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Taxonomical Classification of Arable Lands in the District Pulwama of Kashmir, India

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ABSTRACT

Knowledge about morphological, physical and chemical characteristics of soil is an essential requirement for successful crop establishment and output in an area. Taking this concept into cognizance, nine representative soil profiles exposed in the study area were assessed for various properties. Results revealed that the topographical as well as soil morphological features were diverse thereby leading to development of different soil assets. The soils showed varying degree of profile development on foothills (A-C), low hill plateaus (A-Bw-C) and inland valleys (A-Bt-C) horizons, respectively. Particle size analysis revealed that the variation of sand, silt and clay content ranged from 11.7 to 60.6, 22.3 to 60.5 and 17.1 to 35.3 percent, respectively. Organic carbon ranged from 0.02 to 1.72 percent with a mean value of 0.42 percent. Bulk density and particle density ranged from 1.21 to 1.58 Mg m^{-3} and 2.3 to 2.8 Mgm^{-3}, respectively. The soils were finally recognized to fall under the Entisol, Mollisol and Alfisol orders under taxonomical classification and II, III and IV classes under capability classification with limitations of slope, erosion and wetness. Proper soil managements and diversification of crops can decrease the risk of crop failures caused by such soil limitations.

Keywords: arable land, characterization, classification, evaluation, Pulwama, toposequence.

INTRODUCTION

The significance of a life supporting system in any region lies within the effective land use to give distributional patterns of crops. The rising food prices in the international market, progressive conversion of good lands to grow bio fuel crops, industrial and other non-agricultural uses demand effective soil resource management to ensure productivity, profitability and national food security[1]. For sustainable use of soil resources, a detailed inventory is necessary to strengthen the sustainable development of a region. To achieve soil resource management in agro ecological regions, knowledge on morphological, physical and chemical characteristics and classification is an essential requirement. District Pulwama is a major part of Kashmir valley, India with respect to agricultural perspective[2] and pertinent information about the arable soils is unavailable[3] and hence the present investigation was carried out.

MATERIALS AND METHODS

District Pulwama falls between 33° 46' N to 33° 52' N latitude and 74° 45' to 75° 35' longitude

with a mean elevation of 1630 m amsl. The entire area is characterized by sub-humid temperate climate with a mean annual temperature of 14°C. The moisture and temperature regimes of the area are Udic and mesic, respectively. The natural vegetation of the area consists of trees like *Salix spp., Populous spp., Planetarium orientalis, Roubinea spp.* etc. The hill ranges are covered with forests and dominant species are *Pinus sylvestris, Pinus walichiana*, *Cedrus deodara, Abies pindrow and Picea smitheana*. The district is rich in horticulture and agriculture[4] and the main crops include paddy, fodder, saffron (*Croccus sativus*), apple (*Malus spp.*) and condiments.

After a general traversing of the study area nine representative profiles were selected for study (Fig-1). Landforms were delineated on the basis of image interpretation of Resourcesat-1 LISS-III data and ground truth study i.e. geology, drainage pattern, surface features, slope characteristics and present land use (Fig-2). The reconnaissance survey was carried out in 1:50,000 scale using Survey of India toposheet as a base map of the same scale. The soil site description was made following the standard proforma of soil site description of NBSS&LUP soil bulletin no. 23[5]. The detailed morphological description of these nine profiles was studied in the fields as per the guidelines in Field guide for Soil Survey[6]. The soil samples collected from different horizons were air dried and grounded in a wooden pestle and mortar. Ambient soil was passed through 2 mm sieve and then subjected to various physical and chemical analysis. The particle size analysis was carried out by international pipette method[7] using sodium-hexametaphosphate as a dispersing agent. The textural class was determined using the USDA textural triangle. Soil reaction (1:2.5 soil and water suspension) was determined by pH meter[8] and electrical conductivity (EC) of soil water extract was determined with the help of conductivity bridge[9]. Organic carbon (OC) was determined by chromic acid wet digestion method[10]. Estimation of calcium carbonate was done by rapid titration method[7]. Cation exchange capacity (CEC) was determined by Schollenberger and Simon (1945)[11] method of leaching the soil with neutral normal ammonium acetate. The exchangeable cations were extracted with neutral normal ammonium acetate. Potassium (K) and sodium (Na) were determined by flame photometer while, calcium (Ca) and magnesium (Mg) were determined by atomic absorption spectrophotometer procedure[12]. Bulk density (BD) and particle density (PD) were determined by Core sampler[13] and Pycnometer method[14],respectively.

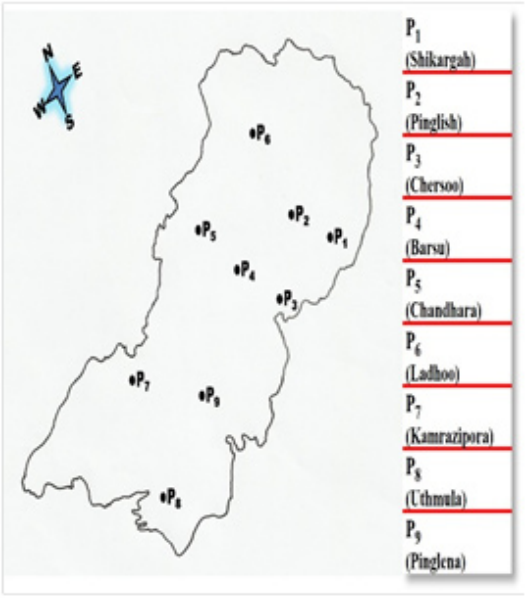

Fig. 1: Profile Sites selected in District Pulwama

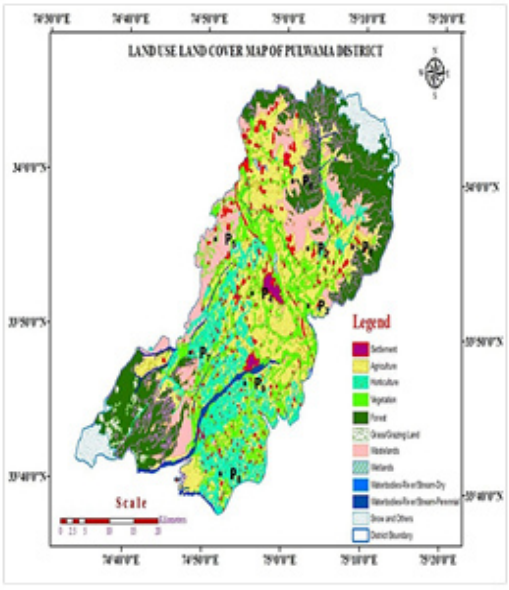

Fig. 2: LISS III image of District Pulwama

Table 1: Site characteristics of arable soils of district Pulwama

Profile	Latitude and Longitude	Altitude (m amsl)	Topography (Land form type)	Slope (%)	Erosion	Drainage	Depth of ground water (m)	Natural vegetation	Present land use
P1 (Shikargah)	33° 53. 657' N 75° 08. 209' E	1800	Undulating Hill slope	3-8	Slight	well drained	>10	Pinus, Ulmus, Populus, Salix, Ciderus	Cultivated single crop (Apple)
P2 (Pinglish)	33° 55. 345' N 75° 07. 603' E	1717	Level Plain Inland Valley	0-1	Very slow	Moderately well drained	5-10	Ulmus, Populus, Salix	Cultivated double crop (Kharif – Paddy) (Rabi- Mustard)
P3 (Chersoo)	33° 54. 121' N 75° 01. 603' E	1605	Level Plain Inland Valley	0-1	No erosion	Somewhat poorly drained	1-2	Populus, Salix, Plantarinum	Cultivated single crop (Paddy)
P4 (Barusu)	33° 59. 366' N 74° 55. 862' E	1779	Rolling Foot Hills	08-16	Severe	Excessively drained	>10	Juglans, Wild Apricot, Chestnut	Cultivated single crop (Almond)
P5 (Chandhara)	33° 54. 345' N 74° 53. 862' E	1617	Level Inland Valley	0-1	Very slow	Well drained	>10	Salix and some wild grasses	Cultivated single crop (Saffron)
P6 (Ladhoo)	33° 59. 985' N 75° 00. 125' E	1685	Nearly Level Inland Valley	1-13	Very slow	Well drained	>10	Populus, Ulmus, Juglans, Chestnut, Salix	Cultivated single crop (Maize)
P7(Kamrazipora)	33° 49. 898' N 74° 47. 944'E	1940	Undulating Low Hill Plateau	3-08	Slight	Well drained	>10	Acacia, Populus, Chestnut, Juglans, Salix	Cultivated double crop (Kharif-Maize or Beans) (Rabi-Oats or Mustard)
P8 (Uthmula)	33° 42. 060' N 74° 52. 441' E	1810	Nearly Level Inland Valley	0-1	Very slow	Well drained	2-5	Morus, Populus, Ulmus, Juglans, Salix	Cultivated single crop (Apple)
P9 (Pinglena)	33° 48. 385' N 74° 55. 708' E	1599	Level Inland Valley	0-1	Very slow	Moderately well drained	2-5	Typhus, Populus, Ulmus, Juglans, Salix and other grasses	Cultivated double crop (Kharif – Paddy) (Rabi- Mustard)

The soils were classified taxonomically up to sub-group level following Keys to Soil Taxonomy[15]. Moreover, considering limitations and potentials of the soils, Land Capability Classification was evaluated as per guidelines outlined by Klingebiel and Montgomery (1961)[16].

RESULTS AND DISCUSSION

Soil Morphology

The solum (A+B horizon) was moderately deep to deep in all the profiles except P_4 which was shallow (Table-2). The colour hue was 10YR in all the profiles with a value of 2 to 5 and chroma from 1 to 4. In general, all the soils were characterized by brown colour mixed with shades of grey and yellow. The soil colour appears to be the function of chemical and mineralogical composition as well as the textural makeup of the soils and conditioned by topographic position and moisture regime[17]. The various shades like dark brown, very dark brown, yellow brown colour in surface and sub-surface horizons of profiles indicate a good drainage condition of the soils[18]. The structure of the surface soils varied from fine weak granular to medium moderate crumb which can be attributed to continuous soil manipulation and continuous addition of organic matter[19]. The sub-surface horizons showed a definite structure of sub-angular to angular blocky which may be attributed to the increase in clay fraction and compaction[20].

The consistence of the soils varied from slightly hard to hard (dry), friable to very firm (moist) and slightly sticky to sticky (wet). The increase in hardness, firmness and stickiness with depth is due to increase in compaction and clay content in sub-surface horizons[1]. Slight to strong effervescence was observed in all profiles especially in sub-surface horizons except P_2 P_6, P_8 and P_9 which showed no effervescence. The horizon boundaries are clear to gradual in distinctness and smooth to broken in topography.

Physical characteristics

The detailed physical characteristics of the soils are presented in table-3. Perusal of the data reveals that the sand, silt and clay content are in the range of 11.7 % to 60.6 %, 22.3 % to 60.5 % and 17.1 % to 35.3 % with mean value of 32.14 %, 42.01 % and 25.84 %, respectively. All profiles showed a decrease in sand fraction down the depth except P_3 and P_6 which showed an increasing trend that can be attributed to the *in situ* weathering of the parent material. The silt fraction showed a decrease with depth in all the profiles except P_3 with an increase in silt fraction down the depth which may be due to the less weathering intensity and alluvial depositions of the parent material[21]. Clay exhibit a decrease down the depth in P_4 which may be attributed to the less intense weathering due to low rainfall, severe erosion and sparse vegetation[18]. The bulk density and particle density ranged from 1.21 to 1.58 Mgm^{-3} and 2.3 to 2.8 Mgm^{-3}, respectively with a regular increasing trend with the depth. The increase in bulk density may be attributed to the increase in organic matter and more compaction of finer particles in deeper layers caused by over-head weight of surface soil[17]. The increase in particle density could be attributed to increase in total sand fraction in sub-surface horizon[22].

Chemical Characteristics

In general, the soils were neutral to slightly alkaline in reaction with the pH variation from 6.49 to 8.42 (Table 4). The pH showed a regular increase with the depth in all the profiles which can be attributed to decrease in organic matter, leaching of bases and accumulation of calcium carbonate at sub-surface horizons of the profiles[23]. EC of the soils showed non-saline nature and ranged between 0.01 to 0.19 dSm^{-1} with a regular increase with the depth in all the profiles, attributed to the leaching of soluble salts[19].

The organic carbon content of these soils showed a conspicuous variation within the profile which was higher in surface than in the sub-surface horizons. It ranged from 0.02 to 1.72 percent with a mean value of 0.42 percent. The higher values in surface horizons may be due to the continuous organic manuring, addition through vegetation and low mineralization rates in these soils[19].

The exchangeable calcium was dominant cation in all the soil profiles followed by magnesium, potassium and sodium with their values ranging from 3.87 to 4.61 cmol (p^+) kg^{-1}, 0.40 to 0.47 cmol (p^+) kg^{-1}, 0.10 to 0.29 cmol (p^+) kg^{-1} and 0.07 to 0.42 cmol (p^+) kg^{-1}, respectively. The content of these

Table 2: Morphological Properties of arable soils of district Pulwama

Profile	Horizon	Depth (cm)	Boundary	Colour (moist)	Structure	Consistency	Plasticity	Effervescence	Special features
P1 (Shikargah)	Ap	0-18	cs	10YR 4/3 (Brown)	m 2 gr	sh fr ss	sp	-	Many fine roots
	Bt1	18-47	ds	10YR 3/3 (Dark brown)	c 2 abk	h fi ss	sp	-	Few fine roots
	Bt2	47-75	dw	10YR 3/2 (Dark grayish brown)	c 3 abk	vh vfi s	mp	e	few medium roots
	Bt3	75-90	-	10YR2/2 (Very dark grayish brown)	c 3 abk	vh vfi s	mp	e	Many fine roots
P2 (Pinglish)	Ap	0-29	cs	10YR 3/3 (Dark brown)	m 2 cr	sh fr ss	sp	-	Many medium roots
	AB	29-55	cs	10YR 3/2 (Dark grayish brown)	m 3 sbk	h fi ss	sp	-	Few fine roots
	Bt1	55-95	cs	10YR 3/2 (Dark grayish brown)	c 3 sbk	vh vfi s	mp	-	Very few fine roots
	Bt2	95-133	ds	10YR 2/2 (Very dark grayish brown)	c 3 abk	vh efi s	p	-	-
	BC	133-160	-	10YR 2/2 (Very dark grayish brown)	c3abk	vh vfi ss	sp	-	-
P3 (Chersoo)	Ap	0-19	cs	10YR 3/2 (Dark grayish brown)	f 2 sbk	h fi ms	mp	e	Many fine roots
	AB	19-57	cs	10YR 4/1 (Dark gray)	m 3 abk	vh vfi ms	p	es	Few fine roots and redox concentrations
	Bt1	57-80	ds	10YR 3/2 (Dark grayish brown)	f 3 abk	vh vfi vs	p	es	Very few fine roots and redox concentrations
	Bt2	80-110	-	10YR 4/2 (Very dark grayish brown)	f 3 abk	vh fi ss	sp	es	-
P4 (Barsu)	A	0-16	cs	10YR 4/3 (Brown)	f 1 gr	sh fr ss	sp	es	Few fine roots
	AC	16-47	gb	10YR 3/2 (Dark grayish brown)	f 1 gr	sh fr ss	sp	es	Very few fine roots
	C	47-72	-	10YR 3/4 (Dark yellowish brown)	f 2 sbk	l fr ss	sp	es	-
P5 (Chandhara)	Ap	0-20	cs	10YR 3/3 (Dark brown)	f 1 sbk	sh l ss	sp	-	Few fine roots

	Bw1	20-43	dw	10YR 3/2 (Dark grayish brown)	m2 sbk	h l ss	sp	-	Few fine roots
	Bw2	43-66	cs	10YR 4/3 (Brown)	m2 sbk	h vfr s	sp	e	Very few very fine roots
	Bw3	66-190	-	10YR 5/4 (Light brown)	f 2 abk	h vfr s	sp	es	-
P6 (Ladhoo)	Ap	0-22	cs	10YR 3/3 (Dark brown)	m 2 cr	sh fr ss	so	-	few fine roots
	Bw1	22-42	gs	10YR 4/3 (brown)	m 2 sbk	sh vfr ss	so	-	Few very fine roots
	Bw2	42-58	cs	10YR 3/3 (Dark grayish brown)	m 2 abk	h fi s	sp	-	Very few very fine roots
	Bw3	58-93	-	10YR 3/2 (Dark grayish brown)	m 1 abk	h fi s	sp	-	Very few very fine roots
P7 (Kamrazipora)	Ap	0-21	cs	10YR 3/3 (Dark brown)	m 2 cr	h fr ss	sp	-	Fine few roots
	Bw1	21-79	ds	10YR 3/4 (Grayish brown)	m 2 sbk	vh fr ss	sp	-	very few fine roots
	Bw2	79-135	cs	10YR 3/2 (Dark grayish brown)	m 3 abk	eh vfi s	sp	e	Very few fine roots
	BC	135-170	cs	10YR 3/3 (Dark brown)	c 3 abk	eh vfi s	p	es	-
	C	170-194	-	10YR 3/3 (Dark brown)	vc 3 abk	eh vfi s	p	es	-
P8 (Uthmula)	Ap	0-22	cs	10YR 3/3 (Dark brown)	m 2 cr	sh fr ss	sp	-	Few fine roots
	Bw1	22-54	ds	10YR 3/2 (Dark grayish brown)	m 2 sbk	h fi ss	sp	-	Few fine roots
	Bw2	54-82	gs	10YR 4/2 (Grayish brown	c 2 sbk	vh efi ss	sp	-	Few medium roots
	Bw3	82-120	-	10YR 2/1 (Very dark brown)	vc 3 abk	vh efi s	sp	-	few fine roots
P9 (Pinglena)	Ap	0-29	cs	10YR 2/1 (Very dark brown)	f 2 cr	sh fr ss	sp	-	Medium fine roots
	Bt1	29-64	ds	10YR 3/3 (Dark brown)	m 2 abk	vh fi s	p	-	Few fine roots
	Bt2	64-120	-	10YR 3/2 (Dark grayish brown)	m 3 abk	vh fi s	p	-	Very few fine roots

exchangeable cations showed irregular trends with soil depth which can be attributed to the root distribution of principal crops and prevalence of weathering of clay minerals[24]. The calcium carbonate content was present in meagre amounts in most of the profiles while as P_3 and P_4 had considerable amount of calcium carbonate (Table-4).

Cation Exchange capacity of the soils showed little variation between and within the profiles. Profiles P_1, P_5 and P_9 showed an increasing trend, P_2, P_3, P_6, P_7 and P_8 showed irregular patterns while as P_4 showed a decreasing trend of CEC with the depth. The different distributional patterns of CEC

Table 2a: Symbols used in Morphological characterization of (Table-2) soils

Boundary	Structure	Effervescence	Texture	Consistency
b : broken	1 : weak	e : slight	sl : sandy loam	h : hard
c : clear	2 : moderate	es : strong	scl :sandy clay loam	sh : slightly hard
d : diffused	3 : strong		sil : silt loam	vh : very hard
g : gradual	f : fine		sicl : silty clay loam	l : loose
s : smooth	m : medium		l : loam	vfr : very friable
w : wavy	c : coarse		cl : clay loam	fr : friable
	cr : crumb			fi : firm
	gr : granular			vfi : very firm
	sbk : sub-angular blocky			ss : slightly sticky
	abk : angular blocky			s : sticky
				ms : moderately sticky
				vs : very sticky
				so : non-plastic
				sp : slightly plastic
				mp : moderately plastic
				p : plastic

within the depths may be attributed to the presence of organic matter[19] and illuviated clay[25].

Soil Classification

On the basis of morphological and physico-chemical characteristics, the soils of the study area were classified into taxonomical units as per Keys to Soil Taxonomy[15] into three major orders i.e. Alfisol, Mollisol and Entisol. Profile P_1 was classified as Alfisol while P_2, P_3, P_6, P_8 and P_9 as Mollisols and the profiles P_4, P_5 and P_7 were classified under Entisol order. The soils were classified up to sub-group level (Table-5).

The soil of Shikargah (P_1) was classified under the order Alfisol due to the presence of ochric epipedon and kandic endopedon and was further sub grouped as Typic Kandiudalf. The soil profiles of Pinglish (P_2), Chersoo (P_3) and Pinglena (P_9) showed mollic epipedon and argillic endopedon in each and were classified under order Mollisol. The profile P_2 and P_9 were found to be saturated with water for 20 or more consecutive days in a year and were classified under Oxyaquic Argiudolls at sub-group level.

Profile P_3 showed aquic conditions throughout the year with redoximorphic features in sub-surface horizon and was thus sub-grouped under Aquic Argiudoll. The soil profiles of Chandhara (P5) and Kamrazipora (P7) showed ochric epipedon and no distinct endopedon and were classified under Entisol order. Profile P_5 was classified under Typic Udorthents sub-group due to non-fluvial nature of soils while as profile P_7 showed distinct fluvial nature and hence classified under Typic Udifluvents at sub- group level. The soil profile of Ladhoo (P_6) and Uthmula (P_8) showed the presence of only mollic epipedon characteristics with a base saturation of >35 percent throughout the profile and were categorized as Mollisols. These profiles were keyed out as Typic Hapludolls at sub-group level. Profile Barsu (P_4) showed neither an epipedon nor any endopedon, hence qualified for Entisol order. Due to the presence of rock fragments in profile and sandy loam texture throughout the depth and presence of lithic contact, hence the profile was classified under Lithic Udipsamments sub-group.

Land capability classification

Land Capability Classes, on the basis of criteria[16], were framed as per according to site features studied in the field, morphological and physico-chemical characteristics. Three capability classes II, III and IV were found to be prevalent in the study area (Table-6).

The land capability sub-classes indicate that the soils are moderately well to fairly good cultivable

with limitations of slope, physical conditions, erosion and wetness. The inclusion of adaptable crops like almond and saffron in Kamrazipora (P_7), floriculture crops and apricot in Barsu (P_4) and crop rotations and green manuring, conservation of crop residues and animal manures, cover crops, incorporation of leguminous crops etc. in others pave a way to overcome the limitations of topography, wetness

Table 3: Physical properties of arable soils of district Pulwama

Profile	Horizon	Depth (cm)	Bulk density (Mg m^{-3})	Particle density (Mg m-3)	Porosity (%)	Sand Coarse Sand (%)	Sand Fine sand (%)	Total sand (%)	Silt (%)	Clay (%)	Textural class
P1 (Shikargah)	Ap	0-18	1.25	2.3	45.65	1.1	23.3	24.4	53.1	22.5	sil
	Bt1	18-47	1.37	2.5	45.2	0.9	24.1	25	50.2	24.8	sil
	Bt2	47-75	1.39	2.5	44.4	0.1	28.1	28.2	43.1	28.7	cl
	Bt3	75-90	1.46	2.5	41.6	0.7	29.3	30	40.5	29.5	cl
P2 (Pinglish)	Ap	0-29	1.36	2.3	40.87	1.8	47.9	49.7	30.2	20.1	l
	AB	29-55	1.32	2.3	42.61	1.4	49.4	50.8	28.1	21.1	l
	Bt1	55-95	1.37	2.5	45.2	1.1	43.1	44.2	26.5	29.3	cl
	Bt2	95-133	1.41	2.7	47.78	0.8	41.8	42.6	24.2	33.2	cl
	C	133-160	1.49	2.8	46.79	0.7	51.7	52.4	24.1	23.5	scl
P3 (Chersoo)	Ap	0-17	1.21	2.3	47.39	1.2	30.1	31.3	40.4	28.3	cl
	AB	17-57	1.37	2.5	45.2	0.9	28.5	29.4	39.4	31.2	cl
	Bt1	57-80	1.39	2.5	44.4	0.7	25.4	26.1	38.6	35.3	cl
	Bt2	80-110	1.43	2.5	42.8	0.5	21.5	22	51.7	26.3	sil
P4 (Barsu)	A	0-16	1.29	2.3	43.91	2.7	51.8	54.5	27.3	18.2	sl
	AC	16-47	1.4	2.5	44	3.1	53.2	56.3	25.9	17.8	sl
	C	47-72	1.45	2.5	42	3.5	57.1	60.6	22.3	17.1	sl
P5 (Chandhara)	Ap	0-20	1.25	2.3	45.65	2.5	23	25.5	53.2	21.3	sil
	Bw1	20-43	1.36	2.5	45.6	1.7	22.5	24.2	51.1	24.7	sil
	Bw2	43-66	1.39	2.5	44.4	0.9	26.4	27.3	44.5	28.2	cl
	Bw3	66-190	1.46	2.5	41.6	0.5	27.3	27.8	42.9	29.3	cl
P6 (Ladhoo)	Ap	0-22	1.3	2.4	45.83	1.3	16.5	17.8	60.5	21.7	sil
	Bw1	22-42	1.38	2.5	44.8	1.8	12.5	14.3	60	25.7	sil
	Bw2	42-58	1.46	2.5	41.6	0.5	11.2	11.7	60.3	27.7	sicl
	Bw3	58-93	1.48	2.5	40.8	0.6	24.4	25	47.1	27.9	cl
P7 (Kamrazipora)	Ap	0-21	1.32	2.5	47.2	2.4	24.7	27.1	52.6	20.3	sil
	Bw1	21-79	1.37	2.5	45.2	1.6	22.4	24	51.2	24.8	sil
	Bw2	79-135	1.42	2.5	43.2	0.9	26.4	27.3	45.5	27.2	cl
	BC	135-170	1.47	2.5	41.2	0.4	27.5	27.9	43.8	28.3	cl
	C	170-194	1.49	2.5	40.4	0.8	33	33.8	34.9	31.3	cl
P8 (Uthmula)	Ap	0-22	1.27	2.3	44.78	1.6	26.9	28.5	50.3	21.2	sil
	Bw1	22-54	1.41	2.3	38.7	0.9	29.1	30	47.6	22.4	l
	Bw2	54-82	1.45	2.5	42	0.8	30.8	31.6	48.1	20.3	l
	BC	82-120	1.48	2.5	40.8	0.3	35	35.3	40.2	24.5	l
P9 (Pinglena)	Ap	0-29	1.35	2.3	41.3	0.8	28.3	29.1	42.3	28.6	cl
	Bt1	29-64	1.45	2.5	42	0.7	31.1	31.8	35.4	32.9	cl
	Bt2	64-120	1.58	2.5	36.8	0.5	30	30.5	34.4	35.1	cl

Table 4: Chemical properties of arable soils of district Pulwama

Profile	Horizon	Depth (cm)	pH (1:2.5)	EC (dS m^{-1})	OC (%)	Ca CO_3 (%)	CEC (cmol (p^+) kg^{-1})	Ca (cmol (p^+) kg^{-1})	Mg (cmol (p^+) kg^{-1})	K (cmol (p^+) kg^{-1})	Na (cmol (p^+) kg^{-1})	Base saturation (%)
P1 (Shikargah)	Ap	0-18	6.55	0.01	1.06	0	9.12	4.51	0.47	0.26	0.42	62.06
	Bt1	18-47	6.44	0.03	0.38	0	9.46	4.23	0.45	0.13	0.1	51.9
	Bt2	47-75	6.86	0.04	0.35	0.3	9.78	4.35	0.44	0.13	0.11	51.43
	Bt3	75-90	7.2	0.05	0.09	0.7	9.98	4.4	0.42	0.1	0.12	50.5
P2 (Pinglish)	Ap	0-29	6.55	0.08	1.51	0	9.35	4.34	0.44	0.27	0.13	54.13
	AB	29-55	7.21	0.04	0.2	0	8.42	3.91	0.43	0.2	0.13	54.82
	Bt1	55-95	7.28	0.06	0.16	0	9.11	4.43	0.44	0.17	0.1	56.33
	Bt2	95-133	7.31	0.08	0.06	0	9.35	4.31	0.45	0.16	0.11	53.85
	C	133-160	7.44	0.12	0.02	0.1	8.37	4.09	0.44	0.13	0.09	56.78
P3 (Chersoo)	Ap	0-17	7.56	0.12	1.72	0.8	9.45	4.61	0.44	0.17	0.07	55.59
	AB	17-57	7.82	0.17	1.3	2.1	9.67	4.04	0.45	0.15	0.35	51.35
	Bt1	57-80	8.28	0.19	0.71	2.8	9.82	4.44	0.44	0.14	0.29	54.2
	Bt2	80-110	8.3	0.15	0.2	4.7	8.88	3.92	0.42	0.11	0.12	51.43
P4 (Barsu)	A	0-16	7.65	0.07	0.37	3.2	10.5	3.97	0.42	0.19	0.1	44.47
	AC	16-47	8.27	0.09	0.06	4.3	9.4	4.48	0.4	0.19	0.07	54.19
	C	47-72	8.38	0.1	0.02	7.8	8.7	4.39	0.42	0.14	0.12	58.83
P5 (Chandhara)	Ap	0-20	7.21	0.06	0.38	0	8.87	4.07	0.44	0.29	0.13	55.45
	Bw1	20-43	7.83	0.07	0.11	0.12	8.79	4.18	0.46	0.22	0.08	56.18
	Bw2	43-66	8.13	0.11	0.05	1.3	9.05	4.08	0.42	0.18	0.14	53.27
	Bw3	66-190	8.42	0.12	0.02	2.1	9.39	4.21	0.43	0.15	0.13	52.34
P6 (Ladhoo)	Ap	0-22	7.7	0.09	0.94	0	9.67	4.43	0.43	0.14	0.13	53
	Bw1	22-42	7.62	0.08	0.92	0	9.23	4.13	0.42	0.12	0.13	51.94
	Bw2	42-58	7.54	0.13	0.54	0.15	9.31	3.87	0.43	0.11	0.16	49.06
	Bw3	58-93	7.72	0.19	0.28	0.19	9.87	4.2	0.42	0.13	0.34	51.55
P7 (Kamrazipora)	Ap	0-21	7.38	0.07	0.46	0	8.25	4.27	0.45	0.22	0.23	62.71
	Bw1	21-79	7.33	0.12	0.31	0	8.99	4.1	0.44	0.2	0.16	54.6
	Bw2	79-135	7.63	0.1	0.27	1.5	8.75	4.06	0.43	0.22	0.13	55.3
	BC	135-170	8.13	0.05	0.07	4.7	9.13	4.27	0.44	0.19	0.13	55.17
	C	170-194	8.31	0.11	0.09	8.9	9.12	4.03	0.45	0.16	0.1	52.01
P8 (Uthmula)	Ap	0-22	6.49	0.05	0.86	0	8.75	4.54	0.42	0.17	0.08	59.06
	Bw1	22-54	6.68	0.02	0.18	0	9.12	4.29	0.44	0.15	0.17	55.6
	Bw2	54-82	6.9	0.03	0.15	0	8.97	4.48	0.44	0.15	0.16	58.27
	BC	82-120	7.2	0.08	0.02	0	9.87	4.16	0.43	0.12	0.14	49.53
P9 (Pinglena)	Ap	0-29	7.16	0.05	1.29	0	7.23	4.14	0.43	0.14	0.21	68.08
	Bt1	29-64	7.33	0.07	0.06	0	9.12	4.42	0.44	0.13	0.16	56.43
	Bt2	64-120	7.41	0.08	0.02	0	9.23	4.48	0.44	0.11	0.17	56.35

and physical conditions in order to maximize the productivity and profitability out of the soils to enhance better economy of the area.

In conclusion, the varying degree of profile development reflects the different degree of weathering intensity. Soils are having neutral to slightly alkaline reaction. Electrical conductivity is under normal range. Profiles show clay illuviation but the low values of CEC depicts low active clays. The presence of higher organic matter in surface

Table 5: Taxonomical Classification of arable soils of district Pulwama

Profile	Diagnostic Horizon		Order	Sub-order	Great group	Sub-group
	Epipedon	Endopedon				
P1 (Shikargah)	Ochric	Kandic	Alfisol	Udalfs	Kandiudalfs	Typic Kandiudalfs
P2 (Pinglish)	Mollic	Argillic	Mollisol	Udoll	Argiudoll	Oxyaquic Argiudoll
P3 (Chersoo)	Mollic	Argillic	Mollisol	Udoll	Argiudoll	Aquic Argiudoll
P4 (Barusu)	-	-	Entisol	Psamments	Udipsamments	Lithic Udipsamments
P5 (Chandhara)	Ochric	-	Entisol	Orthents	Udorthents	Typic Udorthents
P6 (Ladhoo)	Mollic	-	Mollisol	Udoll	Hapludoll	Typic Hapludoll
P7 (Kamrazipora)	Ochric	-	Entisol	Fluvents	Udifluvents	Typic Udifluvents
P8 (Uthmula)	Mollic	-	Mollisol	Udoll	Hapludoll	Typic Hapludoll
P9 (Pinglena)	Mollic	Argillic	Mollisol	Udoll	Argiudoll	Oxyaquic Argiudoll

Table 6: Land capability classification of arable soils of district Pulwama

Profile	Capability class	Land suitability	Remedial Suggestion
P1 (Shikargah)	IIes	Land suitable for cultivation with moderate restrictions	Proper fertility management, Cover crops, Mulching, Conservation of crop residues and animal manures and green manuring, Good land for Apple, Cherry and Peach.
P2 (Pinglish)	IIs	Land suitable for cultivation with less restrictions	Proper fertility management, Crop rotation, Green manuring, Suitable land for paddy and other cereals.
P3 (Chersoo)	IIws	Land suitable for cultivation with moderate restrictions	Proper drainage and fertility management, Paddy cultivation is best.
P4 (Barusu)	IVes	Cultivable land with severe restrictions.	Terracing, moisture conservation, Green manuring, Fertility management, Floricultural nursery establishment, and Plantation of Apricot are well.
P5 (Chandhara)	IIs	Land suitable for cultivation with less restrictions	Moisture conservation, Fertility management, Almond and Saffron cultivation.
P6 (Ladhoo)	IIs	Land suitable for cultivation with less restrictions	Proper irrigation and fertility management, Cultivation of cereal crops.
P7 (Kamrazipora)	IIIes	Land suitable for cultivation with moderate restrictions	Moisture conservation, Cover crops, Mulching, Fertility management, Almond and Saffron cultivation.
P8 (Uthmula)	IIs	Land suitable for cultivation with moderate restrictions	Good land for Apple, Cherry and Peach Proper with proper fertility management, Conservation of crop residues and animal manures and Green manuring,.
P9 (Pinglena)	IIws	Land suitable for cultivation with moderate restrictions	Proper drainage and fertility management, paddy cultivation is best.

horizons of some profiles reflects good physico-chemical properties. The land capabilty classes viz: II, III and IV in the study area reveals that the soils are cultivable but hold some limitations for use and hence an alternate option was provided.

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