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Characterization and classification of soils of farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani by using RS and GIS techniques

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Abstract

The present research was carried out with aimed to characterize and classify soil as per soil taxonomy. Seventeen representative soil profiles from different land units of study area were characterized and classified. The soils of the study area were very shallow to very deep, colour varied from 10YR 2/1 black to 10YR 7/2 light gray, clayey in texture, medium, weak subangular blocky to medium, strong, angular blocky in structure; slightly hard to very hard in dry, friable to firm in moist and in wet condition slightly sticky slightly plastic to very sticky very plastic in consistency. Bulk density varied from 1.31 to 1.85 Mg m⁻³; hydraulic conductivity varied from 0.46 to 3.88 cm hr⁻¹; the clay content ranged from 54.34 to 68.81 percent and gradually increased with depth; available water capacity (AWC) of the study area varied from 12.46 to 20.79 percent and plant available water capacity (PAWC) varied from 83.09 to 352.91 mm. The soils were neutral to strongly alkaline in pH, safe in salt concentration. Very low to very high in organic carbon percent; slight to highly calcareous CaCO₃ (3.3 to 16.5 percent). The soils were well fertile with CEC ranging from 49.87 to 69.74 cmol (P⁺) kg⁻¹. The ESP of the study area varied from 0.52 to 24.91 percent. The soils were very low to low in available nitrogen as well as in available phosphorus too, high to very high in available potassium, and deficient to sufficient in available sulfur content. Similarly, soils were sufficient to deficient in DTPA Zn and sufficient in Cu, Fe and Mn. whereas available boron was found very low to moderately high. Taxonomically the soils of study area were classified under dominant soil orders Inceptisols and Vertisols whereas at subgroup level these soils are classified as Calcic Haplustepts, Typic Haplusterts, Calcic Haplusterts and Sodic Haplusterts.

Keywords: VNMKV Parbhani, RS and GIS, morphological, physical, chemical and soil classification

Introduction

Soil is considered the living skin of the earth, and it acts as a medium for plant growth and helps to sustain animal and human activity on earth (Wu *et al.*, 2019). Soil plays an integral part in the global environmental sustainability challenges of food security, water security, climate stability, biodiversity, and ecosystem service delivery. Accurate mapping of soil properties is crucial for adequate management both at global and local levels (Forkuor *et al.*, 2017) ^[5].

Soil survey, commonly referred to as soil identification, and the systematic classification of soil types alongside various soil properties within a specified geographical area, as well as the geo-encoding of such data. This discipline employs fundamental scientific principles and is significantly informed by geomorphological studies, theories pertaining to soil genesis, physical geography, and the examination of vegetation and land use patterns. Primary data for conducting surveys are obtained through field sampling methodologies and remote sensing techniques. Remote sensing predominantly utilizes aerial photography; however, the implementation of other advanced digital methodologies is progressively gaining prominence. The information in a soil survey can be used by the public as well as the scientific community. For example, farmers and ranchers can use it to help determine that particular soil type is suited for crops or livestock and what type of soil management might be required. Remote Sensing Technology has exhibited considerable capability in the identification, characterization, and classification of issues and opportunities pertaining to natural resources. Hence, the aim of present research was to characterize and classify soils of VNMKV farm Parbhani for sustainable land use planning.

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Materials and Methods

The study area “Farm, VNМКV” comes under “Parbhani District” lies between 19° 11' 49.2" N latitude and 76° 47' 34.4" E longitude. The total area of the study area is 7,697.21 acres (3,116.47 ha) with elevation in the range of 388 to 435 M above MSL. The study area falls in parts of survey of India toposheet No. 56A/15 and 56A/16. The region receives annual rainfall in the range of 500 to 1100 mm with average of 767.8 mm and comes under assured rainfall zone. The mean maximum and minimum air temperature are 30.4 °C and 22.0 °C respectively.

The sampling sites were decided on the basis of landform. To understand the soil variability in the different farms of VNМКV, Parbhani seventeen representative soil profiles as shown in Fig no.1 were collected. Site and soil characteristics like slope, stoniness, erosion, color, texture, structure, soil type shallow to deep etc. were recorded as per Soil Survey Division Staff (2000) [17]. Nearly 1.0 kg of representative soil sample from each horizon of all the representative profiles were collected and dried in laboratory at room temperature, grinded using wooden mortar and pestle, screened through 2 mm sieve, properly labeled and stored in polythene bags for laboratory analysis.

The particle size distribution analysis was carried out as per the international pipette method (Jackson, 1979) [8]. The bulk density was determined by clod coating method (Piper, 1966) [14]. Hydraulic Conductivity of soil was determined by constant head method as described by Richard (1954) [15]. (AWC) and (PAWC) was determined at the soil moisture range of 33 kPa and 1500 kPa on pressure plate apparatus using the expression suggested by Gardner *et al.* (1984) [6] and latter modified by Coughlan *et al.*, (1986) [3]. The chemical properties of soils pH and EC was determined 1:2.5 soils: water suspension using pH and conductivity meter as per method described by Jackson (1979) [8]. The calcium carbonate was estimated by rapid titration method as described by Piper (1966) [14]. Modified Walkley and Black's rapid titration procedure was followed for estimating the organic carbon content (Jackson 1958) [10]. CEC was estimated with 1N sodium acetate (pH 8.2) (Richards, 1954) [15]. Exchangeable calcium and magnesium were determined by leaching with 1 N NaCl solution (Piper, 1966) [14] and titrating the leachate with standard EDTA solution as per the method of Richards (1954) [15]. Exchangeable sodium and potassium were determined by leaching soil with 1N ammonium acetate (pH 7.0) solution using flame emission photometer (Jackson, 1958) [10]. Available Nitrogen was determined by alkaline permanganate method by using Kel-plus distillation unit (Subbiah and Asija, 1956) [20]. Available phosphorus was determined by Olsen's method; reading was recorded using spectrophotometer (Jackson, 1967) [9]. Available potassium was determined by flame photometer using 1 N Neutral ammonium acetate (pH 7.0) solution as an extractants described by (Jackson, 1967) [9]. Available sulphur was determined by turbidity method described by Williams and Steinberg (1959) [22]. Available boron was determined as per the standard procedure by Berger and Truog (1939) [1].

Results and Discussion

Morphological Characteristics

Morphological characteristics as given in Table.1 like soil depth, soil colour, texture, structure, consistency, porosity, roots and effervescence which refers to the intrinsic properties of the soils profile that can be felt in the field all are taken into study as per the process outlined in the “field guide for soil survey handbook”, (NBSS & LUP, Nagpur). results shows that the soil colour of study area varied from 10YR 2/1 black to 10YR 7/2

light gray and 5YR 3/3 Dark reddish brown (Cr-horizon). The soils were shallow 30 cm (P₁₁ and P₁₅), moderately deep to very deep >150 cm near the valley, along with cracks at surface and extended up to a depth of 50 cm, the pressure faces were observed in most of the profiles with well-developed slicken sides. similar results were also reported by (Malode *et al.*, 2021) [11] in arid and semi-arid zones of Marathwada region of Maharashtra during 2011-12. Soil structure in general observed is medium, weak sub-angular blocky to medium strong angular blocky. Whereas soil consistency of study area varied from slightly hard to very hard, friable to firm and slightly sticky slightly plastic to very sticky very plastic in dry, moist and wet condition respectively.

Physical properties

Physical properties of soils were presented in Table.2 shows that bulk density of study area varied from 1.31 to 1.85 Mg m⁻³. The hydraulic conductivity of the study area varied from 0.46 to 3.88 cm hr⁻¹. The hydraulic properties of Vertisols are impaired due to the formation of pedogenic CaCO₃ and the concomitant development of subsoil sodicity even at a low ESP (Vaidya and Pal, 2002) [21]. The particle size distribution i.e. sand, silt and clay content of the study area varied from 1.04 to 5.31, 29.79 to 41.85, and 54.34 to 68.81 percent respectively, the soil developed on lower topographic positions showed higher clay content gradually increased with depth, indicating clay illuviation in Vertisols (Pal *et al.*, 2006; Deshmukh., 2012) [12, 4]. topography and slope were found to affect the particle size distribution (Ghode *et al.*, 2023) [7]. The moisture retention at 33 kPa and 1500 kPa were analyzed and results shows that available water capacity (AWC) of the study area varied from 12.46 to 20.79 percent and plant available water capacity (PAWC) varied from 83.09 to 352.91 mm.

Chemical properties and Nutrient status

The soils chemical and nutrient data presented in Table.3 shows that the pH of the study area varied from neutral (7.30) to strongly alkaline (8.70), safe in salt concentration in the range of 0.11 to 2.20 dSm⁻¹. Organic carbon varied from (0.30%) low to very high (1.14%). The calcium carbonate ranges from 3.3 to 16.5 percent, it was observed highest CaCO₃ in soils of *Calcic Haplustepts* (P₁₁ and P₁₅) followed by *Calcic Haplusterts* (P₁₂ and P₁₇). It was observed that calcium carbonate is low in soils developed on undulating upland whereas it was high in the soils of undulating lowland and valley, this may be due to the leaching of calcium salts from up-slope and its deposition down the slope (Patangray *et al.* 2018) [13]. Cation exchange capacity (CEC) varied from 49.87 to 69.74 cmol(P⁺) kg⁻¹. Whereas exchangeable bases in most of the pedons were found in the order of Ca²⁺ > Mg²⁺ > Na⁺ > K⁺ on the exchange complex of soils. The high CEC of black soils is attributed to the high clay content and the presence of smectite minerals (Sinha *et al.* 2020) [16]. Exchangeable sodium percentage (ESP) of study area varied from 0.52 to 24.91 percent indicating highest in soils of *Sodic Haplusterts* (P₃ and P₁₀).

The nutrient data presented in Table.4 shows that, the soils were very low (62.72 kg ha⁻¹) to low (222.79 kg ha⁻¹) in available nitrogen as well as in available phosphorus too (2.60 to 13.80 kg ha⁻¹), high to very high in available potassium (316.12 to 875.30 kg ha⁻¹). Deficient to sufficient in available sulfur content. Likewise, soils were sufficient to deficient in DTPA Zn and sufficient in Cu, Fe and Mn. whereas available boron was found very low to moderately high in some soils and it was found decrease with depth.

Soil classification

Soils of VNMKV farms were classified according to USDA 'Soil Taxonomy', a comprehensive system of soil classification (Soil Survey Staff, 1998) [19]. The dominant soils of the study area are typified under two orders *viz.* *Inceptisols* and *Vertisols*. The soils of pedons (P₆, P₁₁, P₁₅, and P₁₆) have subsurface horizons within 100 cm of the mineral soil surface and were grouped in the order *Inceptisols*. Further, the study area was coming under ustic moisture regime, therefore these were classified as *Ustepts* at the sub-orders. Furthermore, these pedons having a calcic horizon within 100 cm of the mineral soil surface as a result these soils were grouped under *Calcic Haplustepts*. The pedons (P₁, P₂, P₃, P₄, P₅, P₇, P₈, P₉, P₁₀, P₁₂, P₁₃, P₁₄ and P₁₇) having more than 25 cm thick layer, within 100 cm of the mineral soil surface along with slickensides, wedge-shaped peds and deep cracks that open and close periodically, hence these soils were classified under order *Vertisols*. Pedons

(P₁, P₂ and P₉) classified at sub-group level as *Typic Haplusterts* because these soils do not key out for other sub-groups. Furthermore, Pedons (P₇, P₈, P₁₂, P₁₄ and P₁₇) are classified at sub-group level as *Calcic Haplusterts* because these soils having calcic horizons within 150 cm of the mineral soil surface. Likewise, Pedons (P₃, P₄, P₅, P₁₀ and P₁₃) classified at sub-group level as *Sodic Haplusterts* because these soils having horizons with exchangeable sodium percentages of more than 15 within 100 cm of the mineral soil surface.

The extent and distribution of soil orders shows that major soil order *viz.* *Inceptisols* and *Vertisols* occupy an area of 11.06 percent (344.53 ha) and 88.94 percent (2771.75 ha) respectively. Whereas, the Extent and distribution of major soil subgroups and soil type as shown in Fig. 2 of *Calcic Haplustepts* covers 344.53 ha (11.05 percent), *Typic Haplusterts* occupied 693.78 ha (22.26 percent), *Calcic Haplusterts* occupied 1194.03 ha (38.31 percent), *Sodic Haplusterts* occupied 883.94 ha (28.36 percent).

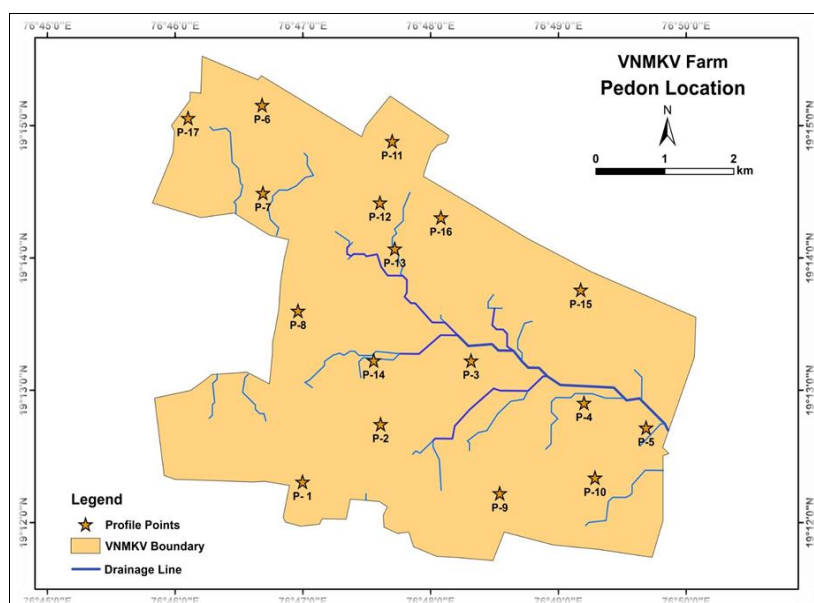


Fig 1: Location map of soil profile samples of VNMKV Farm, Parbhani

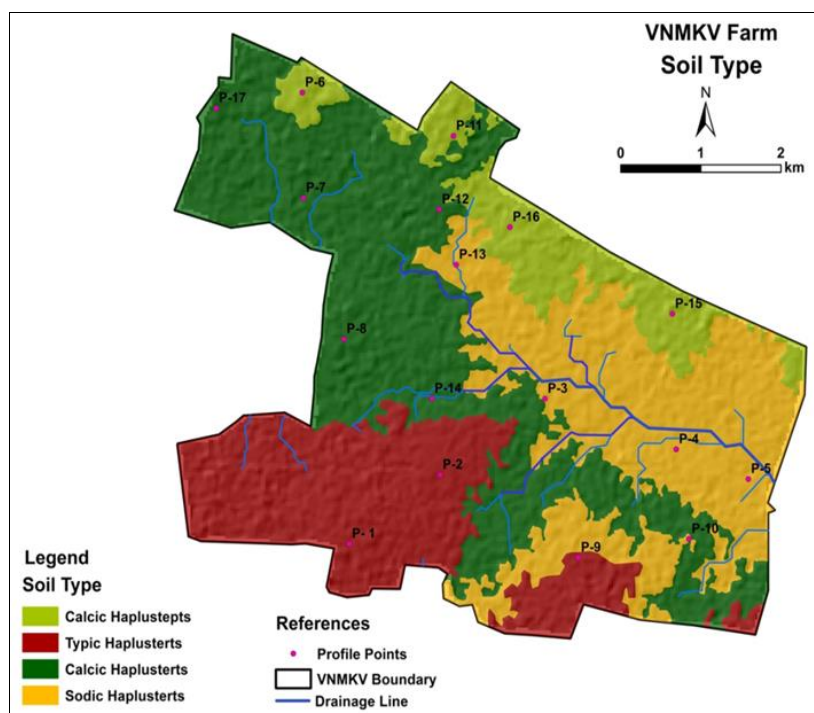


Fig 2: Soil type map of VNMKV Farm, Parbhani

Table 1: Morphological characteristics of soils of VNMKV, Farm Parbhani

Horizon	Depth (cm)	Boundary		Matrix Colour	Texture	Structure			Consistency			Pores		Root		Effervescence
		D	T			Size	Grade	Type	Dry	Moist	Wet	Size	Quantity	Size	Quantity	
Pedon 1 Central farm “A” block (Taroda block) VNMKV, Parbhani. (Typic Haplusterst)																
Ap	0-25	c	s	10YR 3/2	c	m	2	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw1	25-47	c	s	10YR 3/1	c	m	3	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw2	47-68	c	s	10YR 3/1	c	m	2	abk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	es
Bss1	68-102	c	s	10YR 3/1	c	m	3	abk	h	fi	vsvp	vf, f	m, m	f, c	f, m	es
Bss2	102-135	c	s	10YR 3/1	c	m	3	abk	h	fi	vsvp	vf, f	m, m	c	m	es
Cr	135-150			10YR 6/2	s	m	1	gr	l	fr	nsnp	c	m	c	f	ev
Pedon 3 Khanapur “B” block VNMKV, Parbhani. (Sodic Haplusterst)																
Ap	0-26	c	s	10YR 4/1	c	m	2	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw	26-50	c	s	10YR 3/1	c	m	3	sbk	h	fi	vsvp	vf, f	m, m	vf, f	m, m	es
Bss1	50-75	c	s	10YR 3/1	c	m	2	abk	h	fi	vsvp	vf, f	m, m	vf, f	f, m	ev
Bss2	75-110	s	s	10YR 3/1	c	m	3	abk	vh	fi	vsvp	vf, f	m, m	f, c	f, m	ev
Bss3	110-150	c	s	10YR 3/1	c	m	3	abk	vh	fi	vsvp	vf, f	m, m	c	m	ev
Pedon 9 Central farm “C” block (Sayala block) VNMKV, Parbhani. (Typic Haplusterst)																
Ap	0-25	c	s	10YR 2/1	cl	m	2	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw	25-47	c	s	10YR 3/ 1	c	m	3	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	es
Bss1	47-80	c	s	10YR 4/1	c	m	2	abk	h	fi	vsvp	vf, f	m, m	vf, f	f, m	es
Bss2	80-120	c	s	10YR 4/1	c	m	3	abk	h	fi	vsvp	vf, f	f, m	f, c	f, f	es
Ck	120+	c	s	10YR 5/2	s	m	1	gr	sh	fr	nsnp	c	m	c	f	ev
Pedon 10 Shendra “C” block (New organic farm, Takalgavhan) VNMKV, Parbhani. (Sodic Haplusterst)																
Ap	0-22	c	s	10YR 3/1	c	m	2	sbk	h	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw	22-55	c	s	10YR3/1	c	m	3	sbk	h	fr	vsvp	vf, f	m, m	vf, f	m, m	es
Bss1	55-74	c	s	10YR 3/2	c	m	2	abk	vh	fi	vsvp	vf, f	m, m	vf, f	f, m	ev
Bss2	74-122	c	s	10YR 3/2	c	m	3	abk	vh	fi	vsvp	vf, f	f, m	f, c	f, f	ev
Ck	122+	c	s	10YR 6/4	s	m	3	gr	h	fi	nsnp	c	m	c	f	ev
Pedon 11 Organic farming research project (behind NAHEP cent.) VNMKV, Parbhani. (Calcic Haplustepts)																
Ap	0-18	c	s	10YR 4/2	c	m	1	sbk	sh	fr	ssps	vf, f	m, m	vf, f	m, m	e
Bw	18-30	c	s	10YR 4/2	sic	m	2	sbk	sh	fr	ssps	vf, f	m, m	f, c	f, m	es
Ck	30 +	c	s	10YR 7/1	s	m	1	gr	sh	fr	nsnp	c	m	c	f	ev
Pedon 12 Dept. of Agricultural Meteorology VNMKV, Parbhani. (Calcic Haplusterst)																
Ap	0-23	c	s	10YR 3/2	cl	m	2	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw	23-49	c	s	10YR 3/1	cl	m	3	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bss1	49-74	c	s	10YR 2/2	c	m	2	abk	h	fi	vsvp	vf, f	m, m	vf, f	m, m	e
Bss2	74-98	c	s	10YR 2/2	c	m	2	abk	h	fi	vsvp	vf, f	f, m	f, c	f, m	e
Ck	98+	c	s	5YR 3/3	s	m	1	sbk	sh	fr	nsnp	c	m	c	f	ev
Pedon 15 Old Shendra village (near railway track line) VNMKV, Parbhani. (Calcic Haplustepts)																
Ap	0-22	c	s	10YR 3/2	sic	m	1	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	es
Bw	22-40	c	s	10YR 3/2	c	m	2	sbk	sh	fr	vsvp	vf, f	m, m	f, c	m, f	ev
Cr	40+	c	s	10YR 6/2	s	m	1	gr	h	fi	nsnp	c	m	c	f	ev
Pedon 17 AICRP Sorghum research station VNMKV, Parbhani. (Calcic Haplusterst)																
Ap	0-24	c	s	10YR 4/2	c	m	2	sbk	sh	fr	vsvp	vf, f	m, m	vf, f	m, m	e
Bw	24-48	c	s	10YR 5/2	c	m	3	sbk	h	fi	vsvp	vf, f	m, m	vf, f	m, m	es
Bss1	48-74	c	s	10YR 5/2	c	m	2	abk	h	fi	vsvp	vf, f	m, m	vf, f	m, m	es
Bss2	74-91	c	s	10YR 5/2	c	m	3	abk	h	fi	vsvp	vf, f	m, m	vf, f	m, m	ev
Bss3	91-123	c	s	10YR 6/3	c	m	3	abk	h	fi	vsvp	vf, f	f, m	f, c	f, m	ev
Cr	123+	c	s	10YR 5/4	s	m	2	gr	h	fi	nsnp	c	m	c	f	ev

Table 2: Physical properties of soils of VNMKV Farm Parbhani

Horizon	Depth range (cm)	Depth (cm)	Coarse Fragment (%)	BD (Mg m ⁻³)	HC (cm hr ⁻¹)	Particle size analysis (%)			Moisture retention (%)		AWC (%)	PAWC (mm)
						Sand	Silt	Clay	33 kPa	1500 kPa		
Pedon 1 Central farm “A” block (Taroda block) VNMKV, Parbhani. (Typic Haplusterts)												
Ap	0-25	25	02.78	1.41	3.85	4.78	33.68	61.54	34.25	20.61	13.63	329.03
Bw1	25-47	22	04.43	1.43	2.46	3.37	36.59	60.04	37.07	22.74	14.33	
Bw2	47-68	21	3.25	1.51	2.18	1.04	35.71	63.25	38.27	22.41	15.86	
Bss1	68-102	34	5.17	1.53	1.62	1.92	33.09	64.99	41.36	23.61	17.75	
Bss2	102-135	33	7.69	1.63	1.86	1.81	34.17	64.02	44.58	27.24	17.34	
Cr	135+		18.24	1.58	8.25	24.41	28.71	46.88	28.40	17.81	10.59	
Pedon 3 Khanapur “B” block VNMKV, Parbhani. (Sodic Haplusterts)												
Ap	0-26	26	3.78	1.53	1.28	3.99	36.32	59.69	39.77	27.30	12.46	352.91
Bw	26-50	24	2.49	1.72	1.32	2.20	37.78	60.02	41.71	28.56	13.15	
Bss1	50-75	25	1.49	1.73	1.08	1.20	38.63	60.17	44.81	28.92	15.89	
Bss2	75-110	25	4.21	1.81	0.61	1.72	32.72	65.56	45.29	29.11	16.18	
Bss3	110-150	40	5.79	1.85	0.46	1.48	36.63	61.89	42.93	28.46	14.47	

Pedon 9 Central farm “C” block (Sayala block) VNMKV, Parbhani. (Typic Haplusterts)												
Ap	0-25	25	6.36	1.58	2.55	3.78	35.68	60.54	39.27	22.96	16.31	351.64
Bw	25-47	22	5.21	1.63	2.34	2.37	38.59	59.04	40.73	24.41	16.32	
Bss1	47-80	33	6.31	1.77	1.77	1.88	33.87	64.25	42.24	24.75	17.49	
Bss2	80-120	40	4.36	1.79	1.51	1.92	36.09	61.99	42.41	24.73	17.68	
Cr	120+		19.34	1.70	8.11	29.41	32.49	38.10	31.54	16.89	14.65	
Pedon 10 Shendra “C” block (New organic farm, Takalgavhan) VNMKV, Parbhani. (Sodic Haplusterts)												
Ap	0-22	22	7.61	1.49	3.88	4.00	33.65	62.35	36.16	20.19	15.97	327.30
Bw	22-55	33	5.34	1.64	2.95	3.40	35.37	61.23	36.71	22.13	14.58	
Bss1	55-74	19	7.65	1.75	1.10	1.24	33.47	65.29	39.36	21.61	15.74	
Bss2	74-122	48	9.21	1.78	1.70	1.05	33.22	65.73	42.41	25.59	16.82	
Cr	122+		21.53	1.70	8.97	28.41	25.93	45.66	28.64	17.47	11.17	
Pedon 11 Organic farming research project (behind NAHEP cent.) VNMKV, Parbhani. (Calcic Haplustepts)												
Ap	0-18	26	3.51	1.31	3.16	5.31	39.53	55.16	33.98	1.93	19.05	83.09
Bw	18-30	22	8.64	1.53	2.09	3.77	35.44	60.79	37.91	17.12	20.79	
Cr	30+		38.41	1.79	9.51	32.01	32.97	35.02	19.64	11.54	8.10	
Pedon 12 Dept. of Agricultural Meteorology VNMKV, Parbhani. (Calcic Haplusterts)												
Ap	0-23	23	3.51	1.31	2.29	3.51	34.18	62.31	31.76	16.92	14.84	231.23
Bw	23-49	26	5.41	1.49	2.26	3.19	32.71	64.10	33.73	17.34	16.39	
Bss1	49-74	25	3.61	1.58	1.32	1.51	29.79	68.70	36.23	21.75	14.48	
Bss2	74-98	24	4.17	1.66	1.35	1.13	30.06	68.81	37.41	22.63	14.78	
Cr	98-150>	52	17.34	1.73	9.41	29.44	26.13	44.43	22.87	13.25	9.62	
Pedon 15 Old Shendra village (near railway track line) VNMKV, Parbhani. (Calcic Haplustepts)												
Ap	0-22	22	6.71	1.57	2.08	3.81	41.85	54.34	26.82	13.73	13.09	91.05
Bw	22-40	18	5.16	1.62	2.64	3.47	40.25	55.28	28.43	12.71	15.72	
Cr	40+		19.34	1.74	11.32	38.79	29.15	32.06	21.11	10.43	10.68	
Pedon 17 AICRP Sorghum research station VNMKV, Parbhani. (Calcic Haplusterts)												
Ap	0-24	24	4.36	1.58	3.28	3.98	39.24	59.49	34.94	19.32	15.61	352.59
Bw	24-48	24	3.51	1.63	2.33	4.11	31.24	64.65	33.89	17.77	16.12	
Bss1	48-74	26	4.13	1.71	1.93	3.70	30.29	66.01	33.12	16.46	16.66	
Bss2	74-91	17	6.43	1.78	1.86	2.49	31.03	66.48	36.38	18.99	17.39	
Bss3	91-123	32	8.16	1.73	1.75	1.27	27.37	68.65	37.23	18.51	18.72	
Cr	123+		18.47	1.71	9.20	24.65	31.65	43.70	24.56	13.63	10.93	

Table 3: Chemical properties of soils of VNMKV Parbhani

Horizon	Depth (cm)	pH	EC (dSm ⁻¹)	OC (%)	CaCO ₃ (%)	CEC (Cmol (p ⁺) / kg)	Exchangeable Cations (cmol (p ⁺) / kg)					B.S. %	Ca:Mg	ESP %
							Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	Sum of Cation (p+) kg ⁻¹			
Pedon 1 Central farm “A” block (Taroda block) VNMKV, Parbhani. (Typic Haplusterts)														
Ap	0-25	7.84	0.14	1.11	4.5	64.12	48.55	12.95	0.37	0.44	62.31	97.18	3.75	0.71
Bw1	25-47	7.88	0.17	1.01	5.2	63.54	51.85	12.80	0.64	0.56	65.85	103.64	4.05	0.85
Bw2	47-68	8.09	0.16	0.92	7.3	66.74	47.80	15.70	0.69	0.70	64.89	97.23	3.04	1.08
Bss1	68-102	8.13	0.16	0.73	7.3	69.74	50.30	16.75	1.10	0.82	68.97	98.89	3.00	1.19
Bss2	102-135	7.95	0.20	0.60	8.1	68.64	52.32	15.64	0.89	0.99	69.84	101.75	3.35	1.42
Cr	135+	8.03	0.16	0.20	10.8	38.21	21.32	25.41	1.36	1.12	49.21	128.79	0.84	2.28
Pedon 3 Khanapur “B” block VNMKV, Parbhani. (Sodic Haplusterts)														
Ap	0-26	8.57	0.29	1.14	5.8	66.78	37.80	17.55	0.86	8.76	64.97	97.29	2.15	13.48
Bw	26-50	8.70	0.28	0.91	8.5	64.86	35.33	18.64	0.91	7.55	62.43	96.25	1.90	12.09
Bss1	50-75	8.03	0.56	0.90	12.5	62.91	30.15	20.25	1.35	9.83	61.58	97.89	1.49	15.96
Bss2	75-110	8.50	1.40	0.84	13.0	67.59	29.87	21.64	1.41	12.33	65.25	96.54	1.38	18.90
Bss3	110-150	8.45	2.20	0.40	16.0	66.61	23.40	23.00	1.13	15.77	63.30	95.03	1.02	24.91
Pedon 9 Central farm “C” block (Sayala block) VNMKV, Parbhani. (Typic Haplusterts)														
Ap	0-25	7.51	0.18	0.75	7.8	57.34	44.80	12.60	0.71	0.54	58.65	102.29	3.56	0.93
Bw	25-47	7.73	0.15	0.43	9.0	57.61	42.01	12.06	1.08	0.30	55.45	96.25	3.48	0.54
Bss1	47-80	7.90	0.13	0.31	9.8	55.73	39.95	10.80	1.03	0.27	52.05	93.40	3.70	0.52
Bss2	80-120	7.91	0.25	0.40	12.3	49.87	33.75	10.11	0.76	0.45	45.07	90.37	3.34	1.00
Cr	120+	8.10	0.22	0.18	28.0	53.98	38.70	9.45	0.54	0.57	49.26	91.26	4.10	1.16
Pedon 10 Shendra “C” block (New organic farm, Takalgavhan) VNMKV, Parbhani. (Sodic Haplusterts)														
Ap	0-22	7.63	0.11	0.52	5.3	57.19	45.30	7.10	0.56	3.15	56.11	98.12	6.38	5.62
Bw	22-55	8.21	0.59	0.49	8.8	58.35	44.87	7.85	0.71	5.64	59.07	101.23	5.72	9.55
Bss1	55-74	8.30	0.26	0.50	13.2	58.64	35.65	15.10	1.13	7.39	59.27	101.08	2.36	12.47
Bss2	74-122	8.38	0.65	0.30	14.5	61.28	32.12	16.21	0.71	12.15	61.19	99.85	1.98	19.86
Cr	122+	8.29	0.76	0.19	39.2	48.82	25.45	9.90	0.94	8.10	44.39	90.93	2.57	18.25
Pedon 11 Organic farming research project (behind NAHEP cent.) VNMKV, Parbhani. (Calcic Haplustepts)														
Ap	0-18	7.45	0.18	0.49	6.8	57.47	45.90	11.25	0.81	0.74	58.70	102.14	4.08	1.26
Bw	18-30	7.70	0.12	0.35	9.3	59.43	44.10	14.85	1.13	0.88	60.96	102.58	2.97	1.44
Cr	30+	8.30	0.19	0.07	36.8	48.51	34.87	13.24	0.59	0.56	49.26	101.55	2.63	1.14
Pedon 12 Dept. of Agricultural Meteorology VNMKV, Parbhani. (Calcic Haplusterts)														
Ap	0-23	7.30	0.82	0.52	3.3	62.14	47.15	12.60	0.62	0.61	60.98	98.13	3.74	1.00
Bw	23-49	7.43	0.9	0.51	4.5	62.53	48.25	11.52	0.60	0.55	60.92	97.43	4.19	0.52
Bss1	49-74	7.63	0.11	0.49	7.4	65.62	52.65	9.45	0.91	0.39	63.40	96.61	5.57	0.61

Bss2	74-98	7.72	0.24	0.39	9.5	64.16	45.32	15.55	0.74	0.43	62.04	96.70	2.91	0.81
Cr	98+	8.00	0.26	0.14	24.3	36.87	25.13	7.22	0.58	1.28	34.21	92.79	3.48	0.95
Pedon 15 Old Shendra village (near railway track line) VNMKV, Parbhani. (Calcic Haplustepts)														
Ap	0-22	7.81	0.12	0.51	9.5	51.24	38.40	9.25	0.44	0.65	48.74	95.13	4.15	1.34
Bw	22-40	7.83	0.18	0.42	11.3	52.62	39.85	8.65	0.36	0.45	49.31	93.72	4.61	0.92
Cr	40+	7.61	0.28	0.39	25.8	39.41	30.12	6.64	0.12	0.91	37.79	95.89	4.54	2.41
Pedon 17 AICRP Sorghum research station VNMKV, Parbhani. (Calcic Haplusterts)														
Ap	0-24	7.83	0.15	0.64	7.3	63.43	49.65	12.35	0.35	0.46	62.81	99.03	4.02	0.74
Bw	24-48	7.40	0.16	0.53	8.3	61.61	45.88	10.32	0.35	0.73	57.28	92.97	4.45	1.27
Bss1	48-74	7.74	0.21	0.43	10.8	55.52	40.32	11.35	0.26	1.04	52.97	95.41	3.55	1.97
Bss2	74-91	7.75	0.39	0.28	12.5	58.00	38.74	14.66	0.31	1.13	54.84	94.55	2.64	2.06
Bss3	91-123	7.71	0.21	0.28	16.5	56.48	32.51	18.32	0.48	1.36	52.67	93.26	1.77	2.59
Cr	123+	7.85	0.2	0.06	25.3	49.79	17.25	28.61	0.52	0.90	47.28	94.96	0.60	1.90

Table 4: Available nutrients status of soils of VNMKV farm, Parbhani

Horizon	Available Nutrients (Kg/ha)			Micronutrients (mg/kg)				mg/kg	
	N	P	K	Mn	Zn	Cu	Fe	B	S
Pedon 1 Central farm "A" block (Taroda block) VNMKV, Parbhani. (Typic Haplusterts)									
Ap	225.79	13.80	875.3	11.68	0.76	3.02	10.46	0.48	8.75
Bw1	188.16	10.50	698.5	10.85	0.66	2.42	9.70	0.43	4.10
Bw2	175.62	9.70	676.2	8.54	0.55	2.02	8.64	0.41	3.45
Bss1	125.44	9.0	637.2	5.43	0.24	1.70	6.42	0.49	3.00
Bss2	112.90	2.60	479.0	4.36	0.23	0.86	4.82	0.37	2.63
Cr	62.72	0.0	0.0	0	0	0.00	0.00		0.00
Pedon 3 Khanapur "B" block VNMKV, Parbhani. (Sodic Haplusterts)									
Ap	191.70	13.44	759.92	11.35	0.84	2.86	12.50	1.05	10.85
Bw	166.07	11.57	621.67	9.84	0.73	2.65	11.31	0.73	9.20
Bss1	100.35	7.84	550.67	8.28	0.66	1.75	8.56	0.48	7.70
Bss2	75.26	6.35	335.07	4.25	0.24	1.12	7.11	0.35	6.30
Bss3	62.72	5.60	316.12	3.58	0.17	0.78	4.31	0.31	3.30
Pedon 9 Central farm "C" block (Sayala block) VNMKV, Parbhani. (Typic Haplusterts)									
Ap	175.62	11.07	709.71	13.13	0.85	2.54	11.36	0.84	4.98
Bw	137.98	9.20	607.51	9.82	0.72	2.48	8.10	0.71	3.48
Bss1	100.35	4.11	439.08	6.77	0.24	2.40	8.88	0.91	2.70
Bss2	75.26	2.61	335.27	5.95	0.27	1.68	6.04	0.64	2.05
Cr/Ck	37.63	0.00	0.00	5.34	0.20	1.32	4.21	0.60	0.00
Pedon 10 Shendra "C" block (New organic farm, Takalgavhan) VNMKV, Parbhani. (Sodic Haplusterts)									
Ap	163.07	10.08	739.29	11.83	0.67	2.42	12.68	0.81	7.43
Bw	112.90	9.33	570.17	10.15	0.29	2.02	11.66	1.21	5.73
Bss1	100.35	6.35	421.59	7.06	0.57	1.75	8.82	0.81	3.03
Bss2	62.72	4.48	354.67	5.39	0.48	1.37	8.26	0.68	2.45
Ck	37.63	0.00	0.00	4.36	0.33	1.56	6.74	0.00	0.00
Pedon 11 Organic farming research project (behind NAHEP cent.) VNMKV, Parbhani. (Calcic Haplustepts)									
Ap	150.53	12.81	718.76	12.66	0.65	2.80	11.36	0.75	2.30
Bw	100.35	7.09	434.56	8.01	0.54	2.76	11.54	0.46	2.18
Cr	37.63	0.00	0.00	0	0	0.00	0.00	0.39	0.00
Pedon 12 Dept. of Agricultural Meteorology VNMKV, Parbhani. (Calcic Haplusterts)									
Ap	175.62	10.07	770.47	13.42	0.73	3.04	11.88	0.74	4.95
Bw	125.44	8.08	726.79	11.88	0.50	2.87	10.50	0.64	3.95
Bss1	100.35	7.09	471.89	6.10	0.22	1.51	8.82	0.48	2.85
Bss2	87.81	5.23	338.24	3.84	0.13	0.92	8.24	0.54	2.35
Cr	37.63	0.00	0.00	0	0	0.00	0.00	0.00	0.00
Pedon 15 Old Shendra village (near railway track line) VNMKV, Parbhani. (Calcic Haplustepts)									
Ap	150.53	10.83	636.07	15.10	0.62	2.93	11.68	0.83	5.41
Bw	112.90	6.35	440.93	9.73	0.37	2.70	8.44	0.71	4.28
Cr	50.18	-	-	-	-	-	-	-	-
Pedon 17 AICRP Sorghum research station VNMKV, Parbhani. (Calcic Haplusterts)									
Ap	175.62	11.20	776.76	11.54	0.44	2.78	9.24	0.55	9.05
Bw	150.53	9.33	682.08	11.25	0.40	2.70	11.66	0.64	7.73
Bss1	112.90	7.47	668.08	8.45	0.30	2.61	9.26	0.57	3.30
Bss2	100.35	4.85	666.59	5.64	0.14	1.10	7.68	0.59	2.55
Bss3	75.26	2.61	530.93	3.52	0.10	0.92	7.18	0.62	2.23
Cr	0.00	-	-	-	-	-	-	-	-

Conclusion

The study area VNMKV farm, Parbhani exhibits diverse soil characteristics, Soil depths vary from shallow to very deep, with noticeable surface cracks and slickensides. The bulk density

ranges from 1.31 to 1.85 Mg m⁻³, and hydraulic conductivity varies between 0.46 and 3.88 cm/hr. Particle size analysis reveals sand (1.04-5.31%), silt (29.79-41.85%), and clay (54.34-68.81%), with higher clay content in lower topographic

positions. PAWC ranges from 83.09 to 352.91 mm. pH levels extent from neutral (7.30) to strongly alkaline (8.70). Organic carbon content varies from 0.30% to 1.14%, while calcium carbonate ranges from 3.3% to 16.5%. Nutrient availability shows low nitrogen and phosphorus levels but high potassium content and deficient to sufficient in micronutrients. The soils are classified as Inceptisols (11.06%) and Vertisols (88.94%), with sub-group classifications based on distinct characteristics. Overall, these findings highlight the variability and complexity of soil profiles, essential for effective soil management and agricultural practices in farm VNМКV, Parbhani.

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