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Soil physico-chemical properties as impacted by different land use systems in district Ganderbal, Jammu and Kashmir: India

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Abstract
Seven land use practices were investigated for their differences in soil physico- chemical properties. The land use types are native forest, horticulture, pastures, wastelands, agri-horticulture, agriculture irrigated and agriculture unirrigated. Structural parameters such as soil texture, bulk density, particle density, total porosity, moisture content, organic carbon and dispersion ratio were taken. In chemical parameters pH, EC, OC and $CaCO_3$ were analyzed. The results showed that the pastures fallowed by forest show stable structure based upon above physical parameters. pH varied from acidic to slightly alkaline range under different LUSs with lowest mean value of pH under forestry (6.42) fallowed by agriculture irrigated (7.14) and highest under waste lands (7.65). The electrical conductively was found normal under all land uses. The soil organic carbon was found highest under forests (23.68 gkg^{-1}), followed by pasture (20.80 gkg^{-1}) and lowest value under waste lands (3.80 gkg^{-1}) followed by agriculture irrigated (4.35 gkg^{-1}). $CaCO_3$ found highest under wastelands (2.86%) and lowest under forests (0.92%). Thus it may be concluded that the different land uses have significant effect on soil physico-chemical properties of soil which in turn lead to the change in nutrient status of soil.

Keywords: Ganderbal, Land use system, Physico-chemical properties, Soil degradation indicators

1. Introduction
Adoption of appropriate land use management practices and land use planning would help to minimize the degradation in soil physical quality and would ensure sustainable crop production and productivity (Ramesh *et al.*, 2008) [32]. Soil structure is a soil property which influences the mechanical properties of the soil, germination, root growth and soil erosion. It is influenced by manures, fertilizers, tillage, and cropping system (Grieve, 1980., Hewitt and Dexter, 1980) [14, 18]. As per Brewer (1976) [9] described that soil structure as the physical constitution of soil solid as expressed by the size, shape and arrangements of soil particles and voids and its associated properties. It is soil structure which is affected by changes in climate, biological activity and soil management practices (Hillel, 1980) [19]. The relevance of mineralogy and Fe oxide in the development of soil structure was showed by Rampazzo *et al.,* 1993) [33]. In the Kangara District of India, Sharma and Aggarwal (1984) [36] assessed the structural status of soils under different land uses and observed their differences with variations in management. Indicated that long practices of deforestation and/or replacement of natural forests by agro ecosystem and uncontrolled overgrazing have been the major causes for soil erosion and climatic change. The capacity of the land to produce is limited and the production is mainly governed by soil physico-chemical properties, climatic conditions and management practices, inappropriate land use aggravates the degradation of soil physicochemical and biological properties (Singh *et al.*, 1995; Saikhe *et al.*, 1998; [38, 35] He *et al.*, 1999) [17]. Since soils in general are degrading due to poor management and faulty land use at a rate, much faster than their natural regeneration or resilience. Adoption of appropriate land use management practices and land use planning would help to minimize the degradation in soil physico-chemical quality and would ensure sustainable crop production and productivity (Ramesh *et al.*, 2008) [32]. Thus land use types had a significant effect on soil quality properties and also interrelationship between land use type and soil properties (Oyetola and Philip, 2014) [30]. Different land use systems viz., agriculture (irrigated and un irrigated), horticulture, forestry, agri-horticulture, pastures and wasteland systems leads to the change in physico-chemical properties and also change in nutrient content (Ally-Said *et al.*, 2015) [3]. Therefore, an attempt was made to study the impact by different land use systems on physico- chemical

propertiesof soil in district Ganderbal, which spread mostly in north-east direction of J&K, the objective of this study was to examine the structural status and chemical properties of soils in district Ganderbal of Jammu and Kashmir under the seven land use systems, the aim was to set useful guidelines and sustainable productivity for the proper utilization and management of the soil for particular land use.

Materials and Methods

Location of the investigated area

The study area is a notified area committee carved out from Srinagar district in the state of Jammu and Kashmir-India and has been recognized as separate district. It is located at 34.23° N, 74.78° E. It has an average elevation of 1,619 meters (5,312 feet). It is bordered by the Srinagar district in the south, Bandipore to the north, Kargil in the northeast, Anantnag to the southeast and Baramulla in the southwest. The district is constituted into three tehsils (Ganderbal, Kangan and Lar). It covers a total area of 39304 thousandhectares. Out of this aarea 18.121 thousand hatters is cultivated land, 0.988 thousand hectors is area under Forests, 8.435 is under horticulture, 4.896 thousand hectares comes barren and marshy lands, 1.674 thousand hectares as permanent pastures and 13.23 is under miscellaneous tree crops, other fallows. It comes under western Himalayan region having temperate agro climatic zone, normal annual rain fall is about 676 mm with 67 rainy days and the temperature varies between 3.9-22.56^{0}C, respectively (Department of Agriculture & Cooperation http://agricoop.nic.in).

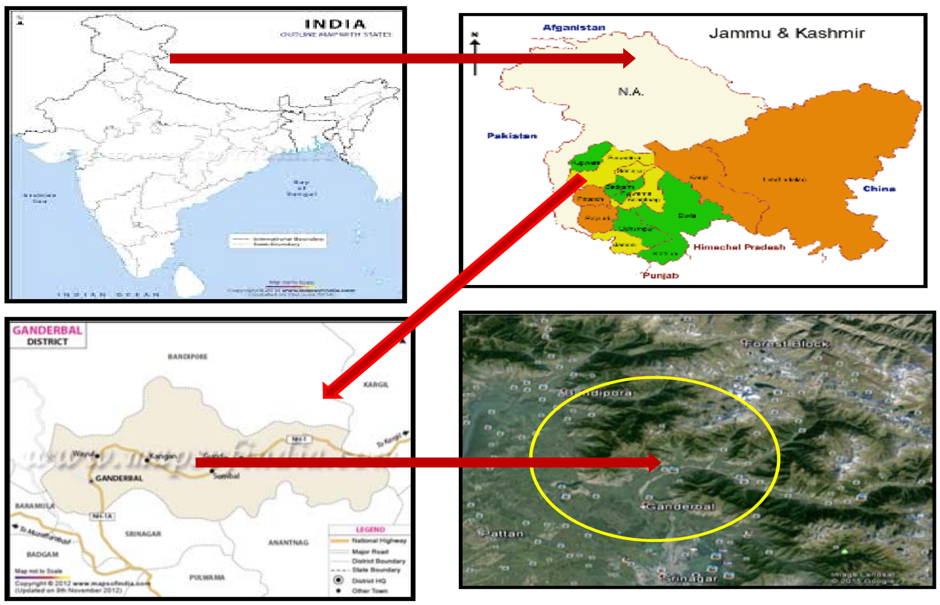

Fig 1: Location map of study area (Ganderbal District) Survey set up

1. Land use system (LUS) selection

Soils under particular land use system may affect physico-chemical properties which may modify fertility status and nutrient availability of plants. As land use pattern plays a vital role in governing the effect, seven land use systems have been identified viz. forestry, horticulture, pastures, wasteland, agri-horticulture agriculture irrigated and agriculture unirrigated for study.

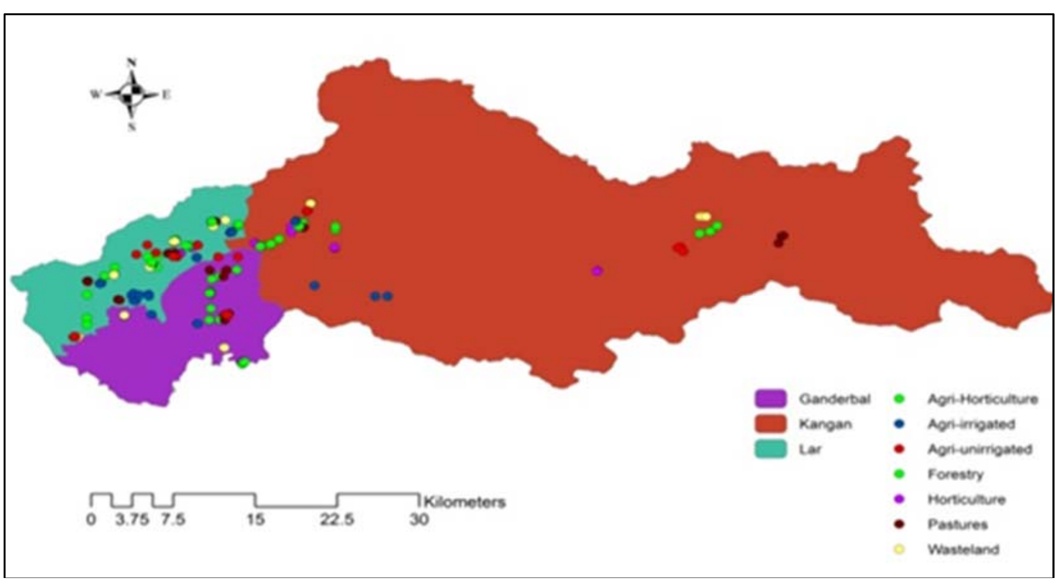

Fig 2: Map of district Ganderbal showing sampling sites under different land use systems

2. Site selection and sample collection

Seven land use systems each were selected under three different locations viz; Kangan, Ganderbal and Lar district of Ganderbal. From these locations three sites per LUS was identified for collection of soil sample. Four replication per site per LUS was taken. Sampling was done after harvest of crops in case of agriculture, horticulture and agri-horticulture. With the help of core sampler which comprises of volume 981.25 cm^3 soil samples were taken at depth of 0-15 cm in all LUSs except horticulture soil samples were taken at depth of 0-30 cm by using similar sized core sampler. The samples were then stored properly and taken to the lab of SKUAST-K for further processing and analysis for chemical properties of soil such as soil texture, bulk density, particle density total porosity, moisture content, organic carbon and dispersion ratio acidity, EC, calcium carbonate and organic carbon to assess soil quality.

Table 1: Description of sampling sites under different land use systems

S. No.	Land use system (LUS)	Location	Site		
			1	2	3
1.	Forestry	Kangan	Yarmukam	Chattergul	Gagangeer
		Ganderbal	Rangil	Vurpash	Gutlibag
		Lar	Babi salun	Banihama	Main lar
2.	Horticulture	Kangan	Gund	Kachnambal	Chettergul
		Ganderbal	Gulabag	Vurpash	Gutlibag
		Lar	Banihama	Gurbag	Main lar
3.	Pasture	Kangan	Yarmukam	Chittergul	Sonamarg
		Ganderbal	Rangil	Yurpash	Borusa
		Lar	Babisalun	Banihama	Main lar
4.	Wasteland	Kangan	Yarmukam	Babarishi	Gagangeer
		Ganderbal	Dab	Pandich	Tullamulla
		Lar	Babisalun	Banihama	Gurbag
5.	Agri-Horticulture	Kangan	Yarmukam	Chittergul	Kachinambal
		Ganderbal	Gulabag	Nunar	Gutlibag
		Lar	Banihama	Gurbag	Rapora
6	Agriculture-Irrigated	Kangan	Yarmukam	Chettergul	Bonibag
		Ganderbal	Tullamulla	Nagbal	Saloora
		Lar	Yungur	Banihama	Main lar
7	Agriculture-Unirrigated	Kangan	Chettergul	Gagangeer	Raizen
		Ganderbal	Wayil	Shuhama	Dab
		Lar	Banihama	Main lar	Waliwar

3. Laboratory analyses

The collected samples from different LUSs were air dried in soil science lab of SKUAST-K Shalimar and was then analyzed for the required observation. Moisture content was determined by gravimetric method.

$$\text{Moisture content (\%)} = \frac{\text{Weight of wet sample} - \text{weight of dry sample}}{\text{Wt. of dry sample}} \times 100$$

The particle size analysis was worked out by hydrometric method as described by Bouyouco (1951). Dispersion ratio (DR) was obtained by formula proposed by Middleton (1930) as:

$$\text{Description ratio} = \frac{\text{Easily dispersed silt + clay}}{\text{Per cent total silt + clay (mechanical analysis)}}$$

Bulk density was determined by Core method as described by Blacke, G.R. and Hartge, K.H. (1986a) [6]. The particle density was measured by the Pycnometer method as given by Blacke and Hartge (1986b) [6]. Organic carbon was determined by rapid titration method given by Walkley and Black (1934) [41].

The pH of soil sample was determined in 1:2.5 soil: water suspension with the help of glass electrode pH meter as described by Jackson, (1973) [20]. The electrical conductivity was conducted by method as described by Jackson (1973) [20]. Organic carbon was determined by rapid titration method given by Walkley and Black (1934) [41]. Estimation of $CaCO_3$ was done by rapid titration method as described by Puri (1930) [31].

Statistical analysis

Design of survey used is Stratified random sampling. The data was statically analyzed by using the CPCS 1 and SPSS software.

Results and Discussions

Particle size distribution

Table 3 revealed that the land use systems varied in texture from course to fine with order of course texture found in the trend of forestry > wastelands > pasture > agriculture unirrigated = horticulture > agri-horticulture > agriculture irrigated with finner texture in south facing sites as compared to north, similar results were depicted by Najar *et al.,* 2009 [28] emphasized that content of sand, silt and clay in the northern aspect varied from 14.1 to 52.7, 27.4 to 63.0 and 18.5 to 33.2%, respectively whereas on the southern aspect the contents varied from 10.5 to 30.2, 37.8 to 50.6 and 21.8 to 44.0%, respectively.

Forest soils varied in texture from course to moderate textured (sandy loam-silt) under all three locations in all sites with mean value of sand, silt and clay 42.68, 49.62 and 7.90 per cent respectively, the texture of horticulture and agri-horticulture ranged from moderately textured to fine texture (loam-clay loam) having mean values of sand, silt, clay as 37.03, 39.96, 23.00 and 33.27, 43.48, 23.12 per cent in horticulture and agri-horticulture respectively, pastures also varied in texture from course textured to fine texture (sandy loam-clay loam) with 41.08, 36.08, 22.82 per cent mean values of sand, silt and clay respectively. Texture of wastelands showed conspicuous variation from course to fine texture (sandy loam-clay loam) it may be attributed to wide variation in slope from flat-steep with mean of sand, slit and clay as 40.59, 37.18, 22.21 per cent respectively. Agr.-irrigated fall mostly in fine textured range (sandy clay loam-clay loam) with mean of sand, slit and clay as 40.88, 26.00,

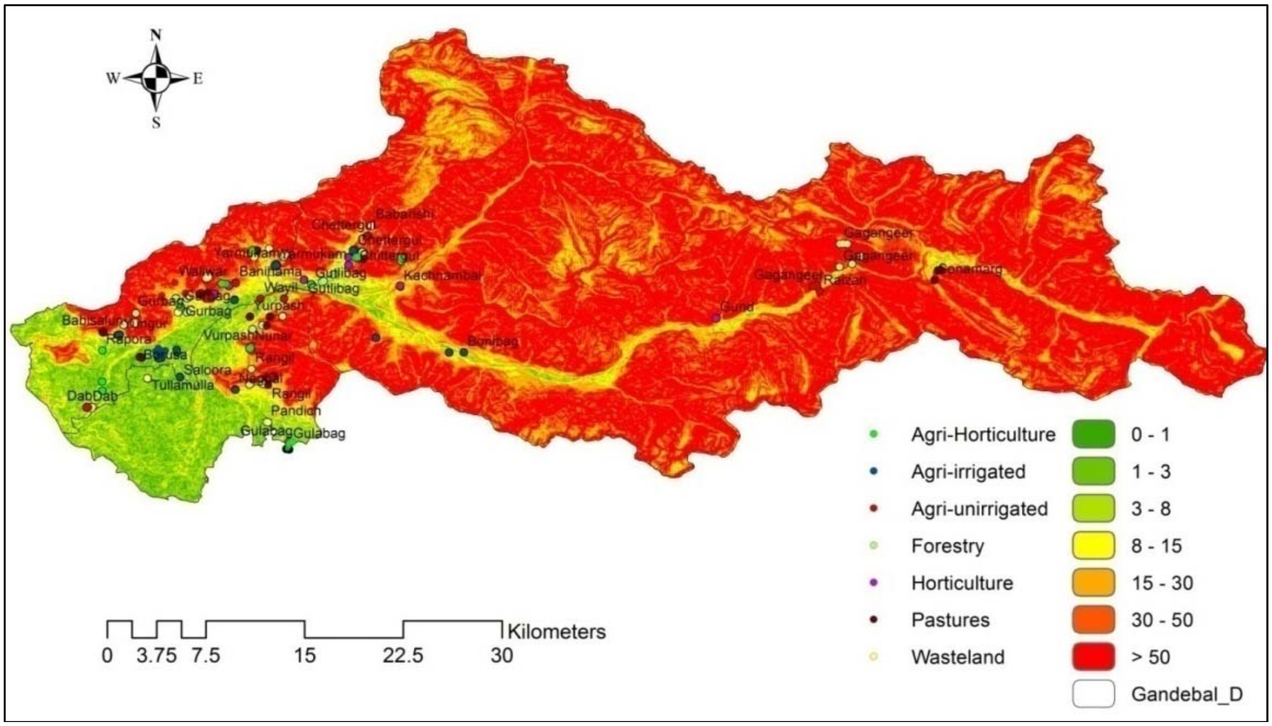

Fig 3: Map of district Ganderbal showing sampling sites with Slope (%) under different land use systems

33.22 per cent respectively and the texture of Agr.-unirrigated varied from moderately-fine textured (loam-clay loam) with 38.84, 43.21 and 17.94 mean values of sand, silt and clay per cent respectively. This may be attributed due to higher altitudes with steep slopes have less penetration of water, more erosion, low temperature thus less development of soil like in forests having very low amount of clay and high amount of sand and vice versa in agriculture irrigated having high amount of clay and low amount of sand. Mahapatra *et al.* (2000) [24] while working with the soils of Kashmir concluded that the altitude and relief have significant effect on properties like texture, structure, consistency etc. This is further supported by the findings of Arun Kumar (2002) [5] who noticed that the soils occurring on plains had loam to sandy loam texture and recorded higher clay content than upland soils. Shrestha *et al.* (2006) [37] who reported that the forest soils contained more sand and few clay particles than the cultivated soils. Gebrelibanos and Assen (2013) [12] who worked on four major landuse/cover categories: natural forest, plantation forest, grassland and cultivated land in Northern Ethiopia and showed that the sand, silt and clay content showed significant variations between the natural forest and the other landuse/cover types ($p<0.05$). Osakwe and Igwe (2013) [29] who found that land use significantly ($p< 0.05$) affected the clay content evidenced by 8% higher value in the cultivated land use compared to the forest land use., Kiflu and Beyene (2013) [22] who found relatively higher sand content in grass lands followed by Enset and maize fields in 0-15 cm depth. Abad *et al.* (2014) [1] found that the per cent of silt in agriculture land is lower than other land use types significantly but between forest and pastureland was observed no significant difference, Khan and Romshoo (2014) [21] whose results depict that forest soil has sandy loam texture, orchard soil has silt-loam, karewa, soils under barren including degraded forest, agriculture, alluvium, plantation and exposed rock have loam-silt loam, silt clay-loam, silt loam-loamy, loamy, clay loam and rock outcrop texture respectively.

Table 2: Some general characteristics of the surface soil studied under different land use systems

Soil property	Minimum value	Land use system	Maximum value	Land use system	Over all Mean
Clay (%)	1.80	Forestry	39.80	Agriculture irrigated	12.46
Slit (%)	8.50	Pastures	89.30	Forestry	38.93
Sand (%)	7.10	Forestry	75.90	Forestry	39.61
Moisture content (%)	20.16	Wastelands	63.06	Agriculture irrigated	30.09
Bulk density (g cm^{-3})	1.23	Forestry	1.65	Agriculture unirrigated	1.40
Particle density (g cm^{-3})	2.35	Forestry	2.68	Wastelands	2.51
Organic carbon (g- kg^{-1})	1.0	Agriculture irrigated	37.4	Forestry	12.13
Dispersion ratio	0.49	Forestry	0.85	Wastelands	0.73

Table 3: Percentage of particle size distribution of the investigated soils under different land use systems

Land use systems	Clay	Slit	Sand	Textural class range
Forestry Mean ±SE	7.90±3.01	49.62±11.06	42.68±17.74	sandy loam - silt
95% C.I	1.99-13.81	27.94-71.31	7.90-77.45	
Horticulture Mean ±SE	23.00±1.65	39.96±5.69	37.03±5.00	loam-clay loam
95% C.I	19.76-26.23	28.80-51.11	27.23-46.83	
Pastures Mean ±SE	22.82±5.87	36.08±9.56	41.08±7.27	sandy loam-clay loam
95% C.I	11.31-34.32	17.33-54.81	26.83-55.32	
Wastelands Mean ±SE	22.21±4.46	37.18±5.14	40.59±5.16	sandy loam-clay loam
95% C.I	13.45-30.97	27.10-47.26	30.46-50.72	
Agri-horticulture Mean ±SE	23.12±2.77	43.48±6.62	33.27±6.39	loam-clay loam
95% C.I	17.69-28.56	30.49-56.47	20.73-45.81	
Agriculture Irrigated Mean ±SE	33.22±2.67	26.00±1.94	40.88±3.82	sandy clay loam-clay loam
95% C.I	27.97-38.47	22.18-29.82	33.39-48.37	
Agriculture Unirrigated Mean ±SE	17.94±2.70	43.21±6.34	38.84±5.14	loam-clay loam
95% C.I	12.64-23.24	30.78-55.64	28.75-48.93	
C.D ($p \leq 0.05$)	0.11E-01	0.14E-05	0.14E-05	

C.D ($p \leq 0.05$)- Critical difference at 5% level of significance.
SE- standard error, C.I- confidence interval at 95% of significance level

Moisture content

The moisture ranged in all land use systems as 20.16-63.06 with order of agriculture irrigated > pastures > agri-horticulture > wastelands > forestry > horticulture > agriculture unirrigated with mean values of 39.09, 32.47, 31.72, 29.54, 28.86, 28.63, 23.64 per cent respectively (Table 4). The high moisture content in irrigated agriculture may be attributed to application of surplus irrigation water, finer texture of soil having high micro porosity which leads to high retention of water while as low moisture content in agriculture unirrigated may be due to low OM, high BD, higher slope than irrigated. Similar results were corroborated by Getachew (2012) [13] who emphasized that *Eucalyptus saligna* plantation has low moisture contents compared to the other landuses/land covers including the natural forest and grazing lands and Wang *et al.* (2012) [42] reported that the Soil moisture under the corn crop (0.252 cm^{-3}) was consistently higher than the other surfaces, Grass and sub-shrubs showed an intermediate moisture level, Grass (0.181 cm^{-3}) had slightly higher readings than those of sub-shrub (0.111 cm^{-3}) most of the time, Shrubs and plantation forests were characterized by lower soil moisture readings, with the shrub levels consistently being slightly higher than those of the forests (0.096 cm^{-3}).

Table 4: Soil physical properties of the investigated soils under different land use systems

Land use systems	Moisture content (%)	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Organic carbon (g- kg^{-1})	Dispersion ratio
Forestry Mean ±SE	28.86±0.42	1.28±0.011	2.44±0.04	2.36 ±0.37	0.61±0.02
95% C.I	28.03-29.70	1.28-1.31	2.36-2.52	1.6-3.10	0.57-0.66
Horticulture Mean± SE	28.63 ±0.75	1.43±0.015	2.45±0.015	0.95±0.20	0.76±0.01
95% C.I	27.16-30.11	1.40-1.46	2.42-2.48	0.48-1.42	0.73-0.78
Pastures Mean± SE	32.47±2.63	1.31±0.02	2.56±0.025	2.08±0.11	0.65±0.002
95% C.I	27.31-37.63	1.27-1.35	2.51-2.62	1.86-2.27	0.64-0.65
Wastelands Mean ±SE	29.54±2.84	1.52±0.02	2.63±0.02	0.38±0.07	0.82±0.02
95% C.I	23.96-35.11	1.48-1.56	2.59-2.66	0.23-0.52	0.78-0.86
Agri-horticulture Mean ±SE	31.72±0.56	1.44±0.02	2.56±0.02	1.45±0.28	0.78±0.02
95% C.I	30.62-32.82	1.39-1.49	2.51-2.61	0.90-2.00	0.74-0.82
Agriculture-Irrigated Mean ±SE	39.09±4.05	1.42±0.02	2.56±0.03	0.43±0.09	.80±0.02
95% C.I	31.15-47.03	1.38-1.46	2.53-2.61	0.24-0.62	0.76-0.84
Agriculture-Unirrigated Mean± SE	23.64±0.83	1.57±0.01	2.62±0.01	0.82±0.15	0.82±0.01
95% C.I	22.00-25.28	1.54-1.59	2.60-2.65	0.52-1.11	0.79-0.85
C.D ($p \leq 0.05$)	0.95E-02	0.14E-05	0.17E-01	0.53E-03	0.14E-05

C.D ($p \leq 0.05$)- Critical difference at 5% level of significance.
SE- standard error, C.I- confidence interval at 95% of significance level

Bulk density

The bulk density ranged from 1.23-1.65 g cm^{-3} with trend of agriculture unirrigated > wastelands > agri-horticulture > horticulture > agriculture irrigated > pastures > forestry with mean values of 1.57, 1.52, 1.44, 1.43, 1.42, 1.31, 1.28 g cm^{-3}(Table 5). It may be attributed due to the increased organic matter in forestry as compared to agriculture unirrigated having continuous removal of organic matter with no addition. Similar results were found by Woldeamlak and Stroosnijder (2003) [43] revealed that the bulk density of cultivated soils was higher than the bulk density of forest soils, Gupta *et al.* (2010) [16] reported that the soils of forest lands had generally higher values of pore space (41.4 to 47.2%) followed by cultivated well managed land (41.4 to 45.1%), barren (40.1 to 43.4%) and unmanaged cultivated lands (40.0 to 43.2%) in the foot hills of shiwaliks in North West India. Sofi *et al.* (2012) [40] reported that the bulk density of 1.37 to 1.51 Mgm^{-3} in apple orchard soils of Shopian Kashmir. Abad (2014) [1] reported that the soils of agriculture land had the highest bulk densities in comparison to other land use types (forestry and pasture lands) and this difference was significant and Ali *et al.* (2014) [2] reported that the land use Changes from rangeland to irrigated farming, porosity decreased to 4.8% and bulk density increased by about 0.22%, as well as land use change from pasture to dryland farming porosity is reduced by 15% and bulk density increased by 0.4%.

Particle density

The overall range of particle density varied from 2.35-2.68 g cm^{-3} in all land use systems with trend of wastelands > agriculture unirrigated > agriculture irrigated = agri-horticulture = pastures > forestry with mean values of 2.63, 2.62, 2.56, 2.56, 2.56, 2.45, 2.44 g cm^{-3} respectively(Table 4). It may be attributed to the north facing sites and moderate slope by which organic matter decomposition is less so more particle density and due to high compaction in wastelands than forests, similar results were found by Gupta *et al.* (2010) [16] revealed that the values of particle density decreases in the order: barren lands (2.57 to 2.68 Mgm^{-3}) > cultivated un managed (2.52 to 2.67 Mgm^{-3}) > cultivated well managed (2.44 to 2.62 Mgm^{-3}) > forest lands (2.38 to 2.62 Mgm^{-3}). Yihenew and Ayanna (2013) [45] reported that the highest PD of 2.6 and 2.63 Mg m-3 were recorded at 15-30 cm (cultivated lands), whereas the lowest were at 0-15 cm (natural forest) of the Abechikeli Mariam (2.41 Mg m-3) and Aferfida Georgis sites (2.40 Mg m-3).

Dispersion ratio

The dispersion ratio in all LUSs varied from 0.49-0.85 with trend of wasteland = agriculture unirrigated > agriculture irrigated > agri-horticulture > horticulture > pastures > forests with mean values of 0.82, 0.82, 0.78, 0.76, 0.65 and 0.61 per cent respectively (Table 4). It may be attributed to the high organic matter which helps in the formation of stable aggregates and holding of soil particles by roots in forests and vice versa in wastelands. The results are according with Gupta *et al.* (2006) [15] revealed that average value of dispersion ratio was 76.5% lower in soils under agro forestry than in control, Korkanc *et al.* (2008) [23] showed that dispersion ratio of soils in farmlands was greater than in forests and rangelands, Singh and Khera (2008) [39] showed that dispersion ratio among different land uses it was in the order of barren (0.97) > cultivated (0.84) > grassland (0.74) > forest (0.63).

Table 5: Ranking land use in order of structural stability

Soil structural properties	Land use systems						
	Forestry	Horticulture	Pastures	Wastelands	Agri-horticulture	Agriculture irrigated	Agriculture unirrigated
Clay	7	3	4	5	2	1	6
Moisture content	5	6	2	4	3	1	7
Bulk density	1	4	2	6	5	3	7
Particle density	1	2	3	7	3	3	6
Organic carbon ($g\text{-}kg^{-1}$)	1	4	2	7	3	6	5
Dispersion ratio	1	3	2	6	4	5	6
Total	16	22	15	35	20	19	37
Overall ranking	2	5	1	6	4	3	7

1= best in terms of good structure, 7=least structured.

Ranking of the structural indices

An attempt is carried out to rank the different land uses in order of structural quality (Table 5). In the ranking, 1 shows the best structure while 7 indicates the lowest structural quality., land use systems based on above ranking in terms of structural stability could be arranged in the following order, pastures> forest > agriculture irrigated>agri.-horticulture> horticulture> wastelands>agriculture irrigated. The structural properties or indices which are good indicators in this assessment are texture, bulk density, and organic matter while as dispersion ratio is moderate and volumetric moisture content was the lowest in the indices considered. According to the study of Sharma and Aggarwal (1984) [36] bulk density is the best indices in assessing the structural quality. However, the efficiency of structural indices varied with the soil type Bryan (1971) [10].

Table 6: Variation of pH of soil under different land use systems of District Ganderbal

Location (Tehsils)	Forestry	Horticulture	Pastures	Wastelands	Agri-horticulture	Agriculture irrigated	Agriculture unirrigated
Kangan	6.23	6.88	7.87	6.61	7.53	5.45	6.93
	6.07	6.72	8.05	6.95	6.01	5.48	6.70
	5.87	7.27	6.30	7.38	7.30	8.00	7.58
Ganderbal	5.70	8.01	8.00	8.48	7.99	8.00	8.12
	7.40	8.11	8.28	8.24	8.00	8.07	7.50
	5.87	7.00	8.23	8.50	7.42	7.93	7.66
Lar	7.20	7.00	8.04	7.96	8.13	8.03	8.11
	6.64	7.27	6.77	6.78	7.35	6.79	8.15
	6.85	7.85	6.99	7.99	7.66	6.51	8.04
Mean ±SE	6.42±0.24	7.34±0.20	7.61±0.28	7.65±0.32	7.48±0.24	7.14±0.43	7.64±0.20
95% C.I	5.94-6.90	6.94-7.74	7.05-8.17	7.08-8.29	7.00-7.96	6.28-7.99	7.23-8.05

Critical difference at 5% level of significant between land use systems (C.D ($p \leq 0.05$))=0.17E-02

Soil Reaction

As per the table 6, the soils of district Ganderbal under different LUS were acidic to slightly alkaline in reaction and the pH varied from 5.45-8.50 under different LUSs. The pH showed a regular trend from forestry < agriculture irrigated < horticulture < agri-horticulture < pasture < agriculture unirrigated < wastelands with mean values of 6.42, 7.14, 7.34, 7.48, 7.61, 7.64 and 7.65 which may be attributed to uptake of bases by tree biomass, acidic nature of litter after its decomposition, leaching of salts from upper layers which leads to low pH as in case of forestry and agriculture irrigated and accumulation of calcium carbonate and accumulation of salts in case of wastelands and agriculture unirrigated due to less leaching. Similar findings were observed by Regmi and Zoebisch (2004) [34] found that the lowest pH was found in *Khet* (low land) land and the highest on *Bari* (upland) land. On an average, pH-levels in *Bari* land were higher than in *Khet* land.

Table 7: Variation of electrical conductivity (dS m^{-1}) of soil under different land use systems of District Ganderbal

Location (Tehsils)	Forestry	Horticulture	Pastures	Wastelands	Agri-horticulture	Agriculture irrigated	Agriculture unirrigated
Kangan	0.035	0.100	0.241	0.051	0.264	0.010	0.127
	0.032	0.098	0.302	0.062	0.031	0.021	0.099
	0.020	0.138	0.044	0.227	0.164	0.306	0.238
Ganderbal	0.014	0.301	0.300	0.443	0.301	0.304	0.334
	0.249	0.321	0.371	0.377	0.300	0.342	0.221
	0.106	0.103	0.353	0.463	0.245	0.300	0.255
Lar	0.142	0.102	0.302	0.306	0.323	0.303	0.303
	0.099	0.138	0.132	0.040	0.171	0.191	0.344
	0.121	0.233	0.190	0.302	0.192	0.134	0.328
Mean ±SE	0.09±0.03	0.17±0.03	0.24±0.04	0.25±0.06	0.22±0.03	0.21±0.05	0.24±0.03
95% C.I	0.03-0.15	0.10-0.24	0.16-0.32	0.12-0.38	0.15-0.29	0.11-0.31	0.18-0.31

Critical difference at 5% level of significant between land use systems (C.D ($p \leq 0.05$)) = 0.14E-03

Electrical conductivity

According to the table 7, the land use systems under study were found non saline to slightly saline in nature and the electrical conductivity of the soils ranged between 0.010-0.463 dS $m^{-1}$the trend followed by different land use systems as forestry < horticulture < agriculture irrigated < agri-horticulture < pasture = agriculture unirrigated < wastelands with mean value of 0.09, 0.17, 0.21, 0.22, 0.24, 0.24, 0.25 dSm^{-1}. It can be due to accumulation of calcium carbonate in case of wastelands and low salt content of forest litter. Similar finding were seen by Farida (1997) [11] observed that the electrical conductivity in high altitude, Karewa and valley basin soils of Kashmir varied from 0.14 to 0.15, 0.15 to 0.24 and 0.30 to 0.42 dSm^{-1}, respectively. Najar *et al.* (2009) [28] revealed a variation in electrical conductivity with the aspect but it remained well under normal range. It ranged from 0.20 to 0.56 dSm^{-1} in pedons facing south and 0.15 to 0.40 dSm^{-1} in pedons facing north. Kiflu and Beyene (2013) [22] found the similar findings reported that the relatively higher EC values at both depths (0-15 and 15-30 cm were recorded in the enset farms followed by grassland soil. Although the EC values among different land use systems have negligible significant differences ($p \leq 0.05$). Sharma *et al.*(2013) [32] revealed that the EC value of forest and rice LUS was almost same i.e. 0.10 to 0.28 dSm^{-1}.

Table 8: Variation of organic carbon (g-kg^{-1}) of soil under different land use systems of District Ganderbal

Location (Tehsils)	Forestry	Horticulture	Pastures	Wastelands	Agri-horticulture	Agriculture irrigated	Agriculture unirrigated
Kangan	10.9	9.7	15.6	3.5	5.9	1.0	3.9
	12.4	9.5	19.3	1.9	5.3	3.5	9.3
	15.9	1.2	25.7	2.5	5.6	9.7	2.2
Ganderbal	37.4	23.9	22.3	2.5	19.0	3.1	5.3
	29.5	10.1	22.5	6.5	16.2	2.9	11.5
	25.5	8.5	22.4	3.2	14.5	3.5	14.3
Lar	22.6	9.0	19.9	3.3	21.4	5.1	9.0
	36.5	8.8	19.4	3.5	19.7	4.9	9.9
	22.5	5.0	20.1	7.3	23.3	5.5	8.5
Mean ±SE	23.68±3.78	9.52±2.39	20.80±1.11	3.80±0.72	14.54±2.81	4.35±0.95	8.21±1.50
95% C.I	16.27-31.09	4.82-14.22	18.62-22.97	2.37-5.23	9.02-20.06	2.48-6.22	5.28-11.13

Critical difference at 5% level of significant between land use systems (C.D ($p \leq 0.05$)) = 5.3E-03

Soil organic carbon

As table 8 clearly represents that the organic carbon content showed a conspicuous variation 0.10-37.4 g kg^{-1} between the land use systems, fallowing the trend of forestry > pastures > agri.-horticulture > > horticulture > agriculture unirrigated > agriculture irrigated > wastelands with mean values of 23.68, 20.8, 14.54, 9.52, 8.21, 4.35, 3.8 g kg^{-1} respectively. It may be attributed to related high biomass production and lower decomposition at higher reaches as compared to agriculture irrigated and wastelands having lower biomass because of less vegetation. The results were corroborating with the findings of Yihenew (2002) [44] revealed that most cultivated soils of Ethiopia are poor in OM contents due to low amount of organic materials applied to the soil and complete removal of the biomass from the field. Regmi and Zoebisch (2004) [34] reported that the organic matter content of the topsoil on *Bari* land was significantly higher than on *Khet* land. Yimer *et al.* (2007) [46] found that soil organic C and total N decreased in croplands as compared to forestlands. Najar *et al.* (2009) [28] reported higher content of organic carbon in North facing pedons that ranging from 1.6 to 35.0 g kg^{-1} soil, whereas in the Southern aspect, it ranged from 1.0 to 24.0 g kg^{-1} respectively. Mansha and Lone (2013) [25] long-term cultivation caused decrease of soil organic matter from

2.40%, Yitbarek *et al.* (2013) [47] soil organic matter OM content of cultivated land was significantly ($p<0.001$) lower than forest and grazing lands of Abobo area,

Table 9: Variation of calcium carbonate (%) of soil under different land use systems of District Ganderbal

Location (Tehsils)	Forestry	Horticulture	Pastures	Wastelands	Agri-horticulture	Agriculture irrigated	Agriculture unirrigated
Kangan	0.13	0.55	2.59	0.30	0.38	0.10	0.05
	0.13	0.50	2.70	0.51	0.27	0.20	0.04
	0.12	0.50	0.63	0.55	0.35	0.30	0.23
Ganderbal	0.09	0.47	2.71	4.95	3.85	2.49	2.90
	0.38	0.60	2.75	4.80	3.80	2.51	2.30
	0.01	0.70	2.74	5.30	0.54	2.45	2.39
Lar	3.5	0.73	2.65	4.40	4.90	2.50	2.50
	0.07	0.94	0.68	0.40	0.30	0.19	2.54
	0.40	4.65	0.60	4.60	2.39	0.13	2.47
Mean ±SE	0.92±0.40	1.07±0.52	2.00±0.40	2.86±0.9086	1.86±0.73	1.20±0.47	1.71±0.47
95% C.I	0.14-1.71	0.03-2.1	1.21-2.79	1.08-4.65	0.41-3.31	0.27-2.14	0.78-2.6

Critical difference at 5% level of significant between land use systems (C.D ($p\leq 0.05$))= 0.40E-0**3**

Calcium carbonate

According to the table 9, land use systems showed predominance of calcium carbonate in some sites especially in wasteland which may be due to free calcium and the process of calcification prevalent in these sites, however calcium carbonates were in traces in most of sites it may be due to leaching of calcium to sub surface, range of calcium carbonate was about 0.01-5.30 per cent. The trend among land use systems is as wasteland > pasture > agri.-horticulture > agriculture unirrigated > agriculture irrigated > horticulture > forestry with mean values 2.86, 2.05, 1.86, 1.71, 1.2, 1.07 and 0.92 per cent respectively. The results are in agreement with the findings of Najar (2002) [27] studied soils of Kashmir and observed that the $CaCO_3$ content varied from 0.40 to 4.80, 3.70 to 7.80 and 0.15 to 3.50 per cent in high altitudes, Karewa and valley basin soils.

Conclusions

The results revealed that the soil texture, bulk density, particle density, dispersion ratio and organic carbon are good indices for predicting soil structural properties and thus helps in accurate characterization of soils under different land use systems. The study indicates that pastures, as well as forest land use system is the best land use option for promoting a better structural stability and development. To achieve this condition in modern agriculture it is recommended that well established agro-forestry systems such as alley cropping should be established in the degraded land use systems in order to increase biomass production and better aggregate stability. As rapid increase in human population leading to a scarcity of prime land for agriculture, it is difficult to keep land fallow for a long period or converted into other land use system like forestry, in order to overcome this problem well established agro-forestry should be developed which is sustainable in terms of agricultural production and provides some basic needs for the environment. It is seen that the land use systems adversely affect the chemical properties of soil like in agriculture irrigated and wastelands which in turn can affect both physical properties and nutrient status of soil. Land use system also improve the soil physico-chemical properties like in forestry. The presence of higher organic matter reflects good soil properties of different land use in terms of physical condition having positive effect on porosity and texture, enhancement of moisture holding capacity, aggregation etc.

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