Assessment of Physico-chemical Properties of Soil from Different Blocks of Namchi district of Sikkim, India

ABSTRACT

The present research topic entitled "Assessment of Physico-chemical Properties of Soil from Different Blocks of Namchi District of Sikkim, India" was carried out at Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. Department of Soil Science and Agricultural Chemistry (U.P.), during the year 2023. The soil samples were collected at three depths: 0-15 cm, 15-30 cm, and 30-45 cm, from nine different villages of three different blocks under Namchi district. A total of 27 samples collected and analysed for their physical and chemical parameters by using the standard Laboratory Technique. The result showed that the Soil Texture of Namchi, Temi and Sikkip blocks were mainly Sandy clay loam. The Bulk Density reported 1.1 -1.29 Mg m^{-3}, Particle Density reported 2.1- 2.6 Mg m^{-3}, Percent of Pore Space varied 45-47.6%, Water holding Capacity ranged from 45-49.3 %. Results suggest that farmers should adopt appropriate soil management techniques, such as crop rotation and conservation tillage, which will contribute to maintain the soil's physical characteristics to ensure the sustainability of agricultural practices and the long-term health of the soil.

Keywords: Physico-chemical parameters, Namchi, Sikkim.

1. INTRODUCTION

Soil is one of the most important natural resources for human welfare. It has been meeting the needs of food, clothing, shelter for a long time. It is a resource vulnerable to decay. Once lost, it is almost impossible to recover. (Zubber *et al.*, 2021) . An understanding of physical and chemical condition of any soil is essential for proper implementation of the other management practices. The physical properties of a soil play an important role in determining its suitability for crop production. The characteristics like for supporting power and bearing capacity, tillage practices, moisture storage capacity and its availability to plants, drainage, ease of penetration by roots, aeration, retention of plant nutrients and availability to plants are all intimately connected with the physical properties of the soils. Therefore the physico-chemical study of soil is very important because both physical and chemical properties which affect the soil productivity. This physico-chemical study of soil is based on various parameters like pH, electrical conductivity, texture, moisture, temperature, soil organic matter, available nitrogen, phosphorus and potassium. This knowledge will create awareness among the farmers about economic productivity. (Sangita Pradeep Ingole, 2015)

2. MATERIALS AND METHODS

2.1 Soil sampling

Namchi district of sikkim is located on the map with the GPS coordinates of 27°09'20.5"N 88°22'07.0"E (fig 1). A total of twenty seven soil samples were collected at different depths of 0-15cm, 15-30cm and 30-45 cm, from three different blocks and three villages per each block

of namchi district of sikkim with the help of a soil auger. These villages are upper ghurpisey, pabong and kholaghari under namchi block, deu, peku and lower tea Garden under Temi block and middle wok, lower wok and upper chumlok under sikkip block.

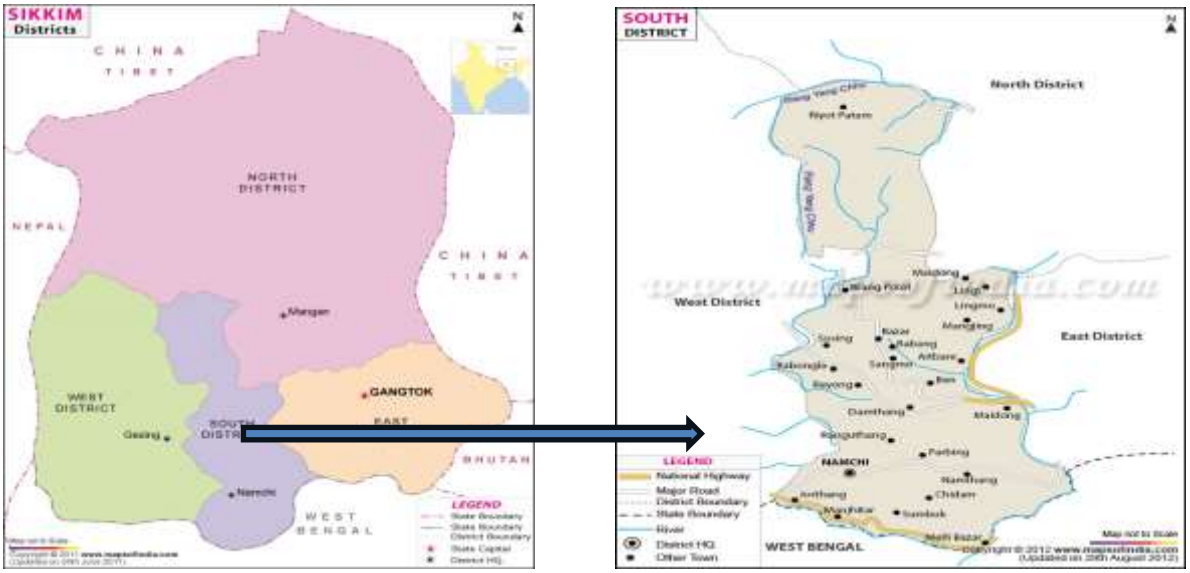

Fig 1 Location of study area

Samples were dried in shade and large clods were broken using wooden mallet. Using 2 mm sieve the powdered soils were sieved and were collected in a polythene bag and was labeled properly for laboratory analysis. The collected samples were analysed for physical and chemical parameters. Soils were analyzed for its textural class by Bouyoucos hydrometer method (Bouyoucos, 1927), soil colour by using Munsell soil colour chart (Albert H. Munsell, 1954), bulk density and particle density was determined by graduated measuring cylinder method (Muthuvel *et al.*,1992), pH was determined by pH meter by making 1:2 soil water suspension (Jackson, 1958), where as EC was measured by digital EC meter (Wilcox, 1950), organic carbon was determined by wet-oxidation method (Walkley,1947), available nitrogen was determined by alkaline potassium permanganate method by 800ml kjeldhal flask (Subbiah and Asija, 1956), available phosphorous was determined by colorimetric method by using spectrophotometer (Olson *et al.*, 1954), available potassium was determined by flame photometer using neutral ammonium acetate solution (Toth and Prince, 1949), exchangeable calcium and magnesium were estimated by versanate titration method (Gupta, 1999).

2.2Statistical Analysis

The data recorded during the course of the investigation will be subjected to statistical analysis by CRD (Completely Randomized Design), as per the method "Analysis of Variance (ANOVA) technique" as given by Fisher (1960). The data derived from various determinations will be subjected to statistical analysis including mean, Pearson's Correlation, t-test and ANOVA. The means for the levels in soil in the three divisions will be determined. Using ANOVA and t-test, the means will be compared to determine whether they were significantly different.

3.Result and Discussion

3.1 Physical properties of soil

The data of all the physico-chemical properties of the soil of some selected areas under Namchi distrit of sikkim along with its line graphs and correlation with respect to depths 0-15cm, 15-30cm and 30-45cm are presented in the Table1-5. The data show that soil texture varied from sandy clay loam to loam at different depths of soil which was found to be similar to the study of Deb *et.al.,*(2013). The colours of dry condition were light brown, brown, dark brow and pale brown and that of of wet condition were light gray, dark gray, red, reddish brown and dark brown. The dominant colour was found to be red and dark brown due to the presence of sesquioxides and high organic matter content. This results were similar to Nayak *et.al.* (2002)

The Bulk Density varied from 1.1-1.29 Mgm^{-3} and the Particle Density varied from 1.15-2.6 Mgm^{-3}. The porosity of the soil decreased with respect to depth in loamy soils but increase with depth in sandy loam soil. The bulk density, particle density and porosity were widely considered to be important factors contributing to the water holding capacities of the soil. It was observed that the mean percent of water holding capacity decreases with increase in bulk density and particle density and increases with increase in porosity which had similar results to that of Guo *et al.,*(2011) and Bisth *et al.* (2010).

3.2 Chemical Properties of soil

The value of pH ranges from . 5-6.3 with a mean of 5.3, 5.5 and 5.6 with respect to depth. The results were similar to that of Pradhan *et.al.,*(1996). The organic carbon status of soil sample ranged from 0.38-0.74% with a mean value of 0.57, 0.53 and 0.54 percent with respect to depth. The organic carbon content decreased with range because the top 0-15cm is associated with intensive cropping associated with application of organic manures by farmers during cultivation of different crops. Debnath *et.al.,* (2009) also reported the higher organic carbon content in rice growing soils of Terai Zone of west bengal where the farmers usually apply organic manure.

The available Nitrogen content of soil ranged from 200-326kg/ha. This is believed to be due to the addition of organic amendments in the soil. The study of Mishra *et.al.,* (2000)showed similar results. The available phosphorus content ranged from15-26 kg/ha which is similar to the findings of Ram *et.al.,* (2014). Available Potassium content of soil ranged from 238-348 kg/ha which is considerend medium to high and this could be because of the presence of feldspar and muscovite mica found in the soils of this region. This finding is similar to that of Ram *et.al.,* (2014).

Exchangeable Calcium content of soil ranged from 0.06-0.39meq/100g and Exchangeable Magnesium content of soil ranged from 0.04-0.56meq due to the amount of rainfall prevailing in the study area that causes surface leaching of bacic cations, this findings were similar to the study of Ray *et.al.,* (2012). The Sulphur content of soil ranged from 8.5-21.45kg/ha.

Table 1 : Bulk density and particle density (Mgm^{-3})

Blocks	Village	Bulk density			Particle density		
Namchi	Depth	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
	Pabong	1.1	1.16	1.18	2.25	2.27	2.3
	U. ghurpisey	1.14	1.18	1.21	2.2	2.6	2.7
	Kholaghari	1.24	1.28	1.29	2.3	2.5	2.6
Temi	Lower tea garden	1.22	1.24	1.26	2.1	2.4	2.52
	Deu	1.26	1.28	1.3	2.3	2.5	2.6
	Peku	1.21	1.25	1.27	2.26	2.3	2.4
Sikkip	Middle vok	1.27	1.29	1.3	2.28	2.29	2.32
	Lower vok	1.26	1.27	1.29	2.24	2.3	2.4
	Upper chumlok	1.12	1.15	1.18	2.05	2.13	2.2
		F-test	S.Em.(±)	C.D @5%	F-test	S.Em.(±)	C.D@5%
Due to depth		S	0.0257	3.6808	S	0.1158	0.00016
Due to village		S	0.0566	4.4612	S	0.1174	0.00202

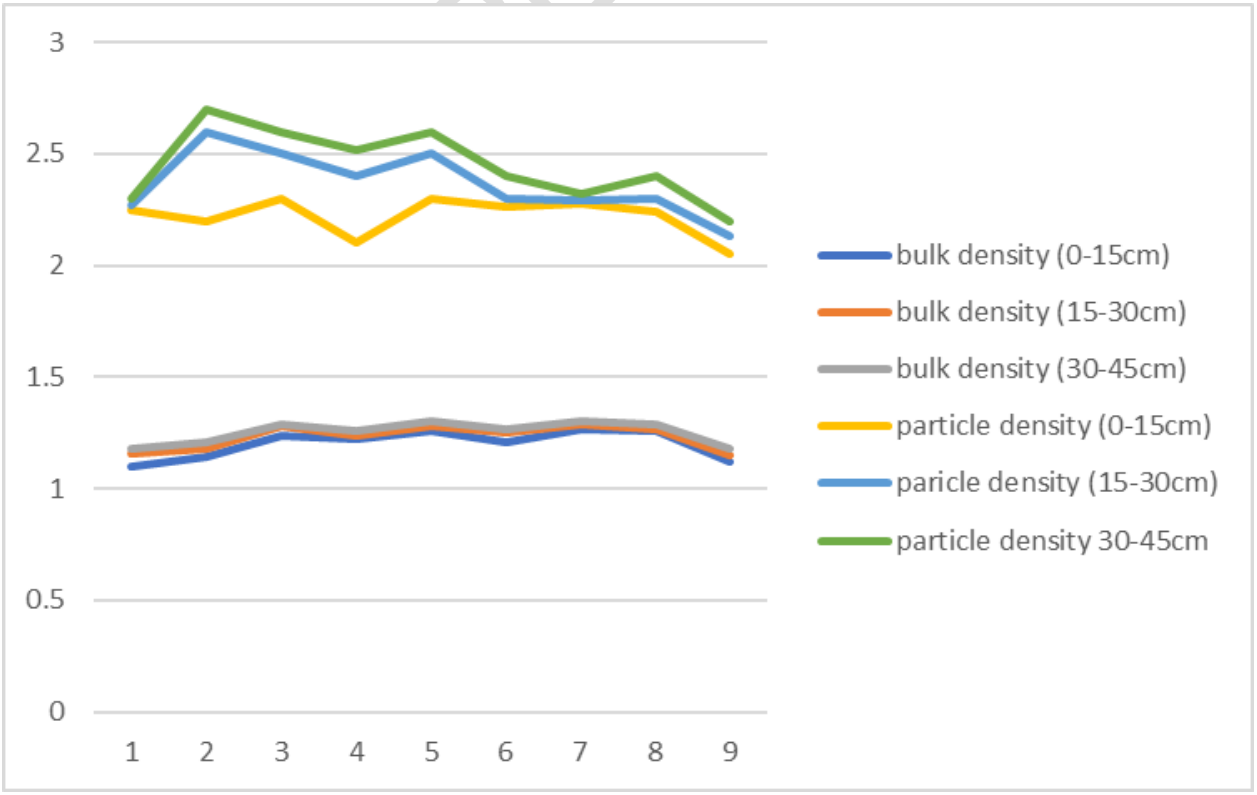

Fig 2) Shows bulk density and particle density at depths 0-15cm,15-30cm and 30-45cm respectively.

Table 2: Pore space and water holding capacity (%)

Blocks	villages	Pore space			Water holding capapcity		
Namchi	Pabong	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
		47	46	45.5	46	46.7	47
	U. ghurpisey	46	45	45.6	47	48	48.7
	Kholaghari	46	45	45	46	45.8	45
	Lower tea garden	48	46	45.7	45.61	45	44.8
Temi	Deu	48	47	46	48	48.6	49
	Peku	47	46.8	46	47	47.8	48
	Middle vok	49	48	46	47	46	45.9
	Lower vok	47	46	45.5	46	45.8	45
Sikkip	Upper chumlok	48	47.6	46	48	49	49.3
		F-test	**S.Em.(±)**	**C.D@5%**	**F-test**	**S. Em. (±)**	**C.D @5%**
Due to depth		**NS**	0.820594	1.3905	S	0.134074	0.651115
Due to village		**NS**	**0.760381**	0.000519	NS	1.351001	4.5106

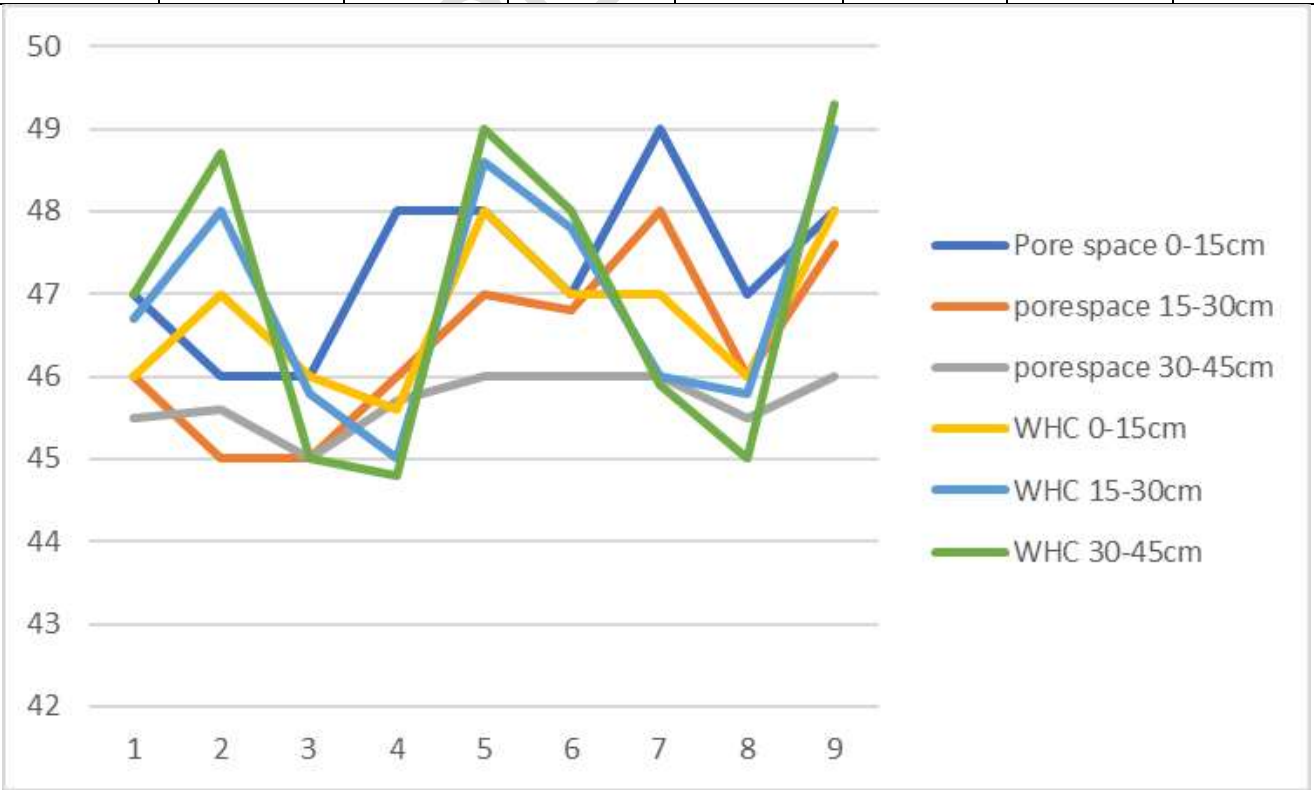

Fig 3) Shows Pore space and WHC at depths 0-15cm, 15-30cm and 30-45cm respectively.

Table 3: pH, EC(dSm^{-1}) and Organic carbon (%)

Blocks	Villages	pH			EC			Organic Carbon		
		0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
Namchi	Pabong	5.5	5.6	5.8	0.06	0.07	0.08	0.5	0.49	0.45
	u. ghurpisey	5.3	5.4	5.5	0.04	0.05	0.07	0.6	0.56	0.55
	Kholaghari	5.8	5.9	6	0.04	0.05	0.06	0.8	0.74	0.72
	Lower tea garden	5	5.3	5.4	0.08	0.09	1.02	0.5	0.5	0.48
Temi	Deu	5	5.2	5.4	0.07	0.09	1	0.4	0.38	0.38
	Peku	5.2	5.3	5.4	0.06	0.07	0.08	0.6	0.6	0.59
	Middle vok	6	6.2	6.3	0.13	0.14	0.15	0.5	0.49	0.46
	Lower vok	5.3	5.4	5.6	0.11	0.12	0.13	0.6	0.5	0.6
Sikkip	Upper chumlok	5.4	5.6	5.8	0.13	0.14	0.15	0.7	0.6	0.59
		F-test	S. Em. (±)	C.D @5%	F-test	S. Em. (±)	C.D @5%	F-test	S. Em. ±	C.D @5%
Due to depth		NS	0.150034	5.5309	NS	0.126498	0.099391	NS	0.02320	0.0090
Due to village		NS	0.322653	7.9913	NS	0.136678	0.446734	NS	0.10596	1.72

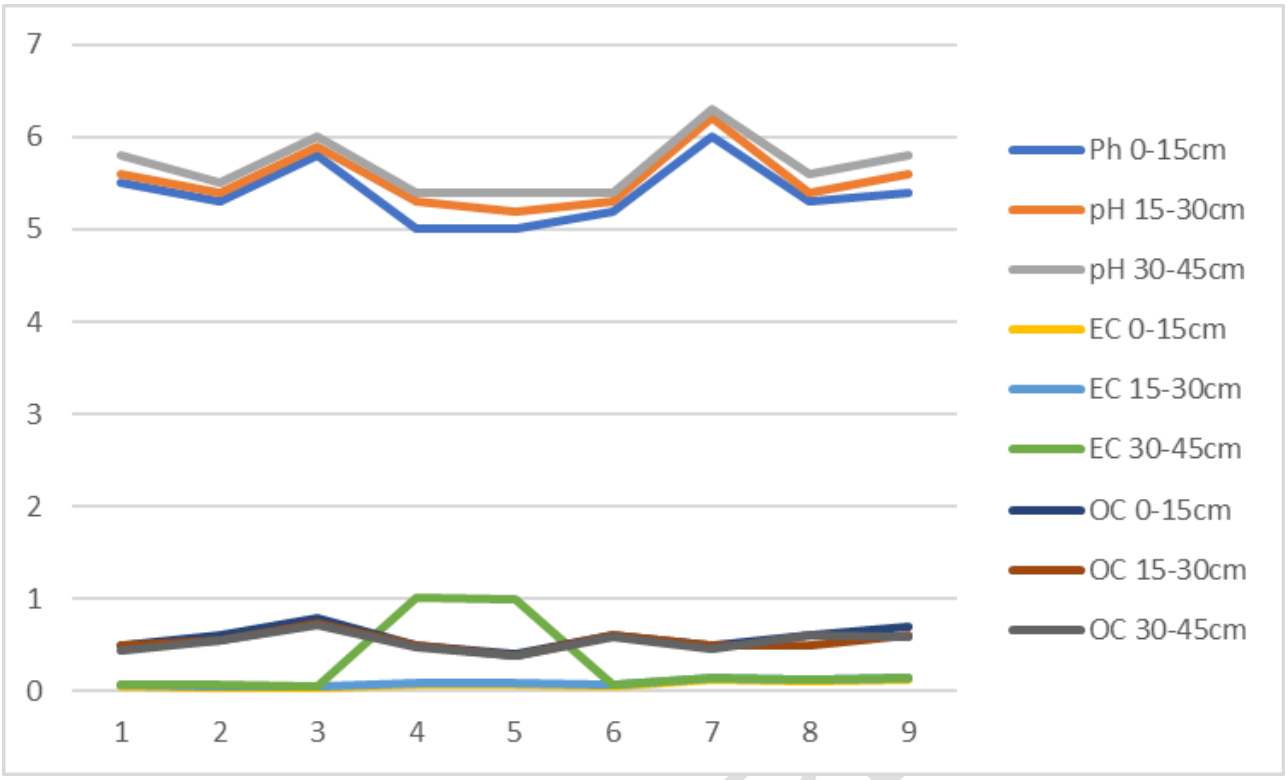

Fig 4) Shows pH, EC and OC at depths 0-15cm, 15-30cm and 30-45cm respectively.

Table 4: Available Nitrogen, Available Phosphorus and Available potassium (Kg/ha)

Blocks	Village	Available Nitriogen			Available phosphorus			Available potassium		
		0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
Namchi	Pabong	272	268	266	17.5	18	15	287.4	283	280
	U. ghurpisey	200	189	186	15	16.5	26	312	298.5	292
	Kholaghari	312	310	308	21	25	19.5	358	321	296
Temi	Lower tea garden	240	237	255	16	18	23	287	280.8	234
	Deu	245	240	232	25	27	21	243	233	220.5
	Peku	311	300	326	18	26	23	287	279	256
Sikkip	Middle vok	243	231	229	20.5	21	24	289	285	283
	Lower vok	289	285	279	22	26	23	316	309.4	301.5
	Upper chumlok	254	248	245	21	25	19	321	305	285
		F-test	**S. Em. ±**	**C.D @5%**	**F-test**	**S. Em. ±**	**C.D @5%**	**F-test**	**S. Em. ±**	**C.D @5%**
Due to depth		S	4.703	0.10568	S	1.4972	0.172046	S	14.083	0.0001
Due to village		NS	37.35	3.67	NS	2.4043	0.176288	NS	27.328	7.13

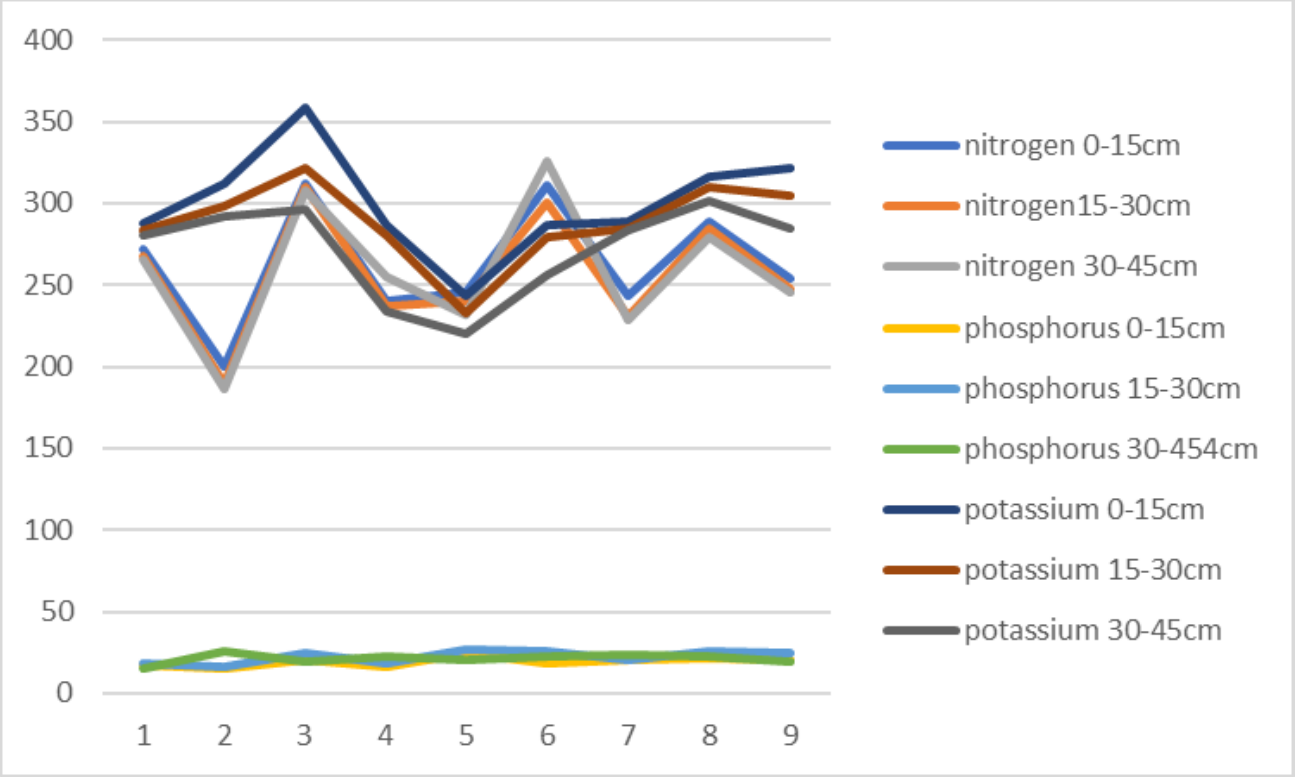

Fig 5) Shows NPK range at depths 0-15cm, 15-30cm and 30-45cm respectively.

Table 5: Exchangeable calcium(meq/100g), Exchangeable magnesium(meq/100g) and Available sulphur (kg/ha)

Blocks	**Villages**	**Exchangeable calcium**			**Exchangeable magnesium**			**Available sulphur**		
		0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
Namchi	**Pabong**	0.33	0.30	0.27	0.28	0.25	0.21	11	13	12.6
	U. ghurpisey	0.39	0.35	0.29	0.21	0.19	0.11	16	18	14
	Kholaghari	0.28	0.25	0.3	0.29	0.15	0.15	19	14	14
	Lower Tea Garden	0.12	0.9	0.06	0.31	0.27	0.24	9	9.8	7
Temi	**Deu**	0.06	0.05	0.03	0.56	0.43	0.28	8.5	9	12
	Peku	0.10	0.9	0.4	0.29	0.24	0.21	17	15	18
	Middle vok	0.15	0.12	0.10	0.04	0.04	0.06	20	21	23
Sikkip	**Lower vok**	0.18	0.10	0.08	0.07	0.06	0.05	15	17	18
	Upper chumlok	0.32	0.21	0.21	0.56	0.03	0.09	21.45	20	17
		F-test	**S. Em. ±**	**C.D @5%**	**F-test**	**S. Em. ±**	**C.D @5%**	**F-test**	**S. Em. ±**	**C.D @5%**
Due to depth		S	0.0865	0.2232	S	0.0707	4.977	S	0.082215	0.984
Due to village		NS	0.1342	0.3003	NS	0.113	4.283	NS	4.220074	8.06

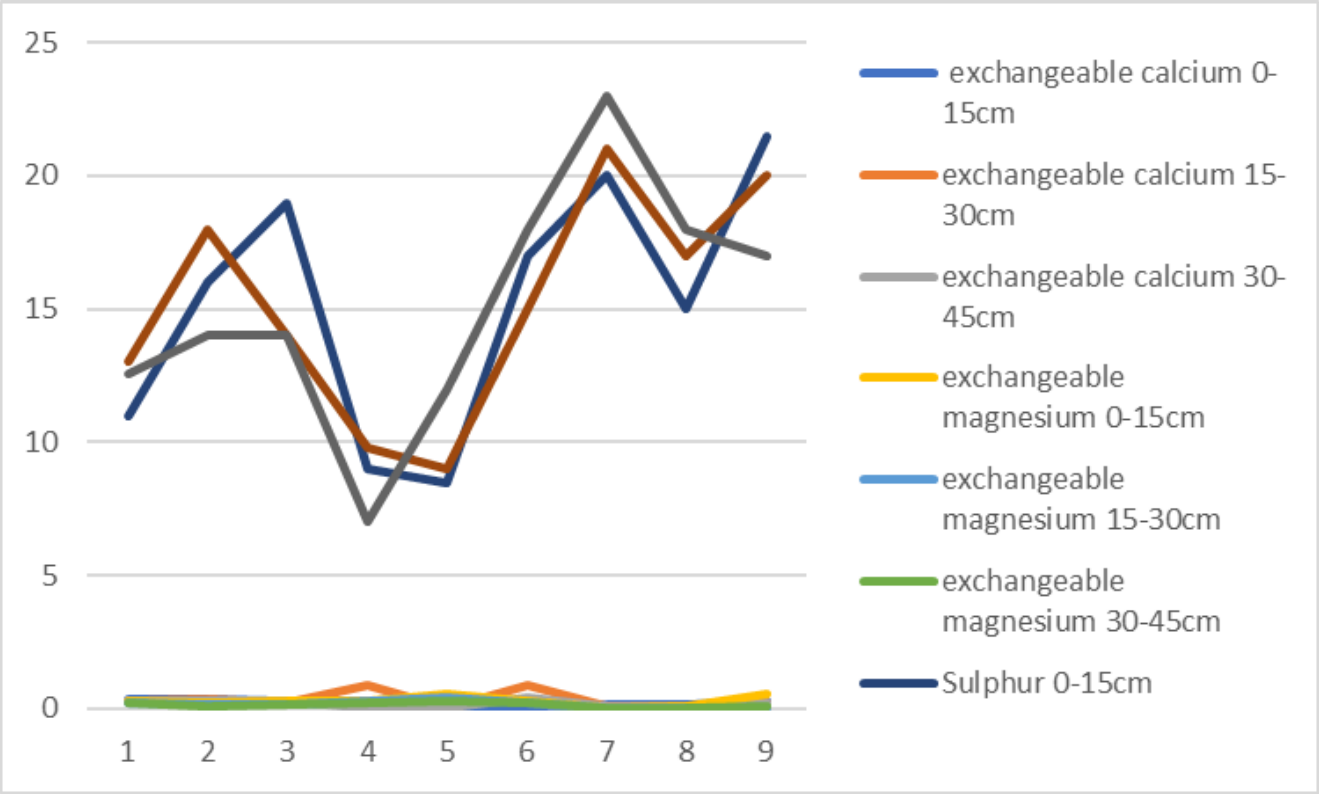

Fig 6) Shows Ca, mg and S range at depths 0-15cm, 15-30cm and 30-45cm respectively.

Table 6 :Correlation of different physical and chemical parameters of soil from different villages under Namchi, Temi and Sikkip blocks at depths 0-15cm, 15-30cm and 30-45cm.

	Bd	Pd	Porespace	WHC	pH	EC	OC	N	P	K	Ca	Mg	S
Bd	1												
Pd	0.500135	1											
porespace	-0.32623	0.281027	1										
WHC	-0.07259	0.126405	0.587084	1									
pH	0.08072	0.330142	0.191093	0.575717	1								
EC	0.17856	-0.37849	-0.40603	0.422061	-0.220274	1							
OC	-0.16802	-0.16408	0.597674	0.49218	0.39428	-0.11767	1						
N	0.243141	0.366331	0.455162	0.285202	0.191973	-0.10313	0.450183	1					
P	0.526295	0.356968	0.200699	0.542518	0.082372	0.372862	-0.06185	0.30043	1				
K	-0.14701	-0.15113	0.405503	0.434687	0.503716	-0.08214	0.941985	0.334777	-0.16083	1			
Ca	-0.7605	-0.27406	0.425127	0.34931	0.338544	-0.21328	0.520385	-0.22888	-0.42201	0.613408	1		
Mg	-0.31511	-0.34764	0.320127	0.006696	-0.48419	-0.09544	-0.01719	-0.06608	0.3035	-0.25113	-0.03862	1	
S	-0.06441	-0.09953	0.428316	0.731279	0.679187	0.354502	0.718168	0.207629	0.052196	0.658815	0.373734	-0.20584	1

Table 6. a) At depth 0-15cm

	Bd	Pd	Porespace	WHC	pH	EC	OC	N	P	K	Ca	Mg	S
Bd	1												
Pd	0.296016	1											
Porespace	-0.22234	0.086236	1										
WHC	-0.09604	-0.42222	0.572673	1									
pH	0.179045	-0.21915	0.058620	0.480501	1								
EC	0.075107	-0.70611	-0.42868	0.417065	-0.290983	1							
OC	-0.092	0.015247	0.582150	0.254821	0.351368	-0.34189	1						
N	0.319765	-0.30056	0.398258	0.228249	0.080046	-0.12909	0.468986	1					
P	0.461121	-0.23313	0.394157	0.48173	-0.10745	0.271624	0.108198	0.61185	1				
K	-0.19829	-0.16377	0.259435	0.375480	0.436775	-0.01698	0.778611	0.284321	-0.09894	1			
Ca	-0.08858	0.001668	-0.22882	-0.72068	-0.38743	-0.35097	0.208507	0.122818	-0.26206	-0.03814	1		
Mg	0.110351	0.511518	-0.0319	-0.62279	-0.63068	-0.54301	-0.44126	-0.08329	-0.02438	-0.78883	0.265682	1	
S	-0.2033	-0.40363	0.170947	0.689057	0.582223	0.479866	0.308599	-0.16905	-0.03314	0.568724	-0.31543	-0.88391	1

Table 6. b) At depth 15-30cm

	Bd	Pd	porespace	WHC	pH	EC	OC	N	P	K	Ca	Mg	S
Bd	1												
Pd	0.343273	1											
Porespace	-0.28419	-0.01475	1										
WHC	-0.11567	-0.48260	0.576994	1									
pH	0.066343	-0.40659	0.006220	0.571145	1								
EC	0.304299	0.322417	-0.57445	-0.66441	-0.49135	1							
OC	0.012964	0.052528	0.449850	0.376466	0.172445	-0.59766	1						
N	0.272216	-0.23467	0.285072	0.04209	-0.02108	-0.21795	0.520824	1					
P	0.438433	0.45594	-0.3552	-0.22704	-0.21853	0.096862	0.037069	-0.33485	1				
K	-0.24939	-0.22002	0.328228	0.660042	0.564696	-0.87714	0.639557	0.032874	-0.03464	1			
Ca	-0.39362	-0.01377	0.711979	0.175189	0.010617	-0.70274	0.563520	0.409199	-0.15204	0.386232	1		
Mg	0.046139	0.323104	-0.02762	-0.68325	-0.57227	0.666603	-0.44731	0.1787	-0.29139	-0.84717	-0.02822	1	
S	0.205911	-0.47785	0.241952	0.746091	0.590029	-0.65030	0.207308	0.073005	0.222146	0.526026	0.162272	-0.71759	1

Table 6 c) At depth 30-45cm

CONCLUSION

The study of physical and chemical properties of soils of Namchi district of Sikkim concluded that the soils have good physical properties for the cultivation of most crops. The colour of the soil is dominantly red and brown. The bulk density and particle density values were considerably low and increased with increase in depth. The water holding capacity decreases with increase in depth and increases with increase in pore space. The available nitrogen, phosphorus and potassium content is high due to the application of organic soil amendments and good management practices. All these properties of the soil is indicative of good cultivation of crops like ginger, cardamom, paddy, buckwheat, oranges and guava and vegetables like cabbage, squash and spinach.

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