



## Characterization and Classification of Upland Soils of Chikkarsinkere Hobli, Maddur Taluk, Mandya District of Karnataka

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**Abstract :** A detailed soil survey (1:8000 scale) was carried out in 2010-2011 to delineate homogenous soil management units in the Chikkarsinkere Hobli covering an area of 16,873 ha, out of which uplands occupy an area of about 8749 ha (52%). The survey area was divided into three major landforms namely uplands, midlands and lowlands. Based on variation in physiography and landform, eight soil series were identified in uplands. Eight typifying pedons representing the soils were analyzed for their physico-chemical properties and mapping. The soils of uplands are moderately shallow to very deep, well drained, light colored, light clayey texture developed over granite and gneissic parent materials. The pH of the upland soils ranged from 5.6 to 8.7 with a mean value of 7.52, electrical conductivity (EC) ranged between 0.02 to 0.37 dSm<sup>-1</sup> with a mean value of 0.12 dSm<sup>-1</sup>, organic carbon (OC) varied from 0.07 to 1.3 g kg<sup>-1</sup> with a mean value of 0.70 g kg<sup>-1</sup>, cation exchange capacity (CEC) ranged from 4.4 to 57.7 cmol (p<sup>+</sup>) kg<sup>-1</sup> with a mean value of 17.02 cmol (p<sup>+</sup>) kg<sup>-1</sup> and CaCO<sub>3</sub> ranged between 1 to 2 g kg<sup>-1</sup> with a mean value of 1.6 g kg<sup>-1</sup>. Pedons 1, 3, 4 and 6 were classified as *Typic Rhodustalfs*, whereas pedons 2, 7 and 8 were classified as *Rhodic Paleustalfs* and pedon 5 was classified as *Vertic Haplustepts*.

**Key words:** Detailed soil survey, soil morphology, land resources, soil characteristics

### Introduction

Sustainable management of land resources is essential for food security, maintenance of environment and general well being of the people. Indiscriminate use of resources coupled with lack of management has, however, led to degradation echoing the concern of planners, researchers and farmers alike (Sharma 2006). Adequate knowledge about the properties and distribution of soils is key issue to support sustainable land management, which among others, includes fertility management, crop choice and possibility for irrigation. Soil resource inventory through characterization of the resources provides an insight into the potentials and limitations of soils (Manchanda *et al.* 2002). The information generated through soil resource inventory is generally interpreted for various grouping of soils for land capability, land irrigability and suitability of soils for different crops through evaluation procedure which helps the

administrator managers of agriculture and related developmental activities.

The concept of using the land for suitable utilization lies within the land use planning process (Bauer 1973), which aims at optimizing the use of land while sustaining its potential by avoiding resource degradation. It has been recognized that the land assessment and its reliability for land use decisions depend largely on the quality of soil information (FAO 1976; Bogaert and D'or 2002; Salehi *et al.* 2003). In this connection, detailed soil survey and Geographic Information System (GIS) are very useful tools to get quality information about land. Keeping this in view, the present study was attempted.

### Materials and Methods

Geographically, the Chikkarsinkere Hobli (Block) lies between 76° 58' to 77° 05' E longitude and 12° 26' to 12° 6' N latitude with an area of 16,873 hectare (Fig. 1).

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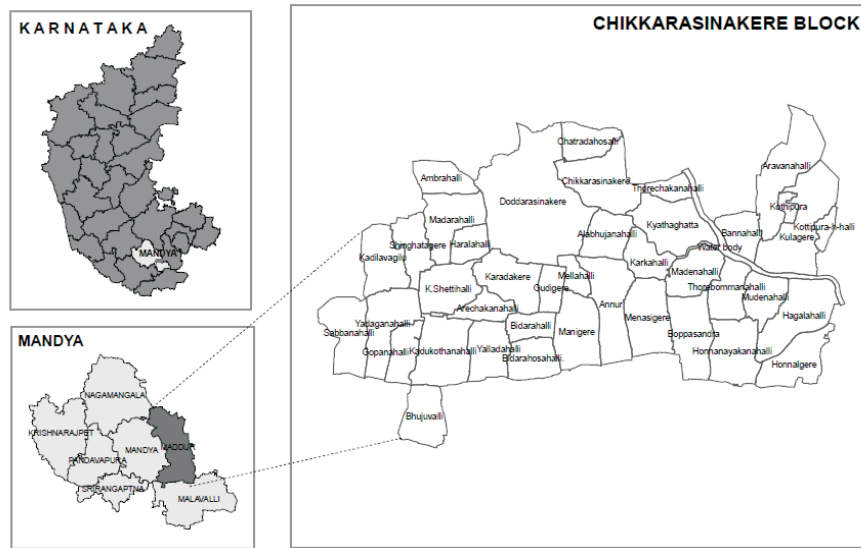


Fig. 1 Location of Chikkarsinakere Hobli in Mandya district

The general elevation of the study area ranges from 600 to 769 m above mean sea level (MSL). The drainage is essentially subparallel and dendritic in the Hobli. Based on relief features the area is divided into lowlands, midlands and uplands. Climate of the Hobli is hot moist and semi-arid with mean annual rainfall of 770 mm, mean annual temperature of 31°C and Potential evapetranspiration of 1794 mm. The relative humidity is high during monsoon season (77 to 89%) and low during rest of the season (23 to 35%). The area qualifies for 'Isohyperthermic' soil temperature regimes. Geology of the study area is dominantly granite. Major part of the Hobli is under Kaveri and Hemavathi canal irrigation. The natural vegetation comprises of babul (*Acacia nilotica*), banyan (*Ficus bengalensis*), mango (*Mangifera indica*) tamarind (*Tamarindus indica*) and neem (*Azadirachta indica*) etc. The major crops in the study area are rice and sugarcane in the irrigated area and ragi, pulses and oilseeds in rainfed uplands.

The soil survey was carried out using base map on 1: 8000 scale. A detailed traverse of the Hobli was made to identify the major landforms like uplands, midlands and lowlands. Pedon sites were located in transects along the slope from the upper to lower slopes. In the upland soils eight pedons were exposed and studied for morphological characteristics as per Soil Survey Manual (Soil Survey Division Staff 1999). The horizon-wise soil samples were collected, air dried and passed through 2 mm sieve and analysed for particle-size distribution following International Pipette method (Richards 1954), pH and electrical conductivity

(EC) in 1:2.5, soil: water suspension (Pipper 1966). Organic carbon was estimated by Walkley and Black (1934) method and calcium carbonate by rapid titration method (Piper 1966). The cation exchange capacity (CEC) and exchangeable cations were determined as described by Jackson (1958). The soils were classified as per Soil Taxonomy (Soil Survey Staff 2003).

**Results and Discussion**

Eight soil series namely, Honnannayakanahalli (Hnl), Manigere (Mgr), Torebommanahalli (Tbl), Bidarahalli (Bdh), Kulagere (Kgr), Yadaganahalli (Ydh), Kadakothanahalli (Kkh) and Aravanahalli (Avl) were identified and mapped based on their morphological properties (Table 1) and physico-chemical properties (Table 2) and classified at family level in upland soils (Fig. 2).

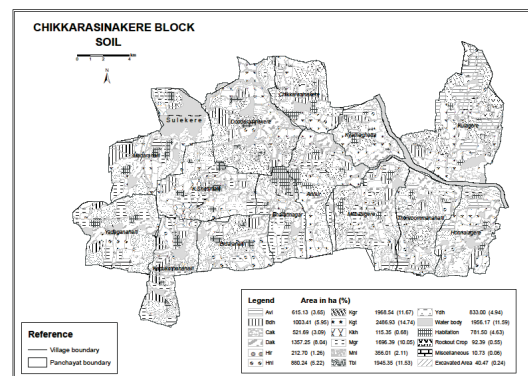


Fig. 2 Soil map, showing the distribution of soil series in Chikkarsinakere Hobli

**Table 1.** Morphological characteristics of pedons in upland soils of Chikkarsinkere Hobli.

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Concretions	Effervescence	Root distribution
Pedon 1 (Torebomnhalli) : Clayey-skeletal, mixed, isohyperthermic <i>Typic Rhodustalfs</i>							
Ap	0-18	10YR 3/4	scl	m2sbk	-	-	cf
Bt1	18-26	5YR 3/4	scl	m2sbk	ff conca	-	ff
Bt2	26-50	2.5YR 3/4	sc	m1sbk	ff conca	-	ff
Bt3	50-87	2.5YR 3/6	sc	m1sbk	mf conca	-	ff
Cr	87	Weathered granite	-	-	-	-	-
Pedon 2 (Manigere) : Clayey-skeletal, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>							
Ap	0-16	5YR 4/4	scl	m1sbk	-	Es	mf
Bt1	16-49	2.5YR 3/6	gsc	m1sbk	ff conca	-	ff
Bt2	49-74	2.5YR 3/6	gsc	m1sbk	ff conca	-	-
Cr	74	Weathered granite	-	-	-	-	-
Pedon 3 (Honnanaya kanahalli) : Fine-loamy, mixed, isohyperthermic, <i>Typic Rhodustalfs</i>							
Ap	0-16	5YR 4/4	gsc	m1sbk	ff conca	-	ff
Bt1	16-28	2.5YR 3/4	sc	m1sbk	ff conca	-	ff
Bt2	28-56	2.5YR 3/4	scl	m1sbk	ff conca	-	ff
Cr	56-79	Weathered granite	-	-	-	-	-
Pedon 4 (Bidarahalli) : Fine-loamy, mixed, isohyperthermic <i>Typic Rhodustalfs</i>							
Ap	0-14	2.5YR 3/4	gsl	m2sbk	-	-	cf
A2	14-35	5YR 3/4	sl	m2sbk	-	-	ff
Bt1	35-45	2.5YR 3/6	sc	m2sbk	ff conca	-	ff
Bt2	45-60	2.5YR 3/4	gscl	m2sbk	-	-	cf
Bt3	60-90	2.5YR 3/4	gscl	m2sbk	-	-	cf
Pedon 5 (Kadakothanahalli) : Fine, mixed, isohyperthermic, <i>Vertic Haplustepts</i>							
Ap	0-18	10YR 3/2	c	m2sbk	-	Es	mf
Bw1	18-47	10YR 3/2	c	m2sbk	-	Es	mf
Bw2	47-76	10YR 3/2	c	m2sbk	ff conca	Es	-
Bw3	76-103	10YR 3/2	c	m2sbk	ff conca	Ev	-
Pedon 6 (Yadaganahalli) : Clayey-skeletal, mixed, isohyperthermic, <i>Typic Rhodustalfs</i>							
Ap	0-16	10YR 3/3	gsl	m1sbk	-	-	cf
Bt1	16-33	2.5YR 3/6	gsc	m2sbk	ff conca	-	ff
Bt2	33-62	2.5YR 3/4	gsc	m2sbk	-	-	-
Bt3	62-94	2.5YR 3/4	gsc	m2sbk	-	-	-
Bt4	94-105	2.5YR 3/6	sc	msbk	-	-	-
Bc	105-126	2.5YR 3/6	gscl	m2sbk	-	-	-
Pedon 7 (Aravanhalli) : Fine, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>							
Ap	0-20	2.5YR 3/4	sl	m1sbk	-	-	ff
A2	20-38	2.5YR 3/4	sl	m1sbk	-	-	vf
Bt1	38-62	2.5YR 3/4	sc	m2sbk	-	-	-
Bt2	62-90	2.5YR 3/4	sc	m2sbk	-	-	-
Bt3	90-120	2.5YR 3/4	sc	m2sbk	-	-	-
Bt4	120-157	2.5YR 3/4	c	m2sbk	-	-	-
Pedon 8 (Kulagere) : Fine, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>							
Ap	0-17	10YR 3/4	gsl	m2sbk	-	-	vf
Bt1	17-44	2.5YR 3/6	gsc	m2sbk	-	-	cf
Bt2	44-66	2.5YR 3/4	gc	m2sbk	-	-	-
Bt3	66-102	2.5YR 3/4	gc	m2sbk	-	-	-
Bc	102-140	2.5YR 3/4	sc	m2sbk	-	-	-

**Table 2.** Physico-chemical properties of typifying pedons in upland soils of Chikkarsinkere Hobli

Horizon	Depth (cm)	Sand	Silt (%)	Clay	pH	EC (dSm <sup>-1</sup> )	OC	CaCO <sub>3</sub> (g kg <sup>-1</sup> )	CEC [cmol (p+) kg <sup>-1</sup> ]	Exchangeable cations	ESP	BS (%)			
													Ca	Mg	Na
emol (p <sup>+</sup> ) kg <sup>-1</sup>															
Pedon 1 (Torebomhalli) : Clayey-skeletal, mixed, isohyperthermic <i>Typic Rhodustalfs</i>															
Ap	0-18	64.2	5.5	30.3	7.6	0.34	0.89	-	14.8	4.8	6.2	0.28	0.27	1.9	78
Bt1	18-26	63.2	6.2	30.6	7.9	0.14	0.75	-	12.2	5.7	4.9	0.30	0.30	2.5	92
Bt2	26-50	54.9	5.9	39.2	7.9	0.18	0.43	-	13.5	5.6	7.1	0.41	0.27	3.0	99
Bt3	50-87	57.1	3.9	39.0	7.9	0.09	0.32	-	11.0	4.6	5.1	0.36	0.17	3.3	93
Cr	87	Weathered granite													
Pedon 2 (Manigere) : Clayey-skeletal, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>															
Ap	0-16	74.4	4.5	21.1	8.7	0.37	1.11	-	7.6	5.9	4.8	0.44	0.42	5.8	>100
Bt1	16-49	48.5	5.1	46.4	8.4	0.18	0.78	-	12.1	8.8	2.7	0.46	0.35	3.8	>100
Bt2	49-74	59.4	4.7	35.9	8.3	0.17	0.60	-	10.5	8.8	2.9	0.40	0.22	3.8	>100
Cr	74	Weathered granite													
Pedon 3 (Honnanaya kanahalli) : Fine-loamy, mixed, isohyperthermic, <i>Typic Rhodustalfs</i>															
Ap	0-16	55.2	4.3	40.5	7.9	0.25	1.05	-	16.2	9.4	3.7	0.56	0.41	3.8	87
Bt1	16-28	58.2	2.8	39.0	7.4	0.13	0.98	-	11.5	6.9	2.6	0.39	0.26	3.3	89
Bt2	28-56	73.3	1.1	25.6	7.1	0.14	0.73	-	8.5	5.6	1.9	0.26	0.16	4.5	93
Cr	56-79	Weathered granite													
Pedon 4 (Bidarahalli) : Fine-loamy, mixed, isohyperthermic <i>Typic Rhodustalfs</i>															
Ap	0-14	80.7	3.9	15.4	8.0	0.06	0.71	-	14.2	8.8	5.1	0.12	0.20	0.85	100
A2	14-35	81.8	3.8	14.4	7.5	0.09	0.67	-	12.8	7.2	4.6	0.21	0.19	1.64	95
Bt1	35-45	56.5	7.7	35.8	7.5	0.09	0.57	-	17.4	9.8	3.6	0.34	0.15	1.95	80
Bt2	45-60	57.4	7.8	34.8	7.4	0.08	0.58	-	11.8	6.6	3.4	0.17	0.17	1.44	87
Bt3	60-90	61.5	9.6	28.9	7.6	0.07	0.47	-	10.4	5.3	2.5	0.13	0.16	1.25	78
Pedon 5 (Kadakothonahalli) : Fine-loamy, mixed, isohyperthermic <i>Vertic Haplustepts</i>															
Ap	0-18	39.6	16.6	43.8	8.1	0.07	1.30	2	43.6	37.6	11.3	0.36	2.24	0.8	>100
Bw1	18-47	29.0	12.5	58.5	8.1	0.06	1.01	2	56.8	51.0	11.4	1.09	0.83	1.9	>100
Bw2	47-76	31.1	13.1	55.8	7.9	0.08	0.62	1	57.4	58.7	10.7	1.25	0.37	2.2	>100
Bw3	76-103	27.1	17.5	55.4	7.9	0.12	0.63	1	55.1	53.4	11.0	0.95	0.32	1.7	>100
Pedon 6 (Yadaganahalli) : Clayey-skeletal, mixed, isohyperthermic, <i>Typic Rhodustalfs</i>															
Ap	0-16	77.6	5.3	17.1	5.6	0.09	1.25	-	5.5	3.2	1.0	0.06	0.07	3.3	78
Bt1	16-33	58.5	4.7	36.8	6.8	0.07	1.24	-	11.7	3.5	3.5	0.03	0.07	1.0	61
Bt2	33-62	49.0	5.5	45.5	7.3	0.09	1.12	-	13.1	7.5	4.3	0.11	0.15	1.7	92
Bt3	62-94	47.3	5.0	47.7	7.3	0.07	0.96	-	14.1	8.0	4.8	0.27	0.16	1.6	94
Bt4	94-105	58.8	5.9	35.3	7.3	0.06	0.89	-	14.3	9.0	3.6	0.22	0.14	2.5	91
Bc	105-126	61.3	8.5	30.2	7.3	0.06	0.07	-	10.0	3.3	1.9	0.12	0.09	1.7	54

Pedon 7 (Aravanhalli) : Fine, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>															
Ap	0-20	74.7	5.6	19.7	6.3	0.03	0.52	-	4.9	2.5	0.8	0.01	0.13	0.20	69
A2	20-38	77.4	2.8	19.8	6.0	0.02	0.49	-	4.4	2.6	0.6	0.01	0.07	0.23	75
Bt1	38-62	58.0	5.5	36.5	6.1	0.04	0.46	-	8.1	4.8	1.4	0.08	0.11	0.99	79
Bt2	62-90	53.1	5.5	41.4	6.7	0.05	0.43	-	9.2	6.3	2.2	0.10	0.13	1.09	95
Bt3	90-120	47.5	4.1	48.4	6.9	0.05	0.39	-	10.6	8.0	1.9	0.12	0.14	1.13	96
Bt4	120-157	42.9	5.6	51.5	7.1	0.05	0.36	-	10.8	8.4	2.1	0.12	0.15	1.11	100
Pedon 8 (Kulagere) : Fine, mixed, isohyperthermic, <i>Rhodic Paleustalfs</i>															
Ap	0-17	74.4	5.7	19.9	8.6	0.15	0.77	-	7.6	5.2	2.9	0.27	0.43	3.6	>100
Bt1	17-44	49.3	2.8	47.9	8.3	0.18	0.75	-	12.5	9.4	2.7	0.33	0.67	2.6	>100
Bt2	44-66	37.2	6.5	56.3	8.1	0.20	0.57	-	12.7	10.8	2.7	0.29	0.50	2.3	>100
Bt3	66-102	36.5	4.5	59.0	7.9	0.21	0.54	-	14.0	11.0	2.3	0.35	0.35	2.5	>100
Bc	02-140	47.9	6.9	45.2	7.9	0.32	0.50	-	11.4	12.2	2.3	0.23	0.24	2.0	>100

### Characterization of soils

Soils of Torebommanahalli-1 (Tbl) occurring on uplands were moderately deep, well drained sandy clay loam to sandy clay texture, dark red (2.5YR 3/6) to dark yellowish brown (10YR 3/4) color and classified as Clayey-skeletal, mixed, isohyperthermic *Typic Rhodustalfs*. These soils occur on very gently sloping to gently sloping uplands with 1 to 3% slopes. The soils of Manigere-2 (Mgr) series occurring on uplands are moderately shallow, well drained, sandy clay loam surface texture and sandy clay sub-surface texture, reddish brown (5YR 4/4) to dark red (2.5YR 3/6) color and classified as Clayey-skeletal, mixed, isohyperthermic, *Rhodic Paleustalfs* which are developed on weathered granite. The soils of Honnanayakanahalli-3 (Hnl) series were moderately shallow, well drained, sandy clay surface texture, reddish brown (5YR 4/4) to dark reddish brown (2.5YR 3/4) in colour and classified as Fine-loamy, mixed, isohyperthermic, *Typic Rhodustalfs*. The soils of Bidarahalli-4 (Bdh) series were moderately deep, well drained, sandy loam surface texture followed by sandy clay loam sub-surface texture, dark reddish brown (2.5YR 3/4) and dark reddish brown (5YR 3/4) in colour and classified as Fine-loamy, mixed, isohyperthermic *Typic Rhodustalfs*. The Kadakothanahalli-5 (Kkh) series occurring on uplands are deep, well drained, clay texture, very dark grayish brown (10YR 3/2) in color and classified as Fine, mixed, isohyperthermic, *Vertic Haplustepts*. The Yadaganahalli-6 (Ydh) series occurring on uplands are deep, well drained, dark red (2.5YR 3/6) to dark reddish brown (2.5YR 3/4) in color, gravelly sandy clay and classified as Clayey-skeletal, mixed, isohyperthermic, *Typic Rhodustalfs*. The Aravanahalli-7 (Avl) series were very deep, well drained, sandy clay to clay, dark reddish brown (2.5YR 3/4) in color and classified as Fine, mixed, isohyperthermic, *Rhodic Paleustalfs*. The Kulagere-8 (Kgr) series were deep, well drained, sandy clay to clay, dark reddish brown (2.5YR 3/4) in colour and classified as Fine, mixed, isohyperthermic,

### *Rhodic Paleustalfs*.

The data revealed (Table 1) that under moist conditions, the color of the soils of pedon 1 was dark yellowish brown and color of the soils of pedon 2 was reddish brown to dark red whereas the color of the soils from pedon 3, 4, 6, 7 and 8 was dark reddish brown. The color of the soils of pedon 5 was very dark grayish brown. This difference in color may be attributed to the organic matter, high clay content, presence of sufficient iron and manganese compounds and their hydration. (Diwakar and Singh 1992).

### Physico-chemical properties

Physico-chemical characteristics of the soils are presented in Table 2. The sand content in upland soils of Chikkarsinkere Hobli ranged from 27.1 to 81.8% with a mean value of 55.23%, silt content ranged from 1.1 to 19.2% with a mean value of 6.65% and clay content ranged from 14.4 to 59% with a mean value of 37.86%. The sand content was higher in surface horizons of uplands, whereas higher clay content was found in the sub-surface horizons because of the illuviation of fine fractions from the surface layers. Sand content in soils of uplands of higher altitude was higher and decreased with increasing depth. The silt content in all the pedons have irregular trend with the depth. The pH of the soils ranged from 5.6 to 8.7 with a mean value of 7.52, electrical conductivity ranged between 0.02 to 0.37 dSm<sup>-1</sup> with an average value of 0.12 dSm<sup>-1</sup>, OC varied from 0.07 to 1.3 g kg<sup>-1</sup> with a mean value of 0.70 g kg<sup>-1</sup>, CaCO<sub>3</sub> ranged between 1 to 2 g kg<sup>-1</sup> with a mean value of 1.6 g kg<sup>-1</sup>.

### Exchangeable properties

Cation exchange capacity (CEC) of typifying pedons ranged from 4.4 to 57.7 cmol (p<sup>+</sup>) kg<sup>-1</sup> with an average value of 17.02 cmol (p<sup>+</sup>) kg<sup>-1</sup>. The CEC increased with increase in clay content of the pedons. The higher values of CEC in upper horizons commensurate with amount of clay ( $r = 0.55^*$ ) may be due to high organic matter content and soil reaction (Diwakar 2005). The dominance of clay mineral being smectite appears to be responsible for higher CEC. The CEC decreased with depth in the pedons of Torebommanahalli, Honnanayakanahalli and Bidarahalli due to variation in clay and organic matter content (Mishra and Ghosh 1995).

The exchangeable bases had distinct pattern regarding their sequential dominance. In all the pedons, the order followed was Ca>Mg>Na>K. The Ca<sup>2+</sup> in soils ranged from 2.5 to 60.9 cmol (p<sup>+</sup>) kg<sup>-1</sup>, with a mean value of 13.0 cmol (p<sup>+</sup>) kg<sup>-1</sup>, Mg<sup>2+</sup> ranged from 0.6 to 11.4 cmol (p<sup>+</sup>) kg<sup>-1</sup> with a mean value of 4.24 cmol (p<sup>+</sup>) kg<sup>-1</sup>, Na<sup>+</sup> ranged from 0.01 to 1.25 cmol (p<sup>+</sup>) kg<sup>-1</sup>, with a mean value of 0.33 cmol (p<sup>+</sup>) kg<sup>-1</sup> and K<sup>+</sup> ranged from 0.07 to 2.24 cmol (p<sup>+</sup>) kg<sup>-1</sup> with a mean value of 0.31 cmol (p<sup>+</sup>) kg<sup>-1</sup>. The variation observed in base saturation percentage (BSP) indicates the degree of leaching which was used as diagnostic character for classifying the soils. High base saturation was due to high Ca<sup>2+</sup> followed by Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> (Patil and Dasog 1996).



## Conclusions

The upland soils of Chikkarsinkere Hobli (Block) were moderately shallow to very deep in depth, neutral to strongly alkaline in reaction, non-saline, medium to high in organic carbon and exchangeable complex was dominated by Ca followed by Mg>Na>K. The soils of Block were classified as *Typic Rhodustalfs*, *Rhodic Paleustalfs* and *Vertic Haplustepts*.

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