Phytosociological Analysis of FunctionalComponents in Silvopastoral Land Use Systems of Himachal Pradesh, North Western Himalaya

Comment [A1]: The author needs to explain the meaning of the "functional components" in this manuscript.

ABSTRACT

Phytosociological studies are important for devising suitable conservation strategies of the plant genetic resources. Himachal Pradesh is a north-western Himalayan state with diverse landscape having rich and unique floristic diversity.Silvopastoral systems are one among the most prominent agroforestry land use systems which contributes significantly in productivity, ecological balance and livelihood of local communities. Thus, to know the status of floristic and phytosociologicaldiversity in these land use systemsa study was conducted during the period April, 2018 to March, 2022 in 12 selected villages of Himachal Pradesh. Total number of plant species recorded in study area was 1046(including 114 tree,170 shrub and 762 herb species),belonging to 108 families and 538 genera.Poaceae,Asteraceae,Fabaceae, RosaceaeandLamiaceaewerethefivemostdominant families. Maximum tree density recorded for species *Myrica esculenta* (980 ind. ha^{-1}) at site 3, *Grewia optiva* (660 ind. ha^{-1}) at site 2 and *Grewia optiva* (640 ind. ha^{-1}) at Site 1 Naun, Mandi, followed by *Bauhinia variegata* (630 ind. $ha^{-1)}$at Site 2 Banalgi, Solan in zone-II.On the basis of IVI, *Cedrus deodara*(252.30) was most dominant species followed by *Quercus oblongata* (193.11), *Pinus wallichiana* (164.68) and *Myrica esculenta* (149.10). Among the shrubs*Hippophae salicifolia* (119.24)was most dominant species followed by *Berberis lycium* (96.14) and *Berberis aristata* (90.98).However, *Achyranthus aspera* (107.66) was most dominant herb species followed by *Commelina benghalensis* (97.50) and *Sonchus asper* (44.01). The lowest value of IVI was observed for*Capsella bursa-pastoris* (9.63) and *Tanacetum dolichophyllum* (10.54).According to CAMP, 2013 nine species viz., *Angelica glauca,Berberis aristata,Dioscorea deltoidea, Polygonatum cirrhifolium, Hyoscyamus niger, Bunium persicum, Ephedra gerardiana, Juniperus communis* and *Selinum vaginatum* are threatened and requires conservation and management efforts.In past no study was conducted on floristic and phytosociology diversity of silvopastoral systems of Himachal Pradesh. Hence, present study will definitely act as base line data for further in-depth studies on restoration of degraded lands and silvopastoral system management and improvement programs.

Comment [A2]: What's CAMP, 2013?

Keywords: Agroforestry, Floristic diversity, Important value index, Phytosociology, Silvipastoral systems.

1. INTRODUCTION

Floristic composition refers to a measure of species diversity in a community[41]. Knowledge of the biodiversity of any area is required for sustainable utilization, management, and conservation of natural resources [5]. The floristic composition of different land use systems is liable to change with season besides biotic and abiotic factors [39]. Floristic composition enables scientists to understand differences among various land use systems, their role in biodiversity and the conservation of important vulnerable species [3,12].The adaptation potential and gene pool of any community is reflected by the species diversity [22]. Nature has gifted Indian Himalayn Region with diverse landscapes which retains a variety of unique habitats having rich repository of plant wealth. But, with the modernization the forest genetic resources are highly affected due to their over exploitation and unsustainable utilization. These negative impacts are visible in all parts of Himalayas but, low and mid Himalayan regions are severely affected due to high human and livestock population.

Traditional Himalayan agroforestry systems are complex in nature and structural and functional attributes of constituent species of these systems are greatly affected by complex interactions. Performance of components are also determined by the associated components density and frequency. Phytosociological analyses of agroforesty systems help us to access the production potentials under specific site conditions [30].Silvipastoral systems are one of the most important land use system type of agroforestry systems in which trees and shrubs are combined with livestock and pasture production on the same unit of land. Within this broad category, several types of systems and practices can be identified depending on the role of the tree/shrub component; viz. cut and carries system, live fences, browsing and grazing [20].Functional unit's woody + grass/forbs components and/or livestock were considered to identify silvopastoral systems and system units[21,44].

Silvipastoral systems are most common form of agroforestry [43].Effect of altitudinal variation on structure and composition of the vegetation in natural Himalaya forest of Parshuram Kund area in Lohit district of Arunachal Pradesh was studied by [25] and they recorded higher shrub and herb species richness on middle altitude followed by lower and upper altitudes.A study on dominance, diversity and species richness of the species along an altitudinal gradient of Mandakani catchment of Garhwal Himalaya conducted by [8] and they recorded the values of the density (trees/ha) and total basal area (m^2/ha) of selected strands range between 2448 and 600 trees/ha and 53.44-29.36 m^2/ha.Tree diversity in the agroforestry systems of North-eastern part of Karnataka was studied by [9] and they reported 52 tree species with a mean species density 9.04 ha^{-1} and mean number of trees 104.24 ha^{-1}.Phytosociological analysis of woody species in sub-montane, montane and sub-alpine zones of Garhwal Himalaya was done by [18] andin their study, they reported a total of 94 woody plant species belonging to 72 generaand 44 families and the density varied from 235±9 to 505±21 trees ha^{-1} and 4,730±474 to 9,530±700 shrubsha^{-1}.

Floristic diversity studies along an altitudinal gradient in Kinnaur district of Himachal Pradesh was studied by [41]and they reported 142 plant species belonging to 49 families and 105 genera from study area. They also found that the number of shrub and herb species decreased as elevation increased and the distribution of species at different elevation was contiguous. *Populus nigra* was the dominant tree species at 3000-3500 m asl and *Ephedra gerardiana* was dominant at 3000 to 4000 m asl.Floristic composition and distribution pattern of plant communities under different agroforestry systems in Kinnaur, Himachal Pradesh was studied by [28] and a total of 17 tree species belonging to 8 different families were recorded by them in agri-horticulture, agri-silviculture and agri-horti-silviculture systems. The apple tree (*Malus domestica)* was recorded to be dominant fruit tree species with highest IVI values. Among all shrubs, *Artemisia vulgaris* (426.67 plants ha^{-1}) was most dominant shrub species found in both climatic conditions with (87.39) IVI value. *Malus domestica* was most dominant tree species showed highest density (503.33 plants ha^{-1}) and highest IVI (287.58). Floristic composition and natural regeneration status of Chir pine forests in Sirmaur district of Himachal Pradesh was studied [1] and the maximum density (690 individuals ha^{-1}), abundance (6.9), basal area of 44.65 m^2 ha^{-1} and IVI of 269.95 was recorded for Chir pine tree species.Phytosociological analysis of woody and non-woody components under some agroforestry systems in Kuthar village of Kuthar forest range, district Solan of Himachal Pradesh was carried out by [40] andin their study they found that horti-silvipastoral system was more diversified with 12 tree, 4 shrubs, 7 herbs and 6 fruit species.*Acacia catechu, Grewia optiva, Celtis australis* and *Pyrus pashia* were dominant trees; *Murrya koenigii, Lantana camera* and *Berberis lycium* were dominant shrubs and *Lathyrus aphaca, Chrysopogon montanus* and *Cyperus rotundus* were dominant herb species in different

agroforestry systems. The review of literature revealed that, in general, few studies are available on floristic and phytosociological analysisof different agroforestry systems in different parts of India as well as in Himachal Pradesh. However, phytosociological analysissilvopastoral land use systems have not been studied considering the whole Himachal Pradesh as a single unit although it caters various domestic needs viz., fuel, fodder etc., of the farming communities.

MATERIALS AND METHODS

In the present study firstly, the state was divided into four agroclimatic zones based on agroclimatic conditions of the state. Extensive field surveys were conducted in all four agroclimatic zones of Himachal Pradesh. Total 360 villages were surveyed form all four agroclimatic zones of Himachal Pradesh of which 12 villages viz., Zone I: Jogipanga (Una), Masiyana (Hamirpur), Bhakra (Bilaspur), Shiun Khas (Kangra); Zone II: Naun (Mandi), Banalgi (Solan), Keela Kalanj (Sirmour); Zone III: Ghiaghi (Kullu), Jarashi (Shimla), Kundi (Chamba); Zone IV: Roghi (Kinnaur), Muling (Lahaul-Spiti) representing all twelve districts and agroclimatic zones of Himachal Pradesh were selected for the present study. For the selection of villages, detailed information regarding the occurrence of silvipastoral systems and community dependency was obtained from forest officials of respective areas. The species composition of herbs, shrubs and trees were recorded in standard sample plots. In silvipastoral systems of all twelve selected villages of different agroclimatic zones three experimental plots (1ha each) were laid out for qualitative assessment of herbs, shrubs and trees following standard ecological methods [30, 36, 7, 12]. In all 36 sampled plots, trees were sampled randomly by laying 10 quadrates of 10x10m, shrubs by 30 quadrates of 5x5m and herbs by 50 quadrates of 1x1m. The circumference at breast height (cbh) i.e., 1.37m from ground level was measured for each individual tree. Individual with cbh>31.5 cm was considered tree. Shrubs were considered as woody species having several branches arising from the base [30] and herbs were considered as those species having aerial part surviving for one season through their underground parts i.e. roots, rhizomes, bulb etc., may remain alive during the other season. Samples of the species also collected from each site and identified with the help of available floras [4, 24, 2, 6, 38, 14, 35, 39] and other published literature. Sampling of the population in each site will be done in a peak season of growth i.e., Mid-June to September. Data analysis was performed on the data using MS Excel 2016. Species diversity (H') was calculated by using the Shannon-Wiener information index (Shannon and Wiener 1963) as follows.

$$H' = \sum_{i=1}^{S} pi \ln pi$$

Where, pi = the proportion of individuals of species i

The Concentration of dominance (Cd) was calculated using Simpson's index (Simpson 1949) as follows.

$$D = \sum (n / N)^2 \qquad D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

Where, n = the total number of organisms of a particular species

N = the total number of organisms of all species

(The value of D ranges between 0 and 1)

Basal area, Frequency, Density, Abundance, Relative Frequency, Relative Density and ~~Realtive~~ Relative dominance andImportant Value Indexof the species were calculated as:

Comment [A3]: include a reference to the formula used

Basal area=πr^2, where 'r' is the radius of the species.

Frequency (%) = $\frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}}$

Density = $\frac{\text{Total number of individual of a species}}{\text{Total number of quadrats studied}}$

Abundance = $\frac{\text{Total number of individual of species}}{\text{Total number of quadrate of occurrence}}$

Relative Frequency= $\frac{\text{Frequency of a species}}{\text{Frequency of all the species}}$ x 100

Relative Density = $\frac{\text{Density of a species}}{\text{Density of all the species}}$ x 100

Relative Dominance= $\frac{\text{Basal area of a species}}{\text{Basal area of all species}}$ x 100

Importance Value Index (IVI) = Relative Frequency+ Relative Density + Relative Dominance

RESULTSAND DISCUSSION

Phytosociological studies for trees, shrubs and herbs were conducted in the selected villages of different agroclimatic zones of Himachal Pradesh. The range of altitude varied from 500m to 3080m. The total number of plant species recorded in the study area was 1046, belonging to 538 genera and 108 families.The dominant families included Poaceae,Asteraceae,Fabaceae, RosaceaeandLamiaceae.Some photographs of plant species found in Silvipastoral systems of Himachal Pradesh is given in plate 1.The comparative phytosociological status of tree, shrubs and herb species in silvopastoral systems of Himachal Pradesh are described as below:

Phytosociologicalstudiesontreespeciesinsilvipastorallandusesystemsrevealedthatin Zone I, maximum IVI in Una was found in *Pinus roxburghii* (86.86), in Kangra *Acacia catechu*(59.54), in Hamirpur *Acacia catechu* (72.06), in Bilaspur *Acacia catechu* (60.74); MaximumTBA in Una was found in *Pinus roxburghii* (16.98), in Kangra *Mangifera indica* (17.72), inHamirpur *Acacia catechu* (16.46), in Bilaspur *Mangifera indica* (10.92); Maximum Density inUnawasfoundin*Pinusroxburghii*(400.00Ind/ha),inKangra*Acaciacatechu*(320.00Ind/ha),inHamirpur*Acaciacatechu*(560.00Ind/ha),inBilaspur*Acaciacatechu*(260.00Ind/ha);Maximum Species diversity in Una was found in *Pinus roxburghii* (0.36), in Kangra *Acaciacatechu* (0.35), in Hamirpur *Acacia catechu* (0.36), in Bilaspur *Acacia catechu* (0.36); MaximumConcentration of dominance in Una was found in *Butea monosperma* (0.5540), in Kangra *Acaciacatechu*(0.0846),in Hamirpur*Acacia catechu*(0.1176), inBilaspur *Acaciacatechu*(0.0958).

In Zone II, maximum IVI in Mandi was found in *Myrica esculenta* (149.10), in Sirmour *Pinusroxburghii* (83.56), in Solan *Phoenix sylvestris* (100.31); maximum TBA in Mandi was found in*Myrica esculenta* (26.31), in Sirmour *Melia azaderach* (9.33), in Solan *Albizia odoratissima*(92.30); maximum density in Mandi was found in *Myrica esculenta* (980.00 Ind/ha), in Sirmour*Pinusroxburghii*(310.00Ind/ha),inSolan*Bauhiniavariegata*(630.00Ind/ha);maximumspecies diversity in Mandi was found in *Grewia optiva* (0.36), in Sirmour *Melia azaderach*(0.36),inSolan*Phoenixsylvestris*and*Bauhiniavariegata*(0.36,each);maximumconcentration of dominance in Mandi was found in *Myrica esculenta* (0.2997), in Sirmour

Comment [A4]: The use of the terms silvopastoral or silvipastoral requires consistency. It would be better if it appropriateto the terms used in the title.

Meliaazaderach(0.0942), in Solan *Phoenix sylvestris*(0.1233).

In Zone III, maximum IVI in Kullu was found in *Cedrus deodara* (138.31), in Shimla *Quercusoblongata*(193.11), inChamba*Cedrusdeodara*(109.87);MaximumTBAinKulluwasfound in *Cedrus deodara* (20.56), in Shimla *Quercus oblongata* (99.74), in Chamba *Pinus wallichiana*(199.10); Maximum density in Kullu was found in *Cedrus deodara* (430.00 Ind/ha), in Shimla*Quercus oblongata* (610.00 Ind/ha), in Chamba *Cedrus deodara* (100.00 Ind/ha); Maximumspecies diversity in Kullu was found in *Quercus floribunda* (0.35), in Shimla *Quercus oblongata*(0.37), in Chamba *Cedrus deodara* (0.37); maximum concentration of dominance in Kullu wasfound in *Cedrus deodara* (0.5244), in Shimla *Quercus oblongata* (0.7262), in Chamba *Cedrusdeodara*(0.3537).

In Zone IV, maximum IVI in Kinnaurwas found in *Cedrus deodara* (252.30), in Lahaul andSpiti*Pinuswallichiana*(164.32);maximumTBAinKinnaurwasfoundin*Alnusnitida*(1027.66), in Lahaul and Spiti *Salix fragalis* (137.90); maximum Density in Kinnaur was foundin *Alnus nitida* (620.00 Ind/ha), in Lahaul and Spiti *Salix fragilis* and *Pinus wallichiana* (190.00Ind/ha);maximumspeciesdiversityinKinnaurwasfoundin*Pinus wallichiana*(0.37),in Lahauland Spiti*Salix acmophylla*(0.36); maximumconcentration ofdominance inKinnaurwas found in *Cedrus deodara* and *Alnus nitida* (0.5000, each), in Lahaul and Spiti *Salix fragilis*(0.5278).

Phytosociological studies on shrub species in silvipastoral land use systems revealed that inZone I, maximum IVI in Una was found in *Agave americana* (83.59), in Kangra *Dodoneaviscosa* (55.19), in Hamirpur *Lanatana camera* (77.06), in Bilaspur *Lanatana camera* (76.36);maximumTBAinUnawasfoundin*Dendrocalamusstrictus*(128.98),inKangra*Dendrocalam us strictus* (123.52), in Hamirpur *Reinwardia indica* (79.85), in Bilaspur *Jatrophaceroides* (238.75); maximum density in Una was found in *Dodonea viscosa* (6444.44 Ind/ha), inKangra *Dodonea viscosa* (6481.48 Ind/ha), in Hamirpur *Murraya koenigii* (5074.07 Ind/ha), inBilaspur *Jatropha ceroides* (8185.19 Ind/ha); maximum species diversity in Una was found in*Opuntia monocantha* (4.25), in Kangra *Euphorbia royleana* and *Dodonea viscosa* (0.30, each),in Hamirpur *Dendrocalamus strictus* (4.24), in Bilaspur *Indigofera cassioides* (4.30); maximumconcentrationofdominanceinUnawasfoundin*Agaveamericana*(0.2786),inKangra*Dodon ea viscosa* (0.1698), in Hamirpur *Lantana camera* (0.0660), in Bilaspur *Jatropha ceroides* (0.2721).

In Zone II, maximum IVI in Mandi was found in *Dodonea viscosa* (68.21), in Sirmour *Isodonrugosus*(68.55),inSolan*Mimosarubicaulis*(44.54);maximumTBAinMandiwasfoundin *Indigoferaheterantha*(183.02),inSirmour*Euphorbiaroyleana*(403.08),inSolan*Rubusellipticus*(541 .32);maximumdensityinMandiwasfoundin*Dodoneaviscosa*(4592.59Ind/ha), in Sirmour *Isodon rugosus* (5148.15 Ind/ha), in Solan *Isodon rugosus* (3341.25 Ind/ha);maximum species diversity in Mandi was found in *Roylea cineara* (4.64), in Sirmour *Bauhiniavahlii*(4.00),inSolan*Isodonrugosus*and*Justiciaadathoda*(3.70,each);maximumconcentrat ion of dominance in Mandi was found in*Dodonea viscosa* (0.0449), in Sirmour*Isodonrugosus* (0.0522),in Solan *Mimosa rubicaulis*(0.0220).

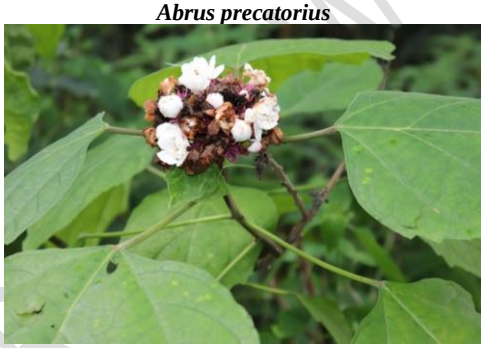
In Zone III, Maximum IVI in Kullu was found in *Sarcococca pruniformis* (89.56), in Shimla*Berberis lycium* (96.14), in Chamba *Daphne papyracea* (85.15); maximum TBA in Kullu was

Plate 1. Some photographs of plant species found in Silvipastoral systems of Himachal Pradesh

Mucuna pruriens

Abrus precatorius

Erythrina suberosa



Clerodendrum chinense

Vigna vexillata

Zingiber chrysanthum

Evolvulus alsinoides

Bauhinia variegata

foundin*Sarcococcapruniformis*(99.03),inShimla*Berberislycium*(153.28),inChamba*Daphne papyracea* (91.05); maximum density in Kullu was found in *Sarcococca pruniformis*(12000.00Ind/ha), in Shimla*Spirea canescence*(16925.93Ind/ha), in Chamba*Desmodiumelegans*(4592.59Ind/ha);maximumspeciesdiversityinKulluwasfoundin*Sarcoccapruniformis* (0.36), in Shimla *Asparagus racemosus* and *Clematis grata* (3.85, each), in Chamba*Daphnepapyracea*(0.36);maximumconcentrationofdominanceinKulluwasfoundin*Sarcoccapruniformis*(0.2985),inShimla*Berberislycium*(0.3205),inChamba*Daphnepapyracea*(0.2838).

In Zone IV, maximum IVI in Kinnaur was found in*Berberis aristata* (90.98), in Lahaul andSpiti*Hippophaesalicifolia*(119.24);maximumTBAinKinnaurwasfoundin*Sorbariatomentosa* (613.97), in Lahaul and Spiti *Hippophae salicifolia* (79.79); maximum density inKinnaurwasfoundin*Rubusfruticosus*(7037.04Ind/ha),inLahaulandSpiti*Astragalusfilicaulis* (3370.37 Ind/ha); maximum species diversity in Kinnaur was found in *Berberis arstata*and *Rubus fruticosus* (0.36, each), in Lahaul and Spiti *Hippophae salicifolia* (0.37); maximumconcentration of dominance in Kinnaur was found in *Juniperus indica* (0.3033, each), in LahaulandSpiti*Hippophaesalicifolia*(0.3975).

Phytosociological studies on herb species in silvipastoral land use systems revealed that in ZoneI, maximum IVI in Una was found in *Saccharum spontaneum* (19.01), in Kangra *Alternentherasessilis* (24.32), in Hamirpur *Achyranthes aspera* (107.66), in Bilaspur *Cymbopogon ambiguus*(38.39); maximum TBA in Una was found in *Fimbristylis cymosa* spp *cymosa* (4.27), in Kangra*Alternentherasessilis*(0.0834),inHamirpur*Achyranthesaspera*(13.38),inBilaspur*Stellaria media* (112.11); maximum density in Una was found in *Commelina benghalensis* (17140.59Ind/ha),inKangra*Oplismenuscompositus*(17100.00Ind/ha),inHamirpur*Paspalidiumflavidum* (18200.00 Ind/ha), in Bilaspur *Veronica persica* (20400.00 Ind/ha); maximum speciesdiversity in Una was found in *Cymbopogon martini* (0.17), in Kangra *Alternenthera sessilis*(0.32),inHamirpur*Achyranthesaspera*(0.37),inBilaspur*Cymbopogonambiguus*(0.26);maximum concentration of dominance in Una was found in *Cymbopogon martini* (0.0618), inKangra *Alternenthera sessilis* (0.1965), in Hamirpur *Achyranthes aspera* (0.3560), in Bilaspur*Cymbopogonambiguus* (0.1252).

In Zone II, maximum IVI in Mandi was found in*Chrysopogon fulvus* (21.90), in Sirmour*Commelina benghalensis* (97.50), in Solan *Solanum manguivi* (25.47); maximum TBA in Mandiwasfoundin*Apludamutica*(13.48),inSirmour*Commelinabenghalensis*(4.81),inSolan*Xanthium strumarium* (563.56); maximum density in Mandi was found in*Thymus linearis*(21545.00Ind/ha),inSirmour*Sennatora*(18140.59Ind/ha),inSolan*Tripogon filiformis* (18140.59 Ind/ha); maximum species diversity in Mandi was found in *Urtica dioica* (0.22), inSirmour*Commelinabenghalensis*(0.37),inSolan*Trichodesmaindicum*(17.9);maximumconcentrationofdominanceinMandiwasfoundin*Thymuslinearis*(0.0904),inSirmour*Commelinabenghalensis*(0.3250), in Solan*Thalictrum foliolosum*(0.0838).

InZoneIII,maximumIVIinKulluwasfoundin*Micromeriabiflora*(15.15),inShimla*Amaranthes spinosus* (13.43), in Chamba *Malva neglecta* (33.64); maximum TBA in Kullu wasfoundin*Micromeriabiflora*(2.85),inShimla*Amaranthesspinosus*(4.04),inChamba*Cymbopogon martini* (28.04); maximum Density in Kullu was found in *Ranunculus laetus* and*Dactylis glomerata* (10204.08 Ind/ha), in Shimla *Rumex hastatus* (19274.38 Ind/ha), in Chamba*Malva*

neglecta (6462.85 Ind/ha); maximum Species diversity in Kullu was found in *Micromeriabiflora* (0.16), in Shimla *Amaranthes spinosus* (0.14), in Chamba *Salvia canariensis* (0.31);maximum concentration of dominance in Kullu was found in *Micromeria biflora* (0.0505), inShimla*Amaranthes spinosus*(0.0448), in Chamba*Malva neglecta*(0.0893).

In Zone IV, maximum IVI in Kinnaur was found in *Cannabis sativa* (29.22), in Lahaul and Spiti*Sonchus asper* (44.01); maximum TBA in Kinnaur was found in *Rubus fruticosus* (981.83), inLahaulandSpiti*Sonchusasper*(29.24);maximumdensityinKinnaurwasfoundin*Cymbopogonpospischilii*(23809.52Ind/ha),inLahaulandSpiti*Geraniumwallichianum* (6425.85Ind/ha);maximumspeciesdiversityinKinnaurwasfoundin*Adiantumcapillusveneris* (0.37), in Lahaul and Spiti *Sonchus asper* (0.28); maximum concentration of dominancein Kinnaur was found in *Adiantum capillus veneris* (0.3354), in Lahaul and Spiti *Sonchus asper*(0.1467).

Biodiversity is essential for human survival and economic well being and for the ecosystem function and stability [33]. As important part of life it acts as resource base of our daily needs and fate of future generation also depends on its sustainability [25].Species diversity is one of the most important characteristics of community and its mechanism, which generates stability [20].Maintenance and periodic assessment of diverse ecosystems and a whole of biological diversity therein are, therefore, crucial for long term survival of human beings [18, 19].The species diversity varies in particular forest areadue to the varying altitudinal range, aspect, habitats, degree of prevailing abiotic and biotic pressures and adaptation of species[10] and elevation and aspect are major physiographic factors which influences distribution, growth form and structure of species and due to which the individual species has different value of density and basal cover [43]. Considering this knowledge of plant community, diversity, population, distribution etc., are essential for the sound management of Himalayan ecosystem [10].The floristic composition results of present study are in conformity with the reportsgivenby following workers [11, 40, 32, 31, 29, 27, 34, 41, 16, 37, 18, 15].

CONCLUSION

North western Himalayan occupies a special place in the mountain ecosystems of the world mainly because of its unique environmental conditions, flora, fauna anddiverse demographic profile.In the present study 1046 woody and non-woody species, representing 108 families and 538 genera reported from silvopastoral land use systems of Himachal Pradesh along with population status. According to CAMP, 2013 species viz., *Angelica glauca,Berberis aristata,Dioscorea deltoidea, Polygonatum cirrhifolium, Hyoscyamus niger, Bunium persicum, Ephedra gerardiana, Juniperus communis* and *Selinum vaginatum* are threatened and requires *in situ* and *ex situ* conservation and management efforts. There was no authentic data on floristic composition and phyto-sociology of silvopastoral systems of Himachal Pradesh in the past. In view of ecological, economic and social importance of silvopastoral systems the present study will definitely act as base line data for further in-depth studies on developmentand introduction of suitable demonstration/silvopastoral models, tree-grass suitability and compatibility studies, quantitative and qualitative improvement in livestock, restoration of degraded lands and silvopastoral system management improvement programs.

Comment [A5]: What is CAMP?

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