 5/3	m2sbk	41.0	20.3	38.6	8.1	0.10	0.31	0.5	11.3
BW4	84-107	10YR 5/4	m2sbk	35.9	26.5	37.5	8.3	0.09	0.25	0.9	10.6
BW5	107-127	10YR 5/4	m2sbk	44.8	22.9	32.3	8.4	0.10	0.20	3.9	11.2
BC	127-152	10YR 5/4	m2sbk	59.8	18.7	21.5	8.4	0.07	0.20	3.3	9.8
Sirsi-C : Coarse-loamy, mixed hyperthermic, Typic Haplustepts											
Ap	0-16	10YR 4/3	f1sbk	62.0	19.4	18.6	8.0	0.09	0.52	-	6.4
Bw1	16-40	10YR 4/3	f1sbk	57.5	31.6	10.8	7.8	0.08	0.41	-	5.9
Bw2	40-65	10YR 4/3	m1sbk	54.1	27.2	18.7	7.8	0.06	0.37	-	7.8
Bw3	65-89	10YR 4/4	m1sbk	53.1	27.4	19.5	7.9	0.06	0.29	-	7.1
Bw4	89-107	10YR 4/4	m1sbk	52.7	29.2	18.1	8.3	0.09	0.25	-	6.9
Bw5	107-158	10YR 5/4	m2sbk	60.9	26.6	12.5	8.4	0.10	0.18	-	6.8

Contd. ...

Sirsi-D : Coarse-loamy, mixed hyperthermic Fluventic Haplustepts												
Ap	0-18	10YR 4/3	f1sbk	65.5	18.0	16.5	7.8	0.11	0.25	0.97	6.7
Bw1	18-35	10YI. 5/4	f1sbk	58.0	29.4	12.5	8.0	0.10	0.23	1.95	7.1
Bw2	35-51	10YR 4/4	f1sbk	54.2	28.3	17.5	8.1	0.09	0.27	2.04	7.4
Bw3	51-74	10YR 4/4	m1sbk	59.1	26.4	14.4	8.4	0.08	0.08	2.04	6.9
Bw4	74-98	10YR 5/4	m1sbk	55.7	31.0	13.3	8.4	0.10	0.14	2.43	7.7
Bw5	98-121	10YR 5/4	m1sbk	57.5	30.0	12.5	8.2	0.08	0.04	2.43	7.5
Bw6	121-140	10YR 4/4	m2sbk	52.7	32.5	14.8	8.3	0.08	0.12	7.80	7.3
Bw7	140-160	10YR 4/4	m2sbk	57.9	25.2	16.9	8.2	0.08	0.29	8.28	7.1
Sirsi-E : Fine-loamy, mixed, hyperthermic Typic Haplustepts												
Ap	0-21	10YR 5/3	f1sbk	54.3	27.7	18.0	8.8	0.20	0.23	2.34	9.9
A12	21-42	10YR 5/3	f1sbk	52.5	30.3	17.2	8.7	0.20	0.20	1.46	10.7
Bw1	42-64	10YR 5/3	m2sbk	44.2	32.3	23.5	8.7	0.19	0.18	12.18	10.1
Bw2	64-84	10YR 5/2	m2sbk	43.4	31.8	24.8	8.8	0.19	0.16	20.96	10.4
Bw3	84-108	2.5YR5/3	m2sbk	46.7	32.3	21.0	8.9	0.22	0.14	27.00	9.4
Bw4	108-128	2.5YR 5/4	m2sbk	42.5	34.4	23.1	8.9	0.22	0.08	17.74	11.5
Bw5	128-152	2.5 YR 5/4	m2sbk	40.3	35.8	23.8	8.8	0.21	0.04	13.16	11.3
Sirsi-F : Fine-loamy, mixed, hyperthermic Fluventic Haplustepts												
Ap	0-16	10YR 4/2	m1sbk	52.4	30.2	17.4	8.3	0.17	0.20	0.97	11.1
A12	16-38	10YR 4/2	m1sbk	32.6	47.3	20.1	8.5	0.10	0.20	0.98	12.1
Bw1	38-60	2.5YR 4/2	m2sbk	30.6	48.6	20.8	8.5	0.08	0.21	1.25	12.3
Bw2	60-82	2.5YR 4/2	m2sbk	25.2	50.9	23.9	8.5	0.07	0.18	2.10	13.9
Bw3	82-108	2.5YR 5/4	m2sbk	20.1	51.1	28.8	8.8	0.08	0.04	2.18	13.6
Bw4	108-139	2.5YR 4/4	m2sbk	18.1	50.5	31.4	8.9	0.10	0.18	6.51	11.7
BC	139-150	2.5YR 4/4	m2sbk	27.9	43.5	27.6	8.9	0.15	0.18	8.90	13.2

Table 2. Land capability classification and management needs

Soil mapping unit	Land capability sub-class	Land irrigability sub-class	Limitations/ potentials	Management / recommendations	Area	
					ha	%
1, 3 5, 8,10	IIs	2s	Good lands (slight limitations of soil)	Suited to all climatically adapted crops, Adoption of recommended agro-managements.	98.3	37.8
2,4,6,11	IIes1	2st	Good lands (slight limitations of erosion)	Suited to climatically adapted crops. Adoption of recommended agro-management including INM.	71.2	27.4
7, 9, 12, 13	IIes2	2st, 3st	Good lands (slight to moderate limitations of topography and erosion)	Suited to regional crops under frequent irrigation and recommended package of practices.	36.2	13.9
14, 15	IIIes1	2sd	Moderately good to good lands (moderate limitations of erosion and calcareousness)	Suited to regional crops under light irrigations and INMS.	19.5	7.5
16	III sw2	3sd	Moderately good lands (limitations of soil, drainage and slight salinity/ sodicity)	Suited for salt tolerant crops, Chemical amendments, organic manures, recommended dose of fertilizers, frequent irrigation to sustained crop production. Mixing tube well water with canal water.	9.6	3.7
17	VIew1	3sd	Moderate lands under forest plantation (problems of drainage, calcareousness and erosion)	Silvi-pasture, gap filling with forest species, control grazing and vegetative cover.	8.0	3.1
18	IVes2	4st	Fairly good lands (problems of topography and severe erosion)	Suited for agro-forestry, need conservation measures such as leveling and vegetative cover, afforestation.	5.2	2.0
			Miscellaneous lands		12.0	4.6
			Grand Total		260	100

Land capability subclass-limitations: e-erosion, s-soil limitation, w-drainage/wetness ; Land irrigability subclass-limitations : s-soil limitation, t- topography ,d-drainage.

followed same pattern of distribution as that of organic carbon. The cation exchange capacity of soils followed in the increasing sequence of Sirsi F > Sirsi E > Sirsi B > Sirsi A > Sirsi D > Sirsi C. The soils of Sirsi series are grouped under medium category whereas those of A, D, E and F in low to medium status (Surya *et al.* 2006).

Land capability and land irrigability grouping revealed that the area was differentiated into seven land capability sub-classes (IIs. IIes1, IIes2, IIIes, IIIsw2, Ives2 and VIes2) and six land irrigability sub-classes (2s, 2st, 2sd, 3st, 3sd, 4st). Soil properties, erosion were major limitations for grouping the soil mapping units into these sub-classes. Mapping unitwise land capability and irrigability classes and their management needs were mentioned in the table 2. The distribution of land capability classes of the area revealed that out of total area, 90.3 and 9.7 % area is arable and non-arable lands, respectively. Land capability classes III (IIIes1 and IIIsw2) and IV (IVes2) lands cover 11.2 and 2.0 % area respectively and remaining area belongs to class II (IIs. IIes1, IIes2). Major area of village falls under land irrigability class 2s (71.4%), and 2sd (11.1%). Moderately good lands (7.5% TGA) had limitations of erosion, calcareousness, and texture. Site-specific nutrient management, frequent and light irrigations are recommended for sustained productivity. Crops like wheat, sugarcane, sorghum, mustard, pearl millet, mustard, horticultural crops and vegetables are best suited in these soils. Moderately good soils (3.8%) having drainage, slight/salinity sodicity problems can be alleviated through gypsum, green manuring and frequent irrigation for salt tolerant crops. The tube well water should be mixed with canal water for irrigation to check further salinaization. Moderate lands (VIew) under forestry (3.1%) pose problem of drainage and indurated lime nodules and relatively heavier texture in sub-soil. The soils are to be brought under silvi-pasture adopting suitable forest species. Protective grazing and maintenance of vegetative cover are recommended. Fairly good land under miscellaneous use having limitation of topography, severe erosion, needs conservation measures such as leveling and afforestation (social-forestry).

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