

Soils of Selsura research farm in Wardha district, Maharashtra and their suitability for crops

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Abstract : Detailed soil survey of Selsura KVK research farm of Dr. P.D.K.V., Akola in Wardha district, Maharashtra was carried out using 1:6000 scale cadastral map. There were nine soil series and thirteen mapping units. The soils were very dark gray to very dark grayish brown in hue 10YR, calcareous and clayey but differed in depth and are classified under Entisols, Inceptisols and Vertisols. In general, pH (8.0-9.2) increased with depth whereas reverse trend was observed for organic carbon. Soils of Selsura-1 are prone to sodicity problems. DTPA-Zn and Fe were deficient in these soils but DTPA-Mn and Cu were optimum. The mapping units were grouped under II to IV land capability classes and 2 to 4 land irrigability classes. Except soils of Selsura-7 series (very shallow), others are moderately or marginally suitable for one or more commonly growing rainfed kharif crops viz. cotton, sorghum, pigeonpea, soybean and groundnut.

Additional key words: *Detailed soil survey, buried soils, land capability, land suitability*

Introduction

Soil is one of the most important natural resources. Its proper understanding in terms of its distribution on a landscape, and knowledge of its nature and properties are essential for judicious, beneficial and optimal use on sustainable basis. Such basic information about soils is provided by soil survey (Jagdish Prasad and Mandal 1996; Ray *et al.* 2000; Jagdish Prasad 2000). As no information was available on soils of KVK farm at Selsura, Wardha district, a detailed soil survey was carried out for characterization of soil resources. Suitability evaluation of commonly grown rainfed crops was also undertaken in the identified soils.

Material and Methods

Study area

Krishi Vigyan Kendra (KVK) farm in Selsura (20°40' N latitude and 78°31' 25" longitude) is located at two sites, one at Agricultural school (Polytechnic Campus, site I) which is about 10 kms from Wardha town on the Wardha-Yavatmal road and the other site (Site II) is in between the Agricultural school campus and Selsura village on the right side of Wardha-Yavatmal road and situated on the north-western segment of the river Bhadadi which forms the boundary along the north-eastern part. The area of the farm is 22.42 ha, which includes 4.04 ha at Agricultural school campus.

Table 1. Description and extent of soil mapping units

Mapping Symbol	Mapping unit description	Area (ha)
Ss1mA1	Selsura-1, very deep, clay, very dark gray to very dark grayish brown (10YR 3/1 to 3/2), calcareous, level to nearly level land (0-1% slope), slight erosion	1.32
Ss1mB2	Selsura-1, very deep, clay, very dark gray to very dark grayish brown (10YR 3/1 to 3/2), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	4.37
Ss2mB2	Selsura-2, deep, clay, very dark gray (10YR 3/1), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	1.12
Ss2mC3	Selsura-2, deep, clay, very dark gray (10YR 3/1), calcareous, gently sloping to undulating land (3-5% slope), severe erosion	1.93
Ss3mB2	Selsura-3, deep, clay, very dark grayish brown (10YR 3/2), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	3.15
Ss3mC3	Selsura-3, deep, clay, very dark grayish brown (10YR 3/2), calcareous, gently sloping to undulating land (3-5% slope), severe erosion	1.52
Ss4mB2	Selsura-4, very deep, clay, very dark grayish brown (10YR 3/2), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	0.91
Ss5mB2	Selsura-5, moderately deep, clay, very dark grayish brown (10YR 3/2), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	0.81
Ss6mB2	Selsura-6, moderately deep, clay, very dark grayish brown (10YR 3/2), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	1.93
Ss7mB2	Selsura-7, very shallow, clay, very dark grayish brown to dark brown (10YR 3/2.5), calcareous, very gently sloping land (1-3% slope), moderate erosion	0.29
Ss8mB2	Selsura-8, shallow, clay, very dark grayish brown (10YR 3/2), calcareous, very gently sloping land (1-3% slope), moderate erosion	0.31
Ss9mB2	Selsura-9, deep, clay, very dark grayish brown to dark brown (10YR 3/2.5), calcareous, very gently sloping to slightly undulating land (1-3% slope), moderate erosion	1.22
Ss9mC3	Selsura-9, deep, clay, very dark grayish brown to dark brown (10YR 3/2.5), calcareous, gently sloping to undulating land (3-5% slope), severe erosion	0.40

The physiography of the area is level to gently sloping (0-5% slope) and even depression at places. The various natural streams (very narrow) drain into Bhadadi river. The climate is sub-humid (dry) with mean rainfall of 933.5 mm. The mean annual maximum and minimum temperatures are 32.6°C and 19.4°C, respectively. Soil moisture and temperature regimes are 'Ustic' and 'Hyperthermic', respectively.

Detailed soil survey was carried out as per standard methodology (AIS&LUS 1970; Soil Survey Division Staff 1997). Nine series were identified and mapped as phases of series (13 mapping units). The soil samples were collected from typifying pedons and were characterized following standard methods (Black 1965). Available micronutrient cations were extracted by 0.005 M DTPA-solution (Lindsay and Norvell

1978) and analysed on atomic absorption spectrophotometer.

The mapping units were grouped into land capability classes (LCC) and land irrigability classes (LIC). The delineated polygons were also evaluated for suitability of rainfed cotton, sorghum, pigeonpea, groundnut and soybean (NBSS&LUP 1994).

Results and Discussion

The soils are very deep (Selsura-1 and 4), deep (Selsura-2, 3 and 9), moderately deep (Selsura-5 and 6), shallow (Selsura-8) and very shallow (Selsura-7), very dark gray to very dark grayish brown in colour, calcareous and clay in texture. The description and extent of soil mapping units have been shown in table 1 and fig. 1, respectively.

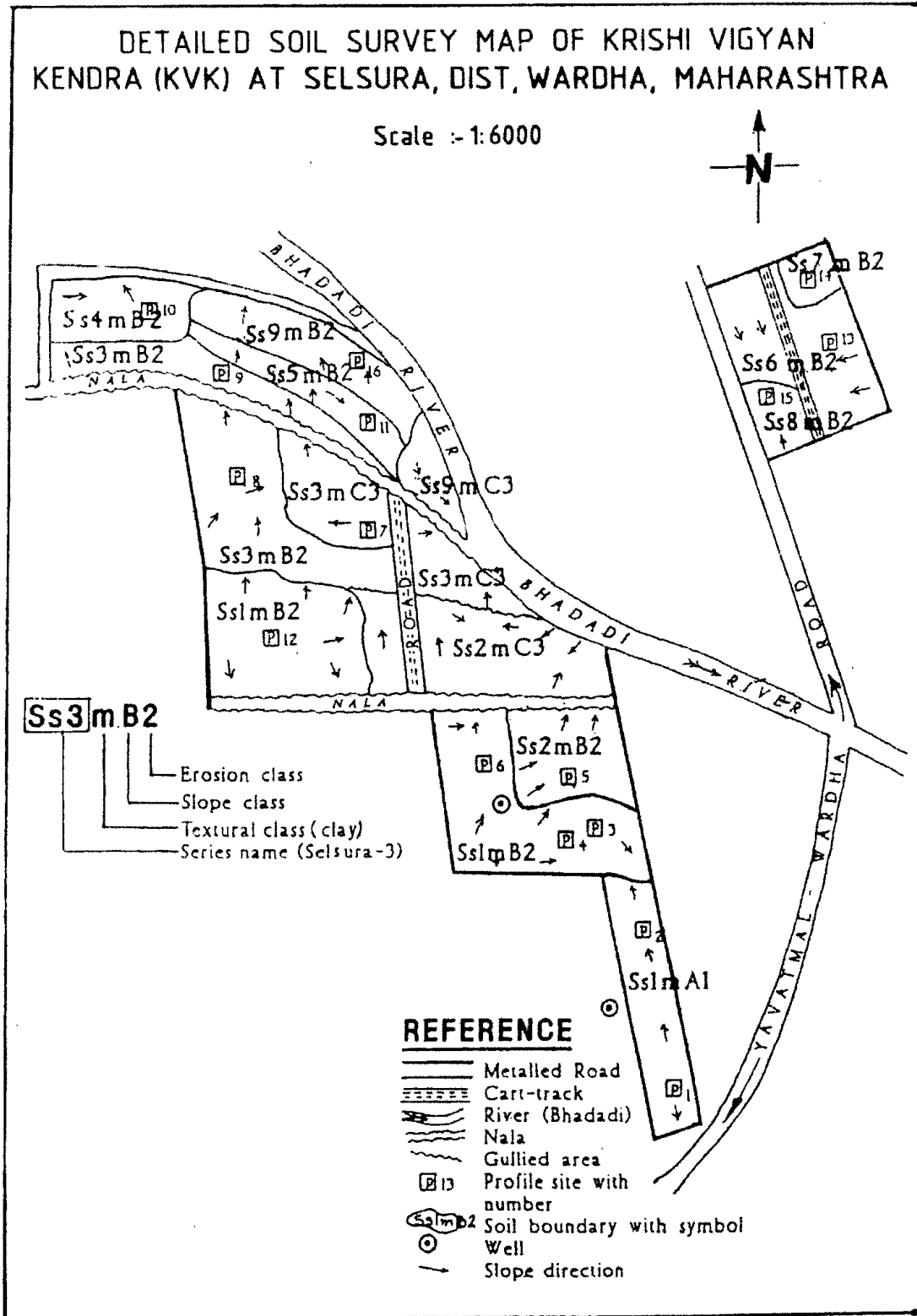


Fig. 1. Detailed soil map of KVK farm at Selsura, Wardha district

Table 2. Physical properties of soils

Hori- zon	Depth (cm)	Particle-size and diameter (mm)			Water retention		Sand/silt ratio
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	33 kPa	1500 kPa	
Selsura-1 (Very fine, smectitic Typic Haplusterts)							
Ap	0-11	14.0	30.5	55.5	36.1	27.7	0.48
Bw1	11-29	12.2	29.3	58.5	37.9	30.5	0.42
Bw2	29-50	11.9	28.8	59.3	38.4	30.8	0.41
Bss1	50-81	12.0	27.5	60.5	39.0	31.8	0.44
Bss2	81-104	11.6	27.0	61.4	40.0	31.7	0.43
BC	104-151+	10.7	26.4	62.9	41.5	28.7	0.41
Selsura-2 (Fine, smectitic Typic Haplustepts)							
Ap	0-16	16.9	28.7	54.6	27.2	17.6	0.59
Bw1	16-39	16.0	27.6	56.4	28.8	18.9	0.58
Bw2	39-53	24.7	26.0	49.3	26.7	14.9	0.95
Bw3	53-61	15.3	27.5	57.2	35.5	19.4	0.55
3Bw4	61-105	17.4	26.4	56.2	30.5	18.6	0.66
3Bss	105-130	13.2	28.4	58.4	38.4	24.8	0.46
3BC	130-148	12.0	27.7	60.3	39.3	21.5	0.43
Selsura-3 (Very fine, smectitic Typic Haplusterts)							
A	0-12	13.2	29.4	57.4	34.8	21.7	0.45
Bw1	12-31	12.9	28.0	59.1	37.5	22.2	0.46
2Bw2	31-61	10.6	27.1	62.3	28.8	22.2	0.39
3Bss1	61-99	1.3	26.0	63.7	29.0	20.5	0.40
4Bss2	99-123	9.4	25.4	65.2	31.4	25.5	0.37
5BC	123-140	21.1	24.0	54.9	23.7	09.5	0.88
Selsura-4 (Fine, smectitic Typic Haplusterts)							
A	0-13	25.6	27.3	47.1	30.3	11.2	0.94
Bw1	13-23	26.3	25.9	47.8	27.9	13.7	1.02
Bw2	23-64	25.8	25.0	49.2	28.4	14.0	1.03
2Bw3	64-99	19.6	24.0	56.4	29.2	20.9	0.82
2Bss1	99-122	17.8	23.5	58.7	31.2	21.9	0.76
2Bss2	122-152	16.4	23.0	60.6	31.4	22.4	0.71
Selsura-5 (Fine, smectitic Vertic Haplustepts)							
A	0-9	27.2	27.9	44.9	22.9	10.0	0.97
Bw1	9-20	26.4	27.0	46.5	22.7	14.4	0.98
Bw2	20-51	22.8	28.0	49.2	23.7	13.8	0.81
Bss	51-65	20.4	28.6	51.0	24.5	15.8	0.71
2C	65-139	42.9	17.6	39.5	15.1	09.4	2.44
Selsura-6 (Very fine, smectitic Typic Haplusterts)							
Ap	0-11	12.4	29.8	57.8	35.6	20.5	0.42
Bw1	11-26	11.5	29.0	59.4	43.6	28.1	0.40
Bw2	26-50	11.2	28.5	60.3	42.6	28.4	0.39
Bss	50-87	10.4	28.1	61.5	38.6	26.5	0.37
Selsura-7 (Clayey, smectitic Typic Ustorthents)							
A	0-16	22.6	23.2	54.2	39.1	202.	--
Selsura-8 (Clayey, smectitic Typic Haplustepts)							
Ap	0-18	12.8	29.1	58.1	38.3	22.6	0.44
Bw	18-33	11.6	28.0	60.4	36.7	23.4	0.41
Selsura-9 : Fine, smectitic Typic Haplusterts							
A	0-14	14.8	30.5	54.7	32.7	24.0	0.49
Bw1	14-38	12.7	29.5	57.8	34.6	23.7	0.43
Bw2	38-71	12.6	29.1	58.3	36.9	23.9	0.43
Bss	71-96	14.0	26.6	59.4	39.1	24.0	0.53
BC	96-126	14.3	25.5	60.2	41.2	24.5	0.56

Table 3. Chemical properties of soils

Hori- zon	Depth (cm)	pH (1:2.5)	Org. C. ----- g kg ⁻¹ -----	CaCO ₃	Exchangeable bases				CEC (NaOAc) (cmol _c kg ⁻¹)	DTPA-extractable				ESP
					Ca	Mg	Na	K		Zn	Cu	Fe	Mn	
					----- cmol (p+) kg ⁻¹ -----				----- mg kg ⁻¹ -----					
Selsura-1 (Very fine, smectitic Typic Haplusterts)														
Ap	0-11	8.4	7.7	95	36.0	10.4	1.4	1.1	50.7	0.72	3.44	1.84	16.04	2.8
Bw1	11-29	8.7	5.5	91	32.0	12.6	4.3	0.6	52.5	0.46	2.72	1.82	10.34	8.2
Bw2	29-50	8.8	5.1	87	33.6	12.0	4.8	0.7	52.9	0.44	2.84	1.80	10.42	9.1
Bss1	50-81	9.0	4.0	98	34.0	13.0	4.7	0.6	53.2	0.28	2.40	1.94	9.04	8.8
Bss2	81-104	9.1	2.9	135	29.2	13.6	4.2	0.5	52.2	0.24	1.60	1.84	6.26	8.0
BC	104-151+	9.2	2.6	153	30.0	10.4	3.4	0.4	46.8	0.18	1.24	2.06	7.20	7.3
Selsura-2 (Fine, smectitic Typic Haplustepts)														
Ap	0-16	8.3	6.6	139	28.0	12.0	0.2	1.1	46.0	0.34	2.26	2.60	17.76	0.2
Bw1	16-39	8.5	5.5	207	28.4	17.6	0.3	0.6	50.0	0.20	1.98	2.64	11.48	0.6
Bw2	39-53	8.6	3.7	228	25.0	7.0	0.2	0.3	36.0	0.12	0.90	2.14	4.82	0.6
Bw3	53-61	8.6	2.8	207	32.4	8.6	0.4	0.3	45.0	0.20	1.36	2.36	6.22	0.9
3Bw4	61-105	8.7	2.6	230	22.6	4.0	0.3	0.2	32.0	0.30	0.66	2.10	4.44	0.9
3Bss	105-130	8.8	2.4	90	34.6	18.6	0.5	0.4	56.0	0.06	0.88	1.70	4.30	0.9
3BC	130-148	8.9	2.2	174	26.0	13.8	0.4	0.2	48.0	1.14	1.56	2.54	4.98	0.8
Selsura-3 (Very fine, smectitic Typic Haplusterts)														
A	0-12	8.4	9.1	83	39.4	11.8	0.2	0.9	55.4	0.32	2.62	2.80	18.48	0.4
Bw1	12-31	8.5	8.3	77	39.8	13.8	0.3	0.4	56.7	0.14	2.40	3.06	12.86	0.5
2Bw2	31-61	8.5	6.8	58	38.6	16.4	0.5	0.4	56.3	0.14	1.76	2.36	8.42	0.9
3Bss1	61-99	8.6	6.0	55	38.2	18.8	0.9	0.4	57.2	0.12	1.40	2.12	6.72	1.6
4Bss2	99-123	8.7	5.7	116	30.2	20.0	1.3	0.4	52.4	0.16	1.70	2.60	6.56	2.3
5BC	123-140	8.9	3.8	187	18.2	8.2	0.8	0.2	36.2	0.14	0.68	2.08	3.70	2.3
Selsura-4 (Fine, smectitic Typic Haplusterts)														
A	0-13	8.3	11.4	177	33.8	07.0	0.2	0.5	44.7	0.34	2.76	2.88	17.76	0.4
Bw1	13-23	8.4	8.4	196	32.8	07.8	0.2	0.2	45.5	0.18	2.68	2.66	14.96	0.4
Bw2	23-64	8.5	7.9	206	27.0	06.8	0.2	0.2	36.8	0.14	1.40	2.58	10.80	0.5
2Bw3	64-99	8.5	6.3	101	36.6	12.4	0.3	0.3	52.2	0.18	2.54	3.44	13.80	0.6
2Bss1	99-122	8.5	5.4	111	33.8	15.4	0.3	0.3	53.8	0.10	1.22	1.92	07.18	0.6
2Bss2	122-152	8.5	2.2	097	34.4	16.4	0.4	0.4	54.2	0.20	2.42	3.22	12.62	0.7
Selsura-5 (Fine, smectitic Vertic Haplustepts)														
A	0-9	8.4	5.4	206	24.2	11.8	0.2	0.4	42.0	0.26	1.88	2.84	10.84	0.5
Bw1	9-20	8.5	3.5	157	26.6	15.4	0.2	0.2	44.5	0.18	2.54	3.08	11.20	0.6
Bw2	20-51	8.6	3.0	178	25.4	15.4	0.2	0.2	44.0	0.20	2.72	3.32	10.64	1.5
Bss	51-65	8.6	2.1	206	14.4	14.4	0.3	0.2	48.0	0.18	2.64	3.26	08.06	1.8
2C	65-139	8.5	0.6	206	09.6	09.6	0.2	0.2	36.0	0.24	1.42	2.84	08.00	2.2
Selsura-6 (Very fine, smectitic Typic Haplusterts)														
Ap	0-11	8.1	7.2	53	40.0	11.2	0.3	0.9	55.0	0.96	3.34	3.32	22.22	0.5
Bw1	11-26	8.2	4.9	68	42.0	7.2	0.3	0.5	52.0	0.36	1.34	1.88	11.34	0.6
Bw2	26-50	8.3	3.9	53	43.2	9.2	0.9	0.3	56.5	0.26	2.10	3.14	18.66	1.6
Bss	50-87	8.4	2.6	60	44.4	9.4	0.9	0.4	58.0	0.22	2.14	3.04	15.24	1.6
Selsura-7 (Clayey, smectitic Typic Ustorthents)														
A	0-16	8.1	4.1	65	42.4	4.6	0.2	0.5	48.6	0.44	2.34	3.36	13.54	0.4
Selsura-8 (Clayey, smectitic Typic Haplustepts)														
Ap	0-18	8.3	9.5	63	42.6	11.4	1.3	0.6	57.0	0.54	1.96	1.96	19.06	2.3
Bw	18-33	8.4	6.1	55	40.4	13.6	1.2	0.4	58.0	0.40	2.62	3.30	18.82	2.1
Selsura-9 (Fine, smectitic Typic Haplusterts)														
A	0-14	8.0	5.7	111	34.4	11.0	0.3	0.5	48.0	0.42	3.84	3.54	19.32	0.6
Bw1	14-38	8.3	4.9	142	32.0	11.2	0.4	0.3	52.0	0.30	3.26	3.54	13.64	0.8
Bw2	38-71	8.5	4.3	143	30.6	13.0	0.7	0.3	48.0	0.31	3.20	3.45	12.12	1.5
Bss	71-96	8.8	3.2	153	26.0	16.0	1.7	0.2	49.0	0.28	3.17	3.39	11.91	3.5
BC	96-126	8.9	1.7	137	24.0	17.0	2.6	0.2	52.0	0.25	3.12	3.21	10.23	5.0

The distribution of particle-size fractions (Table 2) and their nature shows allegiance towards basaltic parent material. The amount of clay in Selsura-1, Selsura-3 and Selsura-6 series varied from 60 to 63% in the control section. In Selsura-2 series, there is a

decrease in clay content at 39-53 cm due to lithological discontinuity (70-80% gravels mainly of calcretes). In case of Selsura-4 series, there is a sudden change in horizon sequence at 64 cm due to lithological discontinuity. The C horizon of this series mainly

comprises calcareous gravels greater than 2 mm size about 80-90% by volume (not analysed). This may be due to paleo-channels of streams which have been buried by basaltic alluvium. Similar is the case with Selsura-9 series, where C horizon, mainly a sandy layer that shows the shifting of river channels. Series Selsura-7 and Selsura-8, though shallow, have relatively high clay (>54%).

Soil-water pH of the series ranged between 8.0 to 9.2. The pH of the soils showed that there is slight trend towards sodicity from the more or less CaCO_3 buffered-soil system of pH 8.2. Calcium carbonate (CaCO_3) equivalent varied from 53 to 230 g kg^{-1} . Organic carbon ranged from 11.4 to 4.1 g kg^{-1} at the surface and as low as 2.2 g kg^{-1} at a depth of about 150 cm. Exchange characteristics of these soils are typical of shrink-swell soils with calcium dominating the exchange complex. Calcium is relatively less in Selsura-2, Selsura-3, Selsura-4, Selsura-5 and Selsura-9 than in Selsura-1, Selsura-6, Selsura-7 and Selsura-8 series. Exchangeable sodium is reasonably high in Selsura-1 series and thus sub-soil sodicity may be a matter of concern. This is because the ESP values vary between 7 to 9 in the sub-surface horizons (Table 3).

DTPA-extractable Zn shows a more or less decreasing trend with increasing depth for all the soils. It further indicates that all the soils except few surface horizons are deficient in Zn content as its value is below the critical level set at 0.6 mg kg^{-1} by Katyal (1985) and Sharma *et al.* (1996). These soils are usually calcareous accompanied by high pH which may aggravate the deficiency of available Zn due to deleterious effect of CaCO_3 on one hand and formation of insoluble Zn $(\text{OH})_2$ or ZnO on the other. The cultivated soils (Selsura-1, Selsura-6, Selsura-8) had slightly higher values of available Zn than uncultivated soils (Selsura-3, Selsura-4, Selsura-5, Selsura-9)

because of root zone activity (Jagdish Prasad and Gajbhiye 1999). Zinc did not show any relationship with clay or organic carbon. The DTPA-extractable Cu is not deficient in any of these soils, irrespective of the soils being cultivated/ uncultivated as the value of available Cu is higher than the critical level of 0.2 mg kg^{-1} (Katyal and Randhawa 1983). The surface horizons of cultivated soils are normally higher in Cu than those of uncultivated soils. The available Fe ranged from 1.7 to 3.5 mg kg^{-1} and found to be lower than the critical value of 4.5 mg kg^{-1} (Lindsay and Norvell 1978). Iron deficiency in calcareous black soils has also been reported by Yelvikar *et al.* (1996) in Bhir district of Maharashtra. Malewar and Randhawa (1978) have shown that all forms of Fe were positively correlated with organic carbon, which however, is not evident in these soils. DTPA-Mn in these soils varies from 3.7 to 22.2 mg kg^{-1} which is much higher than the critical value of 3 mg kg^{-1} (Takkar *et al.* 1989). Mn deficiency usually does not occur in black soils because a sizeable portion of Mn is bound with manganese oxide which may be readily available (Singh *et al.* 1988). DTPA-Mn decreased drastically with depth for most of these soils.

The mapping units were grouped into land capability classes II and IV associated with limitations of erosion and wetness hazards and land irrigability class of 2 to 4 with limitations of soil, drainage and topography. The soils of Selsura-7 are not suitable for rainfed cotton, sorghum, pigeonpea, groundnut and soybean, Selsura-2 for groundnut, Selsura-8 for soybean but others are suitable (moderately/ marginally suitable) for these crops. The climate, flooding, depth of soil, drainage, erosion, pH, CaCO_3 and organic carbon are limiting factors (Table 4).

Table 4. Land capability, land irrigability and suitability of soils for different crops

Mapping Symbol	Land capability	Land Irrigability	Suitability class (with limitations)				
			Soybean	Cotton	Sorghum	Pigeon pea	Groundnut
Ss1mA1	IIs	2ds	S2 (d,c,k,o, p,e)	S2 (dko)	S2 (dko)	S2 (dko)	S3 (dc,p,e)
Ss1mB2	IIIs	3ds	S2 (dckope)	S2 (sdko)	S2 (dkop)	S2 (sdko)	S3 (sdcpe)
Ss2mB2	IIIs	3ds	S2 (ckop)	S2 (sko)	S2 (kop)	S2 (sko)	S3 (scp)
Ss2mC3	IVes	4dts	S2 (ckop)	S3 (sko)	S3 (skop)	S3 (sko)	S3 (scp)
Ss3mB2	IIIsw	3ds	S2 (dckp)	S2 (sdk)	S2 (kp)	S2 (sk)	S3 (sdc)
Ss3mC3	IVse	4dts	S2 (ckp)	S3 (sk)	S3 (skp)	S3 (sk)	S3 (scp)
Ss4mB2	IIIs	3ds	S3 (fckp)	S3 (fsdk)	S3 (fkp)	S3 (fsk)	N1 (fsdc)
Ss5mB2	IIIs	3ds	S3 (fkp)	S3 (fsk)	S3 (fsk)	S3 (fsk)	N1 (fs)
Ss6mB2	IIIs	3ds	S2 (cop)	S2 (so)	S2 (sop)	S2 (so)	S3 (scp)
Ss7mB2	VI s e	5s	N2 (t)	N2 (t)	N2 (t)	N2 (t)	N1 (tc)
Ss8mB2	VI s	4s	N1 (t)	S3 (sto)	S3 (sto)	S3 (sto)	S3 (sc)
Ss9mB2	IIIs	3ds	S3 (sfcop)	S3 (sfo)	S3 (sfop)	S3 (sfo)	S3 (sfcp)
Ss9mC3	IVs, e	4dts	N1 (sfcop)	N1 (sfo)	N1 (sfop)	N1 (sfo)	N2 (sfcp)

Letters in parentheses show limitations as d-drainage; c-high clay, k-CaCO₃, o-organic carbon, p-pH, e-ESP, s-erosion, f-occasional flooding (stagnation of water); t-depth.

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