Plant Diversity in Prevalent Agroforestry Systems of District Budgam

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Thesis

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Dedicated To The Esteemed Farmers Of The Country

Sher-e-Kashmir
University of Agricultural Sciences and Technology of Kashmir
Faculty of Forestry, Benihama, Ganderbal

Certificate – I

This is to certify that the thesis entitled, **“Plant Diversity in Prevalent Agroforestry Systems of District Budgam”** submitted in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy in Forestry**, to the **Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir** is a record of bonafide research work carried out by **Ms. Sabeena Nabi (Regd. No. 2012-427-D) (INSPIRE Fellow)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that information received during the course of investigation has duly been acknowledged.

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We, the members of the Advisory Committee of **Ms. Sabeena Nabi (Regd. No. 2012-427-D) (INSPIRE Fellow),** a candidate for the degree of **Doctor of Philosophy in Forestry** have gone through the manuscript of the thesis entitled, **"Plant Diversity in Prevalent Agroforestry Systems of District Budgam"** and recommend that it may be submitted by the student in partial fulfilment of the requirements for the award of the degree.

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This is to certify that the thesis entitled, **"Plant Diversity in Prevalent Agroforestry Systems of District Budgam"** submitted by **Ms. Sabeena Nabi (Regd. No. 2012-427-D) (INSPIRE Fellow)** to the **Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir** in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy in Forestry** was examined and approved by the Advisory Committee and External Examiner on …………….. .

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ABSTRACT

The present investigation entitled **"Plant Diversity in Prevalent Agroforestry Systems of District Budgam"** was carried out, during the year 2013 and 2014. The experimental site is located between 34°1′12″N latitude and 74°46′48″E longitude at an altitude of 1610 m above mean sea level (msl). The main aim was to assess the prevalent agroforestry systems, their floristic composition, phytosociology and capacity to fulfill socio-economic needs of the people. Four agroforestry systems viz., Boundary plantation, Homegarden, Horti-agricultural and Horti-silvi-pasture system were found to be prevalent in the area by stratified random sampling procedure. Floristic composition of the agroforestry systems revealed the presence of 4 genera, 6 species of 3 families and 6 genera, 8 species of 3 families of broad leaved and fruit trees, respectively. While, 2 genera having 3 species belonging to 2 families were of shrub layer. Herbage (cultivated and wild) represented 70 genera belonging to 75 plant species and 37 families. Seasonal evaluation of phytosociological /quantitative attributes showed that in terms of cultivated plants in Boundary plantation, *Brassica campestris* and *Oryza sativa* were dominant with highest importance value index (IVI) during spring and summer season, respectively. Correspondingly, *Brassica oleracea var. acephala* during spring, summer and *Brassica rapa* in autumn season exhibited maximum IVI in Homegarden. Similarly, in Horti-agricultural system, *Phaseolus vulgaris* and *Brassica olearacea var. acephala* demonstrated dominance over other cultivated species during spring, summer and autumn, respectively. Likewise, in wild herbage, *Cynodon dactylon* was the dominant species in Boundary plantation and Horti-silvi-pasture system. However, in Homegarden and Horti-agricultural system, *Stellaria media* explicated dominance over other species portraying communities as *Cynodon dactylon- Polygonum hydropiper- Prunella vulgaris* community in Boundary plantation, *Stellaria media- Poa aungustifolia- Galinsoga parviflora* in Homegarden, *Stellaria media- Plantago major- Artemisia absinthium* in Horti-agricultural system and *Cynodon dactylon- Oenothera rosea- Mentha arvensis* in Horti-silvi-pasture system. Shrub species present in different systems include *Asparagus officinalis*, *Rubus niveus* and *Rubus ulmifolius*. However, they were absent in Homegardens. *Populus deltoides* showed dominance in Boundary plantation exhibiting density of 100 individuals ha^{-1}, basal area 2.41 m^2 ha^{-1} with 100 % frequency and 118.01 importance value index (IVI). *Malus domestica* demonstrated dominance in remaining three agroforestry systems viz., Homegarden, Horti-agricultural andb Horti-silvi-pasture system explicating density of 66.67 plants ha^{-1}, 466.67 plants ha^{-1} and 300 plants ha^{-1}; basal area of 0.57 m^2 ha^{-1}, 4.91m^2 ha^{-1} and 4.40 m^2 ha^{-1}; frequency of 83.33 %, 100 % and 100 %; importance value index (IVI) as 57.09, 134.50 and 72.00, respectively. Shannon weiner index for herbs, shrubs and trees was found to be maximum in Horti-silvi-pasture system. However, for wild herbage and trees, species evenness was maximum in Horti-agricultural system. Simpson index and concentration of dominance was higher in Homegarden for wild herbage, while it was maximum in Boundary plantation and Horti-agricultural system for shrubs. For trees, inverse diversity indices i.e. Simpson index and concentration of dominance were maximum in Boundary plantation. Overall scenario of vegetation indices described that Shannon weiner index and species evenness was in the order of herbs > trees > shrubs. While as, Simpson index and concentration of dominance was in sequence of shrubs > trees > herbs. Maximum similarity/resemblance of 51.35 % in vegetation was found between Boundary plantation and Horti-silvi-pasture. Overall results indicated that among four prevalent agroforestry systems evaluated, Horti-silvi-pasture system conserve more number of species i.e. is rich in floristic diversity of herbs, shrubs and trees.

All agroforestry systems support the farmers in terms of income generation either at low or high profit levels. The income of Rs 3,335.71/ha, Rs 7,042.96/ha, Rs 13,46,62.10/ha and Rs 26,77,39.10/ha was generated from Boundary plantation, Homegarden, Horti-agricultural system and Horti-silvi-pasture system, respectively. Fuelwood Value Index (FVI) of preferred tree species displayed highest values of 948.05 and 1067.42 for *Robinia pseudoacacia* and *Prunus dulcis*, respectively. The crude protein content of preferred tree fodders decreased from spring to autumn, whereas, crude fibre, ether extract and ash content increased with advancing season. Furthermore, *Robinia pseudoacacia* and *Populus nigra* proved to be excellent source of protein, fat and fibre for efficient maintenance of ruminants respectively.

Key words: Agroforestry systems, Quantitative attributes/Phytosociology, Socio-economic status, Budgam, Fuelwood, Fodder values

Signature of Student Signature of Major Advisor

Dated____________ Dated ___________________

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"U'NN POSH'E TEL'I YEL'I WAN POSH'E"

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Sabeena Nabi

Place : Benihama, Ganderbal

Dated: ________________

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Chapter-1

INTRODUCTION

Biological diversity means the variation among living organisms from all sources and natural ecosystems of which they are a part of; this includes diversity of ecosystems, diversity within species and between species (Heywood and Watson, 1995). Loss of biodiversity is a major concern among conservation scientists but the motivation to change this trend is generally lacking. Approximately, half of the world's population lives in urban areas and is increasingly disconnected from nature, which is one reason why the people have no concern for nature. If there is a great public support for the conservation of biodiversity, the places where people live and work should be designed so as to provide opportunities for meaningful interactions with the natural world. Doing so has the potential not only to engender support for protecting native species but also to enhance human well-being (Manzoor *et al*., 2013). Agro-biodiversity is a subset of natural biodiversity which includes the plant genetic resources used for food and agriculture (cultivars, landraces, ecotypes, weedy races and wild relatives) (Negri and Polegri, 2009). Maintenance of genetic variation within agricultural crops provides a broad range of essential goods and services which support ecosystem functioning, resilience and productivity (Tilman, 1999 and 2000), and for this reason it has become a core principle of sustainable agriculture and agro-ecology (Le Coeur *et al*., 2002; Marshall and Moonen, 2002). Agro-biodiversity also provides farmers and breeders with raw material for continuously selecting and adapting crops to changing environmental conditions or to the needs of a growing human population (IPGRI, 1993). This continuous process of experimentation leads to an exceptionally strong connection between agro-biodiversity and people, cultures, and landscapes. In the past, the conservation of biodiversity has been mostly understood in terms of the management of protected areas and natural forests, ignoring the possible role of farm areas and the ways through which rural communities have promoted biodiversity in their subsistence agricultural production systems (Fifanou *et al.*, 2011; Acharya, 2006).

The growing concern around the loss of agro-biodiversity in the last decades has fuelled global efforts to improve conservation actions through a number of international policies and agreements. The Convention on Biological Diversity (CBD, 1992) intends to halt the current loss of plant and crop diversity while contributing to poverty reduction and sustainable development. The Global Strategy for Plant Conservation (GSPC, 2002) aims by 2010 to conserve "70 per cent of the genetic diversity of crops and other major socioeconomically valuable plant species'', while maintaining the ''associated indigenous and local knowledge''. The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA, 2001) specifically focuses on the ''conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use''. It requires contracting parties to ''promote or support farmers and local community efforts to manage and conserve on-farm plant genetic resources''.

It is well established that biodiversity conservation and the maintenance of associated ecosystem services are vital for human well-being (Beaumont *et al.*, 2011). However, over 75 per cent of earth's terrestrial biomes have shown alteration as a result of anthropogenic activities. As rates of deforestation, land degradation, losses of biodiversity and ecosystem services continue to rise globally, the international community is faced with the challenge of finding land use interventions that can mitigate or reduce the impact of these environmental issues. Against these backdrops, agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components (Lundgren and Raintree, 1982). In the last three decades, there has been a growing interest in agroforestry because of its biodiversity and ecosystem services it delivers besides providing the tangible benefits of food, fodder, fuelwood, timber and NTFP's. Therefore, trees are increasingly being incorporated as part of the modern farming systems. A recent global assessment of tree cover found that 48 per cent of the world's agricultural land had at least 10 per cent of tree cover. Species diversity is one of the most intuitive and widely adopted measures of determining variability at both ecological and biogeographic scales (Chiarucci *et al*., 2011). However, habitat degradation, fragmentation, and over-exploitation have contributed to the loss of many species all around the world. The impact of these changes on biological systems are manifested as shifts in phenology, interactions, species distributions, morphology and net primary productivity (Gardner *et al*., 2009; Beaumont *et al*., 2011). Several biodiversity hotspots in south-east Asia are endangered as a result of deforestation, habitat destruction, over-exploitation, pollution, and climate change. There has been a lack of concern about ecosystem restoration compounded with primitive and ineffective forest practices and on-going deforestation (Muzaffar *et al*., 2011). The ability of many intensively used landscapes to support native species suggests that maintaining and creating habitats in human influenced landscapes can help to conserve a large proportion of biodiversity (Acharya, 2006; Bhagwat *et al*., 2008).

Correspondingly, *circa situm* conservation via an agroforestry system is also highly promoted in agricultural landscapes (Boffa *et al*., 2005; Philpott *et al*., 2008). This approach focuses on sustainable conservation and utilization of the species. Retention of forest species in agricultural landscapes enhances biodiversity conservation at both species and landscape level (Herve and Vidal, 2008). The practice of maintaining trees on the farm makes farmers the custodians of biodiversity (Acharya, 2006). Multistrata agroforests contribute to biodiversity conservation via: (i) the provision of supplementary habitat for species that tolerate a lower level of disturbance; (ii) conservation of remnant native species; (iii) buffering the pressure on natural habitats; (iv) provision of corridors for persistence and movement of species across landscapes (Negash *et al*., 2012).

However, widespread adoption of agroforestry is still tampered by a myriad of factors including *inter alia* the design features of candidate agroforestry innovations, perceived needs, institutional constraints, the availability and distribution of factors of production, and perception of risks. Understanding the science and factors that facilitate the adoption of agroforestry and how they impact the implementation of agroforestry, is vitally important. Much of modern day conservation is motivated by a desire to conserve 'pristine nature' in protected areas, while there is growing recognition of the long-term human involvement in forest dynamics and of the importance of conservation outside protected areas. Agroforestry has received widespread attention in tropical and temperate regions of the world for providing ecosystem services such as carbon sequestration, biodiversity conservation, soil quality, and preserving air and water quality (Bardhan *et al*., 2012; Thevathasan and Gordon, 2004; Jose, 2009). Especially in tropical landscapes, more than 90 per cent of biodiversity resources are found in human dominated landscapes (Garrity, 2004; Borkhataria, 2012). Considering the fact that ecosystems and species are disappearing at an alarming rate, the role of agroforestry as a conservation tool needs to be exploited further (Bengtsson *et al*., 2000; Alavalapati *et al*., 2004; Jose, 2009 & 2011). The multifunctional role of agroforestry viz., microclimate moderation, biodiversity conservation, carbon sequestration, protecting water sources, soil erosion and pollution control has been highlighted by the Millennium Ecosystem Assessment (MEA, 2005) and the International Assessment of Agricultural Science and Technology and Development (IAASTD, 2008).

Agroforestry as an intentional management of trees with agricultural crops, has the potential for providing habitats outside formally protected land, connecting nature reserves and alleviating resource-use pressure on conservation areas (Bhagwat *et al*., 2008). While enhancing rural livelihoods (Ashley *et al*., 2006), and increasing the connectivity of landscape components, agroforestry ensures more effective conservation of habitats (McNeely and Schroth, 2006). About 50-80 per cent of species from regional species pools typically survive in agroforestry systems, however, many endemic species are lost from agroforests (Noble and Dirzo, 1997; Garcia-Fernandez, 2003).

Agroforestry practice in tropical and temperate regions is probably as old as agriculture itself, and it is considered as a way of life of traditional farmers, although research on it started only about 25 years ago. Many of the traditional systems viz; shifting cultivation or slash-and-burn, homegardens and compound farms, forest gardens/agroforests, trees on farmlands (boundary plantings, scattered trees), parkland systems are base to maintain valued biological interactions and biodiversity at higher levels than some of the new agroforestry technologies (Leakey, 1998). The traditional agroforestry systems identified in Kashmir Valley include; boundary plantations, agri-silviculture on sloping lands, agri-silviculture in plains, horti- silviculture, horti-silvi-pasture, horti-silvi-agriculture and homegardens. These systems are being practiced by farmers to meet out their livelihood needs (Mughal and Bhattacharya, 2002), although the marginal and average household size farmers do not reap all the advantages of this integrated system (Bhat *et al.*, 2010). Since different research programmes have been undertaken with respect to District Budgam viz; identification of prevalent agroforestry systems, carbon sequestration, biomass production in prevalent agroforestry systems and no work has been reported regarding plant diversity evaluation till date. So, in order to evaluate and summarize the plant diversity in prevalent agroforestry systems, the present investigation entitled "Plant Diversity in Prevalent Agroforestry Systems of District Budgam" has been taken up with the following objectives:

1. To assess the status of plant diversity in prevalent agroforestry systems of District Budgam.
2. To analyze and evaluate the contribution of agroforestry in fulfillment of individual household needs in District Budgam.
3. To determine the fuelwood and fodder values of preferred tree species in District Budgam.

Chapter-2

REVIEW OF LITERATURE

The information pertaining to the present study has been reviewed in this chapter. The literature pertaining to plant diversity in different agroforestry systems was available in scanty; therefore cross references of work done in forests regarding plant diversity have been taken into consideration and have been discussed under following headings:

2.1 Plant diversity in different agroforestry systems

2.2 Socioeconomic/household prosperity contribution by agroforestry systems

2.3 Fuelwood and nutritional evaluation of tree species

2.1 Plant diversity in different agroforestry systems

Many authors have shown that traditional agroforestry practices contribute to the conservation of biodiversity through *in situ* conservation of tree species on farms, reduction of pressure on remnant forests, and the provision of suitable habitat for a number of plant and animal species on farmland (Atta-Krah *et al.*, 2004; Acharya, 2006, McNeely and Schroth, 2006). Trees in these systems provide shade, shelter, energy, food, fodder and many other goods and services that enable the farmstead to prosper (Leakey and Tchoundjeu, 2001; Djossa *et al.*, 2008; Ouinsavi and Sokpon, 2008).

Amjad *et al*. (2014) undertook a vegetation study in a traditionally managed mountain woody pasture in Nikyal valley, Rawalpindi, Pakistan to investigate the patterns of species diversity, and regenerating capacity in relation to environmental variables and underlying anthropogenic influence during July 2012 to June 2013. The area was sampled by quadrat method. The quadrats were laid out at regular intervals of 150 m. The size of quadrats was kept 10×10, 5×5 and 1×1 m^2 for trees, shrubs and herbs respectively. Density, frequency and basal cover were recorded. Then diversity, its components and regenerating capacity were calculated. Shannon's diversity ranged from (2.75 to 3.31), Simpson's diversity (0.90 to 0.95), Menhinicks diversity (0.83 to 1.19), evenness (0.41 to 0.65), species richness (4.89 to 6.08) and species distribution pattern (30 to 44). *Pinus roxburghii* was the only regenerating species among four other species i.e. *Quercus dilatata*, *Prunus persica*, *Punica granatum* and *Olea ferruginea*,that were at extereme risk of elimination due to anthropogenic factors.

A comparative study of shrub diversity in lower Dachigam National Sanctuary (Kashmir) was conducted by Yaqoob *et al*. (2014) in two different ecosystems *viz*., village site (Site I) and protected site (Site II) in three different seasons i.e. spring, summer and autumn. The study revealed that the diversity values (2.228) and richness index (0.867) was higher for Site -II while dominance index showed higher value (0.113) at Site-I. The frequently occuring shrub species based on Importance value index (IVI) were *Plectranthus rugosa*, *Rosa webbiana*, *Indigofera heterantha* at Site-I and *Rosa brunoni* at Site-II. The abundance to frequency ratio indicated that most of the species present contagious pattern of distribution.

The study conducted by Hashemi *et al*. (2013) in home gardens of two ecogeographically different areas in Gachsaran, south-western Iran to evaluate crop species diversity. Evaluations were made by questionnaires and inspections of homegardens in two different ecological areas; the mountainous Khamin protected area and the Bavi hilly-plain area. Results showed unsatisfactory species diversity in home gardens: from a total of 192 observed home gardens, the highest mean species richness (12.84) was in a village on the hilly - plains ecological area and the least (1.71) was in a village in the mountainous Khamin area. Villages in the mountainous ecology were less developed. None of the three predefined categories (divisions) demonstrated any specific trend in the division of vegetable and summer crops and there was little difference between the villages. However in the division of fruit trees and shrubs, villages in the hilly plain ecology showed significantly more diversity and this division was the first component of home -

gardens, however, it was less remarkable in the mountainous ecological area (Shannon-Weiner diversity index for this group was up to 1.5 in all villages on the hilly-plain compared to an evaluation of less than 1 in all villages in the mountainous ecology). The division of other homegarden crops showed that total species richness was low especially in the mountainous area ecology and inventories on the Shannon -Weiner index showed the maximum score of 0.73 from one of the villages as 97 crop species relating to 51 families. Only 33 crop species were found in the mountainous Khamin ecology and evaluation by the Sørenson similarity index indicated low ecological similarities between the two ecological areas with the score of 0.49.

Bardhan *et al*. (2012) evaluated the effectiveness of homegarden agroforestry systems (AF) practices to conserve tree species diversity in Bangladesh and compare them with tree species diversity in natural forests (NF). A total of nine locations were selected which comprised of five agroforestry systems sites and four NFs. Shannon-Weiner Diversity Index (H) was similar for homegarden AF (3.50) and NF (2.99), with no statistical difference between them. Based on non-metric multi-dimensional scaling (NMDS) ordination analysis, the AF and NF plots showed distinct separation. However, Bray-Curtis dissimilarity index ranged from 0.95 to 0.70 indicating nearly no overlap in species composition to significant overlap between AF and NF. Based on the results, they concluded that AF can serve as an important ecological tool in conserving tree species diversity, particularly on landscapes where NF fragments represent only a small fraction of the total land area.

Productivity of agricultural crops under traditional agri-hortculture system alongwith structure, composition and diversity of fruit trees and shrub species in mid hill situation of Garhwal Himalaya, India between 1000 to 2000 m asl during summer and winter seasons on northern and southern aspect were studied by Bijalwan (2012). The tree density, composition and diversity in the system varied depending upon aspect, landholding and requirements of the farmers. A total of 12 fruit tree species were recorded in agri-horticulture system; of which 4 trees were common in northern and southern aspect and 6 trees were only noticed in northern aspect while 2 in the southern. The apple tree (*Malus domestica*) was recorded to be dominant fruit tree species with highest IVI values on both northern and southern aspect with prime preference by the farmers for high additional economic return in agri-horticulture system. Among the shrubs, the 6 shrub species were recorded on the northern aspect whereas there number was 16 on southern aspect. The agricultural crop diversity was higher on the northern aspect in summer and winter season. The average annual productivity of grain under agri-horticulture system recorded 1106 kg ha^{-1} $year^{-1}$ on northern aspect and 1122 kg ha^{-1} $year^{-1}$ on southern with a reduction of 34.56 and 38.29 per cent compared to the sole agriculture crops, respectively.

A total of 60 farms were studied by Negash *et al*. (2012) in south-eastern Rift Valley escarpment, Ethiopia representing three agroforest types (enset-AF, enset-coffee-AF and fruit-coffee-AF), were randomly selected along altitudinal gradients. Enset (*Ensete ventricosum*) is a perennial, herbaceous monocarpic banana-like plant which serves as a food plant in Ethiopia.The highest proportion of native woody species was recorded in enset-AF (92%), followed by enset-coffee-AF (89%) and fruit-coffee-AF (82%). Among native tree species, *Millettia ferruginea* and *Cordia africana* were the most widespread. In all, 22 native woody species were recorded as of interest for conservation, according to IUCN Red lists and local criteria. A smaller number of native woody species was recorded in fruit coffee- AF, but a higher mean basal area and stem number. The mean basal area and stem number ranged from 5.4 ± 0.5 to 11.7 ± 1.0 m^2 ha^{-1} and 625 ± 84 to 1,505 ± 142 stems ha^{-1}, respectively. Altitude explained 68 and 7 per cent of the variation in species richness and abundance, respectively. Analysis of variance showed that there were significant differences among agroforest types in terms of mean stem number and number of species (richness) per plot. Fruit-coffee-AF had 42 and 28 per cent significantly higher stem and species numbers respectively, per plot than enset-AF. The native species richness was higher in enset-AF than in enset-coffee-AF and fruit-coffee- AF. Species richness and stem number did not differ between enset-coffee-AF and fruit-coffee-AF. The Shannon diversity index was not significantly different among the agroforest types. However, Margalef's diversity index of species richness showed significant differences. It was highest for enset-AF and least for Fruit-coffee-AF. Moreover, Simpson's evenness for enset-AF was significantly different from that for enset-coffee-AF and fruit-coffee-AF. The Sørensen quantitative index showed moderate species similarity between enset-AF and enset-coffee- AF (53%, i.e., 27 of 51 species recorded in both practices). The highest species similarity was observed between enset-coffee-AF and fruit-coffee-AF (64%; i.e., 32 of 50 species). The least species similarity was recorded between enset-AF and fruit-coffee-AF (17%; i.e. 7 out of 45 species).

The phytosociological attributes of western Himalayan moist temperate forests were investigated by Shaheen *et al*. (2012) in Bagh district, Kashmir. Detailed sampling was carried out in 180 forest stands (30 × 30m) at 13 sites. Average number of vascular plant species varied from 30 and 40; Menhinick's Richness was 0.93-1.63; Simpson's Diversity Index between 0.75 and 2.27; Shannon's Evenness between 0.21 and 0.71; the Maturity Index 38 to 53. Species diversity and community structure patterns were significantly correlated to environmental variables including altitude and slope inclination as well as intensity of anthropogenic pressure. *Abies pindrow* and *Pinus wallichiana* showed exclusive dominance comprising 30 per cent of IVI weightage of all 122 recorded species. Forest ground flora was dominated by grasses of the Poaceae. Average tree density was 151 ha^{-1} whereas basal area was estimated as 68.8 m^2 ha^{-1}. A stem/stump value of 1.62 indicated immense tree felling and logging pressure on local forests. A disturbed forest regeneration pattern was indicated by an average seedling count of 124 ha^{-1}. A negative correlation was found between diversity and richness with altitudinal gradient as well as slope and aspect. Diversity values were similar, whereas tree density, basal area and seedling count were lower, compared to other Himalayan forest sites.

The study was conducted by Udofia *et al*. (2012) to assess the plant species that meet the socio-economic needs of the people of Nsit Ubium Local Government Area of Akwa Ibom State, Nigeria. Simple random sampling was used to select 420 homegardens from 14 villages for enumeration and 20m x 20m quadrat was established at each of the sample homegardens. Simpson's Diversity Index and Menhinick's Richness Index were used to estimate diversity and richness of plant species respectively. The plant species comprised 48 families and 5 life forms (trees, shrubs, palms, climbers and herbs). High species diversity of 0.05 and high richness index of 1.14 were computed for the plant species. Appropriate conservation methods should be applied in homegardens of Nsit Ubium Local Government Area, Akwa Ibom State, Nigeria so that they can sustain the rich and diverse plant species.

The study was carried out by Khanal (2011) in Lekhnath Municipality and Bharatpokhari VDC of Kaski district in Nepal with the aim of assessing the present status and trends of farm tree biodiversity, analyzing the contribution of agroforestry in rural needs fulfillment of forest resources, and determining the potential of medicinal and aromatic plants (MAPs) in forest based agroforestry systems (i.e. Silvi-medicinal system) on three farm land types viz; Bar (rain fed un-irrigated land for growing fodder, fuelwood and timber trees), Khet (it is the land where the most demanding cereal crops like paddy are cultivated), Kharbari (permanently occupied by Khar (*Typha angustata*) grass, other ground grass, fodder as well as timber trees). Reconnaissance survey, direct observation, key informant interview, questionnaire survey with schedule, and group discussion were used for primary data collection where purposive sampling (10% intensity) with the consideration of well being ranking, gender and age groups were selected as sample household for interview. Shannon diversity index (species richness and evenness) was used to analyze farm tree biodiversity. Species richness and evenness were very high in Bari land (3.4) than khet (2.6) and kharbari (3.1) land. Species richness and evenness were high in fodder species (2.6) followed by fruit (2.46), medicine, grass, herbs and shrubs (2.40), timber and live fences (2.37).

Shameem and Kangroo (2011) conducted a study to investigate the comparative assessment of edaphic factors and phytodiversity of herbaceous vegetation on seasonal basis spring (March to May), summer (June to August), autumn (September to November) and winter (December to February), at two different ecosystems in lower Dachigam National Park, Kashmir Himalaya, India. Phytosociological attributes of plant species were studied by randomly laying 25 quadrats of 1×1 m^2 size at both sites. The vegetation data recorded was quantitatively analysed for density, frequency and abundance. Plant diversity was evaluated using different diversity indices. The abundance to frequency ratio (A/F) for different species was determined by eliciting the distribution pattern (regular <0.025, random 0.025-0.05 and contagious >0.05). The results indicated edaphic factors highest at site II (MC, 35.55%), (OC, 4.73%) and (TN, 0.36%). pH showed acidic to nearly alkaline kind of nature at both sites with site I at higher side (5.95 to 7.52). Phytodiversity revealed site II comparatively higher in Shannon diversity and species richness during summer season (3.66, 7.92). However, evenness index showed similar trend with equal value at both sites (0.94). Dominance showed an inverse relationship to diversity (H′). Species at both sites were contagiously distributed followed by random one whereas regular distribution was almost negligible. The study concluded that seasons have great influence on edaphic factors and species diversity. An increase in species diversity was observed during spring and summer season which declined thereafter as autumn and winter approached resulted in decrease in diversity due to multitude of factors.

Plant diversity assessment was carried out in different forests of Kedarnath Wildlife Sanctuary (KWLS), Central Himalaya, India by Semwal *et al*. (2010) on the basis of species richness, tree crown cover and dominance-diversity pattern.

The maximum tree species richness (10 sp.) was observed in *Rhododendron arboreum* Sm. dominated mixed forest and minimum in *Quercus leucotrichophora* A. Camus. forest (8 sp.). Maximum tree density (170 trees ha^{-1}) and high importance value index (89.68) was found in *Q. semecarpifolia* Sm. forest. Mixed *Rhododendron arboreum* Sm. forest showed high tree diversity (H=0.96), while shrubs were found highest in *Quercus leucotrichophora* A. Camus forest (H=0.62) and herb diversity in *Q. semecarpifolia* Sm.forest (H=0.73) respectively. Maximum tree crown cover (82%) was observed in *Rhododendron arboreum* Sm. dominated mixed forest while minimum tree crown cover (58%) was observed in *Q. semecarpifolia* Sm. forest. In general random distribution pattern (A/F ratio) was observed in all three types of forest. Alterations of land use pattern and population pressure are found to be main cause of increase in resources exploitation and that ultimately decreases species richness and diversity. Agroforestry, an alternate use of sites for resources and providing a recovery period to the forests are some of the strategies suggested for forest conservation, management and sustainable utilization of resources by the local people.

A comparative study was conducted at two different ecosystems that is, site I (pastureland) and site II (forest) in the lower Dachigam National Park of Kashmir, Himalaya, India was evaluated by Shameem *et al*. (2010). The pasture site is located outside the National Park and is under grazing whereas forest site is located inside the National Park and is protected. The study was done on seasonal basis and the average results revealed comparatively more or equal values of diversity (H') for both sites (site I = 2.435 and site II = 2.395) while dominance index showed higher value at site I (average = 0.147). The richness index (average = 3.842) and equability index (average = 0.90) both showed higher value at site II. Seasonal trend of Shannon diversity (site I = 3.03, site II = 2.87), richness index (site I = 3.70, site II = 5.83) and evenness or equability index (0.94, site I and II) depicted highest value during summer season whereas lowest variation in

Shannon diversity and richness index was observed in winter season at both sites. However, dominance index was recorded lowest in summer season at both sites (site I = 0.06 and site II = 0.07) hence inversely related to diversity ($H^{'}$). The frequently occurred dominant species during prominent seasons based on importance value (IVI) were *Cynodon dactylon*, *Salvia moorcroftiana* and *Thymus serphyllum* at site I and *Fragaria nubicola*, *Galinsoga parviflora*, *Stipa sibirica* and *Viola indica* at site II. The abundance to frequency ratio (A/F) indicated most of the species performed contagious pattern of distribution.

Herve and Vidal (2008) undertook an ecological survey between July and December 2005 in five cocoa growing regions in the humid forest area of southern Cameroon, which include both evergreen and deciduous rainforest. They selected 17 cocoa plantations (sites) within five types of traditional cocoa forest gardens (TFGs) namely EO, EY, HG, IM, and IY as follows: two EO (Ngomedzap), four EY (Bakoa), IM (Talba), and IY (Kedia), respectively, and three HG (Obala). The plant species richness, Shannon-Weaver index, Shannon evenness and the Berger-Parker index of dominance for each TFG. A significant difference was observed between TFGs when analyzing tree species and herbaceous species richness, respectively. The average tree species richness was two fold higher in EO (11.0) as compared to IY (5.3). IM recorded the lowest herbaceous species richness and herbaceous cover. The Shannon-Weaver index between TFGs ranged from 1.54 to 2.23 for tree species and from 2.45 to 3.10 for herbaceous species. A significant difference was observed between TFGs for both two variables. Nevertheless, EO was the most diverse TFGs when considering the plant diversity indices. When taking into consideration the Jaccard Index (JI), the floristic similarity between TFGs decreased with increasing intensification. Therefore, β-diversity was lower between sites under different land-use management. However, the highest similarity in floristic composition occurred between EY and IY.

A study on basal area and Importance Value Index (IVI) attributes of herbage were investigated in chir pine (*Pinus roxburghii* Sargent) stands of three different ages and also in open grassland in the subtropical region of Himachal Pradesh (India) by Gupta and Dass (2007) during growing season (June to September). A higher basal area of the herbage was recorded in open grassland as compared to chir pine stands of different ages. Basal area of the vegetation increased gradually from July onwards and its highest values were recorded in September in all the systems. Amongst the chir pine stands basal area of herbage was recorded highest in tree stand followed by pole and sapling stands. IVI and basal area values of different species revealed that only few species were major contributors to the total basal area values of the vegetation at different times. The differences in the basal area of vegetation in the four systems at a particular time and changes as recorded in the basal area with the sampling time were found to be statistically significant.

Khan (2007) undertook a study to assess the status of vegetation in Shankaracharya Reserved Forest of Kashmir Valley and reported 10 tree species, 03 shrubs and 17 herbaceous plants. Further, phytosociological assessment was conducted at three different aspects. The vegetation analysis revealed that among tree species, *Cedrus deodara* recorded maximum density (107.5), frequency (100), abundance (74) and IVI (164.5) in north-west aspect-I. In north-east aspect-II, *Robinia pseudoacacia* registered maximum density (6.5), frequency (50), abundance (13) and in south-east aspect-III, *Cupressus torulosa* recorded maximum density of 36, frequency (100) and abundance (72). In both aspects i.e. II and III *Cedrus deodara* registered maximum IVI (96.99) and 120.87 respectively. Among shrubs, *Jasminum humile* was the dominant with IVI (166.65) and (149.57) in the north-west and south-east respectively. In the north-east, *Rosa webbiana* registered density (5.75), frequency (25), abundance (23) and IVI 300.

Kumar and Bhatt (2006) conducted an experiment on floristic diversity, dominance and abundance to frequency ratio of tree, sapling, seedling, shrub and herb species. They were studied in two different forest sites of a tropical foot hill region of Garhwal Himalaya. In tree layer on both the sites, the dominant species recorded were *Lannea coromandelica* (IVI-39.80) and *Anogeissus latifolia* (IVI-29.50) on site I and site II respectively. The ranges of diversity for tree layers were 4.580 to 4.643. Most of the species on both the sites were contagiously distributed except few species which were distributed randomly.

2.2 Socioeconomic/household prosperity contribution by agroforestry systems

Agroforestry development has many links with improving nutrition and health of the rural community. The quantity and expansion of fruit trees and vegetable on farms have a significant impact on the quality of nutrition for children and adults. This is an important especially for countries facing a problem of indigenous fruit tree exploitation. Domestication of wild indigenous fruit trees is popular in Africa and Asian countries. There is potential for agroforestry to generate much-needed income, improve nutrition and reduce labor demands. More than 80 per cent of the population in Africa depends on medicinal plants from farmland and forest for their medical needs. In Indonesia, about 60 to 80% of the rural population relies on medicinal plants because of the high cost of commercial drugs (Handayani and Prawito, 2011).

A survey conducted by Arifin *et al*. (2012) of very small-scale homestead gardens in three Javanese provinces was conducted to analyze the potential beneficial effects on household's quality of life. Aspects included: (1) diet and nutrition, (2) income, (3) level of goods and material assets, (4) family status, (5) credit access, and (6) the role of women in managing production and marketing. The survey encompassed sites on West, Central and East Java, representing a range of agro-ecological zones, watersheds (6), elevations, socio-cultural conditions and development stages. On average, very small homestead plots reduced food expenses by 9.9 per cent. Nutritional benefits are primarily in the form of vitamin A and C-providing 2.4 and 23.6 per cent of recommended dietary allowance (RDA), respectively and only 1.9 per cent of either carbohydrates or protein. As contribution to total household income, average homestead output provides about 11 per cent of total farm income, about 80 per cent of which was derived from animal products such as chicken, eggs, fish and meat. As expected, plot size and value of household assets appear closely correlated and increase based on access to other agricultural land. About 55 per cent of the households feel that social status would decline if the household lost access to their homestead land.

An evaluation experiment on productivity of agricultural crops under traditional agri-horticulture system alongwith structure, composition, diversity of fruit trees and shrub species in mid hill situation of Garhwal Himalaya was under taken by Bijalwan (2012). The tree density, composition and diversity in the system varied depending upon aspect, landholding and requirements of the farmers. A total of 12 fruit tree species were recorded in agri-horticulture system; of which 4 trees were common in northern and southern aspect and 6 trees were only noticed in northern aspect while 2 in the southern. The apple tree (*Malus domestica*) was recorded to be dominant fruit tree species with prime preference by the farmers for high additional economic return in agri-horticulture system. The agricultural crop diversity was higher on the northern aspect in summer and winter season. The average annual productivity of grain under agri-horticulture system recorded 1106 kg ha^{-1} $year^{-1}$ on northern aspect and 1122 kg ha^{-1} $year^{-1}$ on southern with a reduction of 34.56 and 38.29% compared to the sole agriculture crops.

Namwata *et al*. (2012) investigated the productivity of the agroforestry systems and its contribution to household income among farmers in Lushoto District, Tanga, Tanzania. Specifically, the study aimed to determine and compare the level of household's farm production and net income between farmers practicing and not practicing agroforestry. A total of 134 respondents from four villages in Soni and Ubiri wards were involved. Data were collected using structured questionnaire, focus group discussion and through non-participant observation. Results indicate that farmers practicing agroforestry had significantly higher contribution to the household's level of farm production and net income than those who were not practicing agroforestry. Given the average farm size of 3.1 ha, 2.3 cows and 9.2 chicken, the annual production for farmers practicing agroforestry was 425.9 kg for maize, 225.7 kg of beans, 101.1 kg of coffee, and 163.9 bunches of banana, 999.12 litres and 373.5 eggs compared to 342.6 kg of maize, 202.1 kg of beans, 75 kg of coffee, 108 bunches of banana, 1120.6 litres of milk and 338.6 eggs for farmers not practicing agroforestry. The average household annual net income was Tshs 664,992 (Rs 20,681.25) and 547,608 (Rs 17,030.60) for farmers practicing and not practicing agroforestry respectively. The per capita income was Tshs 100,756 (Rs 3,133.51) for farmers practicing and Tshs 82,971 (Rs 2,580.40) for farmers' not practicing agroforestry.

Udofia *et al*. (2012) conducted a study to assess the extent of the availability of plant species that meet the socio-economic needs of the people of Nsit Ubium Local Government Area of Akwa Ibom State, Nigeria. Simple random sampling was used to select 420 homegardens from 14 villages for enumeration. A total of 84 plant species were identified to be of socio-economic importance to the people of Nsit Ubium Local Government Area in the generation of income, food, medicine, fodder for animals, beautification of the environment and erosion control.

Khanal (2011) carried out a study in Lekhnath Municipality and Bharatpokhari VDC of Kaski district of Nepal, with the aim of assessing the present status and trends of farm tree biodiversity, analyzing the contribution of agroforestry systems viz; homegarden (agrohortisiviculture) systems, live fences around farmlands, agrisilvicultural system, agroforestry species for green manure, silvo-fishery system, trees in and around the agricultural fields, silvo-pasture system in rural needs fulfillment of forest resources, and determining the potential of MAPs in forest based agro-forestry systems (i.e. silvi-medicinal system). Both primary and secondary data were collected. Agroforestry systems showed the direct relationship of biodiversity conservation and plantation of multipurpose tree species in farmland especially in Bari land with the fulfillment of diverse needs of the farmers to uplift their socioeconomic condition. There were 172 numbers of species with their respective number of 64 families found in the study area. Annual consumption of fruit was high. Medicine consumption is very low quantity than other forest product. Contribution of fodder, fruit, and fuel wood, and medicine trees, local and exotic grass seems satisfactory. 72 medicinal and aromatic species were found for agroforestry (silvomedicinal system) in the study area. "silvo-medicinal" systems should be practiced in hill area of Nepal and need to be commercialized for extra sources of income.

A number of workers have reported the bioeconomic productivity of agrisilviculture system integrating Elm (*Ulmus wallichiana*) with Kharif (Tomato + Potato) and Rabi (Garlic+Peas). The tree component as Elm (*Ulmus wallichiana*) which was head back at 3.00 m and planted at different spacings (1.0 m, 1.5 m and 2.0 m) with crop combinations where tried with the objective of cultivation of degraded hill slopes thereby enhancing productivity. The observations recorded revealed that with the increase in spacing of trees within alley from 1.0 m to 2.0 m the yield of both Kharif and Rabi crops increased. The spacing at 2.0 m resulted in maximum yield of Kharif (Tomato & Potato) (0.0501 & 0.051 t ha^{-1}) and Rabi (Garlic & Peas) (0.0219 & 4.01 t ha^{-1}.) crops and estimated net profit of Rs. 65,127 $ha^{-1}yr^{-1}$. Also, yield of fodder and fuel wood from trees was more in 1.0 m spacing recording a yield of 0.01222 and 0.05242 t ha^{-1} respectively. Cultivated grasses in buffer zone recorded yield of 0.0769 t ha^{-1} while as natural sward recorded a yield of only 0.00339 t ha^{-1} (Anonymous, 2010).

An investigation was undertaken by Tynsong and Tiwari (2010) in War Khasi community of Meghalaya with an objective of evaluating the plant species diversity in homegardens and their contribution towards livelihoods of people. In total, 197 plant species were recorded with an average of 89 plant species per homegarden. The average size of homegarden was 750 m^2 with the annual gross production of Rs. 3514 per homegarden; this contributes about 7 per cent towards average annual gross income per household. Computing in terms of per unit area, the average annual gross income was found to be Rs.73,748 ha^{-1}. The study revealed that 35 per cent of the produce was used for self consumption and 65 per cent was sold in the local markets. The important plant species which contributed to the household income were: *Piper betle* (24%), *Mangifera indica* (19%), *Litchi chinensis* (15%) and *Areca catechu* (11%). They conclude that although homegardens contribute only a small part of total income, they are particularly important because of low labour input for management and locational advantage.

Zaman *et al*. (2010a) conducted a study on composition and structure of homegardens in Thakurgaon, Bangladesh. Diversity of plant species, contribution of homegarden to household food security, conservation of plant species, socio-economic importance and the constraints of the total production system were the main objectives of the experiment. Using a structured questionnaire, formal and informal interviews and field observations collected. Some information was also gathered by group discussion with the farmers and the information was analyzed by using descriptive statistics. The homegarden size in average in the study area increased with the size of total land holding. A total of 37 useful plant species were identified from the homegardens. Diversity and abundance of fruit tree species were found higher in all farm categories followed by timber and fuel wood species. Total income was found higher in large farm category than that of marginal. Mango and jackfruit were identified as an important cash-growing crop in the study area. Tree management practices and the scopes were very common. The farmer faced many problems during tree plantation and the major cause was the animal. Insect was also another common constraint. The homegardens and its management could be improved by proper management practices, more research, co-operative and extension services.

Bijalwan *et al*. (2009) undertook a study to assess the productivity of traditional agrisilviculture system (agricultural crops + trees) in the northern and southern aspects of mid-hill situation in Garhwal Himalaya, Uttarakhand, India during the 2004−2006. A total of 19 tree species were studied in both northern and southern aspects, out of which 17 tree species were selected in northern aspect and 12 tree species in southern aspect for phytosociological characteristic analysis of trees in agrisilvicultural system. The most dominant tree species are *Grewia optiva*, *Celtis australis* and *Melia azedarach* and successively grown under traditional agrisilviculture system. The results show that the annual productivity of all tree species was 3775 kg ha^{-1} $annum^{-1}$ in northern aspect (site-N) and 3101 kg ha^{-1} yr^{-1} in southern aspect (site-S). *G. optiva* had the highest productivity in both site-N and site-S among the tree species, followed by *M. azedarach*, *Quercus leucotrichophora* and *C. australis*. The dominant agricultural crops were *Eleusine coracana* in summer cereals, *Phaseolus vulgaris* in summer pulses-oilseeds and *Triticum aestivum* in the winter season in the area. The average biological productivity of agricultural crops in northern aspect was about 16 per cent higher than that in southern aspect under traditional agrisilviculture system. The sole agricultural crop productivity (without trees) in northern aspect was also higher than that in southern aspect. An obvious difference in annual productivity of trees and agriculture crops was observed between northern aspect and southern aspect. The overall productivity in traditional agrisilviculture system (crop + tree) was 24 per cent (in northern aspect) and 21 per cent (in southern aspect) higher than that in sole cropping system.

Jeeva (2009) conducted a study on horticultural potential and importance of wild edible fruits in the Khasi tribes of Meghalaya. During the research study 151 species belonging to 49 families were encountered, which include folk name, habit and the season of availability. Among them 100 were trees, 34 shrubs, 12 climbers and 5 herbs. Some edible plants have great economic value and are highly linked with socio-economic development of tribal communities of the state. The importance of documenting the use of wild edible species in this hotspot region is especially important because of rapid loss of biodiversity due to anthropogenic disturbance.

A research study was conducted to analyze the contribution of homegardens to the livelihoods of rural people in Nhema communal area, Zimbabwe by Maroyi (2009). Variables analyzed were plant use and diversity, homegarden input, benefit, and income generation. Data were collected through plant inventories, direct observations, semi-structured and open-ended questionnaires, and interviews. A total of 69 plant species were identified as being important to local livelihoods, either for domestic use or for trading in the local market. Tubers, vegetables, and fruit trees were the most important plant use categories. Food production was found to be the primary function of homegardens, almost all of them being subsistence production systems. Homegardens were an important occupation for rural people, with an average labour investment of 48 h per family per month. Although homegarden production provides a small source of income, it is particularly important for poor households to overcome adversity and meet basic needs. The results of this study demonstrate that properly managed homegardens can improve people's livelihoods and quality of life, reduce poverty, and foster economic growth into the future on a sustainable basis. Some homegardens have extensive collections of plant biodiversity, hence revealing the potential of homegardens in conserving useful plants.

2.3 Fuelwood and nutritional evaluation of tree species

Fuelwood and fodder are the major tangible benefits to the farmers through agroforestry systems. Their ranking in terms of quantitative values is equally important to evaluate/assess the potential trees for fuelwood and fodder needs of the farmers.

2.3.1 Fuelwood value determination

Fuelwood is the largest energy source for the three-quarters of the world's population who live in developing countries (Scurlock and Hall, 1990). Indeed, the demand for fuelwood is likely to continue as the most important energy source for rural areas of many countries (Deka *et al*., 2007). The contribution of fuelwood to the total energy consumed varies from place to place and is mainly determined by the level of development and availability (Kumar *et al*., 2011).

A number of workers evaluated the Fuelwood value index of thirteen plant species viz., *Ailanthus altissima*, *Albizia julibrissin*, *Amorpha fruticosa*, *Fraxinus floribunda*, *Melia azedarach*, *Morus alba*, *Parrotia jacquemontiana*, *Populus nigra*, *Prunus armeniaca*, *Quercus ruber*, *Robinia pseudoacacia*, *Salix alba* and *Ulmus wallichiana*. Based on the results obtained, fuelwood potential among species was in order of *Parrotia jacquemontiana* (2598.75) > *Prunus armeniaca* (1771.91) > *Robinia pseudoacacia* (1159.62) > *Albizia julibrissin* (926.24) > *Amorpha fruticosa* (902.89) > *Ulmus wallichiana* (891.08) > *Quercus ruber* (883.90) > *Fraxinus floribunda* (792.56) > *Ailanthus altissima* (792.56) > *Morus alba* (763.48) > *Melia azedarach* (755.00) > *Populus nigra* (523.75) > *Salix alba* (507.60) (Anonymous, 2010).

Bhatt *et al*. (2010) undertook a quantitative analysis of 19 indigenous fuelwood species of Eastern Himalaya, India was carried out to identify trees with potential for firewood production. A fuelwood value index was the criteria for screening of the species and defined as the calorific value x density/ash content. Over-all rank sum index of the major firewood species was also assessed on the basis of firewood characteristics, fuelwood production, and availability in the region. The results showed that *Castanopsis indica*, *Phoebe attenuata*, *Macropanax undulatum*, *Ixonanthes khasiana*, *Morus laevigata*, *Caryota urens*, *Lithocarpus elegans*, and *Litsea laeta* are the most preferred firewood species.

An evaluation study was carried out by Mishra *et al*. (2010) of some indigenous tree species of mountainous region of Gharwal Himalayas to examine the calorific value of 14 different broad leaved species. Among the evaluated species, *Toona ciliate* with calorific value 22.01 KJ/g showed the best result as the most promising firewood species followed by *Ficus roxburghii* having calorific value of 21.87 KJ/g and the least performance in terms of firewood properties showed by *Alnus nepalensis* 15.09 KJ/g.

Chettri and Sharma (2009) evaluated 16 woody trees species (*Rhododendron arboreum*, *Rhododendron falconeri*, *Rhododendron barbatum*, *Quercus lamellosa*, *Quercus lineate*, *Schima wallichii*, *Prunus cerasoides*, *Prunus nepalensis, Castanopsis hystrix, Beilschmiedia sikkimensis, Acer oblongum, Betula alnoides*, *Eurya acuminate*, *Symplocos ramosissima*, *Alnus nepalensis* and *Litsaea elongate*) the most widely used species in the area, were selected for study. The tree species were evaluated for their fuelwood properties (calorific value, wood density, moisture and ash content) based on the Firewood Value Index (FVI). Most of the highly preferred species were found to have high values for firewood and a significant correlation was found between the community scores and the FVI. The study illustrates the applicability of local knowledge in relation to the chemical properties of species used for firewood.

Wood attributes (calorific value, wood density, moisture and ash content) of 66 woody (12 subtropical and 54 temperate) species from temperate and sub-tropical natural forest of Mamlay Watershed, Sikkim, India, were examined by Rai *et al*. (2002) for estimating fuelwood value index (FVI). The rankings as fuel wood by the local community and by their wood attributes of a sub-set were compared. Among the species highly valued by the local people, *Castanopsis tribuloides, Quercus lineata* and *Quercus lamellose* showed high FVI values; *Eurya acuminata*, and *Cinnamomum impressinervium* with moderate preference scores also had lower FVI values. *Andromeda elliptica* and *Engelhardtia* sp. were ranked lower by local people than was expected on the basis of their FVI. Both the FVI value and community preference should be used in assessing species value for afforestation and management.

Bhatt and Todaria (1992a) undertook a quantitative analysis of 32 indigenous mountain fuelwood species in Gharwal Himalaya and proved that all the temperate species are best for firewood as they have high calorific values, low ash and moisture contents, high wood density and biomass to ash ratio. Out of 32 species *Ilex dipyreana, Viburnum grandiflorum, Viburnum cotinifolium, Betula utilis, Rhododendron campanulatum* among angiosperms and *Juniperus wallichiana* among gymnosperms showed best results as most promising firewood species.

2.3.2 Fodder/nutritional value of tree species

Nutrition is the most important consideration in ruminant production system. Ruminant depends solely on plants for their nutritional requirements in general and energy in particular (Fasae *et al*., 2010). Trees and shrubs are important feed components of ruminant diet (Babayemi and Bamikole, 2006). Many of the preferred and higher quality species in terms of its nutritional values are under pressure, leading to changes in species compositions and forest succession patterns (Chettri *et al*., 2002). In addition, ever-increasing human and livestock populations are exerting additional pressure on forest resources and livelihoods as a result of resource shortages (Chettri and Sharma, 2006). Fodder or browse production from trees and shrubs is one of the benefits of agroforestry (Hafty and Kebede, 2014). It is therefore necessary to have knowledge of the quality of species that are, or could potentially be used for fodder as a basis for promoting planting and management of such species.

Gunasekaran *et al*. (2014) conducted an evaluation study on preference among tree fodders in four Madras red breed of sheep and four Kanni breed of goats fed with four locally available tree species viz. *Albizia lebbek, Gliricidia sepium, Leucaena leucocephala* and *Inga dulce* through intake studies for a period of 35 days. The nutrient composition of the tree leaves was analysed. *Leucaena leucocephala* was mostly preferred by sheep and goats having highest crude protein content of 18.83 per cent and the consumption of tree leaves was 24.41±0.67 and 33.90±3.27g DM/kg metabolic body weight per day respectively. In both sheep and goat, palatability of *Leuceana leucocephala* and *Inga dulce* were ranked first and second respectively. *Gliricidia sepium* was ranked third in goats followed by *Albizzia lebbeck*. From the study it was concluded that leaves of *Leuceana leucocephala* could serve as a better tree fodder for small ruminants.

An investigation was conducted by Hafty and Kebede (2014) to evaluate the adaptation and nutritional composition of four fodder species viz; *Sesbania sesban, Cajanus cajan, Moringa oleifera and Morus alba* in Eastern Ethiopia. Chemical composition of the treatment species had on average 89.63 per cent dry matter, 21.7 per cent crude protein, 66.56 per cent digestible dry matter, 52.95 per cent neutral detergent fiber, 28.66 per cent acid detergent fiber, 11.57 per cent acid detergent lignin, 4.17 per cent ether extract, 7.49 per cent Ash content . From the evaluated species *Sesbania sesban* and *Morus alba* showed promising browse species for mid and highlands of eastern Ethiopia.

Khan *et al*. (2014) conducted a research study on nutritional evaluation of different fodder tree leaves, shrubs and brows plants of district Dir, Khyber Pakhtunkhwa, Pakistan. Top 13 tree leaves, shrubs and brows plants, i.e *Eleusine coracana, Cyperus rotundus, Sorghum halepense, Tike mimosa, Populus euphratica, Morus nigra, Sorghum bicolor, Oryza sativa, Prunus persica, Cynodon dactylon, Cotton seed cake, Ficus carica and Wheat straw* were identified and analyzed for proximate analysis, i.e; DM (Dry Matter), CP (Crude Protein) and Ash. The DM, CP and Ash contents of the foliages varied from 88.45-96.26, 6.90- 26.68 and 4.64-21.90% respectively.

An evaluation trial was conducted by Belachew *et al*. (2013) in Ethiopia for determining the chemical composition, *in sacco* ruminal dry matter and organic matter degradability of leaves and fruits of tropical condensed tannin rich multipurpose tree species (MPTS). The MPTS studied were *Ekebergia capenesis, Ficus sycomorus, Maesa lanceolata,* and *Rhus glutinosa*. Chemical composition of dry matter (DM), crude protein (CP), crude ash (CA), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), non-fibre carbohydrates (NFC), and condensed tannin (CT) was determined. *In sacco* rumen degradability was measured using three rumen fistulated Holstein Friesian- Boran cross steers at 0, 6, 12, 24, 48, 72, and 96 h. The DM and organic matter (OM) degradability data were fitted to the equation $Y = a + b\ (1 - e\text{-}ct)$. The values for each chemical constituent ranged 5.43 11.49% (CA), 7.97-17.06% (CP), 1.57-31% (EE), 12.20-27.5% (CF), 5.84-39.30% (NFC), and 7.2-16.72% (CT). *Ekebergia capensis* leaves had the greatest values for slowly degradable fraction (*b*), effective degradability (*ED*), and rate of degradation (*c*) in DM ($P < 0.001$) whereas *E. capensis* fruit had significantly the greatest soluble fraction (*a*), potential degradability (*b*), and effective degradability (*ED*) values as compared to the *a*, *PD*, and *ED* values in the fruits of other plants($P < 0.001$). Yet in OM degradation kinetics, the greatest and least values of potential degradability (PD) were recorded for *F. sycomorus* (89.89%) and *E. capensis* (55.90%) leaves ($P < 0.001$). Similar to the rapidly soluble fraction *a*, *ED* was found to be the greatest in fruits as compared to leaves of the plants ($P < 0.001$). Generally variation of plant parts led to significant differences in chemical composition, DM, and OM degradability and the degradable parameters. The leaves and fruits recorded more than 60% DM and OM degradability at 24 h, which implied that they were all greatly degradable in the rumen.

Shah (2013) undertook an investigation on distribution, nursery raising, uses of Honey locust (Gleditsia spp.) viz; *Gleditsia triacanthos* and *Gleditsia triacanthos* var. *inermis* in Kashmir and also evaluated their leaves and pods for different nutritional values. Results of the analysis revealed crude protein (24.16 and 26.82%), crude fibre (16.01 and 13.92%) and total ash content (7.35 and 7.94%) respectively.

A study on nutritional value of locally preferred fodder trees in the farmland of middle hills of Nepal was conducted by Dhungana *et al*. (2012) in Hemja VDC of Kaski district. Primary information on distribution and frequency of fodder trees was obtained through key informants survey, group discussion and observation of the study area. The preference ranking of ten most abundant fodder trees was done on the basis of palatability, propagation easiness, growth rate and competition with agricultural crops. The nutritional value of fodder species was analyzed and compared with the farmers' preference ranking to examine association among them. The analysis correspond farmers' preference of fodder tree species to their nutritional values. The results revealed that *Ficus subinisa* was the dominant fodder tree however, the *Artocarpus lakoocha* was highly preferred trees for its palatability and nourishing values. Nutritional analysis of ten preferred fodder species with respect to moisture, ash, crude protein, crude fat, crude fiber and carbohydrate was carried out. The crude protein varied from 15-29%, in which, *A. lakoocha* to contain the highest amount of crude protein. Similarly, *F. lacor* contained highest crude fiber (42.07%), and *Machilus odoratissima* yielded highest amount of carbohydrate (21.92%).

Shenkute *et al*. (2012) conducted a study to identify potential browse species in the mid Rift Valley of Ethiopia and to assess their nutritive value. A total of 120 household from four districts in the mid Rift Valley of Ethiopia were interviewed to identify locally important browse species. Herbarium samples were collected for identification and/or confirmation of the scientific names. Samples were also taken for chemical composition analysis. A total of 18 different browse species were identified, which are regarded as being important for different classes of livestock. The crude protein value of the edible component ranged between 8.95-20.9%, the Neutral Detergent Fiber values ranged from 30.41-78.55%, the Acid Detergent Fiber values ranged from 19.42-47.5% and the Acid Detergent Lignin values ranged from 7.16 to 24.68%. Generally the differences in chemical composition between different browse species were significant. These results indicate that there is a number of promising browse species in the indigenous flora.

An investigation was conducted on *Quercus semecarpifolia* J.E. Smith leaves for evaluation of chemical composition between four seasons i.e before growing season, after growing season, on growing season, on late maturity, respectively, in 2008-2009 from five geological isolated sites ranging from 2450 to 2725 m a.s.l by Singh and Todaria (2012). Seasonal variability ($p < 0.01$) was found in the chemical composition of the *Q. semecarpifolia* foliage. Dry matter and Ash Content significantly decreased in July (after growing season) as compared to the other months. Crude protein (CP) and phosphorus (P) contents significantly increased before growing season (January) and after growing season (July), finally declined in late maturation in October. Calcium contents and soluble protein (SP) significantly decreased before growing season (January) to late maturity (October), Ether extract (EE) decreased before growing season (January), after growing season (July) but increased in late maturity (October). The nutritive value of the leaves of *Q. semecarpifolia* was continually changing, especially CP and soluble protein. *Q. semecarpifolia* harvested at the proper stage of maturity (winter months) offers considerable potential as high quality forage for livestock to fulfill the deficiency of protein.

Nutritional evaluation of different fodder tree leaves and shrubs of district Chakwal, Pakistan was carried out during two different seasons by Azim *et al*. (2011). Top 15 tree leaves and shrubs, i.e *Acacia nilotica, Acacia modesta, Albizzia lebbeck, Capparis decidua, Elaeagnus angustifolia, Grewia optiva, Grewia populifolia, Melia azedarach, Gymnosporia royleana, Indigofera gerardiana, Morus alba, Prosopis cineraria, Panicum antidotale, Ziziphus mauritiana* and *Zizyphus mummularia* were identified and analyzed for proximate analysis, i.e; DM (Dry Matter), CP (Crude Protein), CF (Crude Fiber), Ash, EE (Ether Extract) and gross energy. The gross energy of the foliages is almost lies between 16.09 to 17.96 Mcal/kg. The DM, CP, CF, ash EE contents of the foliages varied from 66.17-40.38%, 11.12-19.05%, 13.91-30.50%, 7.19-13.91%, 1.44-6.45% of DM, respectively.

A study was carried out by Parlak *et al*. (2011) in a shrubland in the South Marmara, Turkey on forage quality of two deciduous woody species [Gall oak (*Quercus infectoria* Oliv.) and Christ's thorn (*Paliurus spina-cristi* Mill.)] and herbaceous species to assess their quality and capacity to meet goats needs. Dry matter (DM), ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), dry matter digestibility (DMD), metabolic energy (ME), Phosphorus (P) and Calcium (Ca) were determined in the shrubs and herbaceous. Results showed that DM and Ca in the gall oak were distinctly low in April. On the other hand, its CP and P were high in April while DMD and ME were high in May and June. Contents of DM, ash and Ca in the Christ's thorn showed a decrease in April-May and those of CP, DMD, and ME increased in May. Herbaceous had their lowest DM, NDF, and ADF in April and highest CP, DMD, and ME in March-April. Consequently, when goats' needs were considered, goats should be fed with supplementary energy feed throughout the year except for spring months, and with CP during autumn months in order to obtain satisfactory productivity.

Ammar *et al*. (2010) conducted an experiment in Spain to determine drought induced nitrogen retranslocation in some Mediterranean shrub leaves as suggested from studies of annual changes in plant nitrogen content. In this regard, crude protein (CP) content and cell wall components in terms of neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assessed in five Spanish shrub leaves viz; *Quercus pyrenaica, Cytisus scoparius, Genista florida, Genista scropius* and *Rosa canina* harvested during wet (spring) and dry (summer) seasons of 1996 and 1998. Shoot N concentration decreased (P <0.0001) in all species during drought occurred either in 1996 (15-42%) or in 1998 (21-53%). The lowest and the highest values (P <0.0001) were recorded in *G. florida* and *Q. pyrenaica*, respectively. Cell wall components followed an opposite trend. Leaves from *C. scoparius* revealed the largest increase (P <0.0001) of NDF (64%) and ADF (47%) in 1996 and ADL (216%) in 1998. No consistent pattern with respect to drought tolerance was apparent in these chemical composition changes among shrubs. *G. florida* and *G. scorpius* (leguminous) seem to be more tolerant and the magnitude of either CP decrease or cell wall content increase was lower as compared to the remaining species. It was suggested that decreases in leaf nitrogen (N) status during drought is a consequence of re-translocation likely result in lower photosynthetic capacity and decreased whole plant carbon gain following relief of water stress after rain.

Ganai *et al*. (2009) evaluated Kiker (*Robinia pseudoacacia*) composition on dry matter basis in the Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir in order to utilize this available material as an alternative feed during critical periods. Results concluded that the leaves contained crude protein (CP) 19.23, ether extract (EE) 4.93, crude fiber (CF) 13.46 and total Ash (TA) 9.67. Leaves were fed to five Corriedale rams (1618 M age and 25.4±0.3kg BW). DM intake was 3.90±0.13% of body weight and 84.04±4.21g/kg $W^{0.75}$. The digestibility coefficients of CP, EE, CF were, 80.16±2.44, 35.44±4.12, and 55.28±3.56, respectively. It was evaluated that leaves contained 15.43±0.29% digestible crude protein (DCP) and 66.69±0.43% total digestible nutrients (TDN). All the animals were in positive nitrogen. Blood parameters were within normal physiological range. It was concluded that Kiker (*Robinia pseudoacacia*) leaves were palatable and could be fed to sheep without any loss in body weight and health status.

An experiment was conducted by Sultan *et al*. (2008) to figure out the nutritive value of fodder tree leaves of Chagharzai valley in Bunair district, North Western Frontier Province (NWFP), Pakistan. Leaves of 12 fodder trees (*Grewia oppsitifolia*, *Morus alba*, *Betula utilis*, *Celtis australis*, *Diospyros lotus*, *Aesculus indica*, *Celtis caucasica*, *Robinia pseudoacacia*, *Olea ferruginea*, *Melia azedarach*, *Ailanthus chinensis* and *Quercus incana*) were selected and analyzed for dry matter (DM), organic matter (OM), ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose and lignin contents. The mean percentage values for DM, OM, ash, CP, NDF, ADF, hemicellulose and lignin were 27.65±1.64, 26.87±1.37, 5.72±0.43, 14.29±1.00, 55.50±1.82, 28.83±1.63, 26.67±1.09 and 6.02±0.54, respectively. In fodder tree leaves the highest potential intake rate (PIR) was observed for *Grewia oppsitifolia* (72.80±16.35 g/4 minute) and the lowest for *Quercus incana* (18.24±2.38 g/4 minute). The relative preference (RP) was the highest for *Betula utilis* (84.25±1.50%) and the lowest for *Quercus incana* (2.08±0.24%). The mean *In vitro* dry matter digestibility (IVDMD) and metabolizable energy (ME) of fodder tree leaves were 54.16±2.06% and 7.24±0.30 MJ/kg DM, respectively.

An evaluation trial on browse potential of black locust (*Robinia pseudoacacia* L.) and thornless honey locust [*Gleditsia triacanthos f. inermis* (L.) Zabel] was undertaken in Arkansas, USA to determine effects of fertilization and pollarding on biomass and foliar nutritive value in separate studies of black locust and thornless honey locust. Shoots were sampled monthly for two consecutive growing seasons in 2002 and 2003 to determine foliar, shoot, and total aboveground biomass, shoot basal diameter, and foliar nutritive value (crude protein and in vitro digestibility). Black locust yielded more foliar biomass when pollarded at 50 or 100 cm and fertilized with 600 kg P ha^{-1}, than at 5 cm with or without P, averaging 3.5 Mg dry matter ha^{-1}. Black locust foliar crude protein and in vitro dry matter digestibility (≤170 and 534 g kg^{-1}, respectively) decreased as leaves aged, but still met maintenance needs for beef cattle (*Bos taurus* L.). Thornless honey locust had little agronomic potential because of slow establishment, low foliar yield (330 kg ha^{-1}), and a 2% reversion to undesirable thorny phenotype. Black locust should be considered for livestock browse when drought induces semi-dormancy of herbaceous forages (Burner *et al*., 2005).

An experiment in Manhattan on the Kansas State University pastures in the Northern Flint Hills was conducted on leaves from bur oak (*Quercus macrocorpo* Mkhx.), red elm (*Ulmus rubra* Muhl.), Osage orange *(Maclura ponifera* (Raf.) Schneid.), and cottonwood *(Populus deltoides* Marsh.) was carried out for analyzing the crude protein, in vitro dry matter digestibility (IVDMD), and tannic acid equivalents (TAE) from mid September through late October during 1979 and 1980. Samples were taken biweekly from the trees and from the ground after leaf fall. Results of the study revaled that crude protein content declined with advancing season in all species. Cottonwood was significantly lower over the season in crude protein than all other species except bur oak. Also, sample date and species significantly affected digestiblity. Digestiblity generally increased during middle sample periods and returned to initial levels in late October. Averages over all dates showed digestibility of Osage orange > cottonwood > red elm > bur oak. Leaves on the tree were generally more highly digestible than those on the ground (Forwood and Owensby, 1985).

Chapter-3

MATERIALS AND METHODS

The research problem entitled "Plant diversity in prevalent agroforestry systems of District Budgam" was conducted in Budgam District of Kashmir Valley during the year 2013 and 2014 (2 year research study). A detailed account of the techniques followed and material used during the research work is described below:

3.1 Site description

3.1.1 Experimental site

The experimental site i.e. District Budgam is located between 34°1′12″N latitude and 74°46′48″E longitude at an altitude of 1610 m above mean sea level (msl), roughly 15 km south east of Srinagar city anciently known to be *Deedmarbag* . The topography of the district is mixed with both mountainous and plain areas.

District Budgam comprises of three Sub-Divisions - Beerwah, Chadoora and Khansahib; Nine Tehsils - Budgam, Beerwah, B.K.Pora, Chadoora, Charisharief, Khag, Khansahib, Magam and Narbal. The district has been divided into seventeen blocks namely Beerwah, Budgam, B.K.Pora, Chadoora, ChrariSharief, Khag, Khansahib, Nagam, Narbal, Pakherpoa, Parnewa, Rathsun, Soibugh, Sukhnag, Surasyar, S.K.Pora and Waterhail which serve as prime units of economic development. Budgam has been further sliced into 283 panchayats comprising 510 revenue villages.

3.1.2 Climate

The climate is of the temperate type with the upper-reaches receiving heavy snowfall during winter. The average annual precipitation of the district is 585 mm (Appendix - I).

3.2 Experimental details

Out of nine tehsils, three tehsils namely: Budgam, Beerwah and Chadoora were selected to carry out the above mentioned research problem. Multistage stratified random sampling was used to select the blocks; villages within tehsils and then farmers within villages. A total of 252 farmers were selected and interviewed through pre-tested questionnaire (Annexure-IV to XXI) regarding different land use patterns (agriculture, agroforestry, horticulture) and their socio-economic status. For fulfillment of assigned research objectives, only 20 per cent of the selected farmers (i.e. of grand total) were considered *viz*; 51 farmers. Each farmer (sample) chosen for further studies were evaluated with respect to prevalent agroforestry systems identified during reconnaissance. The details/methodology of the experimental study is given in Table-1.

Table-1: Details/Methodology for the selection of sample areas

Selected Tehsils	**Beerwah**	**Budgam**	**Chadoora**
Selected Blocks (06)	2	2	2
Selected Villages (06 per Block)	6×2 = 12	6×2 = 12	6×2 = 12
Selected Farmers (7 per Village)	6×2×7 = 84	6×2×7 = 84	6×2×7 = 84
Grand Total	**252**		

3.2.1 Vegetation analysis

For vegetation analysis 20 per cent (51 farmers w.r.t prevalent agroforestry systems) were taken. Random quadrats of 10m × 10 m size for trees and within each of these quadrats, one 5m × 5m quadrat for shrubs and two 1m × 1m quadrats for herbs (cultivated & wild) were laid down and replicated three times for each life form respectively in prevalent agroforestry systems identified (Fig. 1).

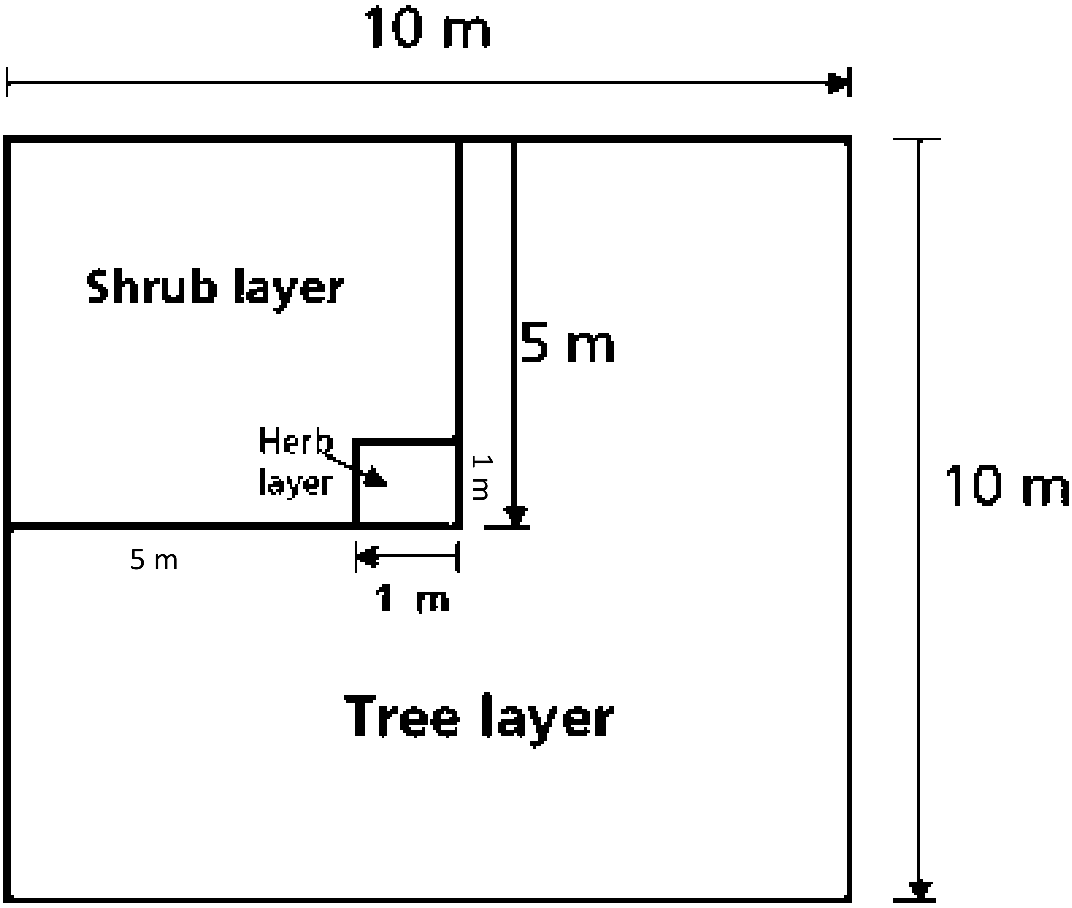

Fig. 1: Layout of vegetation analysis

Herbarium specimens were collected for three consecutive seasons viz; spring, summer and autumn (Saikia *et al*., 2012) and identified from the Division of Environmental Sciences, SKUAST-Kashmir and Centre for Biodiversity & Taxonomy Department of Botany, University of Kashmir. The data on vegetation were quantitatively analysed for density, basal area, frequency, Important Value Index (IVI) separately for three different life forms i.e. trees, shrubs and herb species as per the the methodology of Curtis and Mc Intosh (1950). The relative values of density, frequency and dominance were summed up to get IVI of individual species.

The various vegetational parameters were calculated as :

1) Density

It is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied as:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied}}$$

2) Basal area

For trees, the basal area was calculated as cross sectional area of stem at breast height (1.37 m), while as for seedlings and understorey i.e. shrubs and herbs it was calculated as cross sectional area of stem at 15 cm from the ground level.

$$\text{Basal area} = \pi\, d^2/4$$

Where, d = diameter

3) Frequency (%)

This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence.

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100$$

4) Importance Value Index (IVI)

This index is used to determine the overall importance of each species in the community structure (Curtis and McIntosh, 1950). In calculating this index, the percentage of the relative density, relative dominance and relative frequency were summed up together to get the IVI of each individual enumerated during the study. It is determined as:

IVI = Relative density + Relative dominance + Relative frequency

$$\text{Relative density} = \frac{\text{Density of the individual species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Basal area of the individual species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of the individual species}}{\text{Total frequency of all species}} \times 100$$

Species diversity (H), Species evenness/Equitability following Shannon Weiner's method (1963), Concentration of dominance (Cd) and Simpsons diversity measured from Simpsons index (Simpson, 1949) for different prevalent agroforestry systems were calculated separately for each stratum (trees, shrubs and herbs) from density data as:

5) **Shannon- Weiner Index**: This index is used to measure the amount of information needed to describe every member of the community.

$$H = -\sum (Ni/N) \times \ln (Ni/N)$$

Where, H = Shannon - Weiner Index

Ni = Density of the species i

N = Total density of all the species

6) **Species Evenness/Equitibility**: is calculated as

$$E = H/\ln S$$

Where, H = Shannon - Weiner Index

S = Total number of species

7) **Concentration of Dominance (Simpson, 1949)**: calculated as

$$Cd = \sum (Ni/N)^2$$

Where, Ni and N are same as for Shannon-Weiner information function.

8) **Simpson's Diversity (Simpson, 1949)**

Simpson's diversity index gives the probability that two individuals selected at random will belong to the same species. It is calculated as:

$$D= \sum n (n - 1)/N (N - 1)$$

Where, D = Diversity index;

n = Number of individual of a species;

N = Number of individual of all the species.

9) **Similarity Index (Sorenson, 1948):**

Indices of similarity between two systems were calculated as follows:

$$Is = 2C/A+B \times 100$$

Where, Is = Sorenson's index

A = total number of species in system 1

B = total number of species in system 2

C = number of species common in both systems

3.2.2 Contribution of different agroforestry systems in fulfilment of individual household needs

A total of 252 farmers were selected and interviewed through pretested questionnaire regarding their socioeconomic status through scrupulous reconnaissance. A sample of 42 households was selected from each block. In order to obtain relevant information, various participatory research tools such as group discussion, key informant survey and on-site observations were used to acquire insight into various traditional practices followed by the farmers. The interview schedule comprised of a general introduction concerning their total land holdings, age, family size, education level of respondents, management of various land use systems practising in general and agroforestry in particular, domesticated and wild plants found and the final section of discussion related to various socio-economic status to further evaluate the contribution of identified prevalent/ubiquitous agroforestry systems in fulfilment of individual household needs (Annexure- IV to XXI).

3.2.3 Fuelwood and fodder values of preferred trees species in the study area

To ascertain prioritization of fuelwood and fodder trees two experiments were undertaken:

3.2.3.1 Evaluation of fuelwood species

To evaluate the abundantly available and highly preferred fuelwood species by farmers, ten randomly selected branch cuttings (2-3 cm diameter) of both broad leaved and fruit tree species viz., *Populus deltoides*, *Populus nigra, Robinia pseudoacacia*, *Salix alba*, *Salix fragilis and Malus domestica, Prunus dulcis, Prunus domestica, Pyrus communis* respectively were collected from prevalent agroforestry systems identified from the research site during autumn season of the year 2013 and 2014. These were divided into four replicates of 10 cm length (Bhatt and Todaria, 1992a; Bhatt *et al.*, 2010) and put immediately in polyethylene bag and sealed to avoid moisture loss. Wood samples of all the tree species, thus collected and transferred to the laboratory for determination of their various properties as follows:

a) **Wood moisture content (%)**: was determined after drying the wood sample at 100 ± 5 ^{o}C in oven for 24 hrs - 48 hrs (Bhatt and Badoni, 1990).

b) **Wood density (g/cc)**: wood density was determined by water displacement technique (Purohit and Nautiyal, 1987). Wood samples were ground in a mechanical grinder and pelleted to determine their calorific values.

c) **Calorific value (KJ/g)**: To estimate the energy of wood samples, pellets of known weight (1 g) of plant material were burned in an oxygen bomb calorimeter (Bhatt and Bhadoni, 1990).

d) **Ash content (%)**: For the estimation of ash, 2 g of ground sample was burned in a muffle furnace at 600 ^{o}C for 3 hrs following the method given by Purohit and Nautiyal (1987) and Bhatt and Todaria (1992 a).

e) **Fuelwood Value Index (FVI)**

$$\frac{\text{Calorific value} \times \text{wood density}}{\text{Ash content}}$$

(Bhatt and Todaria, 1992a)

3.2.3.2 Evaluation of fodder species

Fodder value of leaves of trees integrated in identified agroforestry systems were determined for following parameters on seasonal basis i.e. sample collection was done during spring, summer and autumn season. Samples were dried to constant weights in oven at 60°C before subsequent nutrient analysis mentioned below:

a) **Crude protein (%):** Leaf Nitrogen (%) was determined by Microkjeldahl method and multiplied by a factor of 6.25 (AOAC, 1999).

b) **Crude fibre (%):** By acid alkali digestion as described by AOAC (1999).

c) **Ether extract (%):** Extraction in Soxhlet's apparatus by method described by AOAC (1999).

d) **Total ash (%):** Through muffle furnace as per procedure given by AOAC (1999).

3.3 Statistical analysis

The data collected was subjected to statistical analysis using standard procedures followed by Gomez and Gomez (1984).

Chapter - 4

EXPERIMENTAL FINDINGS

The results emerged and obtained from the present investigation entitled "Plant diversity in prevalent agroforestry systems of District Budgam" are presented in this chapter. The results have been obtained from the experiments conducted to achieve the objectives of the investigation. The objectives were:

i) To assess the status of plant diversity in prevalent agroforestry systems of District Budgam.

ii) To analyze and evaluate the contribution of agroforestry in fulfillment of individual household needs in District Budgam.

iii) To determine the fuelwood and fodder values of preferred tree species in District Budgam.

Analysis of variance is given in Appendix - XXII to XXXIX

4.1 Prevalent agroforestry systems in District Budgam

As per the research methodology, the first phase of the research includes the collection of information regarding active landuse patterns/practices, socio-economic status and prevalent agroforestry systems in the said district based on the pre-prepared questionnaire (Annexure-IV to XXI). The second phase of the research was to further evaluate the plant diversity status taking identified prevalent agroforestry systems into account and their contribution for accomplishment of the socio-economic needs of the farmers. From the present investigation, it was appraised that four agroforestry systems are prevalent in the District Budgam being carried out by about 184 (73.01%) farmers out of total sample size of 252 which are presented in Table 2: Plate 1.

Table 2: Prevalent agroforestry systems in the study area (District Budgam)

Agroforestry systems	No. of farmers adopting (%)*	Area in hectares (Kanals)*	Area (%)
Boundary plantation	52.00 (28.26)*	6.90 (138.05)*	23.07
Homegarden	32.00 (17.40)*	5.47 (109.40)*	18.29
Horti-agricultural system	70.00 (38.04)*	11.78 (235.65)*	39.39
Horti-silvi-pasture system	30.00 (16.30)*	5.75 (115.00)*	19.23
Total	**184**	**29.90 (598.10)***	**-**

4.2 Plant/Floristic diversity in prevalent agroforestry systems of District Budgam

Plant diversity and/or floristic composition of four prevalent agroforestry systems revealed the presence of trees, shrubs and herbage layer (both cultivated and wild). Among broad leaved and fruit tree species, a total of 4 genera, 6 species of 3 families and 6 genera, 8 species of 3 families were encountered respectively. While 2 genera having 3 species belonging to 2 families were of shrub layer. Herbage represented 70 genera belonging to 75 plant species and 37 families in the study area (Table-3 & 4; Plate-2, 3 & 4).

Table-3: Plant distribution among plant categories, family, genera and species

S. No.	Plant categories	Genera	Family	Species
1.	Trees			
	i) Broad leaved	4	3	6
	ii) Fruit	6	3	8
2.	Shrubs	2	2	3
3.	Herbage			
	i) Wild	54	29	54
	ii) Cultivated	16	8	21
Total		**82**	**45**	**92**

Boundary Plantation

Homegarden

Horti-agricultural system

Horti-silvi-pasture system

Plate 1: Prevalent agroforestry systems of District Budgam

Table-4: Diversity (trees, shrubs and herbage) recorded in prevalent agroforestry systems in the study area (District Budgam)

S. No.	Plant Names & Family	Global IUCN Status	English/Common Name	Life form	Agroforestry Systems			
					Boundary Plantation	Homegarden	Horti-agricultural system	Horti-silvi-pasture system
Broad leaved trees								
1.	*Populus deltoides* (Salicaceae)	Not Evaluated	Eastern cottonwood/Fras	T	+	+	-	+
2.	*Populus nigra* (Salicaceae)	Least Concern	Black poplar/Kashur fras	T	+	+	-	+
3.	*Robinia pseudoacacia* (Leguminoceae)	Least Concern	Black locust/Kikar	T	-	-	-	+
4.	*Salix alba* (Salicaceae)	Least Concern	White willow/Boti veer	T	+	+	-	+
5.	*Salix fragils* (Salicaceae)	Not Evaluated	Crack willow/Veer	T	+	+	-	-
6.	*Ulmus wallichiana* (Ulmaceae)	Vulnerable	Elm/Bren	T	-	+	-	-
Total					**4**	**5**	**0**	**4**
Fruit trees								
1.	*Cydonia oblonga* (Rosaceae)	Not Evaluated	Quince/Bam-e-Tchoonth	T	-	+	-	-
2.	*Juglans regia* (Juglandaceae)	Threatened	Walnut/Doon	T	-	+	-	-
3.	*Malus domestica* (Rosaceae)	Not Evaluated	Apple/Tchoonth	T	-	+	+	+
4.	*Prunus domestica* (Rosaceae)	Not Evaluated	Plum/Aaer	T	-	-	+	+

5.	*Prunus dulcis* (Rosaceae)	Not Evaluated	Almond/Badam	T	-	+	-	-
6.	*Prunus persica* (Rosaceae)	Not Evaluated	Peach/Czenun	T	-	+	-	-
7.	*Punica granatum* (Punicaceae)	Least Concern	Pomegranate/Daen	T	-	+	-	-
8.	*Pyrus communis* (Rosaceae)	Not Evaluated	Pear/Tang	T	-	-	+	+
	Total				**0**	**6**	**3**	**3**
Shrubs								
1.	*Rubus niveus* (Rosaceae)	Not Evaluated	Mysore raspberry/Snowpeaks raspberry/Chanch	S	+	-	-	+
2.	*Rubus ulmifolius* (Rosaceae)	Not Evaluated	Elm-leaf blackberry/Chanch	S	-	-	+	+
3.	*Asparagus officinalis* (Lilliaceae)	Not Evaluated	Garden asparagus/Parglass	S	-	-	-	+
	Total				**1**	**0**	**1**	**3**
Wild herbage								
1.	*Amaranthus caudatus* (Amaranthaceae)	Not Evaluated	Tassel flower/Lissi	H	+	+	-	+
2.	*Anagallis arvensis* (Primulaceae)	Not evaluated	Shepherd's weather glass/Chari saben	H	-	-	+	+
3.	*Anthemis cotula* (Asteraceae)	Not Evaluated	Mayweed/Stinking chamomile/Fakhigaasi	H	+	-	+	+

4.	*Artemisia absinthium* (Asteraceae)	Not Evaluated	Worm wood/Tethwan	H	+	-	+	-
5.	*Asparagus officinalis* (Liliaceae)	Not Evaluated	Garden officinalis/Parglass	H	-	-	-	+
6.	*Avena fatua* (Poaceae)	Not Evaluated	Wild oat/Jiagassi	H	-	+	-	-
7.	*Cannabis sativa* (Cannabaceae)	Not Evaluated	Hemp/Bhang	H	+	-	-	+
8.	*Capsellabursa-pastoris* (Brassicaceae)	Not Evaluated	Shepherd's purse/Kralmond	H	+	+	-	-
9.	*Chenopodium album* (Chenopodiaceae)	Not Evaluated	Leafy goosefoot/Dodich	H	-	-	+	+
10.	*Clinopodium vulgare* (Lamiaceae)	Not Evaluated	Wild basil	H	+	-	-	+
11.	*Convolvulus arvensis* (Convolvulaceae)	Not Evaluated	Bindweed/Hiran pug or Soi -posh	H	-	-	+	+
12.	*Conyza Canadensis* (Asteraceae)	Not Evaluated	Canadian horseweed/Gur loute	H	+	+	+	+
13	*Cynodon dactylon* (Poaceae)	Not Evaluated	Durva grass/Dramun	H	+	-	-	+
14.	*Daucus carota* (Apiaceae)	Vulnerable	Wild carrot/Bird's nest/Jangli -gazir	H	-	+	+	-
15.	*Equisetum arvense* (Equisetaceae)	Not Evaluated	Field horsetail/Gandum-gund	H	+	-	-	-
16.	*Euphorbia helioscopia* (Euphorbiaceae)	Not Evaluated	Mad woman's milk/Gur-duode	H	+	-	-	-

17.	*Galinsoga parviflora* (Asteraceae)	Not Evaluated	Gallant soldier	H	+	+	+	+
18.	*Galium aparine* (Rubiaceae)	Not Evaluated	Goose grass/Zoa ghasi	H	+	+	-	-
19.	*Geranium polyanthes* (Geranaceae)	Not Evaluated	Cranes bills	H	+	-	-	+
20.	*Hypericum perforatum* (Hypersiaceae)	Not Evaluated	St Jhon’s wort/Amber	H	-	-	+	-
21.	*Impatiens glandulifera* (Balsaminaceae)	Not Evaluated	Policeman's helmet/Ornamental jewelweed	H	+	-	-	-
22.	*Kochia scoparia* (Chenopodiaceae)	Not Evaluated	Burning bush/Lachiji – kul	H	-	+	-	-
23.	*Lithospermemium arvense* (Boraguaceae)	Not Evaluated	Corn/Common gromwell	H	+	-	-	-
24.	*Malva neglecta* (Malvaceae)	Not Evaluated	Purple mallow/Sochal	H	-	+	-	-
25.	*Medicago polymorpha* (Fabaceae)	Not Evaluated	Toothed bur clover/Poshi- gassi	H	-	-	+	+
26.	*Medicago sativa* (Fabaceae)	Vulnerable	Alfa alfa/Poshi- gassi	H	+	-	-	-
27.	*Mentha arvensis* (Lamiaceae)	Not Evaluated	Mint/Pudhni	H	-	+	-	+
28.	*Nepeta cataria* (Lamiaceae)	Not Evaluated	Cat mint/Byari- gassi or Gand soi	H	+	-	-	-
29.	*Oenothera rosea* (Onagraceae)	Not Evaluated	Evening primrose	H	+	+	-	+

30.	*Phragmites australis* (Poaceae)	Stable	Common reed/Narkon	H	-	-	+	-
31.	*Plantago lanceolata* (Plantagionaceae)	Vulnerable	Ribwort Plantain/Narrowleaf plantain/Lakut - gulli	H	+	-	+	+
32.	*Plantago major* (Plantaginaceae)	Not Evaluated	Broadleaf plantain/Greater plantain/Veuth - gulli	H	+	+	-	+
33.	*Poa aungustifolia* (Poaceae)	Least Concern (Stable)	Meadow grass/Gur gassi	H	-	+	-	-
34.	*Poa bulbosa* (Poaceae)	Least Concern (Increasing)	Bulbous meadow-grass/Gassi	H	-	+	+	-
35.	*Poa pretense* (Poaceae)	Least Concern	Smooth meadow grass/Gassi	H	-	-	-	+
36.	*Polygonum hydropiper* (Polygoniaceae)	Least Concern (Stable)	Water-pepper/Marchagan gaasi	H	+	-	-	+
37.	*Portulaca oleracea* (Portulaceae)	Least Concern	Pursley/Nuner	H	-	+	-	-
38.	*Potentilla reptans* (Rosaceae)	Least Concern	Creeping tormentil	H	+	-	+	+
39.	*Prunella vulgaris* (Lamiaceae)	Not Evaluated	Self - heal/Kalevueth	H	+	-	-	+
40.	*Ranunculus muricatus* (Ranunculaceae)	Not Evaluated	Spinyfruit butter cup	H	-	+	-	-

41.	*Rorripa islandica* (Brassicaceae)	Not Evaluated	Yellow Watercress	H	+	-	-	-
42.	*Rumex dentatus* (Polygonaceae)	Least Concern	Toothed dock/Obuj	H	+	-	+	+
43.	*Rumex nepalensis* (Polygonaceae)	Least Concern	Fringed rue/Jangli obuj	H	-	+	-	-
44.	*Scandix pectenveneris* (Apiaceae)	Least Concern	Shepherd's needle	H	+	-	+	+
45.	*Setaria viridis* (Poaceae)	Least Concern	Foxtail or Green bristle grass/Gassi	H	+	-	-	+
46.	*Stellaria media* (Caryphyllaceae)	Least Concern	Chickweed/Losdhi	H	-	+	+	+
47.	*Sonchus oleraceus* (Asteraceae)	Not Evaluated	Sow thistle	H	+	-	-	+
48.	*Sysiumbrium irio* (Brassicaceae)	Least Concern	London rocket/Khub-kalan	H	+	-	-	+
49.	*Taraxacum officinale* (Compositae)	Vulnerable	Dandelion/Madan hande	H	-	+	+	+
50.	*Thymus linearis* (Lamiaceae)	Least Concern	Himalayan thyme/Javind	H	-	-	+	-
51.	*Tragopogan kashmirianus* (Asteraceae)	Data Deficient	Kashmir goatsbeard/Kashmir salsify	H	+	-	-	-
52.	*Trifolium pratense* (Fabaceae)	Least Concern (Stable)	Red clover/Batakh-nuer	H	+	-	-	+

53.	*Veronica persica* (Plantaginaceae)	Not Evaluated	Bird's-eye/Common field-speedwell	H	-	+	+	+
54.	*Viola oderata* (Violaceae)	Not Evaluated	Sweet violet/English violet/Banafsha or Nun posh	H	-	+	-	+
Total					**31**	**21**	**21**	**32**
Cultivated herbage								
Vegetables								
1.	*Allium sativum* (Alliaceae)	N.A	Garlic/Rohan	H	-	+	-	-
2.	*Brassica campestris* (Brassicaceae)	N.A	Mustard/Tiligogul	H	+	-	-	-
3.	*Brassica oleracea var. gongylodes* (Brassicaceae)	N.A	Knol-Khol/Munde	H	-	+	-	-
4.	*Brassica oleracea var. acephala* (Brassicaceae)	N.A	Kale/Hakh	H	-	+	+	-
5.	*Brassica rapa* (Brassicaceae)	N.A	Turnip/Gogij	H	-	+	+	-
6.	*Capsicum annum* (Solanaceae)	N.A	Chilli/Marchwagan	H	-	+	-	-
7.	*Cucumis sativus* (Cucurbitaceae)	N.A	Cucumber/Laer	Cl(H)	-	+	-	-
8.	*Daucus carota subsp. sativus* (Apiaceae)	N.A	Carrot/Gazir	H	-	+	-	-
9.	*Lagenaria vulgaris* (Cucurbitaceae)	N.A	Bottle gourd/Aaliae	Cl(H)	-	+	-	-
10.	*Raphanus sativus* (Brassicaeae)	N.A	Radish/Muje	H	-	+	+	-

11.	*Solanum lycopersicon* (Solanaceae)	N.A	Tomato/Tamatar	H	-	+	-	-
12.	*Solanum melongena* (Solanaceae)	N.A	Brinjal/Wagun	H	-	+	-	-
13.	*Solanum tuberosum* *(*Solanaceae)	N.A	Potato/Aaelvi	H	-	+	+	-
14.	*Spinacia oleracea* (Chenopodiaceae)	N.A	Spinach/Palak	H	-	+	-	-
15.	*Trigonella foenumgraecum* (Fabaceae)	N.A	Fenugreek/Meth	H	-	+	-	-
Pulses								
16.	*Phaseolus vulgaris* (Fabaceae)	N.A	Rajma/Beans/Razma	H	-	+	+	-
17.	*Pisum sativum* (Fabaceae)	N.A	Peas/Matar	H	+	+	-	-
18.	*Vicia faba* (Fabaceae)	N.A	Beans/Razma	H	-	+	-	-
Cereals								
19.	*Avena sativa* (Poaceae)	N.A.	Oats/Khaseeli	H	+	-	-	-
20	*Oryza sativa* (Poaceae)	N.A	Paddy/Daani	H	+	-	-	-
21.	*Zea mays* (Poaceae)	N.A	Maize/Makai	H	-	+	+	-
Total					**4**	**18**	**5**	**-**

H= Herb, T= Tree, S= Shrub, + = Present, **-** = Absent

1. *Amaranthus caudatus*

2. *Anagallis arvensis*

3. *Artemisia absinthium*

4. *Chenopodium album*

5. *Clinopodium vulgare*

6. *Euphorbia helioscopia*

Plate-2: **Herbs/Grasses found in prevalent agroforestry systems of the study area (District Budgam)**

Contd……

7. *Galinsoga parviflora*

8. *Galium aparine*

9. *Geranium polyanthes*

10. *Hypericum perforatum*

11. *Impatiens glandulifera*

12. *Nepeta cataria*

Contd…..

13. ***Oenothera rosea***

14. ***Potentilla reptans***

15. ***Polygonum hydropiper***

16. ***Thymus linearis***

17. ***Tragopogon kashmirianus***

18. ***Stellaria media***

1. *Rubus niveus*

2. *Rubus ulmifolius*

3. *Asparagus officinalis*

Plate-3: Shrub species found in prevalent agroforestry systems of the study area (District Budgam)

Malus domestica

Pyrus communis

Prunus domestica

Prunus persica

Plate-4: Tree species found in prevalent agroforestry systems of the study area (District Budgam)

Contd…..

Populus sp.

Robinia pseudoacacia

Salix sp.

4.3 Seasonal variation in quantitative/phyto-sociological attributes of cultivated plants

Importance value index (IVI) of cultivated plants/herbage showed a marked variation from spring, summer to autumn season in the study area. With respect to agroforestry systems, Homegarden showed higher phytosociological/quantitative attributes than other two systems i.e. Boundary plantation and Horti-agricultural system in three different seasons. The perusal of the data on cultivated plants in different prevalent agroforestry systems are however elaborated below:

4.3.1 Boundary plantation

4.3.1.1 Importance Value Index (IVI)

A critical view of the data on importance value index (Table - 5) revealed that highest IVI values (122.90) was exhibited by *Brassica campestris* in spring achieving dominance over other species followed by *Avena sativa* (106.58) as its co-dominant. On the other hand, the dominant species during summer was *Oryza sativa* with IVI value of 300.

4.3.2 Homegarden

4.3.2.1 Importance Value Index (IVI)

In terms of importance value index (Table-6), the dominant species during spring and summer seasons was *Brassica oleracea var. acephala* with highest value of (42.84) and (44.68) followed by its co-dominants *Allium sativum* (34.71) and *Phaseolus vulgaris* (32.20) during two consecutive seasons respectively.Whereas, in autumn, *Brassica rapa* showed dominance over other species attaining maximum value (103.81) and *Brassica oleracea var. acephala* (73.71) as co-dominant in homegarden agroforestry system.

4.3.3 Horti-agricultural system

4.3.3.1 Importance Value Index (IVI)

Numeric values of importance value index (Table-7) revealed that *Phaseolus vulgaris* attained highest IVI values (97.67) during spring and summer (95.03), followed by *Brassica olearacea var. acephala* as co-dominant species. On the other hand, the dominant species during autumn was *Brassica olearacea var. acephala* with IVI value of 122.17 and *Raphanus sativus* (93.91) as co-dominant.

Table-5: Importance Value Index (IVI) of different cultivated plants in Boundary plantation of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**
1.	*Avena sativa* L.	106.58	1.70	-	-	-	-
2.	*Brassica campestris* L.	122.90	2.46	-	-	-	-
3.	*Oryza sativa* L.	-	-	300	8.23	-	-
4.	*Pisum sativum* L.	70.51	3.99	0	-	-	-
Total		**300**	**-**	**300**	**-**	**-**	**-**

Table-6: Importance Value Index (IVI) of different cultivated species in Homegarden of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**
1.	*Allium sativum* L.	34.71	1.69	-	-	-	-
2.	*Brassica oleracea var. gonglyonoides* L.	18.12	1.20	21.65	0.81	-	-
3.	*Brassica oleracea* var. *acephala* L.	42.84	1.49	44.68	1.51	73.71	7.51
4.	*Brassica rapa* L.	-	-	-	-	103.81	2.02
5.	*Capsicum annum* L.	23.11	1.64	21.90	1.43	-	-
6.	*Cucumis sativus* L.	19.85	2.75	20.25	0.20	-	-
7.	*Daucus carota* subsp. *sativus Hoffm.*	-	-	-	-	67.81	8.05
8.	*Lagenaria vulgaris* Standl.(Molina)	17.94	3.16	20.17	0.72	-	-
9.	*Phaseolus vulgaris* L.	27.98	2.55	32.20	1.55	-	-
10.	*Phaseolus* spp. (String/French beans) L.	-	-	27.31	1.23	-	-
11.	*Pisum sativum* L.	33.35	0.92	-	-	-	-
12.	*Raphanus sativus* L.	-	-	-	-	54.66	6.35
13.	*Solanum lycopersicon* L.	-	-	18.31	0.90	-	-
14.	*Solanum melongena* L.	-	-	13.60	0.30	-	-
15.	*Solanum tuberosum* L.	22.72	1.06	23.61	1.48	-	-
16.	*Spinacia oleracea* L.	-	-	7.28	0.22	-	-
17.	*Trigonella foenumgraecum* L.	20.75	1.08	-	-	-	-
18.	*Vicia faba* L.	24.64	0.37	31.16	1.91	-	-
19.	*Zea mays* L.	14.00	1.22	17.81	1.41	-	-
Total		**300.00**	-	**300.00**	-	**300.00**	-

Table -7: Importance Value Index (IVI) of different cultivated plants in Horti-agricultural system of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Brassica olearacea var. acephala L.*	82.33	4.92	77.32	2.43	122.17	9.20
2.	*Brassica rapa* L.	-	-	-	-	83.90	10.21
3.	*Phaseolus vulgaris* L.	97.67	5.66	95.03	8.26	-	-
4.	*Raphanus sativus* L.	-	-	-	-	93.91	18.75
5.	*Solanum tuberosum* L.	54.48	6.76	61.94	3.61	-	-
6.	*Zea mays* L.	65.50	5.02	65.71	3.74	-	-
Total		**300**	**-**	**300**	**-**	**300**	-

4.4 Vegetation indices of cultivated plants

Various vegetation indices were calculated for cultivated plants in identified prevalent agroforestry systems of District Budgam (Table-8). The evaluated data so obtained for different agroforestry systems in terms of vegetation indices are as described below:

4.4.1 Shannon weiner index

Seasonal Shannon weiner index of herbaceous vegetation in different agroforestry systems was1.06 (spring) and 0 (summer) in Boundary plantation and no cultivated herbage was found during autumn season (i.e. land is left fallow for 2 months). In Homegarden, the diversity values were recorded as 2.40 (spring), 2.49 (summer) and 1.31 (autumn); 1.36 (spring), 1.37 (summer) and 1.05 (autumn) in Horti-agricultural system (Table-8; Fig. 2). In general, maximum value was recorded in summer seasonexcept Boundary plantation system.

4.4.2 Simpson's diversity index

Simpson's diversity index measured for different systems and seasons showed inverse relation to Shanon weiner index. This diversity was 0.33(spring) and 1 (summer) for Bounadary plantation; 0.090 (spring) 0.086 (summer) and 0.280 (autumn) for Homegarden; 0.25 (spring), 0.24 (summer) and 0.35 (autumn) for Horti-agricultural system. From the above data, it was observed that the maximum value for this diversity index was for autumn season (Table-8; Fig. 3).

4.4.3 Species evenness

Data pertaining to species evenness (Table-8; Fig. 4) is analogous to Shanon weiner index i.e. maximum value was achieved during summer season and minimum in following season i.e. during autumn in identified prevalent agroforestry systems, except for Boundary plantation where evenness value was achieved to be minimum during summer, because an individual cultivated plant species (*Oryza sativa*) was found during this particular season. The trend for this index remained as 0.96 (spring) and 0 (summer) in Boundary plantation; in

Homegarden 0.96 (spring), 0.97(summer) and 0.94 (autumn); 0.98 (spring), 0.99 (summer) and 0.96 (autumn) in Horti-agricultural system.

4.4.4 Concentration of dominance

Perusal of the data pertaining to concentration of dominance illustrated similar trend as Simpson diversity i.e. maximum value recorded for autumn season and minimum for summer. The values in three consecutive seasons for prevalent agroforestry systems were 0.35 (spring) and 1 (summer) for Bounadary plantation; 0.095 (spring), 0.087 (summer) and 0.288 (autumn) for Homegarden; 0.26 (spring), 0.25 (summer) and 0.36 (autumn) for Horti-agricultural system (Table-8; Fig. 5).

Table-8: Vegetation indices of cultivated plant species in prevalent agroforestry sytems of the study area (District Budgam)

Agroforestry Systems	Vegetation Indices	Seasons		
		Spring	Summer	Autumn
Boundary plantation	Shannon weiner index	1.06	0	-
	Simpson's diversity	0.33	1	-
	Species evenness	0.96	0	-
	Concentration of dominance	0.35	1	-
Homegarden	Shannon weiner index	2.40	2.49	1.31
	Simpson's diversity index	0.090	0.086	0.280
	Species evenness	0.96	0.97	0.94
	Concentration of dominance	0.095	0.087	0.288
Horti-agricultural system	Shannon weiner index	1.36	1.37	1.05
	Simpson's diversity index	0.25	0.24	0.35
	Species evenness	0.98	0.99	0.96
	Concentration of dominance	0.26	0.25	0.36

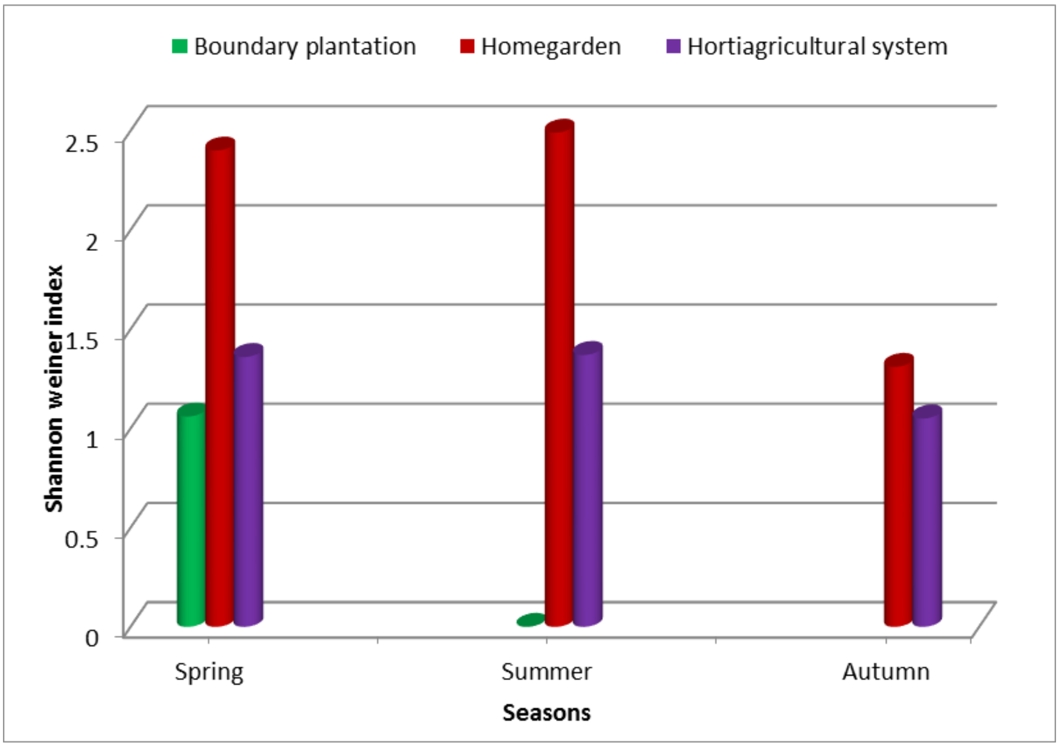

Fig. 2: Seasonal Shannon weiner index of cultivated plants in agroforestry systems of the study area (District Budgam)

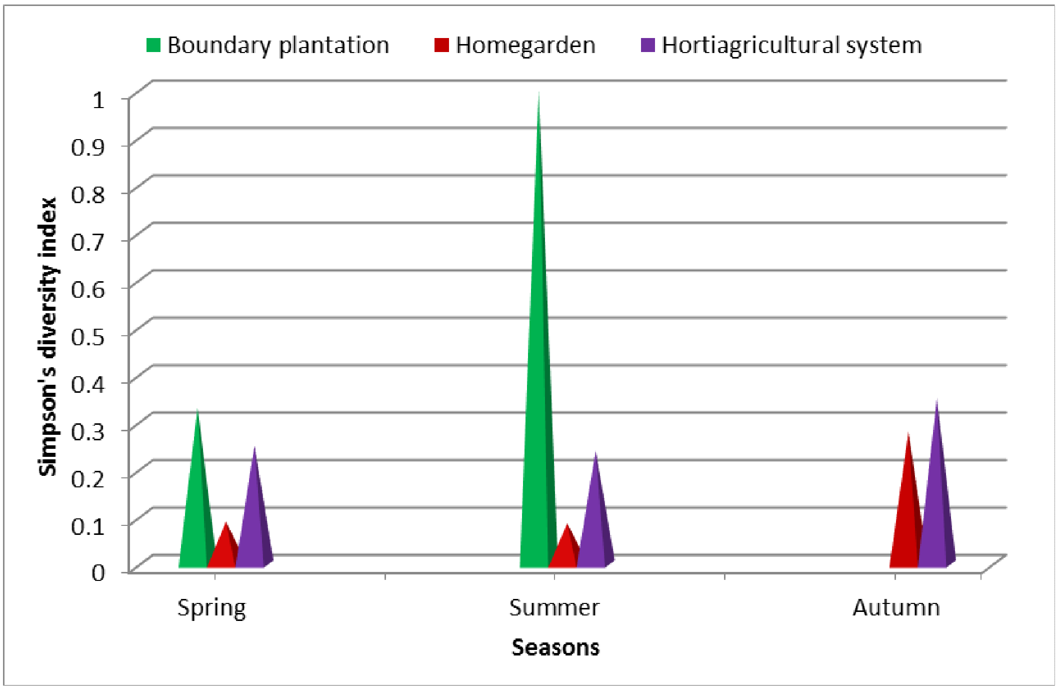

Fig. 3: Seasonal Simpson's diversity index of cultivated plants in agroforestry systems of the study area (District Budgam)

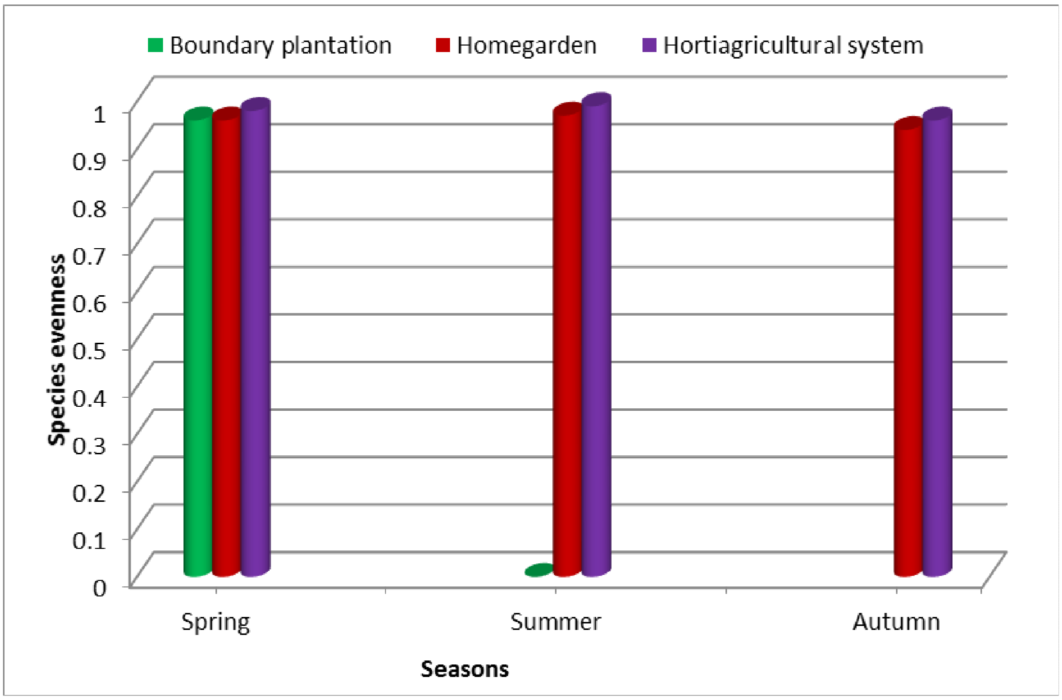

Fig. 4: Seasonal species evenness index of cultivated plants in agroforestry systems of the study area (District Budgam)

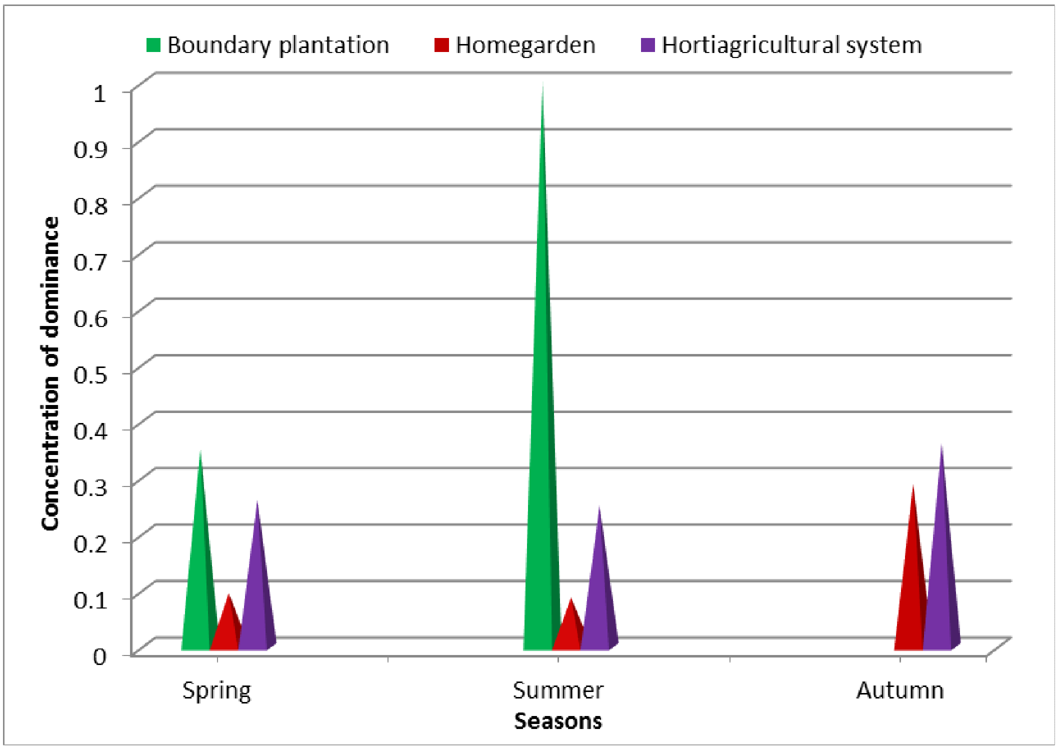

Fig. 5: Seasonal concentration of dominance of cultivated plants in agroforestry systems of the study area (District Budgam)

4.5 Seasonal variation in quantitative/phyto-sociological attributes of wild plants

Density (individuals/ m^2), basal area (cm^2/m^2) and frequency of wild plant species increased gradually from spring to summer and declined in autumn season in all prevalent agroforestry systems of the study area. The phytosociological attributes of herbage showed higher values in Horti-silvi-pasture system compared to other agroforestry systems. The phytosociological/quantitative attributes of the plants in different prevalent agroforestry systems are however described below:

4.5.1 Boundary plantation

4.5.1.1 Density (individuals/m^2)

In Boundary plantation total density (individuals/m^2) of wild plants fluctuated from 826.50 in summer to 161 in autumn (Table- 9). The highest value for density during three seasons was observed for *Cynodon dactylon* with a marked variation from 36 in spring, 95 in summer and 31.83 in autumn. It was followed by *Polygonum hydropiper and Oenothera rosea* in decreasing order. Their density contribution ranged from 32.16 and 25.33 during spring season, 89.16 and 67 in summer, 21.16 and 17.16 during autumn season, respectively. The lowest values for density in different seasons were observed for *Prunella vulgaris* 1.66 (spring), 4.33 (summer) and 0.33 (autumn).

4.5.1.2 Basal area (cm^2/m^2)

Data pertaining to total basal area in Table-10 revealed a marked variation from 11.15 (spring), 16.98 (summer) and 7.45 (autumn). Among the plant species, contribution of *Cynodon dactylon* was the highest to the total basal area of herbage in different sampling seasons. Basal area attained by *Cynodon dactylon* during spring was 1.19 (spring), 1.98 (summer) and 1.06 (autumn). The lowest value for basal area was evaluated for *Prunella vulgaris* as 0.06 (spring), 0.10 (summer) and 0.01(autumn).

4.5.1.3 Frequency (%)

Detailed view of the data in Table-11 indicated that the highest value was observed in *Cynodon dactylon* as the most frequent species with 83.33 per cent in spring, 100 per cent in summer and minimum frequency being observed during autumn as 75.00 per cent and the lowest value was observed for *Prunella vulgaris* 8.33 per cent (spring), 16.66 per cent (summer) and 6.66 per cent (autumn).

4.5.1.4 Importance Value Index (IVI)

Perusal of the data for Boundary plantation revealed that the dominant species was *Cynodon dactylon* with the highest IVI value of 45.09 in autumn season compared to other plant species (Table-12). The co-dominant species in terms of IVI value was *Polygonum hydropiper* that also attained the highest IVI during autumn (35.80). The lowest IVI was observed for *Prunella vulgaris* attaining the highest value during summer (1.96).

Table-9: Density of different wild plants in Boundary plantation of the study area (District Budgam)

S. No.	Plant species	Density/m²					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	5.66	1.96	14.33	1.94	2.83	0.42
2.	*Anthemis cotula* L.	7.00	1.08	18.00	1.60	3.33	0.76
3.	*Artemisia absinthium* L.	4.66	1.66	12.5	1.29	2.16	0.69
4.	*Cannabis sativa* L.	23.66	3.17	57.66	0.31	8.5	0.28
5.	*Capsella bursa-pastoris* L.	6.16	3.08	16.33	1.23	3.16	0.16
6.	*Clinopodium vulgare* L.	10.50	1.52	26.66	2.03	4.83	1.07
7.	*Conyza canadensis* L. Cronquist	9.50	0.14	24.83	2.60	4.00	1.01
8.	*Cynodon dactylon* L.	36.00	1.62	95.00	1.11	31.83	1.16
9.	*Daucus carota* L.	19.83	1.65	50.16	2.52	8.16	1.20
10.	*Equisetum arvense* L.	6.00	2.01	16.00	1.04	-	-
11.	*Euphorbia helioscopia* L.	2.16	0.09	7.83	1.36	0.50	0.50
12.	*Galinsoga parviflora* Cav.	4.50	0.29	10.33	1.48	1.66	1.06
13.	*Galium aparine L.*	7.83	0.92	18.33	1.30	3.83	0.83
14.	*Geranium polyanthes* Edgew & Hook	16.00	3.5	38.83	4.23	7.83	1.16
15.	*Impatiens glandulifera* Royle	2.66	1.33	5.66	2.84	0.66	0.001
16.	*Lithospermemium arvense* L.	3.33	0.13	8.83	1.91	1.00	0.001

Contd…

Table 9 contd…

S. No.	Plant species	Density/m²					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Medicago sativa* L.	9.16	1.19	23.33	2.43	5.00	1.56
18.	*Nepeta cataria* L.	5.33	1.72	14.50	1.60	2.33	0.33
19.	*Oenothera rosea* L'Her. ex. Aiton	25.33	6.78	67.00	8.28	17.16	7.21
20.	*Plantago major* L.	8.16	1.20	13.00	6.50	1.33	0.33
21.	*Polygonum hydropiper* L.	32.16	9.32	89.16	11.81	21.16	4.74
22.	*Potentilla reptans* L.	8.50	1.44	20.00	1.32	4.00	2.17
23.	*Prunella vulgaris* L.	1.66	0.06	4.33	1.33	0.33	0.002
24.	*Rorripa islandica* L.	8.00	1.75	18.83	2.18	-	-
25.	*Rumex dentatus* L.	11.83	0.83	31.16	2.63	4.00	1.08
26.	*Scandix pectenveneris* L.	4.50	0.29	12.00	0.28	1.83	0.03
27.	*Sonchus oleraceus* L.	7.66	0.96	19.66	2.20	1.66	0.06
28.	*Setaria viridis* L.	13.16	1.08	22.33	1.93	8.33	1.01
29.	*Sysiumbrium irio* L.	1.83	0.83	4.50	1.75	-	-
30.	*Tragopogan kashmirianus* GS	2.16	0.16	4.66	2.35	-	-
31.	*Trifolium pratense* L.	25.16	0.56	60.66	4.44	9.50	0.50
Total		**330.16**	-	**826.50**	-	**161.00**	-

Table-10: Basal area of different wild plants in Boundary plantation of the study area (District Budgam)

S. No.	Plant species	Basal area(cm^2/m^2)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	0.36	0.12	0.54	0.05	0.22	0.01
2.	*Anthemis cotula* L.	0.54	0.16	0.70	0.10	0.46	0.16
3.	*Artemisia absinthium* L.	0.11	0.01	0.20	0.07	0.10	0.05
4.	*Cannabis sativa* L.	0.67	0.11	0.94	0.02	0.34	0.082
5.	*Capsella bursa-pastoris* L.	0.11	0.06	0.19	0.005	0.099	0.009
6.	*Clinopodium vulgare* L.	0.89	0.07	1.03	0.09	0.74	0.10
7.	*Conyza canadensis* L. Cronquist	0.31	0.08	0.43	0.03	0.21	0.001
8.	*Cynodon dactylon* L.	1.19	0.02	1.98	0.05	1.06	0.02
9.	*Daucus carota* L.	0.38	0.02	0.44	0.03	0.23	0.083
10.	*Equisetum arvense* L.	0.38	0.10	0.43	0.04	-	-
11.	*Euphorbia helioscopia* L.	0.23	0.01	0.32	0.01	0.05	0.01
12.	*Galinsoga parviflora* Cav.	0.25	0.03	0.33	0.04	0.16	0.06
13.	*Galium aparine L.*	0.25	0.04	0.46	0.16	0.16	0.01
14.	*Geranium polyanthes* Edgew & Hook	0.22	0.03	0.27	0.02	0.12	0.01
15.	*Impatiens glandulifera* Royle	0.23	0.11	0.27	0.05	0.05	0.003
16.	*Lithospermemium arvense* L.	0.31	0.09	0.35	0.09	0.26	0.02

Contd…

Table 10 contd…

S. No.	Plant species	Basal area(cm^2/m^2)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Medicago sativa* L.	0.12	0.06	0.13	0.003	0.10	0.05
18.	*Nepeta cataria* L.	0.17	0.08	0.19	0.004	0.12	0.03
19.	*Oenothera rosea* L'Her. ex. Aiton	0.70	0.15	1.04	0.018	0.57	0.05
20.	*Plantago major* L.	0.42	0.20	0.95	0.06	0.10	0.04
21.	*Polygonum hydropiper* L.	1.02	0.006	1.69	0.15	0.96	0.017
22.	*Potentilla reptans* L.	0.26	0.13	0.32	0.032	0.11	0.05
23.	*Prunella vulgaris* L.	0.06	0.01	0.10	0.06	0.01	0.003
24.	*Rorripa islandica* L.	0.25	0.08	0.57	0.17	-	-
25.	*Rumex dentatus* L.	0.33	0.19	0.72	0.16	0.16	0.08
26.	*Scandix pectenveneris* L.	0.11	0.06	0.52	0.19	0.10	0.015
27.	*Sonchus oleraceus* L.	0.17	0.06	0.23	0.008	0.12	0.01
28.	*Setaria viridis* L.	0.36	0.11	0.58	0.10	0.34	0.13
29.	*Sysiumbrium irio* L.	0.10	0.001	0.28	0.024	-	-
30.	*Tragopogan kashmirianus* GS	0.12	0.01	0.27	0.04	-	-
31.	*Trifolium pratense* L.	0.41	0.05	0.51	0.08	0.34	0.06
Total		**11.15**	-	**16.98**	-	**7.45**	

Table -11: Frequency of different wild plants in Boundary plantation of the study area (District Budgam)

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	33.33	16.66	83.33	10.66	25.00	9.43
2.	*Anthemis cotula* L.	66.66	16.66	83.33	16.66	33.33	16.66
3.	*Artemisia absinthium* L.	16.66	2.66	66.66	16.66	15.00	7.63
4.	*Cannabis sativa* L.	66.66	16.66	75.00	11.43	40.00	17.55
5.	*Capsella bursa-pastoris* L.	33.33	16.66	83.33	10.66	8.33	8.33
6.	*Clinopodium vulgare* L.	50.00	10.11	58.33	8.33	25.00	5.43
7.	*Conyza canadensis* L. Cronquist	41.66	12.04	58.33	8.33	25.00	7.43
8.	*Cynodon dactylon* L.	83.33	6.66	100.00	8.11	75.00	7.43
9.	*Daucus carota* L.	66.66	16.66	75.00	12.43	41.66	8.33
10.	*Equisetum arvense* L.	33.33	16.66	50.00	9.10	-	-
11.	*Euphorbia helioscopia* L.	33.33	16.66	66.66	16.66	16.66	6.66
12.	*Galinsoga parviflora* Cav.	33.33	16.66	83.33	16.66	16.66	2.66
13.	*Galium aparine L.*	50.00	11.12	58.33	8.33	16.66	4.66
14.	*Geranium polyanthes* Edgew & Hook	58.33	8.33	66.66	8.33	50.00	0
15.	*Impatiens glandulifera* Royle	33.33	16.66	50.00	10.86	8.33	1.33
16.	*Lithospermemium arvense* L.	33.33	3.33	66.66	33.33	8.33	1.33

Contd…

Table 11 contd…

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**
17.	*Medicago sativa* L.	50.00	18.86	66.66	16.66	16.66	2.33
18.	*Nepeta cataria* L.	33.33	16.66	50.00	0	8.33	0.33
19.	*Oenothera rosea* L'Her. ex. Aiton	58.33	10.04	75.00	11.43	50.00	-
20.	*Plantago major* L.	50.00	18.86	66.66	33.33	10.00	2.20
21.	*Polygonum hydropiper* L.	77.77	10.78	86.11	7.35	70.33	10.65
22.	*Potentilla reptans* L.	50.00	28.86	66.66	16.66	33.33	16.66
23.	*Prunella vulgaris* L.	8.33	8.33	16.66	8.33	6.66	6.66
24.	*Rorripa islandica* L.	50.00	9.10	83.33	16.66	-	-
25.	*Rumex dentatus* L.	50.00	8.33	75.00	11.43	33.33	10.66
26.	*Scandix pectenveneris* L.	33.33	16.66	66.66	16.66	33.33	33.33
27.	*Sonchus oleraceus* L.	50.00	8.65	58.33	8.33	8.33	8.33
28.	*Setaria viridis* L.	66.66	16.66	83.33	16.66	33.33	10.66
29.	*Sysiumbrium irio* L.	33.33	33.33	66.66	16.66	-	-
30.	*Tragopogan kashmirianus* GS	25.00	8.25	33.33	10.66	-	-
31.	*Trifolium pratense* L.	58.33	8.33	83.33	8.33	36.66	6.66
Total		**1427.77**	-	**2102.77**	-	**745.33**	-

Table -12: Importance Value Index (IVI) of different wild plants in Boundary plantation of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	7.16	1.85	8.88	0.89	7.82	3.91
2.	*Anthemis cotula* L.	12.04	3.68	10.26	0.74	12.24	6.13
3.	*Artemisia absinthium* L.	3.19	0.19	5.94	2.09	4.47	2.24
4.	*Cannabis sativa* L.	17.64	1.54	16.16	2.18	15.37	0.56
5.	*Capsella bursa-pastoris* L.	5.06	2.23	7.11	1.60	3.76	0.76
6.	*Clinopodium vulgare* L.	14.85	1.40	12.03	1.00	13.99	1.15
7.	*Conyza canadensis* L. Cronquist	8.14	1.56	8.32	1.37	8.52	4.29
8.	*Cynodon dactylon* L.	27.42	2.41	27.91	1.42	45.09	5.02
9.	*Daucus carota* L.	14.56	3.56	12.22	1.42	14.25	2.43
10.	*Equisetum arvense* L.	7.45	3.73	6.83	0.38	-	-
11.	*Euphorbia helioscopia* L.	4.88	2.44	6.03	0.73	3.74	0.74
12.	*Galinsoga parviflora* Cav.	5.83	2.92	7.18	0.88	6.19	0.19
13.	*Galium aparine L.*	8.20	0.72	7.72	0.95	5.76	0.76
14.	*Geranium polyanthes* Edgew & Hook	10.75	1.05	9.44	1.09	13.33	0.34
15.	*Impatiens glandulifera* Royle	5.16	2.60	4.61	0.56	2.64	0.64
16.	*Lithospermemium arvense* L.	5.33	0.33	6.38	0.37	5.80	0.80

Contd…

Table 12 contd…

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Medicago sativa* L.	8.05	0.47	6.74	1.43	7.46	3.74
18.	*Nepeta cataria* L.	5.95	2.97	5.25	0.08	4.73	0.73
19.	*Oenothera rosea* L'Her. ex. Aiton	17.82	0.22	17.74	1.87	25.78	5.26
20.	*Plantago major* L.	9.66	0.87	10.25	0.77	3.97	0.97
21.	*Polygonum hydropiper* L.	25.01	4.06	24.87	2.26	35.80	1.07
22.	*Potentilla reptans* L.	8.46	0.73	7.49	0.73	8.11	0.20
23.	*Prunella vulgaris* L.	1.78	0.78	1.96	0.03	1.32	0.03
24.	*Rorripa islandica* L.	8.24	1.06	9.18	2.59	-	-
25.	*Rumex dentatus* L.	9.97	1.70	11.50	2.34	8.93	0.77
26.	*Scandix pectenveneris* L.	4.59	0.34	7.73	0.78	7.40	0.40
27.	*Sonchus oleraceus* L.	7.42	1.61	6.51	0.66	4.32	0.32
28.	*Setaria viridis* L.	12.31	4.48	10.13	1.12	13.53	3.83
29.	*Sysiumbrium irio* L.	4.09	0.09	5.37	1.17	-	-
30.	*Tragopogan kashmirianus* GS	3.11	0.11	3.78	1.92	-	-
31.	*Trifolium pratense* L.	15.81	2.64	14.35	1.80	15.60	1.17
Total		**300**	-	**300**	-	**300**	-

4.5.2 Homegarden

4.5.2.1 Density (individuals/m^2)

Detailed view of the data in Table-13 indicated that in Homegarden agroforestry system, total density (individuals/m^2) of herbage ranged from 79.35 (spring), 347.64 (summer) to 39.47 (autumn). *Stellaria media* exhibited highest value for density during three seasons ranging from 9.17 (spring), 36.33 (summer) to 8.83 (autumn), followed by *Poa aungustifolia* in decreasing order as 8.67 (spring), 32 (summer) and 6.33 (autumn). *Galinsoga parviflora* was observed to achieve the lowest values for density in three different seasons as 0.83 (spring) and 4.83 (summer) with an abrupt declination to 0.33 (autumn).

4.5.2.2 Basal area (cm^2/m^2)

Data pertaining to total basal area in Table-14 revealed a marked variation from 8.12 (spring), 10.38 (summer) and 2.66 (autumn). Among the plant species, contribution of *Stellaria media* was the highest to the total basal area of herbage in different sampling seasons. Basal area attained by *Stellaria media* was 1.02 (spring), 1.16 (summer) and 0.77 (autumn). The lowest value for basal area was evaluated for *Galinsoga parviflora* as (0.05) in spring, (0.10) during summer and autumn season (0.02) which was at par with *Conyza canadensis* and *Mentha arvensis*.

4.5.2.3 Frequency (%)

In terms of frequency *Stellaria media* exhibited the highest value of 86.11% in spring, 94.44% in summer and minimum frequency being observed in autumn 69.44% followed by *Poa aungustifolia* 66.67% (spring), 91.60% (summer) and 50.00% (autumn). The species with the lowest frequency value was *Galinsoga parviflora* achieving 6.67% in spring, 25.00% summer and 5.00% during autumn season (Table-15).

4.5.2.4 Importance Value Index (IVI)

Perusal of the data for Homegarden explicate that the dominant species with highest IVI value of 60.46 in autumn season was *Stellaria media* (Table-16). The co-dominant species in terms of IVI was *Poa aungustifolia*, which also attained the highest IVI during autumn (50.06).

Table-13: Density of different wild plants in Homegarden of the study area (District Budgam)

S. No.	Plant species	Density/m^2					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	4.67	0.64	21.67	4.32	3.00	0.87
2.	*Avena fatua* L.	3.00	0.50	14.83	2.19	2.33	0.04
3.	*Capsella bursa-pastoris* L.	3.00	0.73	16.33	3.17	2.33	0.41
4.	*Chenopodium album* L.	2.17	0.03	12.00	2.52	1.83	0.07
5.	*Conyza Canadensis* L. Cronquist	1.83	0.73	10.50	3.00	0.83	0.03
6.	*Galinsoga parviflora* Cav.	0.83	0.02	4.83	0.17	0.33	0.01
7.	*Galium aparine* L.	2.67	0.04	15.00	2.25	2.33	0.20
8.	*Kochia scoparia* L.	3.17	0.59	15.50	2.52	-	-
9.	*Malva neglecta* Wallr.	3.67	0.86	17.33	5.17	1.67	0.83
10.	*Mentha arvensis* L.	3.67	0.55	17.33	5.46	0.50	0.003
11.	*Oenothera rosea* L'Her.ex. Aiton	3.33	1.67	16.83	4.23	2.50	0.32
12.	*Plantago major* L.	6.50	2.02	30.17	0.83	2.33	0.33
13.	*Poa aungustifolia* L.	8.67	2.40	32.00	4.16	6.33	0.60
14.	*Poa bulbosa* L.	1.67	0.72	9.83	0.44	1.50	0.01
15.	*Portulaca oleracea* L.	2.00	1.04	11.83	1.48	-	-
16.	*Ranunculus muricatus* L.	1.83	0.93	10.33	0.60	0.83	0.03
17.	*Rumex nepalensis* Mill.	4.50	2.47	10.67	2.73	-	-
18.	*Stellaria media* L.(Vill.)	9.17	1.88	36.33	1.92	8.83	0.42
19.	*Taraxacum officinale* Weber	4.83	1.13	14.33	1.69	2.00	0.01
20.	*Veronica persica* L.	1.50	0.76	6.00	1.00	-	-
21.	*Viola oderata* L.	6.67	1.96	24.00	6.64	-	-
Total		**79.35**	-	**347.64**	-	**39.47**	-

Table-14: Basal area of wild plants in Homegarden of the study area (District Budgam)

S. No.	Plant species	Basal area(cm^2/m^2)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	0.35	0.02	0.41	0.04	0.14	0.04
2.	*Avena fatua* L.	0.34	0.07	0.39	0.01	0.13	0.010
3.	*Capsella bursa-pastoris* L.	0.27	0.08	0.31	0.12	0.12	0.09
4.	*Chenopodium album* L.	0.17	0.07	0.34	0.17	0.10	0.07
5.	*Conyza Canadensis* L. Cronquist	0.19	0.01	0.23	0.14	0.02	0.001
6.	*Galinsoga parviflora* Cav.	0.05	0.002	0.10	0.005	0.02	0.004
7.	*Galium aparine* L.	0.22	0.07	0.32	0.33	0.06	0.003
8.	*Kochia scoparia* L.	0.27	0.03	0.33	0.31	-	-
9.	*Malva neglecta* Wallr.	0.33	0.63	0.40	0.07	0.03	0.004
10.	*Mentha arvensis* L.	0.31	0.07	0.39	0.06	0.02	0.004
11.	*Oenothera rosea* L'Her.ex. Aiton	0.69	0.62	0.81	0.05	0.23	0.12
12.	*Plantago major* L.	0.73	0.04	0.89	0.09	0.20	0.04
13.	*Poa aungustifolia* L.	1.01	0.27	1.12	0.07	0.72	0.06
14.	*Poa bulbosa* L.	0.08	0.03	0.21	0.30	0.03	0.001
15.	*Portulaca oleracea* L.	0.23	0.002	0.39	0.17	-	-
16.	*Ranunculus muricatus* L.	0.18	0.02	0.21	0.006	0.03	0.002
17.	*Rumex nepalensis* Mill.	0.73	0.04	0.90	0.19	-	-
18.	*Stellaria media* L.(Vill.)	1.02	0.06	1.16	0.10	0.77	0.12
19.	*Taraxacum officinale* Weber	0.41	0.20	0.43	0.003	0.04	0.001
20.	*Veronica persica* L.	0.15	0.008	0.31	0.16	-	-
21.	*Viola oderata* L.	0.66	0.11	0.73	0.05	-	-
Total		**8.12**	-	**10.38**	-	**2.66**	-

Table-15: Frequency of wild plants in Homegarden of the study area (District Budgam)

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	58.33	8.33	77.78	11.70	25.00	0.10
2.	*Avena fatua* L.	50.00	1.00	83.33	11.67	25.00	1.43
3.	*Capsella bursa-pastoris* L.	33.33	10.67	66.67	10.67	16.67	8.33
4.	*Chenopodium album* L.	50.00	28.87	83.33	1.67	40.00	10.00
5.	*Conyza Canadensis* L. Cronquist	50.00	2.90	66.66	9.62	16.67	9.67
6.	*Galinsoga parviflora* Cav.	6.67	0.67	25.00	2.00	5.00	5.00
7.	*Galium aparine* L.	33.33	10.67	66.67	1.67	26.67	11.53
8.	*Kochia scoparia* L.	33.33	10.67	83.33	1.67	-	-
9.	*Malva neglecta* Wallr.	33.33	11.07	83.33	1.67	33.33	1.67
10.	*Mentha arvensis* L.	50.00	0.30	66.67	1.67	16.67	1.67
11.	*Oenothera rosea* L'Her.ex. Aiton	33.33	8.67	83.33	9.67	25.00	13.43
12.	*Plantago major* L.	58.33	8.33	83.33	8.33	43.33	6.67
13.	*Poa aungustifolia* L.	66.67	8.33	91.67	8.33	50.00	4.00
14.	*Poa bulbosa* L.	16.67	1.07	83.33	7.67	16.67	1.67
15.	*Portulaca oleracea* L.	33.33	6.07	83.33	5.67	-	-
16.	*Ranunculus muricatus* L.	33.33	1.67	66.67	2.67	16.67	0.67
17.	*Rumex nepalensis* Mill.	33.33	6.67	66.67	5.67	-	-
18.	*Stellaria media* L.(Vill.)	86.11	7.35	94.44	5.56	69.44	2.78
19.	*Taraxacum officinale* Weber	70.00	10.00	83.33	10.67	45.00	10.67
20.	*Veronica persica* L.	33.33	1.67	83.33	10.67	-	-
21.	*Viola oderata* L.	58.33	8.33	58.33	8.33	-	-
Total		**921.08**	**-**	**1580.58**	**-**	**471.12**	**-**

Table-16: Importance Value Index (IVI) of wild plants in Homegarden of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**
1.	*Amaranthus caudatus* L.	15.68	2.54	15.08	1.73	19.01	3.01
2.	*Avena fatua* L.	13.03	2.14	13.23	1.16	20.79	4.38
3.	*Capsella bursa-pastoris* L.	9.52	3.95	11.82	0.94	13.58	6.37
4.	*Chenopodium album* L.	9.24	4.31	12.20	1.38	15.57	3.76
5.	*Conyza Canadensis* L. Cronquist	9.96	0.21	9.60	1.00	7.27	0.61
6.	*Galinsoga parviflora* Cav.	3.15	0.33	4.02	0.13	2.34	2.03
7.	*Galium aparine* L.	10.19	2.59	11.60	1.23	14.70	2.83
8.	*Kochia scoparia* L.	9.74	1.08	12.93	1.16	-	-
9.	*Malva neglecta* Wallr.	10.95	4.51	14.10	1.66	13.40	2.82
10.	*Mentha arvensis* L.	14.49	2.31	13.15	3.56	6.46	0.32
11.	*Oenothera rosea* L'Her.ex. Aiton	14.48	5.73	17.87	1.31	19.80	9.41
12.	*Plantago major* L.	23.72	1.98	22.52	0.28	24.23	0.78
13.	*Poa aungustifolia* L.	30.17	1.86	25.77	1.06	50.06	3.98
14.	*Poa bulbosa* L.	4.62	0.74	10.09	1.04	9.14	0.28
15.	*Portulaca oleracea* L.	9.79	1.62	12.36	0.45	-	-
16.	*Ranunculus muricatus* L.	8.41	1.21	9.14	0.45	7.52	0.84
17.	*Rumex nepalensis* Mill.	19.26	6.38	15.86	2.44	-	-
18.	*Stellaria media* L.(Vill.)	33.22	1.23	27.60	0.44	60.46	11.64
19.	*Taraxacum officinale* Weber	18.47	2.41	13.54	0.47	15.60	5.98
20.	*Veronica persica* L.	7.87	1.13	9.94	0.93	-	-
21.	*Viola oderata* L.	23.93	4.57	17.50	2.53	-	-
Total		**300.00**	-	**300.00**	-	**300.00**	-

4.5.3.1 Horti-agricultural system

4.5.3.1 Density (individuals/m^2)

Density (individuals/m^2) of herbage in Horti-agricultural system during sampling seasons varied from 221.07 (spring), 413.44 (summer) to 103.43 (autumn) Table-17. Among the species recorded, *Stellaria media* was the major contributor to the total density of vegetation. Its contribution ranged from 21.83 (spring), 34.83 (summer) and 14.00 (autumn). It was followed by *Plantago major and Plantago lanceolata* in decreasing order. Their contribution ranged from 18.66 and 17.50 during spring season, 30.66 and 30.50 in summer and thereby declined during autumn season attaining the values as 12.16 and 10.66 respectively. Minimum values for density in different seasons were recorded for *Artemisia absinthium* and *Phragmites australis* during spring as 3.16. The density of *Artemisia absinthium* remained minimum during summer (7.66) and showed a marked declination during autumn (1.33).

4.5.3.2 Basal area (cm^2/m^2)

Perusal of the data in Table-18 revealed that total basal area (cm^2/m^2) of the vegetation varied from 10.84 (spring), 17.13 (summer) and 6.68 (autumn). Among the individual species, contribution of *Stellaria media* was highest to the total basal area of herbage in different sampling seasons and was followed by *Plantago major and Plantago lanceolata* in decreasing trend. Basal area attained by *Stellaria media* was 1.19 (spring), 1.42 (summer) and 1.11(autumn). The lowest value for basal area was achieved by *Artemisia absinthium* as 0.07 in spring, 0.16 during summer and 0.02 in autumn season.

4.5.3.3 Frequency (%)

Similar trend was observed for this parameter i.e. highest value during spring and summer season and then marked declination in autumn (Table-19). Among the species, *Stellaria media* again was evaluated as the most frequently occurring species with 83.33% frequency during spring, 94.44% during summer and minimum frequency being observed in autumn 77.77%.

For the same parameter the lowest value was showed by *Artemisia absinthium* 8.33% in spring, 25.00% summer and 6.66% during autumn.

Table-17: Density of different wild plants in Horti-agricultural system of the study area (District Budgam)

S. No.	Plant species	Density/m^2					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Anagallis arvensis* L.	11.33	4.17	19	4.58	1.66	0.08
2.	*Anthemis cotula* L.	8.83	1.59	24	1.00	4.66	0.88
3.	*Artemisia absinthium L.*	3.16	0.16	7.66	1.36	1.33	0.03
4.	*Chenopodium album* L.	5.50	1.92	15.33	3.84	2.16	0.01
5.	*Convolvulus arvensis L.*	9.16	2.45	18.83	1.59	-	-
6.	*Conyza canadensis* L. Cronquist	10.66	1.74	18.66	4.56	4.50	1.73
7.	*Daucus carota* L.	13.66	1.01	19.16	1.45	7.50	1.50
8.	*Galinsoga parviflora* Cav.	17.16	0.28	29.16	1.96	8.66	2.42
9.	*Hypericum perforatum* L.	6.00	1.15	16.00	3.51	3.00	0.50
10.	*Medicago polymorpha* L.	8.66	4.37	14.50	1.44	5.33	0.72
11.	*Phragmites australis* Cav.	3.16	0.87	8.16	3.19	2.00	0.02
12.	*Plantago lanceolata* L.	17.50	1.52	30.50	0.50	10.66	2.84
13.	*Plantago major* L.	18.66	3.44	30.66	4.25	12.16	2.58
14.	*Poa bulbosa* L.	11.33	5.76	23.50	11.85	-	-
15.	*Potentilla reptans* L.	5.83	0.44	15.16	3.41	2.66	0.16
16.	*Rumex dentatus* L.	14.16	7.12	21.83	4.33	11.16	0.44
17.	*Scandix pectenveneris* L.	7.66	3.84	17.00	5.25	3.83	0.09
18.	*Stellaria media* L.(Vill.)	21.83	1.87	34.83	2.24	14.00	0.28
19.	*Taraxacum officinale* Weber	8.66	1.45	14.50	4.35	3.33	1.71
20.	*Thymus linearis* Benth.	9.16	4.63	20.00	1.68	-	-
21.	*Veronica persica* Poiret	9.00	0.50	15.00	7.50	4.83	0.09
Total		**221.07**	-	**413.44**	-	**103.43**	-

Table-18: Basal area of different wild plants in Horti-agricultural system of the study area (District Budgam)

S. No.	Plant species	Basal area(cm²/m²)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Anagallis arvensis* L.	0.50	0.07	0.84	0.14	0.14	0.01
2.	*Anthemis cotula* L.	0.22	0.06	0.84	0.11	0.16	0.02
3.	*Artemisia absinthium L.*	0.07	0.01	0.16	0.01	0.02	0.008
4.	*Chenopodium album* L.	0.19	0.04	0.81	0.05	0.11	0.05
5.	*Convolvulus arvensis L.*	0.46	0.10	0.82	0.15	-	-
6.	*Conyza canadensis* L. Cronquist	0.50	0.05	0.77	0.14	0.16	0.02
7.	*Daucus carota* L.	0.85	0.02	1.08	0.01	0.43	0.07
8.	*Galinsoga parviflora* Cav.	1.09	0.03	1.10	0.21	0.98	0.02
9.	*Hypericum perforatum* L.	0.20	0.04	0.76	0.01	0.13	0.02
10.	*Medicago polymorpha* L.	0.20	0.10	0.54	0.04	0.13	0.009
11.	*Phragmites australis* Cav.	0.14	0.01	0.16	0.01	0.04	0.04
12.	*Plantago lanceolata* L.	1.09	0.004	1.11	0.05	1.00	0.001
13.	*Plantago major* L.	1.09	0.001	1.13	0.006	1.00	0.002
14.	*Poa bulbosa* L.	0.53	0.26	0.83	0.44	-	-
15.	*Potentilla reptans* L.	0.21	0.04	0.57	0.003	0.12	0.012
16.	*Rumex dentatus* L.	0.96	0.05	1.09	0.006	0.76	0.16
17.	*Scandix pectenveneris* L.	0.21	0.04	0.82	0.03	0.12	0.01
18.	*Stellaria media* L.(Vill.)	1.19	0.0002	1.42	0.05	1.11	0.02
19.	*Taraxacum officinale* Weber	0.21	0.05	0.68	0.01	0.10	0.05
20.	*Thymus linearis* Cav.	0.50	0.17	0.88	0.44	-	-
21.	*Veronica persica* Poiret	0.43	0.26	0.72	0.36	0.17	0.01
Total		**10.84**	**-**	**17.13**	**-**	**6.68**	**-**

Table-19: Frequency of different wild plants in Horti-agricultural system of the study area (District Budgam)

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Anagallis arvensis* L.	58.33	8.33	75	25.00	33.33	16.66
2.	*Anthemis cotula* L.	50.00	2.50	69.44	2.78	41.66	8.33
3.	*Artemisia absinthium* L.	8.33	0.33	25.00	2.31	6.66	0.66
4.	*Chenopodium album* L.	66.66	16.66	66.66	8.33	33.33	16.66
5.	*Convolvulus arvensis L.*	50.00	1.30	58.33	8.33	-	-
6.	*Conyza canadensis* L.Cronquist	66.66	16.66	66.66	16.66	50.00	3.30
7.	*Daucus carota* L.	58.33	8.33	83.33	16.66	43.33	6.66
8.	*Galinsoga parviflora* Cav.	66.00	10.01	76.66	8.33	40.00	16.66
9.	*Hypericum perforatum* L.	50.00	6.20	66.66	16.66	43.33	6.66
10.	*Medicago polymorpha* L.	33.33	16.66	75.00	14.43	30.00	5.00
11.	*Phragmites australis* Cav.	25.00	4.43	41.66	8.33	16.66	1.66
12.	*Plantago lanceolata* L.	50.00	5.50	88.33	11.66	43.33	6.66
13.	*Plantago major* L.	61.66	7.26	90.00	10.0	50.00	4.90
14.	*Poa bulbosa* L.	33.33	16.66	66.66	33.33	-	-
15.	*Potentilla reptans* L.	50.00	6.20	66.66	16.66	41.66	8.33
16.	*Rumex dentatus* L.	33.33	16.66	83.33	16.66	21.66	3.33
17.	*Scandix pectenveneris* L.	33.33	16.66	66.66	16.66	13.33	0.26
18.	*Stellaria media* L.(Vill.)	83.33	7.50	94.44	5.55	77.77	2.77
19.	*Taraxacum officinale* Weber	66.66	16.66	83.33	16.66	50.00	8.86
20.	*Thymus linearis* Cav.	33.33	16.66	50.00	7.86	-	-
21.	*Veronica persica* Poiret	33.33	16.66	66.66	33.33	16.66	8.33
Total		**927.61**	**-**	**1460.47**	**-**	**652.71**	**-**

4.5.3.4 Importance Value Index (IVI)

Numeric values of importance value index in Table-20 of different species revealed that in this agroforestry system, *Stellaria media* attained highest IVI values of 42.58 in autumn, 23.44 summer and 28.98 in spring compared to other plant species. The co-dominant species was *Plantago major* with an IVI value of 35.06 (autumn).

4.5.4 Horti-silvi-pasture system

4.5.4.1 Density (individuals/m^2)

Perusal of the data in Table-21 indicated that in Horti-silvi-pasture system total density (individuals/m^2) of herbage ranged from 568.20 (spring), 1023.18 (summer) to 315.94 (autumn). Highest value for density was achieved by *Cynodon dactylon* during three seasons ranging from 90.33 (spring), 103.66 (summer) to 67.33 (autumn) followed by *Oenothera rosea* 51.16 (spring), 77.50 (summer) and 37.00 (autumn). *Mentha arvensis* was observed to achieve lowest values for density in three different seasons as 3.33 (spring), 10.66 (summer) which then declined to 1.33 (autumn).

4.5.4.2 Basal area (cm^2/m^2)

Data pertaining to total basal area in Table-22 revealed a marked fluctuation from 23.21 (spring), 31.12 (summer) and 11.98 (autumn). Among the plant species, contribution of *Cynodon dactylon* was highest to the total basal area of herbage in different sampling seasons. Basal area attained by *Cynodon dactylon* was 1.93 (spring), 2.02 (summer) and 1.65 (autumn). The lowest value for basal area was evaluated for *Mentha arvensis* as (0.02) in spring, (0.12) during summer and in autumn season (0.008).

4.5.4.3 Frequency (%)

In terms of frequency, the highest value was attributed by *Cynodon dactylon* i.e. 94.44% in spring, 100.00% in summer and minimum frequency being observed in autumn 83.33% followed by *Oenothera rosea* 77.77% (spring), 94.44% (summer) and 58.33% (autumn). The species with lowest frequency value was *Mentha arvensis* with 16.66% in spring, 33.33% summer and during autumn season 6.66% (Table-23).

4.5.4.4 Importance Value Index (IVI)

Perusal of the data for Horti-silvi-pasture system indicated that the dominant species with highest IVI value of 41.92 (autumn season) was *Cynodon dactylon* compared to other plant species (Table-24), though being dominant species during summer and spring seasons also. The co-dominant species in terms of IVI value was *Oenothera rosea* that also attained highest IVI during autumn (25.15).

Data pertaining to mean density and basal area of wild plants in different agroforestry systems showed that these were significantly higher in Horti-silvi-pasture compared to other systems (Table-25 & 26). The density and basal area of wild plant species revealed that they were significantly higher in summer season in contrast to other two seasons evaluated.

Table-20: Importance Value Index (IVI) of different wild plants in Horti-agricultural system of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Anagallis arvensis* L.	15.56	3.60	14.26	1.72	8.58	4.13
2.	*Anthemis cotula* L.	10.98	1.78	15.52	1.00	13.60	1.96
3.	*Artemisia absinthium* L.	2.66	0.64	4.48	0.11	2.78	0.67
4.	*Chenopodium album* L.	10.63	2.14	13.08	1.93	8.64	4.19
5.	*Convolvulus arvensis* L.	13.47	2.57	13.58	2.27	-	-
6.	*Conyza canadensis* L.Cronquist.	16.13	3.61	13.40	1.02	14.48	0.75
7.	*Daucus carota* L.	20.46	1.62	16.57	0.78	20.66	2.45
8.	*Galinsoga parviflora* Cav.	24.30	0.98	18.82	0.96	29.48	3.27
9.	*Hypericum perforatum* L.	9.52	1.20	12.82	2.00	11.59	0.36
10.	*Medicago polymorpha* L.	8.65	4.27	11.91	1.21	12.07	1.65
11.	*Phragmites australis* Cav.	5.33	1.38	5.81	0.93	5.21	1.00
12.	*Plantago lanceolata* L.	23.71	1.87	20.39	1.60	32.79	1.94
13.	*Plantago major* L.	25.25	1.74	20.43	1.27	35.06	3.84
14.	*Poa bulbosa* L.	12.71	6.33	15.24	7.52	-	-
15.	*Potentilla reptans* L.	9.41	0.33	11.45	0.65	10.95	1.33
16.	*Rumex dentatus* L.	17.70	8.86	17.76	2.73	21.52	0.71
17.	*Scandix pectenveneris* L.	9.07	0.65	13.47	2.57	7.76	3.66
18.	*Stellaria media* L.(Vill.)	28.98	1.08	23.44	2.21	42.58	2.11
19.	*Taraxacum officinale* Weber	12.28	1.97	12.96	1.28	12.29	5.94
20.	*Thymus linearis* Cav.	11.48	1.95	12.72	1.67	-	-
21.	*Veronica persica* Poiret	11.61	2.83	11.79	5.86	9.87	0.82
Total		**300**	**-**	**300**	**-**	**300**	**-**

Table-21: Density of different wild plants in Horti-silvi-pasture system of thestudy area (District Budgam)

S. No.	Plant species	Density/m^2					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	10.50	2.75	25.50	10.98	6.00	1.73
2.	*Anagallis arvensis* L.	4.00	0.12	10.83	3.37	2.00	0.81
3.	*Anthemis cotula* L.	7.50	2.30	21.83	7.40	4.66	1.16
4.	*Asparagus officinalis L.*	7.83	7.83	24.33	12.18	5.83	0.83
5.	*Cannabis sativa* L.	20.66	4.91	38.83	11.34	10.00	0.86
6.	*Chenopodium album* L.	11.83	6.40	37.33	6.48	6.00	2.02
7.	*Clinopodium vulgare* L.	5.16	0.44	11.66	3.00	2.00	0.15
8.	*Convolvulus arvensis* L.	5.66	1.96	32.00	1.60	3.66	1.85
9.	*Conyza canadensis* L.Cronquist	17.66	1.85	37.33	3.60	12.00	1.25
10.	*Cynodon dactylon* L.	90.33	3.94	103.66	9.40	67.33	9.68
11.	*Daucus carota* L.	17.66	1.45	37.00	3.51	11.66	1.33
12.	*Galinsoga parviflora* Cav.	7.00	2.04	12.16	2.94	3.50	1.75
13.	*Geranium polyanthes* Edgew &Hook	32.66	16.33	54.50	0.28	17.83	1.39
14.	*Medicago polymorpha* L.(Benth.)	42.83	14.87	62.16	7.83	30.50	5.83
15.	*Mentha arvensis* L.	3.33	1.33	10.66	3.35	1.33	0.66
16.	*Oenothera rosea* L ‘ Her. ex Aiton	51.16	1.42	77.50	9.84	37.00	9.25

Contd…

Table 21 contd…

S. No.	Plant species	Density/m²					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Plantago lanceolata* L.	11.16	3.76	34.66	0.16	7.50	2.46
18.	*Plantago major* L.	16.16	8.09	35.83	6.45	8.50	1.50
19.	*Poa pratense* L.	16.33	9.11	23.33	5.10	10.33	1.91
20.	*Polygonum hydropiper* L.	14.66	4.84	18.5	3.25	-	-
21.	*Potentilla reptans* L.	10.33	0.16	14.16	3.16	4.66	0.40
22.	*Prunella vulgaris* L.	6.00	3.21	11.83	1.01	3.00	1.52
23.	*Rumex dentatus* L.	7.66	4.47	29.83	0.72	3.16	1.58
24.	*Scandix pectenveneris* L.	21.16	3.83	45.66	2.45	12.33	1.33
25.	*Sonchus oleraceus* L.	9.00	3.00	29.00	1.60	5.50	1.04
26.	*Setaria viridis* L.	31.33	1.45	38.70	2.12	-	-
27.	*Stellaria media* L.(Vill.)	20.83	10.93	36.70	7.94	11.50	1.25
28.	*Sysiumbrium irio* L.	4.33	2.18	12.70	1.76	-	-
29.	*Taraxacum officinale* Weber	16.83	3.91	38.34	12.17	10.66	2.04
30.	*Trifolium pratense* L.	21.33	0.72	25.16	7.48	11.50	0.50
31.	*Veronica persica* Poiret	12.66	6.33	15.50	2.78	5.16	0.77
32.	*Viola odorata* L.	12.66	6.34	16.00	2.56	6.00	0.34
Total		**568.20**	-	**1023.18**	-	**315.94**	-

Table-22: Basal area of different wild plants in Horti-silvi-pasture system of the study area (District Budgam)

S. No.	Plant species	Basal area(cm^2/m^2)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	0.38	0.05	0.52	0.03	0.14	0.01
2.	*Anagallis arvensis* L.	0.02	0.001	0.13	0.09	0.009	0.004
3.	*Anthemis cotula* L.	0.19	0.003	0.26	0.07	0.12	0.01
4.	*Asparagus officinalis L.*	0.98	0.20	1.23	0.62	0.13	0.01
5.	*Cannabis sativa* L.	1.10	0.25	1.57	0.06	0.48	0.10
6.	*Chenopodium album* L.	0.14	0.003	0.68	0.29	0.11	0.01
7.	*Clinopodium vulgare* L.	0.52	0.25	1.10	0.16	0.28	0.06
8.	*Convolvulus arvensis* L.	0.52	0.10	1.11	0.14	0.27	0.13
9.	*Conyza canadensis* L.Cronquist	0.76	0.29	1.07	0.01	0.55	0.21
10.	*Cynodon dactylon* L.	1.93	0.03	2.02	0.03	1.65	0.29
11.	*Daucus carota* L.	0.76	0.19	1.07	0.01	0.54	0.19
12.	*Galinsoga parviflora* Cav.	0.57	0.29	0.87	0.06	0.20	0.10
13.	*Geranium polyanthes* Edgew &Hook	0.65	0.15	0.89	0.03	0.27	0.06
14.	*Medicago polymorpha* L.(Benth.)	1.42	0.25	1.27	0.22	0.67	0.22
15.	*Mentha arvensis* L.	0.02	0.001	0.12	0.01	0.008	0.001
16.	*Oenothera rosea* L ‘ Her. ex Aiton	1.86	0.03	1.98	0.05	1.06	0.01

Contd…

Table 22 contd…

S. No.	Plant species	Basal area(cm^2/m^2)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Plantago lanceolata* L.	1.22	0.14	1.31	0.04	0.82	0.13
18.	*Plantago major* L.	1.24	0.62	1.33	0.03	0.93	0.13
19.	*Poa pratense* L.	1.25	0.62	1.34	0.01	0.98	0.16
20.	*Polygonum hydropiper* L.	1.32	0.05	1.35	0.02	-	-
21.	*Potentilla reptans* L.	0.35	0.10	0.51	0.11	0.17	0.08
22.	*Prunella vulgaris* L.	0.47	0.23	0.81	0.13	0.22	0.02
23.	*Rumex dentatus* L.	0.68	0.34	1.28	0.34	0.24	0.12
24.	*Scandix pectenveneris* L.	0.82	0.12	1.33	0.32	0.54	0.14
25.	*Sonchus oleraceus* L.	0.22	0.07	0.48	0.16	0.03	0.006
26.	*Setaria viridis* L.	1.05	0.01	1.15	0.04	-	-
27.	*Stellaria media* L.(Vill.)	0.38	0.03	0.83	0.15	0.25	0.06
28.	*Sysiumbrium irio* L.	0.25	0.08	0.41	0.06	-	-
29.	*Taraxacum officinale* Weber	0.71	0.19	1.09	0.08	0.38	0.04
30.	*Trifolium pratense* L.	0.92	0.40	1.10	0.07	0.69	0.11
31.	*Veronica persica* Poiret	0.51	0.25	0.90	0.05	0.24	0.006
32.	*Viola odorata* L.	0.51	0.30	0.91	0.04	0.25	0.004
Total		**23.21**	-	**31.12**	-	**11.98**	-

Table-23: Frequency of different wild plants in Horti-silvi-pasture system of the study area (District Budgam)

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	66.66	16.66	83.33	16.66	50.00	0.11
2.	*Anagallis arvensis* L.	16.66	5.10	33.33	16.66	15.00	1.63
3.	*Anthemis cotula* L.	58.33	8.33	66.66	16.66	50.00	0.32
4.	*Asparagus officinalis L.*	16.66	6.66	33.33	16.66	16.66	6.66
5.	*Cannabis sativa* L.	66.66	16.66	83.33	16.66	50.00	1.11
6.	*Chenopodium album* L.	61.11	30.93	66.66	9.62	50.00	0.12
7.	*Clinopodium vulgare* L.	50.00	1.12	83.33	16.66	33.33	16.66
8.	*Convolvulus arvensis* L.	50.00	0.023	66.66	16.66	33.33	16.66
9.	*Conyza canadensis* L.Cronquist	58.33	8.33	66.66	8.33	50.00	0.45
10.	*Cynodon dactylon* L.	94.44	5.55	100	9.66	83.33	8.33
11.	*Daucus carota* L.	53.33	3.33	65.00	7.63	46.66	3.33
12.	*Galinsoga parviflora* Cav.	50.00	18.86	66.66	16.66	33.33	16.66
13.	*Geranium polyanthes* Edgew &Hook	33.33	16.66	50.00	0.92	33.33	16.66
14.	*Medicago polymorpha* L.(Benth.)	75.00	14.43	86.11	7.34	58.33	8.33
15.	*Mentha arvensis* L.	16.66	6.66	33.33	16.66	6.66	0.33

Contd…

Table 23 contd…

S. No.	Plant species	Frequency (%)					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
16.	*Oenothera rosea* L ‘ Her. ex Aiton	77.77	14.78	94.44	5.55	58.33	8.33
17.	*Plantago lanceolata* L.	50.00	10.99	58.33	8.33	58.33	8.33
18.	*Plantago major* L.	50.00	25	75.00	10.41	50.00	11.09
19.	*Poa pratense* L.	50.00	18.86	66.66	16.66	50.00	18.86
20.	*Polygonum hydropiper* L.	50.00	10.11	83.33	16.66	-	-
21.	*Potentilla reptans* L.	50.00	16.20	66.66	16.66	33.33	16.66
22.	*Prunella vulgaris* L.	50.00	18.86	53.33	10.11	26.66	16.66
23.	*Rumex dentatus* L.	33.33	16.66	50.00	9.14	33.33	16.66
24.	*Scandix pectenveneris* L.	50.00	9.80	66.66	8.33	50.00	10.67
25.	*Sonchus oleraceus* L.	66.66	16.66	83.33	8.33	50.00	18.86
26.	*Setaria viridis* L.	83.33	16.66	91.66	8.33	-	-
27.	*Stellaria media* L.(Vill.)	58.33	10.04	75	14.43	50.00	10.34
28.	*Sysiumbrium irio* L.	41.66	12.04	66.66	8.33	0	0
29.	*Taraxacum officinale* Weber	66.66	16.66	75	10.43	50	18.86
30.	*Trifolium pratense* L.	58.33	8.33	66.66	16.66	50	18.86
31.	*Veronica persica* Poiret	50	18.86	66.66	16.66	33.33	16.66
32.	*Viola odorata* L.	51.66	10.08	70.00	11.09	33.33	8.98
Total		**1704.90**	**-**	**2127.11**	**-**	**1211.60**	**-**

Table-24: Importance Value Index (IVI) of different wild plants in Horti-silvi-pasture system of the study area (District Budgam)

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
1.	*Amaranthus caudatus* L.	7.56	1.14	7.96	1.67	7.10	0.62
2.	*Anagallis arvense* L.	1.81	0.05	2.93	0.81	1.91	0.50
3.	*Anthemis cotula* L.	5.48	1.01	5.94	1.35	6.59	0.48
4.	*Asparagus officinalis L.*	5.98	1.28	7.78	4.16	4.06	0.36
5.	*Cannabis sativa* L.	12.12	0.71	12.37	1.47	11.11	0.67
6.	*Chenopodium album* L.	6.02	3.27	8.82	2.00	6.91	0.68
7.	*Clinopodium vulgare* L.	6.10	1.21	8.45	0.80	5.84	0.31
8.	*Convolvulus arvensis* L.	6.27	1.85	9.59	1.02	6.06	3.10
9.	*Conyza canadensis* L.Cronquist	9.92	2.40	10.06	0.70	12.75	2.64
10.	*Cynodon dactylon* L.	29.63	1.70	21.02	0.83	41.92	6.75
11.	*Daucus carota* L.	9.58	0.69	9.93	0.62	12.22	2.30
12.	*Galinsoga parviflora* Cav.	6.48	1.86	6.94	1.12	5.34	2.82
13.	*Geranium polyanthes* Edgew &Hook	10.87	5.95	10.40	0.18	10.65	5.54
14.	*Medicago polymorpha* L.(Benth.)	17.87	3.53	14.00	1.77	19.52	1.04
15.	*Mentha arvensis* L.	1.48	0.06	2.98	0.73	1.01	0.08
16.	*Oenothera rosea* L ' Her. ex Aiton	21.44	0.97	18.08	0.82	25.15	3.30

Contd…

Table 24 contd…

S. No.	Plant species	Importance Value Index					
		Spring		Summer		Autumn	
		Mean	±S.E	Mean	±S.E	Mean	±S.E
17.	*Plantago lanceolata* L.	10.05	0.58	10.11	0.25	13.41	3.08
18.	*Plantago major* L.	10.89	5.76	11.06	0.84	13.75	4.54
19.	*Poa pratense* L.	10.78	5.75	9.47	1.26	14.56	1.83
20.	*Polygonum hydropiper* L.	11.04	1.04	9.77	0.86	-	-
21.	*Potentilla reptans* L.	6.20	0.96	6.01	0.95	5.58	2.90
22.	*Prunella vulgaris* L.	6.25	0.57	6.10	0.40	4.86	2.55
23.	*Rumex dentatus* L.	6.01	3.23	9.24	0.99	5.66	2.90
24.	*Scandix pectenveneris* L.	10.14	1.35	11.64	1.43	12.44	1.05
25.	*Sonchus oleraceus* L.	6.54	0.98	8.19	1.01	5.80	0.33
26.	*Setaria viridis* L.	14.85	1.26	11.54	0.29	-	-
27.	*Stellaria media* L.(Vill.)	9.08	0.20	9.57	1.65	9.79	0.40
28.	*Sysiumbrium irio* L.	4.12	2.27	5.54	0.53	-	-
29.	*Taraxacum officinale* Weber	9.78	0.77	10.62	1.03	10.53	0.91
30.	*Trifolium pratense* L.	11.22	2.06	8.87	1.69	12.58	0.52
31.	*Veronica persica* Poiret	7.16	3.80	7.32	0.84	6.26	3.22
32.	*Viola odorata* L.	7.15	3.00	7.54	0.45	6.48	3.00
Total		**300**	**-**	**300**	**-**	**300**	**-**

Table-25: Interaction between Density (individuals/m^2) of wild plants in prevalent agroforestry systems and seasons

Systems	Seasons			
	Spring	Summer	Autumn	Mean
Boundary plantation	330.20	826.50	161.00	**439.23**
Homegarden	79.35	347.64	39.47	**155.48**
Horti-agricultural system	221.70	413.44	103.43	**246.19**
Horti-silvi-pasture system	568.20	1023.18	315.94	**635.77**
Mean	**299.86**	**652.70**	**154.96**	**-**

C.D (p≤0.05)

Systems: 30.60
Seasons: 25.60
Systems: Seasons: 51.20

Table-26: Interaction between Basal area (cm^2/m^2) of wild plants in prevalent agroforestry systems and seasons

Systems	Seasons			
	Spring	Summer	Autumn	Mean
Boundary plantation	11.14	17.00	7.45	**13.85**
Homegarden	8.12	10.38	2.66	**7.05**
Horti-agricultural system	10.83	17.13	6.67	**11.54**
Horti-silvi-pasture system	23.21	31.11	11.96	**22.09**
Mean	**13.32**	**18.90**	**7.18**	**-**

C.D (p≤0.05)

Systems: 2.07
Seasons: 1.79
Systems: Seasons: 3.59

4.6 Vegatation indices of wild plants

Similar to other quantitative parameters recorded for wild plants in different seasons among prevalent agroforestry systems of District Budgam, various vegetation indices were also calculated with respect to spring, summer and autumn. The data presented in Table-27 explicated that these indices were also highest for summer and lowest for autumn season. The results so obtained are explained below:

4.6.1 Shannon weiner index

Shannon weiner index of wild herbaceous vegetation in different agroforestry systems showed a marked difference among three seasons and ranged as 2.90 (spring), 3.05 (summer) and 2.52 (autumn) in Boundary plantation; 2.62 (spring), 2.87 (summer) and 2.17 (autumn) in Homegarden; 2.77 (spring), 2.89 (summer) and 2.54 (autumn) in Horti-agricultural system; 2.97 (spring), 3.21 (summer) and 2.74 (autumn) in Horti-silvi-pasture system. In general, it was analyzed that this index was maximum for the summer season in all agroforestry systems (Table-27; Fig. 6).

4.6.2 Simpson's diversity index

Simpson's diversity index measured for different systems with respect to seasons showed inverse relation to Shanon weiner index. This diversity ranged as 0.066 (spring), 0.060 (summer) and 0.09 (autumn) for Bounadary plantation; 0.07 (spring), 0.061 (summer) and 0.11 (autumn) for Homegarden; 063 (spring), 0.05 (summer) and 0.08 (autumn) for Horti-agricultural system; 0.067(spring), 0.046 (summer) and 0.086 (autumn) in Horti-silvi-pasture system. From the above data, it was obtained that the maximum value for this diversity index was evaluated for autumn season (Table-27; Fig. 7).

4.6.3 Species evenness

Data pertaining to species evenness (Table-27; Fig. 8) in wild plants corresponds to Shannon weiner index i.e. maximum value was evaluated for summer season and minimum for autumn. The values for this index obtained for prevalent agroforestry systems of District Budgam during three seasons were 0.84 (spring), 0.88 (summer) and 0.76 (autumn) in Boundary plantation; in Homegarden 0.86 (spring), 0.94 (summer) and 0.78 (autumn); 0.90 (spring), 0.95 (summer) and 0.88 (autumn) in Horti-agricultural system; for Horti-silvi-pasture system as 0.85 (spring), 0.93 (summer) and 0.82 (autumn).

4.6.4 Concentration of dominance

Critical view of the data (Table-27; Fig. 9) pertaining to concentration of dominance illustrated similar trend as Simpson diversity i.e. maximum value evaluated for autumn season and minimum for summer. The values in three consecutive seasons for prevalent agroforestry systems were 0.07 (spring), 0.061 (summer) and (0.10) in autumn for Bounadary plantation; 0.08 (spring) 0.063 (summer) and 0.13 (autumn) for Homegarden; 0.068 (spring), 0.060 (summer) and 0.09 (autumn) for Horti-agricultural system; for Horti-silvi-pasture system 0.07 (spring), 0.047 (summer) and 0.09 (autumn).

Table-27: Vegetation indices of wild plant species in prevalent agroforestry sytems of the study area (District Budgam)

Agroforestry Systems	Vegetation Indices	Seasons		
		Spring	Summer	Autumn
Boundary plantation	Shannon weiner index	2.90	3.05	2.52
	Simpson's diversity index	0.066	0.060	0.09
	Species evenness	0.84	0.88	0.76
	Concentration of dominance	0.07	0.061	0.10
Homegarden	Shannon weiner index	2.62	2.87	2.17
	Simpson's diversity index	0.07	0.061	0.11
	Species evenness	0.86	0.94	0.78
	Concentration of dominance	0.08	0.063	0.13
Horti-agricultural system	Shannon weiner index	2.77	2.89	2.54
	Simpson's diversity index	0.063	0.05	0.08
	Species evenness	0.90	0.95	0.88
	Concentration of dominance	0.068	0.06	0.09
Horti-silvi-pasture system	Shannon weiner index	2.97	3.21	2.74
	Simpson's diversity index	0.067	0.046	0.086
	Species evenness	0.85	0.93	0.82
	Concentration of dominance	0.07	0.047	0.094

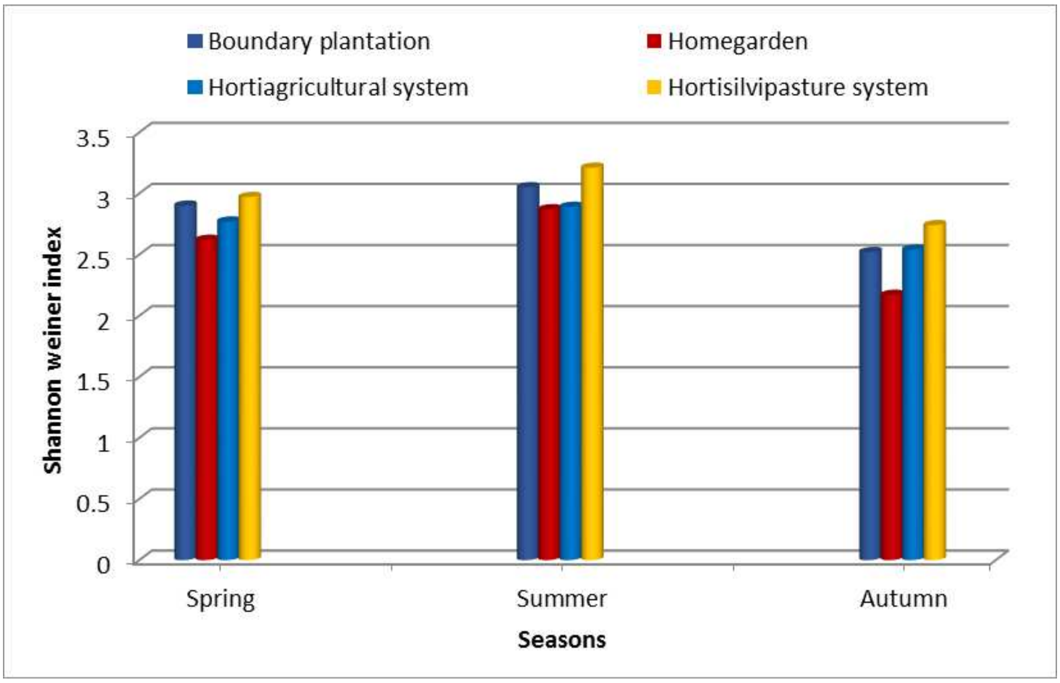

Fig. 6: Seasonal Shannon weiner index of wild plants in agroforestry systems of the study area (District Budgam)

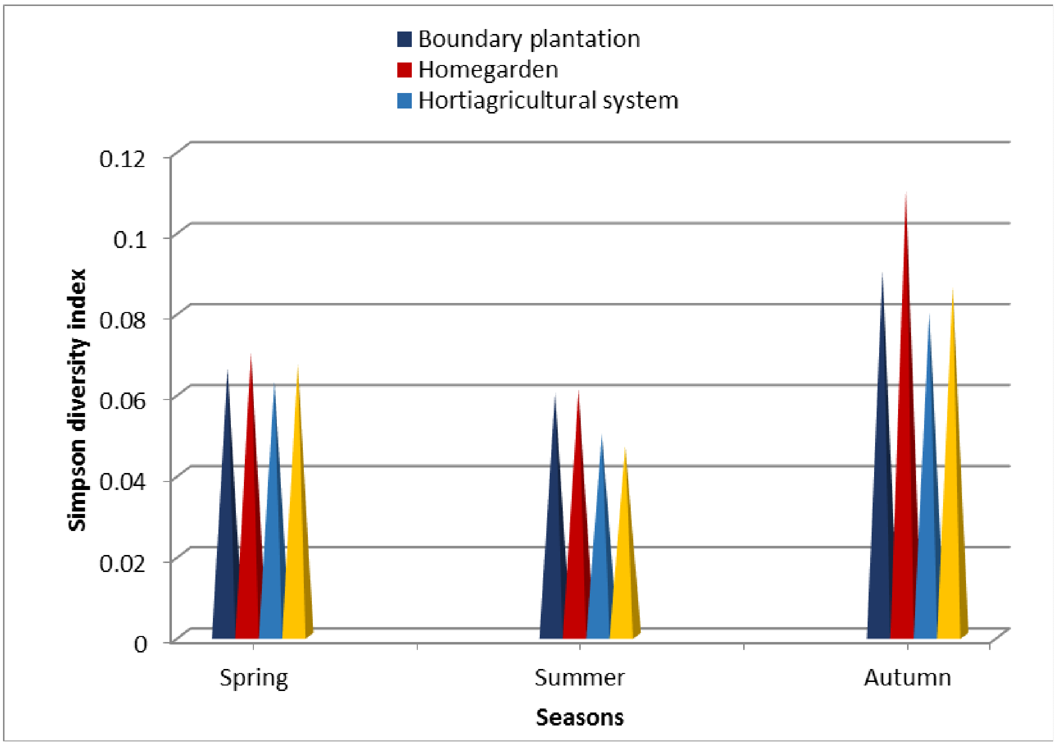

Fig. 7: Seasonal Simpson diversity index of wild plants in agroforestry systems of the study area (District Budgam)

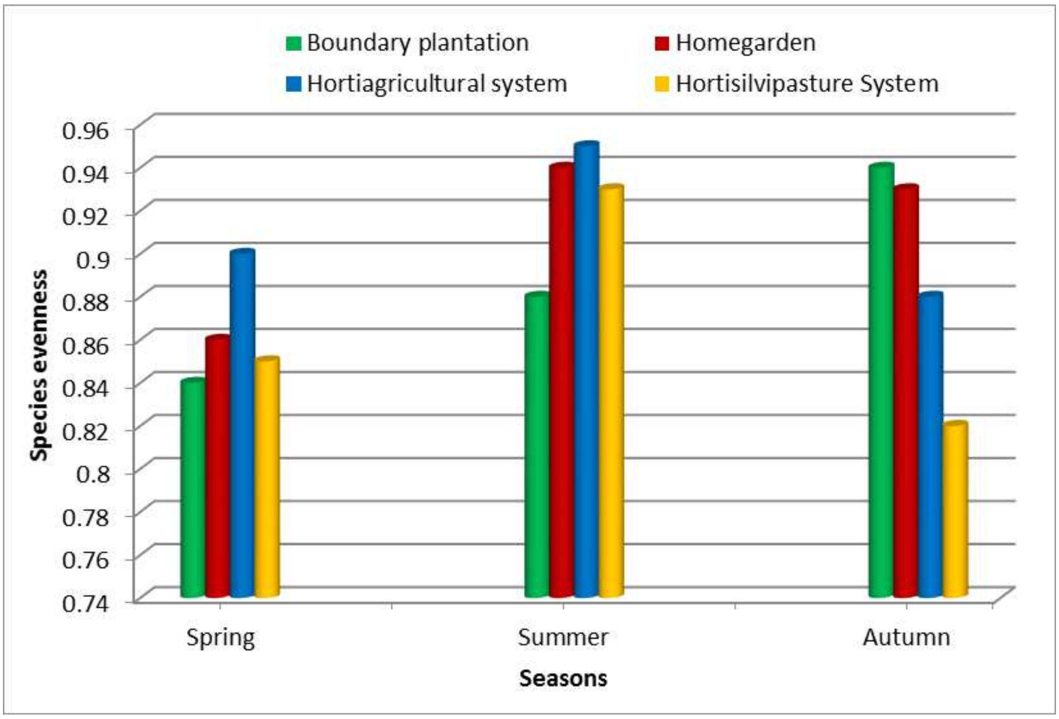

Fig. 8: Seasonal species evenness of wild plants in agroforestry systems of the study area (District Budgam)

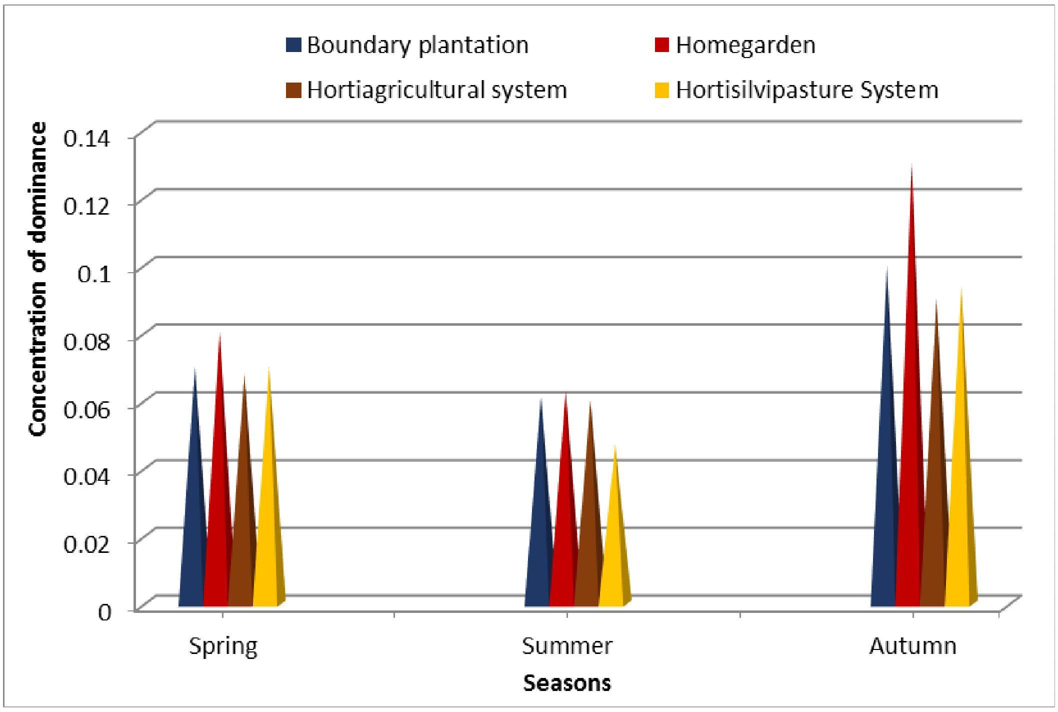

Fig. 9: Seasonal concentration of dominance of wild plants in agroforestry systems of the study area (District Budgam)

4.7 Quantitative/Phyto-sociological attributes of shrubs in prevalent agroforestry systems of District Budgam

The data encapsulated on quantitative/phytosociological attributes/ community structure of shrubs is presented in Table-28. The vegetation analysis of the study area shows that the prevalent agroforestry systems comprised of three shrub species representing two families viz., Rosaceae and Lilliaceae. The findings of the quantitative attributes/phytosociological attributes/community structure of shrubs i.e. density (number of plants ha^{-1}), basal area (m^2 ha^{-1}), frequency (%) and importance value index (IVI) in different prevalent agroforestry systems are described as under:

4.7.1 Boundary plantation

Perusal of the data in Table-28 summarizes that in Boundary plantation agroforestry system, single shrub specie's *viz*., *Rubus niveus* representing the family Rosaceae was found. The data so obtained explained that density of this specie's was found to be 133.33 ha^{-1} with a basal area of 0.066 m^2 ha^{-1}. The frequency exhibited was 20 per cent with an importance value index (IVI) of 300 revealing complete dominance over the site/system.

4.7.2 Homegarden

No shrub species was found in this particular agroforestry system.

4.7.3 Horti-agricultural system

Detailed view of the data presented in Table-28 revealed that *Rubus ulmifolius* was the only shrub species found in this agroforestry system achieving density (number of plants/ha) and basal area of 400 ha^{-1} and 0.087 m^2 ha^{-1} respectively with a frequency value of 33.33 per cent. In view of the fact that *Rubus ulmifolius* was the only shrub species, the importance value index achieved by the species was 300, indicating its complete dominance in this particular agroforestry system.

4.7.4 Horti-silvi-pasture system

The data encapsulated in Table-28 revealed that three shrub species representing/characterizing two families were found in this system viz., *Asparagus officinalis* (Lilliaceae), *Rubus niveus* (Rosaceae) *and Rubus ulmifolius* (Rosaceae). Among the above mentioned three shrub species, maximum density (number of plants/ha) was achieved by *Rubus niveus* (483.33 ha^{-1}) followed by *Rubus ulmifolius* (316.66 ha^{-1}) and minimum by *Asparagus officinalis* (266.67 ha^{-1}).

Basal area followed the similar trend i.e. maximum value exhibited by *Rubus niveus* (0.043 m^2/ha) followed by *Rubus ulmifolius* (0.015 m^2/ha). The frequency value for these species viz., *Asparagus officinalis*, *Rubus niveus and Rubus ulmifolius* was in order of 30.00, 33.40 and 66.70 per cent respectively. The dominant species of this agroforestry system was *Rubus niveus* with highest importance value index (IVI) of 160.23 followed by its co-dominant *Rubus ulmifolius* with 85.04 of IVI (importance value index) with least value obtained by *Asparagus officinalis* as 54.71.

Table-28: Quantitative/phytosociological attributes of shrubs in prevalent agroforestry systems of the study area (District Budgam)

Phytosociological attributes→ Agroforestry systems/species↓	Density (plants ha^{-1})		Basal area (m^{2} ha^{-1})		Frequency (%)		Importance value index (IVI)	
	Mean	±S.E	Mean	±S.E	Mean	±S.E	Mean	±S.E
Boundary plantation								
Rubus niveus Thunb.	133.33	17.09	0.066	0.001	20.00	0.14	300	0.01
Total	**133.33**	**-**	**0.066**	**-**	**20.00**	**-**	**300**	-
Homegarden								
Shrub absent	-	-	-	-	-	-	-	-
Horti-agricultural system								
Rubus ulmifolius Schott.	400	80	0.087	0.03	33.33	10.00	300	10.90
Total	**400**	**-**	**0.087**	**-**	**33.33**	**-**	**300**	-
Horti-silvi-pasture system								
Asparagus officinalis L.	266.67	133.33	0.0084	0.004	30.00	33.33	54.71	23.73
Rubus niveus Thunb.	483.33	60.09	0.043	0.014	66.70	50.00	160.23	12.32
Rubus ulmifolius Schott.	316.66	60.09	0.015	0.004	33.40	50.00	85.04	16.41
Total	**1066.66**	**-**	**0.063**	**-**	**130.10**	**-**	**300**	-

4.8 Vegetation indices of shrub species

Various vegetation indices of shrub layer/species in different prevalent agroforestry systems are presented in Table-29 (Fig. 10) as:

4.8.1 Shannon weiner index

Perusal of the data in Table-29 summarized that Shannon weiner index for shrubs ranged from 0 (Boundary plantation and Horti-agricultural system) to 0.93 (Horti-silvi-pasture system). In Homegardens, shrub layer was absent.

4.8.2 Simpson diversity index

Detailed examination of the data recorded for Simpson index revealed that the value for this index was found to be highest in Boundary plantation and Horti-agricultural system as 1.00. As, these systems were dominated by only one species viz., *Rubus niveus* and *Rubus ulmifolius* each in respective agroforestry systems. For Horti-silvi-pasture system, the value obtained for this index was 0.403 (Table-29).

4.8.3 Species evenness

Species evenness in prevalent agroforestry systems in Table-29 depicted the similar trend as Shannon weiner index for shrubs i.e. 0 (zero) in Boundary plantation and Horti-agricultural system and 0.85 in Horti-silvi-pasture system. The value 0 (zero) depicted for Boundary plantation and Horti-agricultural system indicates presence of single shrub species in these agroforestry systems.

4.8.4 Concentration of dominance

Analogous to Simpson diversity index, this index also showed maximum values for Boundary plantation and Horti-agricultural system as 1.00. For Horti-silvi-pasture system the value obtained so was 0.404 (Table-29).

Table -29: Vegetation indices of shrubs in prevalent agroforestry systems of the study area (District Budgam)

Agroforestry systems \ Diversity Index	Shannon weiner index	Simpson diversity index	Species evenness	Concentration of dominance
Boundary plantation	0	1.00	0	1.00
Horti-agricultural system	0	1.00	0	1.00
Horti-silvi-pasture system	0.93	0.403	0.85	0.404

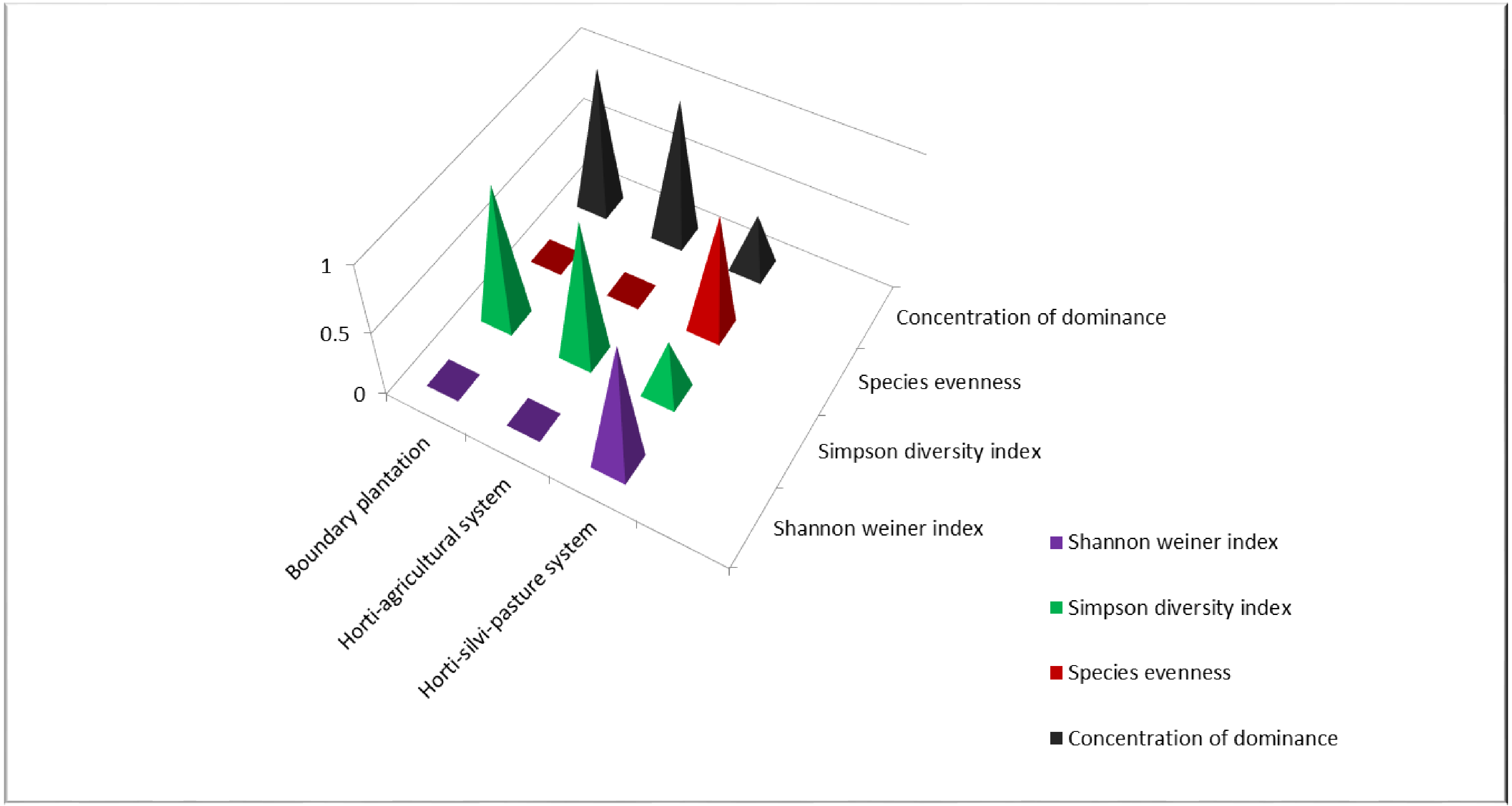

Fig. 10: Vegetation indicesof shrubs in prevalent agroforestry systems of the study area (District Budgam)

4.9 Quantitative/phytosociological attributes of trees in prevalent agroforestry systems of District Budgam

Data on quatitative/phytosociological attributes of trees is presented in Table-30. The vegetation analysis of the study area shows that the prevalent agroforestry systems comprised of fourteen species belonging to six families *viz*., Juglanaceae, Leguminoceae, Punicaceae, Rosaceae, Salicaceae,and Ulmaceae representing both broad leaved and fruit trees. Boundary plantation was represented by four tree species characterizing broad leaved category *viz*., *Populus deltoides*, *Populus nigra*, *Salix alba* and *Salix fragilis*.

Homegarden recorded 12 species comprised of both broad leaved and fruit trees i.e. *Cydonia oblonga, Juglans regia, Malus domestica*, *Populus deltoides, Populus nigra*, *Prunus dulcis*, *Prunus persica, Punica granatum, Pyrus communis, Salix alba*, *Salix fragilis* and *Ulmus wallichiana*.

In Horti-agricultural system 3 fruit tree species *viz*., *Malus domestica*, *Prunus domestica* and *Pyrus communis* represented the upper layer vegetation. Similarly, for Hoti-silvi-pasture system broad leaved category was characterized by *Populus deltoides*, *Populus nigra*, *Robinia pseudoacacia* and *Salix alba*, while fruit trees represented by *Malus domestica*, *Prunus domestica* and *Pyrus communis* showed the prevalence.

The findings of the quantitative /phytosociological attributes/community structure of trees i.e. density (number of plants ha^{-1}), basal area (m^2 ha^{-1}), frequency (%) and importance value index (IVI) in different prevalent agroforestry systems are illustrated as under:

4.9.1 Density

Critical analysis of the data in Table-30 explicated that total density ha^{-1} achieved in prevalent agroforestry systems of the study area were 300/ha (Boundary plantation), 244.01 ha^{-1} (Homegarden), 1033.33 ha^{-1} (Horti-agricultural system and 1268.33 ha^{-1} (Horti-silvi-pasture system). Boundary plantation with density of 100 ha^{-1} was dominated by *Populus deltoides* followed by *Populus nigra* (83.33 ha^{-1}) with minimum density value achieved by *Salix fragilis* (50 ha^{-1}). In Homegarden agroforestry system, the total density achieved by different trees was 244.01 ha^{-1} with *Malus domestica* being dominant exhibiting highest density value of 66.67 ha^{-1} followed by *Populus nigra* (36.66 ha^{-1}) and lowest achieved by *Juglans regia* (6.66 ha^{-1}).

For Horti-agricultural system, the maximum density (466.67 ha^{-1}) was exhibited by *Malus domestica* followed by *Prunus domestica* (366.66 ha^{-1}). *Pyrus communis* indicated minimum density as 200 ha^{-1}.

Malus domestica in Horti-silvi-pasture system with density value of 300/ha was the major contributor to number of trees per hectare followed by *Prunus domestica* 267 ha^{-1} and *Robinia pseudoacacia* as least contributor (34 ha^{-1}).

4.9.2 Basal area

Perusal of the data in Table-30 described the basal area (m^2 ha^{-1}) of the different tree categories in prevalent agroforestry systems of District Budgam. In Boundary plantation, *Populus deltoides* exhibited the maximum basal area value of 2.41 m^2 ha^{-1} with minimum value achieved by *Salix fragilis* (0.84 m^2 ha^{-1}). *Malus domestica* in Homegarden agroforestry system indicated highest basal area value of 0.57 m^2 ha^{-1} followed by *Populus nigra* (0.52 m^2 ha^{-1}) and lowest achieved by *Juglans regia* (0.03m^2 ha^{-1}). The maximum basal area (4.91m^2 ha^{-1}) in Horti-agricultural system was exhibited by *Malus domestica* followed by *Prunus domestica* (3.28 m^2 ha^{-1}) and minimum recorded for *Pyrus communis* as 2.76 m^2 ha^{-1}.

Similarly, in Horti-silvi-pasture system, *Malus domestica* was evaluated as major contributor in terms of basal area achieving 4.40 m^2 ha^{-1} followed by *Prunus domestica* 4.28 m^2 ha^{-1} and *Robinia pseudoacacia* as least contributor (0.69 m^2 ha^{-1}).

Table-30: Quantitative/Phytosociological attributes of tree species in prevalent agroforestry systems of the study area (District Budgam)

Phytosociological attributes → Agroforestry systems/species↓	Density (plants ha^{-1})		Basal area (m^2 ha^{-1})		Frequency (%)		Importance value index (IVI)	
	Mean	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**	**Mean**	**±S.E**
Boundary plantation								
Populus deltoides Bartr.	100.00	0.00	2.41	0.24	100.00	11.09	118.01	18.76
Populus nigra Bartr.	83.33	16.66	1.34	0.33	73.40	12.31	79.40	13.04
Salix alba L.	66.66	13.34	1.02	0.51	53.34	19.05	52.72	16.36
Salix fragilis L.	50.00	8.86	0.84	0.44	50.00	18.86	49.86	14.98
Total	**300.00**	-	**5.61**	-	**276.74**	-	**300**	-
Homegarden								
Cydonia oblonga Mill.	13.34	2.33	0.09	0.001	13.34	1.71	18.08	0.25
Juglans regia L.	6.66	0.60	0.03	0.01	8.34	1.90	7.22	4.55
Malus domestica Borkh.	66.67	1.61	0.57	0.03	83.33	0.34	57.09	6.41
Populus deltoides L.	26.66	1.32	0.50	0.01	60.00	0.67	44.50	1.24
Populus nigra L.	36.66	0.98	0.52	0.21	66.70	11.02	47.81	3.33
Prunus dulcis L.	10.00	0.21	0.11	0.03	46.70	3.65	16.33	4.56
Prunus persica L.	13.33	1.11	0.11	0.03	33.40	7.00	18.14	2.34
Punica granatum L.	26.66	1.22	0.08	0.005	33.40	11.12	22.71	11.98
Pyrus communis L.	13.33	0.45	0.12	0.02	33.40	0.45	13.02	0.34
Salix alba L.	13.33	0.15	0.19	0.009	58.33	2.34	33.73	10.10
Salix fragilis L.	10.00	0.15	0.13	0.01	33.40	0.94	12.15	0.45
Ulmus wallichiana L.	7.34	0.27	0.05	0.08	10.00	1.21	9.15	0.11
Total	**244.01**		**2.50**		**480.31**		**300**	

Contd…

Table 30 contd…

Phytosociological attributes → / Agroforestry systems/species↓	Density (plants ha^{-1})		Basal area (m^2 ha^{-1})		Frequency (%)		Importance value index (IVI)	
	Mean	±S.E	Mean	±S.E	Mean	±S.E	Mean	±S.E
Horti-agricultural system								
Malus domestica Borkh.	466.67	33.54	4.91	0.19	100.00	10.76	134.50	20.18
Prunus domestica L.	366.66	31.32	3.28	0.32	66.66	12.12	93.01	9.68
Pyrus communis L.	200	20.31	2.76	0.22	66.66	20.80	72.48	9.523
Total	**1033.33**	**-**	**10.95**	**-**	**233.32**	**-**	**300**	**-**
Horti-silvi-pasture system								
Malus domestica Borkh.	300.00	57.73	4.40	0.63	100.00	50.56	72.00	7.31
Populus deltoides Bart.	200.00	57.73	4.08	1.44	47.00	10.34	40.00	8.63
Populus nigra Bart.	167.00	88.19	2.77	1.40	35.00	13.33	38.00	8.60
Prunus domestica L.	267.00	33.33	4.28	0.32	84.00	33.33	65.47	6.67
Pyrus communis L.	233.33	88.19	4.15	0.20	67.00	50	54.71	8.92
Robinia pseudoacacia L.	34.00	33.33	0.69	0.18	14.00	3.33	12.00	1.42
Salix alba L.	67.00	33.33	1.03	0.53	24.00	4.12	17.24	8.72
Total	**1268.33**	**-**	**21.40**	**-**	**371.00**	**-**	**300**	**-**

4.9.3 Frequency (%)

The data presented in Table-30 depicts that frequency of tree species varied among different prevalent agroforestry systems. *Populus deltoides* achieved 100 % frequency followed by *Populus nigra* of 73.40 % and lowest frequency of 50 % by *Salix fragilis* in Boundary plantation. Likewise, in Homegarden, *Malus domestica* exhibited highest frequency of 83.33 % and lowest frequency evaluated for *Juglans regia* as 8.34%.

In Horti-agricultural system, a frequency of 100 % was recorded for *Malus domestica* followed by *Prunus domestica* and *Pyrus communis* at the same frequency of 66.66 %. Similarly, in Horti-silvi-pasture system, the maximum frequency of 100 % was calculated for *Malus domestica* followed by *Prunus domestica* as 84 % and minimum of 14 % for *Robinia pseudoacacia*.

4.9.4 Importance value index (IVI)

Critical examination of the result (Table-30 and Fig. 11) revealed a profound variation in IVI of trees amongst agroforestry systems of District Budgam. In Boundary plantation, the dominant and important species exhibiting higher IVI value was found to be *Populus deltoides* (118.01) and *Populus nigra* as its co-dominant (79.40). *Salix alba* and *Salix fragilis* were evaluated as other prominent species with IVI value of 52.72 and 49.86 respectively.

The IVI value also varied among different tree species in Homegarden agroforestry system with *Malus domestica* being the dominant species achieving maximum IVI value of 57.09 followed by *Populus nigra* and *Populus deltoides* as other prominent species exhibiting 47.81 and 44.50 respectively. The minimum IVI was recorded for *Juglans regia* with a value as 7.22.

Malus domestica in Horti-agricultural system showed maximum importance value as 134.50 dominating *Prunus domestica* and *Pyrus communis* as co-dominants with an IVI of 93.01 and 72.48. Likewise, for Horti-silvi-pasture system, the maximum IVI value of 72.00 was evaluated for *Malus domestica*,

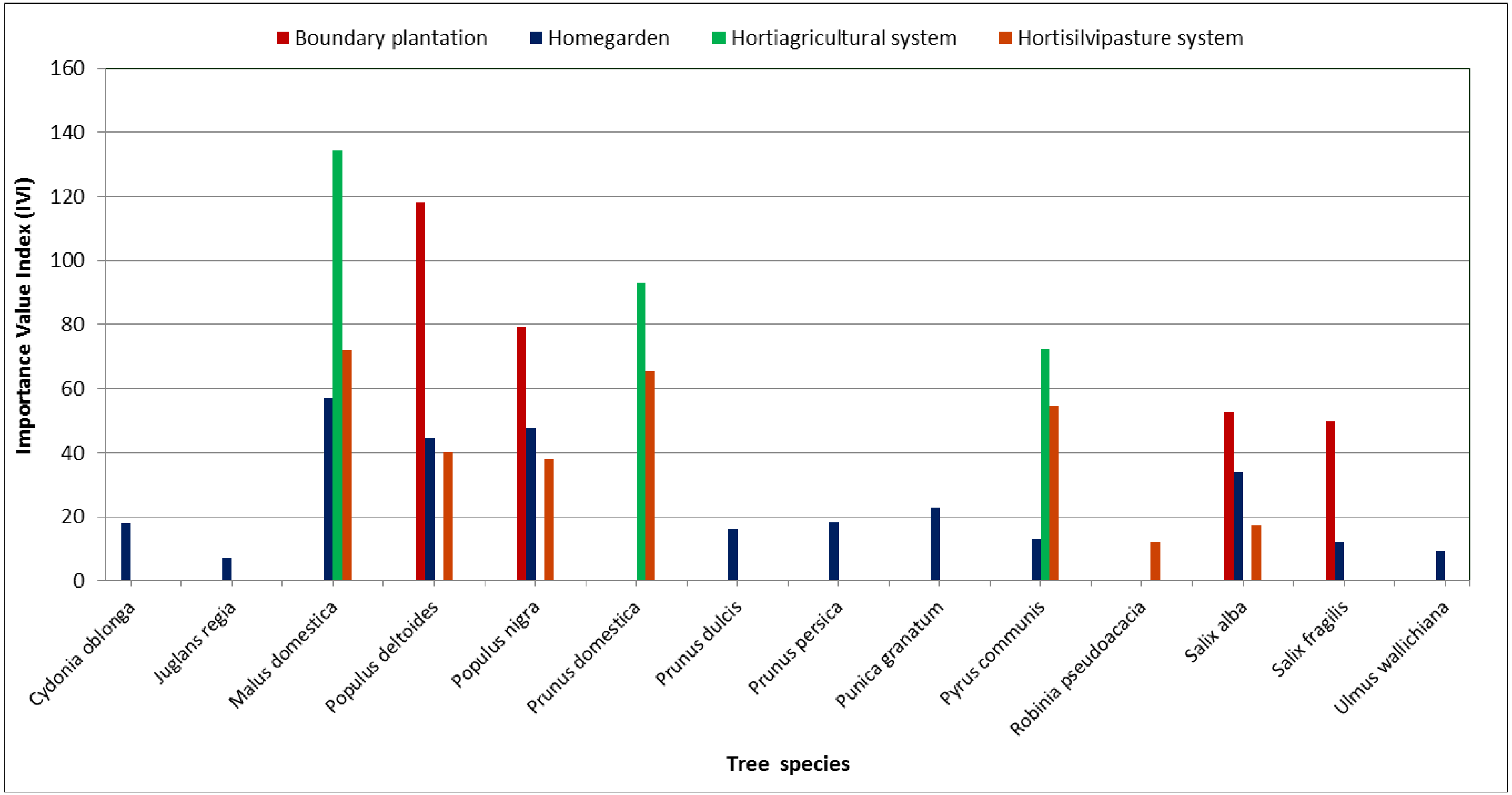

Fig. 11: **Graphical representation of IVI of different tree species in prevalent agroforestry systems of the study area (District Budgam)**

followed by 65.47 for *Prunus domestica*, 54.71 for *Pyrus communis* and minimum for *Robinia pseudoacacia* as 12.00.

4.10 Vegetation indices of tree species

Data pertaining to various indices of tree species in different prevalent agroforestry systems are presented in Table-31 (Fig. 12) as:

4.10.1 Shannon weiner index

Table-31 (Fig. 12) presents the data on Shannon weiner index for tree species in prevalent agroforestry systems of District Budgam. This value ranged between 1.04 to 1.64. Boundary plantation recorded this index as 1.17, 1.60 in Homegarden, 1.04 in Horti-agricultural system and 1.64 in Horti-silvi-pasture system.

4.10.2 Simpson diversity index

Simpson diversity index was recorded as 0.30 for Boundary plantation obtained the value of this index as, 0.22 for Homegarden, 0.35 for Horti-agricultural system and for Horti-silvi-pasture system as 0.207 (Table-31; Fig. 12).

4.10.3 Species evenness

Perusal of the data on species evenness in prevalent agroforestry systems in Table-31(Fig. 12) depicted that Boundary plantation recorded species evenness value as 0.84, 0.64 in Homegarden, 0.95 in Horti-agricultural system and 0.84 in Horti-silvi-pasture system.

4.10.4 Concentration of dominance

Critical investigation of the data in Table-31 (Fig. 12) revealed that concentration of dominance in Boundary planatation was 0.31, 0.24 in Homegarden, 0.36 in Horti-agricultural system. For Horti-silvi-pasture system the value obtained so was 0.208.

4.11 Similarity Index (%)

Similarity index among prevalent agroforestry systems varied from 23.18 % to 51.35%. Boundary plantation showed highest similarity index of 51.35% with Horti-silvi-pasture. However, it had least similarity with Horti-agricultural system achieving a value of 23.18 % (Table-32).

Homegarden agroforestry system demostrated least similarity index with Horti-silvi-pasture system (25.88%). Vegetation in Horti-agricultural system showed highest similarity index value with Horti-silvi-pasture system (43.07%) and least with Boundary plantation (23.18%). Horti-silvi-pasture recorded maximum similarity with Boundary plantation (51.35%) and minimum with Homegarden (25.88%) (Table-32).

Table -31: Vegetation indices of trees in prevalent agroforestry systems of the study area (District Budgam)

Agroforestry systems / Diversity indices	Shannon weiner index	Simpson diversity index	Species evenness	Concentration of dominance
Boundary plantation	1.17	0.30	0.84	0.31
Homegarden	1.60	0.22	0.64	0.24
Horti-agricultural system	1.04	0.35	0.95	0.36
Horti-silvi-pasture system	1.64	0.207	0.84	0.208

Table-32: Indices of similarity (%) in vegetation of prevalent agroforestry systems of the study area (District Budgam)

Agroforestry systems	Boundary planatation	Homegarden	Horti-agricultural system	Horti-silvi-pasture system
Boundary plantation	-	29.21	23.18	51.35
Homegarden	29.21	-	32.50	25.88
Horti-agricultural system	23.18	32.50	-	43.07
Hoti-silvi-pasture system	51.35	25.88	43.07	-

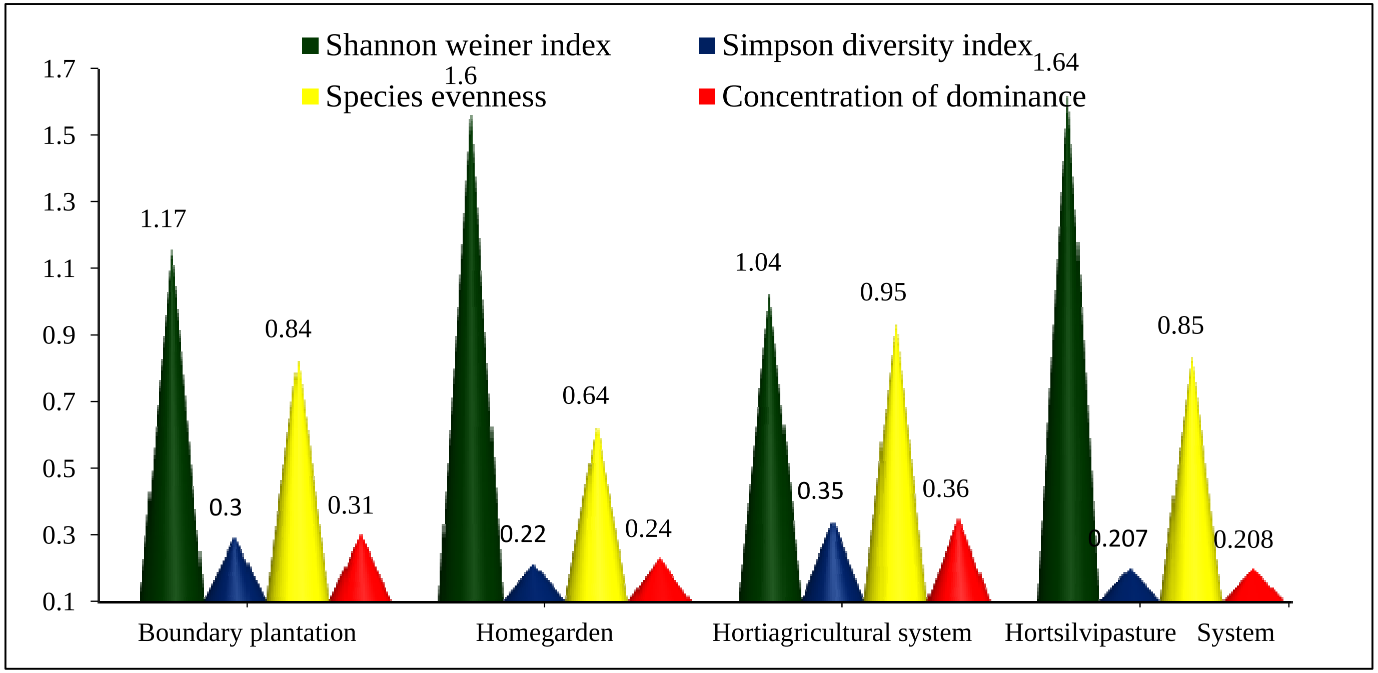

Fig. 12: Vegetation indices of trees in prevalent agroforestry systems of the study area (District Budgam)

4.12 Contribution of prevalent agroforestry systems in fulfilment of household needs

To evaluate the contribution of prevalent agroforestry systems in fulfilment of individual household needs, respondents were interviewed through pre-tested questionnaire (Annexure IV-XXI) seeking information on the following parameters as:

4.12.1 General information of the study area

From the comprehensive investigation (Table-33) of the site, it was calculated that the whole sample area (252 farmers) makeup about 136.84 ha of landholdings inclusive of residential places out of which 1.1 ha was leased out to airdrome @ 300/- per month. It was also evaluated that the dwellings of the farmers were made of pucca houses only.

Table-33: General information of the study area

Blocks	Total land (ha) (kanals)*	Leased in (ha)	Leased out (ha) (kanals)*	House	
				Kuccha	Pucca
B.K.Pora	16.41 (328.20)*	-	1.1 (22)*	-	+
Nagam	39.21 (784.20)*	-	-	-	+
Budgam	17.91 (358.30)*	-	-	-	+
Khan Sahib	25.72 (514.40)*	-	-	-	+
Narbal	20.24 (404.80)*	-	-	-	+
Beerwah	17.35 (347.03)*	-	-	-	+
Total	**136.84 (2736.93)***	**-**	**1.1 (22)***	-	

4.12.2 Age of respondents

On the basis of age groups, the respondents were classified into three categories; young age (<18 years old), middle age (19-50 years old) and old age (>50 years old). Number and percentage distribution of farmers according to their age group has been shown in the Table-34. During reconnaissance, it was assessed that the majority of the respondents occurred in the middle age category (139; 55.15%) as this age group is more involved with the farming activities including agroforestry.

Table-34: Age of respondents

Category	Respondents	
	Number	Percent (%)
Young age (<18 years)	-	-
Middle age (19-50 years)	139	55.15
Old age (>50 years)	113	44.84
Total	**252**	**100**

4.12.3 Family size

The family size of the respondents was classified into three categories. These were small (2-4 members), medium (5-10 members), and large (more than 10 members). Data presented in the Table-35 indicated that, family size of the respondents ranged from 5 to 10 (68.25%) i.e. most of families fall in the medium size category which was also a representative of typical family size in Kashmir valley. In District Budgam, it is very common to live together with parents and with brothers and sisters as joint family.

Table-35: Family size of respondents

Category	Family size	
	Number	**Percent (%)**
2-4 members (Small)	44	17.46
5-10 members (Medium)	172	68.25
>10 members (Large)	36	14.28
Total	**252**	**100**

4.12.4 Education

The levels of education were categorized into four groups viz., illiterate (no schooling), primary level (class I-V), secondary level (class VI-X), and above secondary level (college and university). The education level of the respondents ranged from no formal education to above college levels with highest percentage of respondents falling in illiterate category (50.00%) followed by respondents falling under secondary level education cateogory (25.83%). The level of education of the respondents is shown in Table-36.

Table-36: Education level of respondents

Category	Respondent	
	Number	**Percent (%)**
Illiterate (No schooling)	126	50.00
Primary level (I-V)	23	9.12
Secondary level (VI-X)	65	25.83
Higher educated (College, University)	38	15.07
Total	**252**	**100**

4.12.5 Occupation

In District Budgam, maximum number of population are either involved in agriculture or engaged in business, while some earn their income/livelihood from daily labour in the local areas or elsewhere. The occupation of the respondents was classified into four groups. Among the four occupations of the respondents, daily labour was found to be the major occupation of the people (31.34%) in the study area. Besides it, agriculture (24.60%) ranked second as the occupation of the people/respondents being interviewed (Table-37).

Table -37: Occupation of respondents

Category	**% of the Respondents**
Agriculture	24.60
Service	23.01
Business	21.03
Daily labour	31.34

4.12.6 Income

Through survey/study, it was assessed that people of the area have different sources of income, like they have set up small business units, some are employed in government run departments, institutions etc. and others use to support their families by doing daily labour works in order to meet their needs and requirements easily and get extra income/money saved for smooth management of their land holdings (Table-38). The income from daily labour was found to be more (Rs 453971.20; 41.87%) than business and employment.

Table -38: Income sources in the study area

Source	Income (Rs)	% age
Business	267937.70	24.71
Employment	362237.52	33.41
Labour	453971.20	41.87
Total	**10,84,146.42**	**100**

4.12.7 Land use pattern/system

Mainly agriculture is an important land use pattern covering about 55.16 ha of total land area, but farmers have involved their lands for cultivating horticultural and vegetable crops also. Furthermore, it was appraised that the farmers in the study area belongs to marginal (land holding < 1 ha) to small (land holding 1.0-2.0 ha) farming category. As per the information provided by the respondents/farmers in the study area, they also practice various agroforestry systems with different land holdings viz; Boundary plantation around agricultural fields, Homegardening (cultivation of agricultural/vegetable crops along with the integration of broad leaved and fruit trees), Horti-agriculture (fruit trees + agriculture crops) and Hortisilvipasture system (fruit trees+broad leaved trees+ naturally growing herbage) (Table-39). Regarding information of adoption of agroforestry as a land use pattern have been introduced in the research area was not known to farmers, but it was clear that they have been practicing it since long to meet their basic requirements either at subsistence or small commercial level.

Table-39: Land use pattern/system identified

Tehsil	Area(ha)							Total land area (ha)
	Agriculture	Boundary plantation	Homegarden	Homegarden (with tree component)	Horticulture	Horti-agricultural system	Horti-silvi-pasture system	
Chadoora	23.07 (41.62)*	2.00 (3.60)*	2.80 (5.05)*	2.11 (3.80)*	20.12 (36.29)*	3.68 (6.63)*	1.65 (3.00)*	55.43
Budgam	11.86 (32.46)*	2.76 (7.55)*	4.40 (12.04)*	1.96 (5.36)*	7.55 (20.66)*	6.30 (17.24)*	1.70 (4.65)*	36.53
Beerwah	20.23 (56.70)*	2.13 (5.96)*	3.25 (9.10)*	1.40 (3.92)*	4.47 (12.52)*	1.80 (5.04)*	2.40 (6.72)*	35.68
Total	**55.16**	**6.90**	**10.45**	**5.47**	**32.14**	**11.78**	**5.75**	**127.64**

*The figures in parenthesis are percentage of the total land

4.12.8 Components of agroforestry systems identified

During the course of survey, four agroforestry systems were identified as prevalent in the study area being practiced by the farmers in order to meet their diverse needs in terms of food and money. Various trees, shrubs and herbage (both cultivated as well as wild) species were recorded as structural components of the identified agroforestry systems at different temporal sequences. However, in Horti-silvi-pasture system, the ground flora comprised of only naturally grown wild herbage/grass species. Following species form the composition of identified agroforestry systems in the study area (Table-40).

Table-40: Components of agroforestry systems identified

System identified	Broad leaved tree component	Fruit tree component	Agriculture crop component	
			Kharif	**Rabi**
Boundary plantation	Poplar sp., Willow sp.	-	Paddy	Mustard, Oats and Peas
Homegarden	Poplar sp., Willow sp., Kikar, Ulmus etc.	Almond, Apple, Peach, Plum, Pomegranate, Quince	Kale, Knol-Khol, Tomato, Potato, Brinjal, Rajma/Beans, Maize, Bottle gourd, Cucumber etc.	Kale, Peas, Garlic, Turnip, Radish, Spinach, Carrot, etc.
Horti-agricultural system	-	Apple, Plum, Pear	Rajma/ Beans, Kale, Potato, Maize etc.	Kale, Radish, Turnip etc.
Hortisilvipasture system	Poplar sp., Willow sp., Kikar	Apple, Plum, Pear	Naturally grown herbage/grass species	

4.12.9 Management expenditure

Data pertaining to annual expenditure incurred on different non agroforestry and agroforestry land use systems is presented in Table-41. The information collected, revealed that total amount of money spent by the people (total of 252 farmers) in the study area for management of various land holdings including expenditures related to collection and processing of plant products from these systems was found to be Rs 9,62,242 yr^{-1}. It was also evaluated that both family as well as skilled labour (@ Rs 350-400 per day) is being employed for the purpose.

Table-41: Annual expenditure (Rs.) incurred in management of all land use systems

Land use pattern	Annual expenditure (Rs)	Annual expenditure (Rs)/ha
Agriculture	1,10742	2007.65
Boundary plantation	40,000	5797.10
Homegarden	77,000	4836.68
Horticulture	39,0000	12134.41
Horti-agricultural system	22,9500	19482.17
Horti-silvi-pasture system	11,5000	20000
Grand total	**9,62,242**	**64,258.01**

Standard daily wages of workers during the survey period was Rs. 350-400. These costs calculated by multiplying wage rate by number of days spent.

4.12.10 Livestock

It was observed from the study that the farmers who own large land holdings (> 1 ha in the study area) keep more animals than the farmers who own small land holdings (< 1 ha), probably due to shortage of cash to buy the animal and high maintenance expenditure in terms of expensive feed material. However, lack of manpower for attending the animals and urbanization were also identified as the main reasons for those who do not keep livestock (Table-42). From the data summarized in Table-42, it is clear that poultry is maximum in number (205) than other livestock present in the study area. Large animals and poultry farms serve as contingent funds which are easily encased when needed.

Table -42: Livestock population in the study area

Block	Total number				Average number			
	Cattle	Goat	Cow	Poultry	Cattle	Goat	Cow	Poultry
B.K.Pora	29	7	25	86	0.11	0.02	0.01	0.34
Nagam	22	3	35	21	0.08	0.01	0.13	0.08
Budgam	12	4	31	20	0.04	0.01	0.12	0.08
Khansahib	56	7	20	22	0.22	0.02	0.08	0.08
Narbal	26	7	30	13	0.10	0.02	0.11	0.05
Beerwah	35	15	15	43	0.13	0.06	0.06	0.17
Total	**180**	**43**	**156**	**205**	**0.71**	**0.17**	**0.61**	**0.81**

4.12.11 Fuelwood

Data presented in Table-43 revealed that the fuelwood is being used by all the families in the study area besides other energy alternatives. During survey, it was evaluated that farmers collect fuelwood from trees available in various land use patterns they practice *viz*., elm, poplar, willow, kikar, apple, pear, plum, etc. It was also documented that species like celtis, mulberry etc. are now confined to either holy shrines or graveyards because of myth of having spiritual power. It was investigated that about 50% of the people in the study area were using fuelwood as a main source of energy, 30% using fuelwood and LPG and remaining 20% rely on electricity and LPG for cooking, heating, lighting etc.

4.12.12 Fuel usage ranking

From the appraisal of the study area, it was concluded that during summer and winter, people of the District Budgam use various sources of fuel/energy as per their availability and preference for different purposes i.e. cooking, heating, lighting, festivals, marriages etc.

As far as the availability and inclination towards a particular energy source is concerned, people of the District Budgam were questioned to rank the fuel usage from 1-6 during summer and winter season. It was concluded, that fuel wood as a source of energy dominated among all the available sources for meeting the energy requirement of the studied site for both the seasons (Table-44). The investigation revealed that fuelwood dominates among house holds, with electricity and kerosene oil being either second or third. Neither animal dung nor agricultural waste is being used as fuel by the people of the area and the use of LPG was somewhat at lower side in the study area.

Table-43: Trees species used as fuelwood by the farmers in the study area

Trees used as fuelwood						
***Populus* sp.**	***Salix* sp.**	**Kikar**	**Ailanthus**	**Elm**	**Celtis**	***Other plant species**
+	+	+	-	-	-	+

*Other plant sp. - apple,plum, pear etc.

Table-44: Fuel usage ranking in the study area

Type	Summer Season						Winter Season					
	Electri-city	Kerosene Oil	LPG	Animal dung	Fuel-wood	Agricul-tural waste	Electri-city	Kerosene Oil	LPG	Animal dung	Fuel-wood	Agricul-tural waste
Cooking	2	3	6	-	1	-	3	2	6	-	1	-
Heating	2	3	6	-	1	-	6	2	-	-	1	-
Lighting	1	2	6	-	-	-	2	1	6	-	-	-
Others (marriage, festivals)	-	-	6	-	1	-	-	-	6	-	1	-

1= first, 6= least

4.12.13 Alternate sources of fuelwood

During the course of study, it was evaluated that farmers meet out their fuelwood needs from various sources either from pure forestry wood lots located nearby, market or from alternate sources i.e. different agroforestry systems being practiced by the people directly for burning into chulhas and making charcoal used during winter season. Perusal of the data (Table-45), revealed that the total extraction of fuel wood from different sources in the surveyed village was found to be 10680 (10.68) q (t) annum^{-1} and the major contributor of fuelwood in the study area assessed was Horti-silvi-pasture system (40.54%) followed by Boundary plantation (24.34%) of the total quantity of fuelwood production.

Table-45: Alternate fuelwood sources in the study area

Agroforestry systems	**Fuelwood production kg (q)*annum^{-1}**	**%**
Boundary plantation	2600(26.00)*	24.34
Homegarden	1380(13.80)*	12.92
Horti-agricultural system	2370(23.70)*	22.19
Horti-silvi-pasture system	4330(43.30)*	40.54
Total	**10680(106.8)**	**100**

4.12.14 Production and income contribution of identified (prevalent) agroforestry systems

Perusal of the data in Table-46 presents production and income contribution of four (4) prevalent agroforestry systems in District Budgam. The gross production in Boundary plantation was worth Rs 74,450 yr^{-1} out of which a production of Rs 51,100 yr^{-1} was used for self-consumption, and Rs.23,350 yr^{-1} was sold locally themselves by installing carts on road sides or sell in the near by areas on horse-carts. The most important plant species which contributed to the household income was staple food rice (*Oryza sativa*) contributing 55.74 per cent of the total gross production. Similarly, in homegardens, the total gross production was worth Rs 114,725 yr^{-1}, out of which the production of worth Rs 76,200 yr^{-1} was used for self-consumption and production of worth Rs 38,525 yr^{-1} was sold in order to meet other household needs. The most important plant species on which household income of the farmer sustain were: *Brassica oleracea* (Kale) (7.90%), followed by *Capsicum annum* (Chilli) (5.90%). *Allium sativum* (Garlic) (10.45%) during kharif season and rabi season respectively.

With respect to horticultural crops in Horti-agricultural system, *Malus domestica* (Apple) (35.10%) contributed most towards the annual income of the farmers in District Budgam followed by *Prunus domestica* (Plum) (32.01%). In terms of agriculture/vegetable crops, *Phaseolus vulgaris* (Rajma) contributed about 0.38% followed by *Brassica oleracea* (Kale) (0.22%) in kharif season, while as, *Brassica rapa* (Turnip) contributed highest income (1.14%) during rabi season. From the evaluation, it was concluded that in this agroforestry system, the gross production from horticultural and vegetable crops is Rs 15, 71195 yr^{-1}. Likewise, in Horti-silvi-pasture system, *Malus domestica* is the prime contributor towards sustaining the income of the people practicing this particular agroforestry system. The annual income by Apple was found to be Rs 5,80,500 yr^{-1} (36.33%) followed by *Prunus domestica* Rs 54,50,00 yr^{-1} (34.14%) out of the total gross production of Rs 1,60,0340 yr^{-1} (Table-46). Prunings of both broad leaved and fruit trees species present in these agroforestry systems were used to make coal for use during harsh winter months in “Kangris” for heating purpose, contributing about 1.00 per cent to the total gross production.

It was also evaluated that wild herbage/grassses (e.g. *Cynodon dactylon*, *Convolvulus arvensis*, *Medicago polymorpha*, and *Poa pratense*) growing naturally in this system, were consumed as forage by the animals, occasionally (twice in a week) taken for grazing by the land owners. As per the farmers/land owners, the gross annual expenditure per head of the animal feeds amounts to Rs 27,300. By grazing the livestocks in the Horti-silvi-pasture system, the saving of about Rs 4,360 yr^{-1} is achieved which accounts upto 0.27 per cent of the annual gross production.

4.12.15 Economic returns from agroforestry systems

Critical investigation of the data (Table-47) revealed that the farmers who have engaged their maximum land holdings under agroforestry are capable of generating/earning extra income to support their household needs besides other sources of revenue, either at low or high profit levels. It was evaluated that an income of Rs 1,076.03/farmer (Rs 3,384.05/ha) was achieved from Boundary plantation, contributing less than 10% of the total income to 11.82% of the farmers. From Homegarden Rs 1,454.32/farmer (Rs 70,42.96/ha) was calculated as to support 14.4% of the farmers. Similarly, in Horti-agricultural system, income returns per farmer was examined to be Rs 22,529.98/farmer (Rs 13,0417.65/ha). Horti-silvi-pasture system was summarized to maintain the household economy @ Rs 53,855.50/farmer (Rs 26,9652.17/ha) and contributed most to the total household income (67.46%) of the farmers among all systems followed by Horti-agricultural system (28.81%) in the study area.

4.12.16 Fodder

Table-48 presents the data pertaining to the fodder usage by farmers at three different seasons (spring, summer and autumn). It was observed that the fodder that farmers use to give as feed to their livestock was supplied from either trees i.e. poplar, salix and robinia or agricultural crops viz., oats and paddy straw and sometimes both in order to meet the nutrient and energy requirements of the ruminants.

4.12.17 Ranking of fodder tree species

Critical examination of the data in Table-49 revealed that the farmers give first ranking to Robinia as best feed in terms of health and reproduction of the animal. Second preference given to Salix and least to Poplar species. As far as Celtis and Mulberry are concerned, they are confined to sacred places only and are not being used as fodder.

4.12.18 Fodder quantity

Perusal of the data in Table-50 explicated that farmers preferred three (03) tree species along with other feed components i.e. oats and rice straw as fodder in different quantities in order to supplement their livestock at fullest. Farmers use these feed sources either as sole supplement or in an amalgam/ratio of different fodder components viz., in 100% (50% of any one fodder material + 50% of another feed component) and 50% (25% of any one fodder material + 25% of another feed component).

4.12.19 Fulfillment of subsistence needs of farmers through different agroforestry systems

Data pertaining to Table-51 elucidated that prevalent agroforestry systems in District Budgam supports to fulfill only about 50 per cent of the household needs of the farmers in terms of food, fodder, fuelwood, timber and medicinal plants and rest of the 50% they fulfill from market.

Table-46: Production and percentage contribution of various plant species found in prevalent agroforestry systems towards annual income of households

Land use system	Agriculture/Horticulture crop		Production(kg yr^{-1})		Rate (Rs kg^{-1})	Amount (Rs)		Gross Production	% (Gross Production/ Total*100)
	Kharif	**Rabi**	**Self consumption**	**Sale**		**Self consump-tion**	**Sale**		
Boundary Plantation	Paddy		1060	600	25	26500	15000	41500	55.74
		Mustard	145	10	20	2900	200	3100	4.16
		Oats	250	700	4	1000	2800	3800	5.10
		Peas	20	50	35	700	1750	2450	3.29
		Poplar sp. prunings	1080	600	6	6480	3600	10080	13.53
		Willow prunings	920	0	6	5520	0	5520	7.41
	Tree fodder		4000	0	2	8000	0	8000	10.74
Total						**51100**	**23350**	**74450**	**100**
Homegarden	Bottle Gourd		48	31	30	1440	930	2370	2.06
	Brinjal		37	26	30	1110	780	1890	1.64
	Chilli		44.75	23	100	4475	2300	6775	5.90
	Cucumber		68	34	30	2040	1020	3060	2.66
	French beans		15	45.5	60	900	2730	3630	3.16
	Dandelion		19	0	100	1900	0	1900	1.65
	Kale		55	80	60	3300	4800	8100	7.06
	Knol-Khol		49	40	30	1470	1200	2670	2.32
	Maize		34	0	25	850	0	850	0.74
	Malva		10	0	60	600	0	600	0.52
	Mint		12.5	0	60	750	0	750	0.65
	Parsley		7.5	0	0	0	0	0	0.00

	Potato		50	27	25	1250	675	1925	1.67
	Rajma (beans)		37.75	14	120	4530	1680	6210	5.41
	Spinach		38.5	27	60	2310	1620	3930	3.42
	Tomato		70	56	50	3500	2800	6300	5.49
		Cabbage	23	16	35	805	560	1365	1.18
		Carrot	16	32	25	400	800	1200	1.04
		Cauliflower	20	18	35	700	630	1330	1.15
		Coriander	32	0	35	1120	0	1120	0.97
		Fenugreek	37	11	60	2220	660	2880	2.51
		Garlic	40	40	150	6000	6000	12000	10.45
		Onion	12	50	80	960	4000	4960	4.32
		Peas	20	14	35	700	490	1190	1.03
		Radish	14	25	35	490	875	1365	1.18
		Shallot	45.5	16	150	6825	2400	9225	8.04
		Turnip	55	45	35	1925	1575	3500	3.05
	Almond		2	0	200	400	0	400	0.34
	Apple		13	0	50	650	0	650	0.56
	Peach		4	0	50	200	0	200	0.17
	Pear		13	0	50	650	0	650	0.56
	Plum		10	0	60	600	0	600	0.52
	Pomegranate		15	0	150	2250	0	2250	1.96
	Poplar sp. prunings		990	0	6	5940	0	5940	5.17
	Quince		2	0	100	200	0	200	0.17
	Tree fodder		3000	0	2	6000	0	6000	5.22
	Walnut		22	0	200	4400	0	4400	3.83
	Willow sp. prunings		390	0	6	2340	0	2340	2.03
Total						**76200**	**38525**	**114725**	**100**

Horti-agricultural system	Kale		34	25	60	2040	1500	3540	0.22
	Maize		29	28	15	435	420	855	0.05
	Potato		40	30	25	1000	750	1750	0.11
	Rajma		25	25	120	3000	3000	6000	0.38
	Apple		50	10980	50	2500	549000	551500	35.10
	Pear		40	9000	50	2000	450000	452000	28.76
	Plum		60	10000	50	3000	500000	503000	32.01
		Kale	38	190	60	2280	11400	13680	0.87
		Radish	40	150	35	1400	5250	6650	0.42
		Turnip	50	250	60	3000	15000	18000	1.14
		Apple pruning	1000	0	6	6000	0	6000	0.38
		Pear pruning	450	0	6	2700	0	2700	0.17
		Plum prunings	920	0	6	5520	0	5520	0.35
Total						**34875**	**1536320**	**1571195**	**100**
Horti-silvi-pasture system	Apple		20	11610	50	1000	580500	581500	36.33
	Plum		30	10900	50	1500	545000	546500	34.14
	Pear		20	8500	50	1000	425000	426000	26.61
		Apple prunings	990	0	6	5940	0	5940	0.37
		Kikar prunings	600	0	6	3600	0	3600	0.22
		Plum Prunings	890	0	6	5340	0	5340	0.33
		Poplar pruning	1050	0	6	6300	0	6300	0.39
		Willow prunings	800	0	6	4800	0	4800	0.30
	Tree fodder		8000	0	2	16000	0	16000	1.00
	Grass fodder		2180	0	2	4360	0	4360	0.27
Total						**49840**	**1550500**	**1600340**	**100**

Table-47: Total income from prevalent agroforestry systems of the study area (District Budgam)

Land use system	Income Percentage (From Total* Net income)				Income(Rs)/farmer	Income(Rs)/ha
	<10	10-20	20-30	>30		
Boundary plantation	11.82	-	-	-	1076.03	3384.05
Homegarden	2.3	-	-	12.1	1454.32	7042.96
Horti-agricultural system	-	-	9.5	27.56	21947.42	130417.65
Hortisilvipasture system	-	-	4.47	11.18	51683.33	269652.17

*Total income = Income from Boundary plantation + income from Homegardens+ Income from Horti-agricultural system + income from Hortisilvipasture system

Table-48: Plant species (used dry/green) exploited for fodder as per season

Season											
Spring				Summer				Autumn			
Poplar	Kikar	Salix	Others	Poplar	Kikar	Salix	Others	Poplar	Kikar	Salix	Others
+	+	+	+	+	+	+	+	+	+	+	+

Others= Oats & Paddy straw

Table-49: Ranking of tree fodder given to each animal in the study area

Ranking of tree fodder component				
Poplar	Salix	Robinia	Celtis	Mulberry
3	2	1	-	-

Table-50: Quantity of other fodder material/component mixed with tree fodder or solely given to each animal

FCS (100%)					MFC (100%= 50%+ 50%)									MFC (50%= 25%+ 25%)								
O	RS	P	S	R	P + S	P + R	S + R	P + O	P + RS	S + O	S + RS	R + O	R + RS	P + S	P + R	S + R	P + O	P + RS	S + O	S + RS	R + O	R + RS
-	-	-	-	-	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-

Fodder component given solely = FCS (O= Oats, RS= Rice straw, P= Poplar, S= Salix, R= Robinia), **Mixed fodder component** = MFC (P+S, P+R, S+R, O+RS, P+O, P+RS, S+O, S+RS, R+O, R+RS

Table-51: Subsistence need fulfillment of farmers through different agroforestry systems in the study area

Land use pattern	**Subsistence needs fulfillment**									
	100%					**50%**				
	Food	**Fodder**	**Timber**	**Fuelwood**	**Medicinal plants**	**Food**	**Fodder**	**Timber**	**Fuelwood**	**Medicinal plants**
Boundary plantation	-	-	-	-	-	+	+	+	+	+
Homegarden	-	-	-	-	-	+	+	+	+	+
Horti-agricultural system	-	-		-	-	+	-	-	+	+
Horti-silvi-pasture system	-	-	-	-	-	+	+	+	+	+

4.13 Fuelwood value of preferred trees species in District Budgam.

4.13.1 Fuelwood value of tree species preferred by the people of District Budgam

The data presents the wood moisture content, wood density, ash content calorific value and fuelwood value index for different tree species used in District Budgam (Table-52 & 53).

The perusal of data in Table-52 & 53 is elaborated parameter wise as under:

4.13.1 Wood moisture content (%)

Data pertaining to wood moisture content in Table-52 & 53 showed significant variation among broad leaved tree species, however, non- significant difference was recorded among fruit trees. In broad leaved species, maximum moisture content was observed in *Populus deltoides* (64.63%) which was at par with *Populus nigra*, *Salix alba* and *Salix fragilis*. Whereas, minimum moisture percentage was evaluated in *Robinia pseudoacacia* (59.07%) (Table-52).

Table-53 depicted that among fruit trees, highest wood moisture content was recorded in *Pyrus communis* (47.40%) followed by *Prunus domestica* (46.69%) with lowest value (34.25%) exhibited by *Prunus dulcis*.

4.13.2 Wood density (g/cc)

Critical examination of the data in Table-52 explicated a significant difference in wood densities among the species. As far as broad leaved species are concerned, maximum wood density was found to be 0.64 (g/cc) in *Robinia pseudoacacia* and minimum value for *Populus deltoides* as 0.41 (g/cc).

In fruit trees, highest wood density value was recorded in *Prunus dulcis* (0.89 g/cc) followed by *Malus domestica* (0.81 g/cc). However, lowest value (0.66 g/cc) was recorded in *Prunus domestica* which was at par with *Pyrus communis* and *Malus domestica* (Table-53).

4.13.3 Ash content (%)

Table-52 elaborates the non- significant differences in broad leaved species in terms of ash content. However, maximum ash content was recorded in *Populus deltoides* (1.48%) with minimum content in *Robinia pseudoacacia* (1.19%). In fruit trees, significant differences were observed, with maximum observed in *Pyrus communis* (1.98%) and minimum in *Malus domestica* (1.55%) (Table-53).

4.13.4 Calorific value (KJ/g)

Perusal of the data on fuelwood properties showed that there exists significant variation among evaluated tree species (Table-52 & 53). Among the broad leaved tree species, *Robinia pseudoacacia* demonstrated highest calorific value (22.22 KJ/g), followed by *Salix alba* (19.38 KJ/g) which was found to be at par with *Salix fragilis* (19.37 KJ/g), *Populus deltoides* (18.53 KJ/g) and *Populus nigra* (18.55 KJ/g) (Table-52).

Among fruit tree species (Table-53), the highest energy value of 18.71 KJ/g was elucidated by *Prunus dulcis* followed by *Malus domestica* (16.54 KJ/g) with lowest value evaluated for *Pyrus communis* (15.54 KJ/g) which was found to be at par with *Malus domestica* (16.54 KJ/g) and *Prunus domestica* (16.19KJ/g).

4.13.5 Fuelwood value index (FVI)

Data pertaining to fuelwood value index (Table-52 & 53) revealed that all the species viz., broad leaved trees and fruit trees showed marked difference with respect to FVI. Maximum fuelwood value index was observed in *Robinia pseudoacacia* (948.05) followed by *Salix alba* (614.81). However, minimum value (513.33) was recorded for *Populus deltoides.*

Perusal of the data in Table-53 elaborates that *Prunus dulcis* recorded highest fuelwood value index (1067.42) followed by *Malus domestica* (864.34) and lowest by *Pyrus communis* (525.84).

Table-52: Evaluation of fuelwood values of preferred tree species in the study area (District Budgam)

Plant species	Wood moisture content (%)	Wood density (g/cc)	Ash content (%)	Calorific value (KJ/g)	Fuelwood Value Index (FVI)
Populus deltoides	64.63	0.41	1.48	18.53	513.33
Populus nigra	63.02	0.42	1.48	18.55	526.41
Robinia pseudoacacia	59.07	0.64	1.50	22.22	948.05
Salix alba	63.34	0.46	1.45	19.38	614.81
Salix fragilis	63.41	0.46	1.46	19.37	610.28
Mean	**62.72**	**0.51**	**1.47**	**19.61**	**642.57**
CD ($p \leq 0.05$)	**1.19**	**0.04**	**N.S**	**1.16**	**345.00**

Table-53: Evaluation of fuelwood values of preferred fruit tree species in the study area (District Budgam)

Plant species	Wood moisture content (%)	Wood density (g/cc)	Ash content (%)	Calorific value (KJ/g)	Fuelwood Value Index (FVI)
Malus domestica	42.09	0.81	1.55	16.54	864.34
Prunus domestica	46.69	0.66	1.57	16.19	738.26
Prunus dulcis	34.25	0.89	1.56	18.71	1067.42
Pyrus communis	47.40	0.67	1.98	15.54	525.84
Mean	**42.60**	**0.75**	**1.66**	**16.75**	**828.95**
CD($p \leq 0.05$)	**N.S**	**0.19**	**0.32**	**1.75**	**354.60**

4.14 Seasonal variation in fodder value of preferred tree species in District Budgam

Data pertaining to the seasonal nutrient profile of fodder tree leaves is presented in Table-54 & 55 i.e. crude protein, crude fibre, ether extract and ash content of different tree species preferred by the farmers in District Budgam.

4.14.1 Effect on crude protein

Table-54 elaborates the nutritive value of different tree species recorded during three growing seasons i.e. spring, summer and autumn. Perusal of the data indicated that the three seasons have significant effect on the crude protein content of different preferred tree species i.e. crude protein decrease with successive seasons. The mean values for crude protein content concentration was significantly maximum in spring (13.33%) with highest value recorded for *Robinia pseudoacacia* (18.73%) and lowest for *Populus deltoides* (11.52%), followed by summer (10.87%) with same trend of maximum concentration evaluated for *Robinia pseudoacacia* (18.58%) and minimum for *Populus deltoides* (8.80%). During autumn season, minimum nutritive value of 10.05 per cent in terms of crude protein was evaluated which was found to be at par with summer season with highest value scored by *Robinia pseudoacacia* (17.01%) and minimum (7.73%) by *Populus deltoides* being at par with *Populus nigra*, *Salix alba* and *Salix fragilis*.

4.14.2 Effect on Crude fibre

Perusal of the data in the Table -54 revealed that crude fibre increases with advancing seasons. Significant variation was found among different preferred tree species. The mean values for crude fibre content concentration was found to be minimum during spring (15.00%) with highest value recorded as 15.92 per cent for *Populus nigra* and lowest in *Robinia pseudoacacia* (12.91%), followed by summer (17.09%) with same trend of maximum concentration in *Populus nigra* (19.65%) and minimum in *Robinia pseudoacacia* (13.16%). Highest nutritive profile in terms of crude fibre was evaluated during autumn season as 17.77% with maximum achieved by *Populus nigra* (19.93%) and minimum (14.11%) by *Robinia pseudoacacia.*

4.14.3 Effect on Ether Extract

Numeric values in Table-55 elaborates that seasons showed highly significant variation in terms of ether extract among tree species investigated. It was observed that ether extract increased with advancing seasons. Numeric values in Table-64 indicated that the mean values for ether extract concentration was minimum during spring (3.34%) with highest value recorded in *Robinia pseudoacacia* (4.86%) and lowest in *Populus deltoides* (2.28%), followed by summer (3.96%) with same trend of maximum concentration in *Robinia pseudoacacia* (5.10%) and minimum in *Populus deltoides* (3.03%). Highest ether extract value was evaluated during autumn (4.31%) with highest value scored by *Robinia pseudoacaia* (5.12%) and lowest by *Populus deltoides* (3.38%) which was found to be at par with *Populus nigra, Salix alba* and *Salix fragilis*.

4.14.4 Effect on total ash

Total ash (Table-55) was recorded to be highly significant during three different seasons (spring, summer and autumn) and among different tree species. It was observed that total ash increases with successive season within each species examined. The mean values for total ash was recorded minimum during spring (12.12%) with highest value recorded (13.23%) in *Populus* nigra and lowest in *Robinia pseudoacacia* (8.91%), followed by summer (12.42%) with same trend of maximum percentage in *Populus nigra* (13.36%) and minimum in *Robinia pseudoacacia* (9.51%). Nutritive value in terms of total ash was evaluated maximum (12.87%) during autumn season with highest value exhibited by *Populus nigra* (13.82%) and lowest (9.98%) by *Robinia pseudoacacia.*

Table- 54: Effect of season on crude protein and crude fibre contents of preferred tree species in the study area (District Budgam)

Season / Plant species	Crude protein (%)				Crude fibre (%)			
	Spring	**Summer**	**Autumn**	**Mean**	**Spring**	**Summer**	**Autumn**	**Mean**
Populus deltoides Bartr.	11.52	8.80	7.73	9.35	15.89	19.63	19.92	18.48
Populus nigra Bartr.	11.73	8.93	7.92	9.53	15.92	19.65	19.93	18.50
Robinia pseudoacacia L.	18.73	18.58	17.01	18.10	12.91	13.16	14.11	13.40
Salix alba L.	12.42	9.07	8.87	10.12	15.14	16.53	17.26	16.31
Salix fragilis L.	12.27	8.97	8.71	10.00	14.80	16.15	17.24	16.06
Mean	**13.33**	**10.87**	**10.05**	**-**	**15.00**	**17.02**	**17.77**	**-**

CD ($p \leq 0.05$)

	Crude protein	Crude fibre
Plant species:	1.75	0.71
Season:	1.35	0.55
Plant sp. x Season:	N.S	1.23

Table- 55: Effect of season on ether extract and total ash contents of preferred tree species in the study area (District Budgam)

Seasons / Plant species	Ether Extract (%)				Total Ash (%)			
	Spring	**Summer**	**Autumn**	**Mean**	**Spring**	**Summer**	**Autumn**	**Mean**
Populus deltoides Bartr.	2.28	3.03	3.88	3.06	13.22	13.36	13.80	13.46
Populus nigra Bartr.	2.30	3.09	3.90	3.09	13.23	13.40	13.82	13.48
Robinia pseudoacacia L.	4.86	5.10	5.12	5.03	8.91	9.51	9.98	9.46
Salix alba L.	3.64	4.14	4.34	4.04	12.63	12.94	13.39	12.98
Salix fragilis L.	3.62	4.12	4.31	4.02	12.61	12.90	13.37	12.96
Mean	**3.34**	**3.96**	**4.31**	**-**	**12.12**	**12.42**	**12.87**	**-**

CD ($p \leq 0.05$)

	Ether Extract	Total Ash
Plant species:	0.50	0.60
Season:	0.39	0.47
Plant sp. x Season:	0.87	1.05

4.15 Proximate analysis of agricultural feed crops used in District Budgam

Data pertaining to nutrient profile i.e. crude protein, crude fibre, ether extract and ash content of two agricultural feed crops is presented in Table-56 below:

4.15.1 Crude protein

Numeric values in Table-56 pertaining to crude protein in two agricultural crops revealed that *Avena sativa* exhibited highest crude protein (2.34%), while *Oryza sativa* having the lowest (2.09%).

4.15.2 Crude fibre

Detailed view of the data in Table-56 explicated that the maximum crude fibre percentage was found in *Avena sativa* (36.52%), while in *Oryza sativa* it was observed to be 11.07 per cent.

4.15.3 Ether extract

Perusal of the data regarding ether extract in Table-56 revealed that *Avena sativa* achieved highest value as 3.23 per cent. Whereas, lowest value of 2.36 per cent was explicated by *Oryza sativa.*

4.15.4 Total ash

From the proximate analysis of the two plant varities, it was observed that total ash was found maximum in *Avena sativa* and minimum in *Oryza sativa* as 14.28 and 3.40 per cent respectively (Table-56).

Table 56: Nutritional values of two agricultural crops used in the study area (District Budgam)

Fodder type	Nutrient (%)			
	Crude protein	Crude fibre	Ether extract	Total ash
Oats	2.34	36.52	3.23	14.28
Rice straw	2.09	11.07	2.36	3.40
t-test	2.20	84.96	4.72	22.72
P (T<=t)	0.04	0.00	0.00	0.00

Chapter-5

DISCUSSION

Biodiversity is crucial for survival, health and well-being of humans. It is giving greater resilience to ecosystems and organisms (Qualset *et al*., 1995). Complex, diversified and highly traditional rooted part of plant biodiversity conservation and utilization is found in agroforestry systems (Amberber *et al*., 2014). Forest modification and clearance have negative impacts on biodiversity (Bobo *et al*., 2006), and each 1 per cent reduction of natural area will cost about 1 per cent of steady-state diversity (Rosenzweig, 2003). To improve biodiversity conservation, it becomes crucial to redesign anthropogenic habitats so that their use is compatible with the use by a broad array of other species. The new strategy of conservation biology called ‘‘reconciliation ecology’’ has grown out of a thorough understanding of species-area relationships (Bobo *et al*., 2006). Rather than insist on protecting habitat from human use, the reconciliation ecology works in and with the human dominated habitats. Traditional agroforestry systems are thought to maintain valued biological interactions and biodiversity at higher levels (Leakey, 1998). In general, agroecosystems that are more diverse, more permanent, isolated, and managed with low input technology (e.g., agroforestry systems, traditional polycultures) take complete advantage of ecological processes associated with higher biodiversity than highly simplified, input-driven and disturbed systems, i.e., modern row crops and vegetable monocultures and pure fruit orchards (Atta-Krah *et al*., 2004). Thus, agroforestry system research and development has evolved dramatically with much emphasis on how they function, diversity from local, landscape to regional level, local knowledge systems, economic valuation and environmental services they provide (Beer *et al*., 2005). Agroforestry has combined production with multiple outputs of resource base and places emphasis on indigenous, multipurpose trees, shrubs and also more concerned with socio-cultural value than most other land use systems (Nair, 1993). In agroforestry systems, both biotic and abiotic environments can be modified by the different crop/tree pasture configuration. Different community practices and management of different types of agroforestry system ultimately promote life subsistence. These systems are fundamentally man-made, reflect the evolution of human culture with various traits of location, climate and other ecological parameters carefully considered in their establishment (Deb *et al.*, 2014).

Agroforestry has the potential to improve livelihood as it offers multiple alternatives and opportunities to farmers to improve farm production and incomes and also provides productive and protective (biological diversity, fuelwood, fodder, timber, medicines, protection of soil and water resources, terrestrial carbon storage) forest functions to the ecosystems while protecting the natural environment. This practice is now recognized widely as an applied science that is instrumental in assuring food security, reducing poverty and enhancing ecosystem resilience by alleviating environmental stresses (Padmavathy and Poyyamoli, 2013). The multi-species configuration of agroforestry system of Kashmir valley was reported by few workers and several studies been conducted for plant diversity in natural as well as protected forests but no work was yet been done with respect to plant diversity assessment in traditional agroforestry system. Therefore, the present study was conducted to quantify the plant diversity, structural component and management practices of prevalent agroforestry systems in District Budgam with the following objectives:

1. To assess the status of plant diversity in prevalent agroforestry systems of District Budgam.
2. To analyze and evaluate the contribution of agroforestry in fulfillment of individual household needs in District Budgam.
3. To determine the fuelwood and fodder values of preferred tree species in District Budgam.

The results of the study presented in previous chapter are being discussed under following headings to establish cause and effect relationship among the various parameters studied so as to draw logical information in light of the available literature under following headings:

5.1 Floristic composition and community structure

5.2 Quantitative/ Phytosociological attributes of vegetation

5.3 Socio-economic evaluation and contribution of prevalent agroforestry systems

5.4 Fuelwood value index appraisal of preferred tree species

5.5 Seasonal variation in fodder value of preferred tree species

5.6 Proximate analysis of agricultural crops as feed for ruminants

Since, much work has not been done so far in terms of quantitative and phytosociological attributes of vegetation in agroforestry systems, therefore, cross references of work done in forests regarding plant diversity have been taken into consideration for this chapter in order to support the results obtained during the study period.

5.1 Floristic composition and community structure

The assessment of species diversity is crucial, since it represents a fundamental property of ecological communities and provides a tool to compare assemblages in time and space, independently from species identities (Guyassa and Raj, 2013). The floristic composition and/or plant diversity and community structure are important attributes correlated with prevailing environmental as well as anthropogenic variables (Gairola *et al.*, 2008; Bisht and Bhat, 2011). The present study conducted with four prevalent agroforestry systems of District Budgam, revealed that plant generic spectrum comprised of rich diversity (total of 92 species) comprised of 14 species of both broad leaved and fruit trees belonging to 6 families, while as, 3 species belonging to 2 families were of shrub layer and herbage (both cultivated and/ or domesticated and wild herbaceous plants) represented 75 plant species of 36 families (Table-3 & 4). Rosaceae is the dominant family followed by Salicaceae among trees, Rosaceae in shrubs, Brassicaceae and Poaceae among cultivated and wild plant species respectively. Out of total of 92 species reported in different prevalent agroforestry systems, trees constitute about 15.21 per cent, 3.26 per cent by shrubs, cultivated plants comprised of 16.30 per cent of vegetable crops, 3.26 per cent of both cereals and pulses and 58.70 per cent represented by wild plants. All the three vegetation stratas *viz*., trees, shrubs and herbage except wild herbage evaluated/studied was quite lower than reported by Deb *et al*. (2014) in traditional agroforestry systems of Tripura; Gussaya and Raj (2013) in cropland agroforestry of Ethiopia (40 woody species); 21 woody species by Fifanou *et al*. (2011) in traditional agroforestry systems in Benin (West Africa); areca-nut based agroforestry of Meghalaya (88 woody species) by Tynsong and Das (2010); cocoa agroforests of Cameroon (21 woody species) (Sonwa *et al*., 2007); 21 shrub species studied by Bijalwan (2012) in traditional horti-agriculture system in mid hills of Garhwal Himalayas; 28 shrub species and 70 cultivated plants evaluated by Amberber *et al*. (2014) in homegarden agroforestry systems of Holeta town, Ethiopia 98 cultivated/ edible species by Eichemberg *et al*. (2009) in old urban homegardens in Brazil. In case of wild herbaceous plants, 54 (Table-4) recorded in the present study is much higher than the wild plants (35 wild species) evaluated by Amberber *et al*. (2014); 16 wild species by Mahmoud (2009) in Silvipastoral system in mid hill Himalayas of Himachal Pradesh, but lower than reported by Shameem and Kangroo (2011) as 75 for forest ecosystem in Dachigam National Park, Kashmir; 571 alien species reported by Khuroo *et al*. (2007) for Kashmir Himalayas; 59 plant species evaluated by Ahmad and Habib (2014) for Dawarian Village, Neelum Valley, Azad Jammu and Kashmir, Pakistan.

Less vegetation diversity may be due to selective approach of landholders to grow plants that are required for their primary needs only. The motives for retaining different woody species depend on the uses or benefits that they render to the household and for income generation to some farmers, management strategy. The results are in consonance with Deb *et al*. (2014) in traditional agroforestry systems in Tripura, north east India; Negash *et al*. (2012) for multistrata agroforests in Rift valley escarpment, Ethiopia; Tangjang *et al*. (2004) in traditional agroforestry system of north east India. It is also reported that the regional patterns of species richness are consequences of many interacting factors, such as geographical area, regional species dynamics, regional species pool, environmental variables and human activity (Woodward, 1988; Zobel, 1997; Criddle *et al.*, 2003).

Shrubs represented 3.26 per cent of the total species found in different prevalent agroforestry systems. Low shrub diversity is because of abhorrence of the farmers towards shrubs owing to prickly nature, that cause harm/injury, become an obstacle while working in the fields. Besides it, slow growth rate and non- favorable climatic conditions, clearing of shrubs for arable and tree crops could be the possible reasons for less shrub diversity as also reported by Akinbisoye *et al*. (2014) in taungya agroforestry systems of Nigeria; Abdullah *et al*. (2009) in Yankari Game Reserve, Nigeria; Yaqoob *et al*. (2014) in Lower Dachigam Kashmir Himalayas.

Herbaceous layer represents 16.30 per cent of vegetable crops, 3.26 per cent of cereals and pulses constituting 19.56 per cent of cultivated species and 58.70 per cent of wild plants in the study area (Table-4) indicating less species diversity than evaluated by other authors elsewhere. The choice of cultivated/edible species depends upon the personal preference, medicinal necessities, and it is also related to socioeconomic and cultural factors, as well as the species adaptability according to prevailing climatic and edaphic conditions of a region (Eichemberg *et al*., 2009); Blanckaert *et al.* (2004). This may be due to less diverse agro-geographical conditions in the temperate study area, different micro-environments suitable for species for growth and maintenance as compared to studies done in elsewhere and limited options available for the households to grow different species as also reported by Neelamegam *et al*. (2015) in homegarden plants in rural and urban areas in Kanyakumari, Tamil Nadu, India and in Nepalese homegardens by Subedi *et al*. (2004).

About 54 wild plant species (Table-4) were recorded in different prevalent agroforestry systems in District Budgam which was much lower than reported by various workers. This less species richness may be due to the more human interferences/disturbances, micro-climate and edaphic conditions as also reported by Amjad (2015) for ethnobotanical profiling and floristic diversity of Bana Valley, Kotli (Azad Jammu and Kashmir), Pakistan; Shameem and Kangroo (2011) in lower Dachigam National Park, Kashmir Himalaya, India; Lyaruu (2010) in Western Serengeti, Tanzania. Since, farmers prime and for-most important motive/choice in these agroforestry based land use systems is food (subsistence needs) and socio-economic well-being, thus they have negative attitude towards certain wild plants as weeds that may interfere with the better growth of the cultivated/ edible plants present there.

5.2 Quantitative/phytosociological attributes of vegetation

5.2.1 Seasonal variation in quantitaive attributes of cultivated plants

Quantitative attributes i.e. IVI (Importance Value Index) of cultivated plants showed consistent rise from spring season i.e. with advancement of growing season, attained peak values during summer season and decreased thereafter in autumn.

5.2.1.1 Importance Value Index (IVI)

The IVI is an aggregate index that summarizes the density, abundance, and distribution of a species. It measures the overall importance of a species and gives an indication of the ecological success of a species in a particular area (Mishra, 1968). The IVI values can also be used to prioritize species for conservation, and species with high IVI value need less conservation efforts, whereas those having low IVI value need high conservation effort (Molla and Kewessa, 2015). Considering IVI as an indicator of dominance, the major contributors in prevalent agroforestry systems among three different seasons varied significantly (Table-5, 6, 7). In case of Boundary plantation, the maximum IVI value 122.09 and minimum 70.51 was exhibited by *Brassica campestris* and *Pisum sativum* during spring season, while, during summer, *Oryza sativa* showed dominance achieving IVI value of 300 (Table-5). In Homegarden, *Brassica oleracea var. acephala* (42.84) *and Zea mays* (14.00) obtained maximum and minimum IVI value in spring. However, during summer and autumn seasons, *Brassica oleracea var. acephala* (44.68) *and Brassica rapa* (103.81) exhibited maximum, however, *Spinacia oleracea* (7.28) *and Raphanus sativus* (54.66) achieved minimum values in terms of IVI respectively (Table-6). In Horti-agricultural system, *Phaseolus vulgaris* was evaluated as dominant with maximum IVI value of 97.67 and 95.03 and minimum exhibited by *Solanum tuberosum* as 54.48 and 61.94 in spring and summer respectively. However, during autumn seasons, *Brassica olearacea var. acephala* (122.71) was recorded as dominant with highest value and *Brassica rapa* (83.90) recorded lowest IVI value (Table-7). The reason that IVI peaked in summer season can be ascribed to congenial growth conditions in terms of nutrient availability, soil moisture, humidity, light (solar insolation) and temperature as reported by Singh (2014); Shameem and Kangroo (2011). Also high importance value index (IVI) exhibited by any individual species may be due to the available resource being utilized efficiently (better adaptability) of a particular species under prevailing environmental conditions, market value (socio-economic factors) preference of the farmer, management intensity and families (at species level) often retain /or cultivate a large number of individuals for certain species that are commonly utilized by the households (Kabir and Webb, 2009), can be the possible reasons for varied species composition among prevalent agroforestry systems of district Budgam as also evaluated by Krishnal and Weerahewa (2014) for traditional homegardens in Batticaloa District, Sri-Lanka; Hasanuzzaman *et al*. (2013) for cropland agroforest in south-western Bangladesh ; Zimik *et al*. (2012) for species diversity and plant utilization pattern in homegardens of Assam and Arunachal

Pradesh. Other researchers have also observed a significant variation among crop combinations that farmers choose based on their own wisdom and perceptions acquired over generations of experiences in traditional agroforestry systems in Tripura (Deb *et al*., 2014) and for assessing vegetation characteristics in Bangladesh homegardens (Millat-e-Mustafa and Haruni, 2002). Senanayake *et al*. (2009) also reported that depending on the season, availability of resources, market-oriented value, vegetable species varied among studied homegardens of Meegahakiula Region of Sri Lanka. Moreover, high IVI by any individual species indicated that most of the available resource are being utilized by that species and left over are being trapped by another species as the competitors and the associates. This could be the reason why IVI was reported highest by few species during autumn than rest of the seasons. Similar findings have been documented by Kukshal *et al*. (2009); Hall *et al*. (2004) and Bunker and Carson (2005).

5.2.1.2 Vegetative Indices of cultivated plants

Diversity is considered to be an outcome of evaluation of species in a bio-geographic region. It is considered to be synthetic measure of the structure, complexity and stability of a community (Huston, 1979). Species diversity incorporates two important components *viz*., evenness (distribution of individuals over species/or how equally abundant the species within the landuse system) (Neelamegam *et al*., 2015; Heip *et al*., 1998) and richness (number of species per unit area) (Sterling and Wilsey, 2001). These properties are related with micro-environmental conditions created by man, cultural and economical (commercial crops) factors, which interact to determine structure and composition of agroforestry systems suggesting that this variation is basically idiosyncratic, although marginally dependent of environment (Asfaw *et al*., 2015; Pulido *et al*., 2008).

Seasonal Shannon weiner index and species evenness of the cultivated plant species showed similar trend as IVI i.e. rise from spring season with advancement of growing season, attained peak values during summer and abruptly decreased in autumn season (Table-8; Fig. 2 & 4) for only two prevalent agroforestry systems with cultivated crops except for boundary plantation, where this index decreased with the advancement of season because of the reason that farmers use to cultivate single species (*Oryza sativa*) during summer season and left the respective fields fallow in autumn for a period of two months. The important and possible cause for higher values during summer season can be just similar as for IVI (importance value index) viz., higher species diversification maintained by farmers, congenial growth conditions in terms of nutrient availability, soil moisture, humidity, light and temperature for a large number of plants as reported by Shameem *et al*. (2010); Peyre *et al*. (2006) and Sanchez *et al*. (1996). In general, soil nutrients are most available in the spring and early summer when summer temperature and moisture are favourable, and mineralization by microbial activity, is rapid. Decreased diversity index and evenness of cultivated plants during autumn could be due to lower rate of evolution and diversification of communities (Fischer, 1960) and severity in environment (Connel and Oris, 1964). Therefore, these results cannot be explained by physical environmental factors alone, because human management is certainly a major factor for assuring the maintenance of plant diversity under the presence of higher environmental stress. The results (Table-8; Fig 2 & 4) obtained for species diversity and species evenness in three prevalent agroforestry systems with respect to seasons were summarized as 1.06 and 0.96 (spring) and 0 (zero) for Boundary plantation; 2.40 and 0.96 (spring), 2.49 and 0.97(summer) and 1.31 and 0.94 (autumn) for Homegarden agroforestry system; 1.36 and 0.98 (spring), 1.37 and 0.99 (summer) and 1.05 and 0.96 (autumn) for Horti-agricultural system respectively. Shannon value of zero in case of Boundary plantation means that there is only one species. The results are in unison and within the range reported (mean values) by Neelamegam *et al*. (2015) in homegarden plants in rural and urban areas in Kanyakumari District, Tamil Nadu; Eichemberg *et al*. (2009) in old urban homegardens in Rio Claro, Southeast of Brazil; Varadaranganatha and Madiwalar (2010) in agroforestry systems of Karnataka. The values of the indices were higher as reported by Tynsong and Tiwari (2010) in homegardens of War Khasi community of Meghalaya (Shannon weiner index and 2.52 to 3.03 and 0.85 to 0.95); Wezel (2003) in homegardens in humid and semiarid Cuba (Shannon weiner index =0.08-1.79; evenness (in% =8-74).

In contrast to Shannon weiner index and species evenness, the results recorded for Simpson index and concentration of dominance showed a reverse trend in all prevalent agroforestry systems with respect to Shannon weiner index, species evenness and seasons i.e. achieved lowest values during spring and summer season and highest in autumn (Table-8; Fig 3& 5). The Simpson and concentration of dominance index of prevalent agroforestry systems in three different seasons varied as 0.33 and 0.35 (spring), and a unit value for summer season in Boundary plantation; 0.090 and 0.095 (spring), 0.086 and 0.087 (summer) and 0.280 and 0.288 (autumn) in Homegarden; 0.25 and 0.26 (spring), 0.24 and 0.25 (summer) and 0.35 and 0.36 (autumn) in Horti-agricultural system. Compatible results of inverse relationship between diversity and dominance were also reported by Pokhrel *et al*. (2015) in homegardens of Gulmi and Palpa Districts, Western Nepal; Negash *et al*. (2012) in multistrata agroforests South-eastern Rift Valley escarpment, Ethiopia; Kharkwal *et al*. (2004) in Pine forest stands of Central Himalaya.

Singh and Singh (2013) while evaluating two sites as abandoned (site-I) and cropland (site-II) for two seasons *viz*., rainy (summer) and winter for riparian corridors of Gomati at Rouza Ghat in District Jaunpur, U.P, India reported similar conclusion that diversity and dominance indices shows inverse relation with each other as value of Shannon weiner index, evenness, Simpson index and concentration of dominance at site I and II varied from 3.57 and 2.58; 0.79 and 0.61; 0.25 and 0.36; 0.23 and 0.38 during summer, while in winter these values were observed to be 2.32 and 2.26; 0.81and 0.38 , 0.43 and 0.38 and 0.28 and 0.40 respectively.

Among three prevalent agroforestry systems, Homegarden achieved highest values for Shannon weiner index in all the three seasons as depicted in Table-8 & Fig. 2 but less species evenness index values than Horti-agricultural system and Boundary plantation (Fig. 4). It may be due to the fact that Homegarden agroforestry system possess high diversity values because, there cultivated crops are primary components *viz*., vegetables, spices, pulses and cereals (18 species in number in our results), while as, in Horti-agricultural system these components are raised as secondary constituents where crops are typically limited to vegetables and pulses only (5 species in number) (Table-4). Other possible reasons for high diversity in Homegarden could be as a result of ease of management, selection of species by the owners with utility of the specific products as the main criterion, soil characters, access to water and market and transport facilities affect the diversity and composition of plants in them. The diversity of agricultural crops (cereal crops, cash crops, underground and above ground vegetables, leafy vegetables, climbers, pulses, spices was higher in homestead/ homegarden agroforestry practices. The results are in agreement with Ahmed *et al*. (2004) for agroforestry systems in Bangladesh; Zaman *et al*. (2010 a) for homegarden agroforestry in Thakurgaon District, Bangladesh. Other researchers have documented farm size as one of the reason for having high plant diversity (Wiersum, 1982; Jacob and Alles, 1987; Rico -Gray *et al.*, 1991). Since homegardens are usually established in small land holdings, presumably, the limited space forces farmer to accommodate many different species in relatively small numbers on small plots. This suggests that owners maintain a diverse group of plants to fulfill their regular needs regardless of the homegarden size (Kumar and Nair, 2004). Cruz-Garcia and Struik (2015) and Kehlenbeck *et al*. (2007) emphasized that no individual factor alone determines the plant diversity, but rather a complex combination of agro-ecological, socio-economic, cultural, and political factors causes spatial and temporal variation of plant species.

On the other hand, Homegarden agroforestry system in the study area exhibit a lower species evenness than Horti-agricultural system. Low evenness may be attributed to the dominance of some species such as *Brassica oleracea var. acephala* , *Phaseolus vulgaris,* and *Brassica rapa* which farmers often plant and tend deliberately at high density for their cash value (Guyassa and Raj, 2013); Asfaw and Lemenih, 2010). The evenness values in Horti-agricultural system are high to justify uniformity in composition of plant species. This may be due to farmers manage equally vegetables, cereals and pulses than in homegardens. The slight decrease in evenness value in homegarden may be due to high species interaction that leads to species competition. Other researchers have summarized similar conclusions *viz*., Darcha *et al*. (2015); Rao *et al*. (1998) in tropical agroforestry systems; Zemede and Ayele (1995) in Ethiopian homegardens (Table-8; Fig. 4).

5.2.2 Seasonal variation in quantitaive attributes of wild plants

Quantitative attributes i.e. density (Individuals/m^2), basal area (cm^2/m^2), frequency (%) and IVI (importance value index) of wild herbage and/ or plants showed consistent rise from spring season i.e. with advancement of growing season, attained peak values and species number during summer season and decreased abruptly in autumn (Table-9 to 24).

5.2.2.1 Density

Density/m^2 showed a consistent rise from spring with the advancement of growing season, attained peak values during summer and declined thereafter. The data on density/m^2 recorded in the present study (Table-9) manifests that the density/m^2 of wild plant species in Boundary plantation ranged as 330.16 (spring), 826.50 (summer) to 161 (autumn); 79.35, 347.64, 39.47 during spring, summer and autumn respectively in Homegarden (Table-13). In Horti-agricultural system, the density was correspondingly evaluated as varied from 221.07, 413.44 and 103.43 density/m^2 for spring, summer and autumn season (Table-17). Similarly, for Horti-silvi-pasture system, density/m^2 recorded was 568.40, 1023.18 and 315.94 for spring, summer and autumn season respectively (Table-21). Density reveals strength of any species in a landscape (Baig *et al*., 2013; Alhamad, 2006). The changing pattern in species density can be attributed to a range of factors acting independently or in concert (Nogues-Bravo *et al.*, 2008). The marked variation among seasons in prevalent agroforestry systems may be attributed to the conducive growth and development conditions, amount of litter and rate of litter decomposition which may be influenced by tree density (Lebret *et al*., 2001), availability of soil moisture for optimum nutrient flow in soil-plant system and other environmental factors i.e. humidity and solar radiation from spring onwards which declined with the commencement of autumn. During autumn season, the rate of sprouting of root/seed stock is diminished and species number declined owing to adverse climatic conditions. The results are in line with the findings of Alhassan *et al*. (2006) for Kajimaram oasis of Northeast Nigeria; Sharma and Upadhyay (2002) for herbaceous vegetation of the forestry arboretum on the Aravalli hills at Jaipur; Shadangi and Nath (2005) in plantation and natural forest in Amarkantak; Singh and Yadava (1974) in tropical grassland in Kurukhsetra.

With respective to seasons in agroforestry systems evaluated, among all herbaceous plants encountered, growth attributes (density/m^2) of few wild plants were comparatively higher than other species in different seasons of sampling. These are summarized as: maximum and minimum density (individuals/m^2) of 36 and 1.66 (spring); 95 and 4.33(summer); 31.83 and 0.33 (autumn) was exhibited by *Cynodon dactylon and Prunella vulgaris* in Boundary plantation (Table-9). In Homegarden agroforestry system, *Stellaria media* exhibited highest value for density/m^2 during three seasons ranging from 9.17 (spring), 36.33 (summer) to 8.83 (autumn), while as, *Galinsoga parviflora* was observed to achieve lowest values for in three different seasons as 0.83 (spring), 4.83 (summer) with an abrupt declination to 0.33 (autumn) (Table-13). Likewise, in Horti-agricultural system (Table-17), among the species encountered *Stellaria media* was the major contributor with *Artemisia absinthium* showing minimum values to the total density of vegetation with density/m^2 ranging from 21.83 and 3.16 (spring);

34.83 and 7.66 (summer); 14.00 and 1.33 (autumn). As far as Horti-silvi-pasture is concerned, highest value for density was achieved by *Cynodon dactylon* during three seasons ranging from 90.33 (spring), 103.66 (summer) to 67.33 (autumn), whereas, *Mentha arvensis* was observed to achieve lowest values for density in three different seasons as 3.33 (spring), 10.66 (summer) which then declined to 1.33 (autumn) (Table-21). These results reveals their better adaptation to prevailing environmental conditions i.e. suitable edaphic and climatic conditions that favors growth and survival of species in a particular agroforestry system. The dominance of few species in plant communities has also been reported by Sharma *et al*. (2014) in Sangla Valley, Northwest Himalaya; Mahmoud (2009) in silvipastoral systems in mid-hill Himalaya (H.P.); Dutt and Gupta (2005) in Chir pine stands in sub-tropical region in India; Rao (1998) in silvipastoral systems in North- west Himalaya.

5.2.2.2 Basal area

In the present study, basal area (cm^2/m^2) of wild herbage among three seasons under different prevalent agroforestry systems showed similar trend as in case of density parameter i.e. it increased with the onset of growing season in spring, attained peak values in summer and then declined till autumn (Table-10, 14, 18 & 22). One of the reasons for such changes in basal area of wild herbage in different seasons can be related to corresponding changes in density and may also presuppose the development of an extensive root system for efficient nutrient absorption for growth to take place as have been reported by many researchers Pappoe *et al*. (2010) for moist semi-deciduous forests of Ghana; Semwal *et al*. (2008) for temperate forests in Garhwal; Dutt (1999) for understorey production in Himachal Pradesh; Singh and Yadava (1974) for tropical grasslands of India.

In Boundary plantation, the respective maximum and minimum basal area (cm^2/m^2) revealed a marked variation from 11.15 (spring), 16.98 (summer) and 7.45 (autumn). Among the plant species, contribution of *Cynodon dactylon* was highest to the total basal area of herbage in different sampling seasons attaining

1.19 (spring), 1.98 (summer) and 1.06 (autumn). The lowest value for basal area was evaluated for *Prunella vulgaris* as (0.06) in spring, (0.10) during summer and in autumn season (0.01) (Table-10). In Homegarden agroforestry system, basal area between seasons ranged from 8.12 (spring), 10.38 (summer) to 2.66 (autumn). Among the plant species, contribution of *Stellaria media* was highest to the total basal area of herbage attaining 1.02 (spring), 1.16 (summer) and 0.77 (autumn) and the lowest value for basal area was evaluated for *Galinsoga parviflora* as (0.05) in spring, (0.10) during summer and autumn season (0.02) (Table-14). Similarly, in Horti-agricultural system, basal area (cm^2/m^2) of the vegetation varied from 10.84 (spring), 17.13 (summer) and 6.68 (autumn). Among species, contribution of *Stellaria media* was highest achieving 1.19(spring), 1.42 (summer) and 1.11(autumn), whereas, lowest value was achieved by *Artemisia absinthium* as (0.07) in spring, during summer (0.16) and (0.02) in autumn season (Table-18). Likewise, in Horti-silvi-pasture system, a marked fluctuation was observed in basal area parameter ranging from 23.21 (spring), 31.12 (summer) to 11.98 (autumn). *Cynodon dactylon* was evaluated as major contributor to total basal area (cm/m^2) indicating 1.93 (spring), 2.02 (summer) and 1.65 (autumn) with minimum values calculated for *Mentha arvensis* as (0.02) in spring, (0.12) during summer and in autumn season (0.008) (Table-22). Similar results have been documented by Mahmoud (2009) for silvipastoral systems in mid-hill Himalaya (H.P.); Gupta and Dass (2007) for composition of herbage in *Pinus roxburghii* Sargent stands in Himachal Pradesh; Aiba and Kitayama (1999) for species diversity in Mount Kinabalu, Borneo.

5.2.2.3 Frequency (%)

In present study, frequency values recorded varied in all prevalent agroforestry systems among three different seasons. The results presented in chapter- 4 revealed marked differences in terms of frequency among species with seasons in prevalent agroforestry systems of district Budgam. In Boundary plantation, total frequency contributed by all the species present was evaluated to be 1427.77 (spring), 2102.77 (summer) and 745.33 (autumn) (Table-11) indicating highest value for *Cynodon dactylon* as the most frequent species with 83.33 in spring, 100 in summer and minimum frequency being observed in autumn 75.00 and the lowest value was shown by *Prunella vulgaris* 8.33 in spring, 16.66 summer and during autumn season 6.66 (Table-11). Total frequency in Homegarden ranged from 921.08(spring), 1580.58 (summer) to 471.12 (autumn) with *Stellaria media* exhibiting highest value as 86.11% in spring, 94.44% in summer and minimum frequency being observed in autumn as 69.44. The species with lowest value was *Galinsoga parviflora* with 6.67% in spring, 25% summer and during autumn season 5% (Table-15) in this particular agroforestry system. Likewise in Horti-agricultural system, frequency among seasons was recorded as 927.61(spring), 1460.47 (summer) and 652.71(autumn) (Table-19) with *Stellaria media* evaluated to be the most frequently occurring species with 83.33% frequency in spring, 94.44% in summer and minimum frequency being observed in autumn 77.77%. For the same parameter the lowest value was showed by *Artemisia absinthium* 8.33 in spring, 25.00% summer and 6.66% during autumn. Similarly, in Horti-silvi-pasture system, total frequency was recorded to be 1704.90 (spring), 2127.11 (summer) and 1211.60 (autumn). Highest value was attributed by *Cynodon dactylon* i.e. 94.44% in spring, 100.00% in summer and minimum frequency being observed in autumn 83.33%. The species with lowest value was *Mentha arvensis* with 16.66% in spring, 33.33% summer and during autumn season 6.66% (Table-23). The results in Table-11,15,19 & 23 in chapter-4 shows high frequency values during summer season in all prevalent agroforestry systems owing to optimum resources availability either through litter already present on the ground surface or through fertilizers which farmers apply to enhance growth and production of cultivated crops, good soil-moisture, humidity and temperature.

Frequency is a measure of the uniformity of the distribution of a species; thus a low frequency indicates that a species is either irregularly distributed or rare in a particular stand or a forest. Frequency distribution of plant species as a measure for expressing biological abundance and dominance has been used to describe species composition and its spatial pattern in different plant communities (Shameem and Kangroo, 2011; Chen *et al.*, 2008). The high frequency percentage of some of the species like *Cynodon dactylon* and *Stellaria media* in different prevalent agroforestry systems appraises their greater ecological amplitude or niche breadth (Behera, *et al.*, 2005). The pattern of distribution depends both on physico-chemical natures of the environment as well as on the biological peculiarities of the organisms themselves (Shameem *et al*., 2010) and vegetative reproduction by certain species in addition to their sexuality (Ilorkar and Khatri, 2003). Another reason could be their ability to form dense mat like structure (runners in case of *Cynodon* dactylon and fibrous roots in *Stellaria media*) hence utilizing the available resource efficiently for their growth development and long survival.

Since the diversity was assessed in human dominated landscapes, the possible reasons for low frequency of certain species viz., *Artemisia absinthium*, *Galinsoga parviflora* and *Mentha arvensis* in respective agroforestry systems could be their utility either as herbal medicines or for commercial exploitation in terms of spices are the important sources of low frequency/disturbance. The results are in line with (Singh and Singh, 1992). Abdullah *et al*. (2009) in their study mentioned climatic factors as a reason that influenced the distribution of species in certain habitats. Verma *et al.* (2005) while analyzing plant diversity in plantation forest in Kunihar Forest Division of Himachal Pradesh also reported frequency values between the range of 10-100% in and attributed this to change in microclimate. Man *et al*. (2012) and Pandey (2003) has reported the frequency values for different herb species ranging between 5-31.67% and 20-100% in Porang valley, Himachal Pradesh and mixed oak conifer forest of central Himalayas respectively. Similarly, Pande *et al*. (2001), Agni *et al.* (2000) and Pande (2000) have reported the frequency range of 4.76-100%, 10-100% and 10-

80% in moist temperate, central and western Himalayan forest regions respectively. The findings are well within the range reported by these researchers.

5.2.2.4 Importance Value Index (IVI)

The IVI is an aggregate index that summarizes the density, abundance, and distribution of a species. It measures the overall importance of a species and gives an indication of the ecological success of a species in a particular area (Mishra, 1968). Considering importance value index as an indicator of dominance, the major contributors in prevalent agroforestry systems among three different seasons varied significantly (Table-12, 16, 20 & 24). In case of Boundary plantation, perusal of the data (Table-12) revealed that the dominant species was *Cynodon dactylon* with highest IVI value of 27.42, 27.91 and 45.09 during spring, summer and autumn season respectively. While as, *Polygonum hydropiper* was observed to be co-dominant species in terms of IVI. Lowest IVI was evaluated for *Prunella vulgaris* attaining 1.78 (spring), 1.96 (summer) and 1.32(autumn). For Homegarden, perusal of the data (Table-16) explicate that the dominant species is *Stellaria media* with highest IVI value of 33.22 (spring), 27.60 (summer) and 60.46 (autumn) with *Poa aungustifolia* as co-dominant in this particular system. Whereas, *Galinsoga parviflora* being the least contributor in the system in terms of IVI attaining lowest values as 3.15 (spring), 4.02 (summer) and 2.34 (autumn). In Horti-agricultural system, numerical values in Table-20 indicated that during three seasons *Stellaria media* came out to be the dominant species among all the species present there recording highest values as 28.98 (spring), 23.44 (summer) and 42.58 (autumn) however, *Artemisia absinthium* recorded lowest values for IVI exhibiting 2.66,4.48 and 2.78 during spring, summer and autumn respectively. While, *Plantago major* being co-dominant. Similarly, in Horti-silvi-pasture system (Table-24), data pertaining to IVI indicated that the dominant species with highest IVI value of 29.63, 21.02 and 41.92 during spring, summer and autumn season was *Cynodon dactylon*. The co-dominant species in terms of IVI value was *Oenothera rosea*, however, lowest values were evaluated for *Mentha arvensis* as

1.48 (spring), 2.98 (summer) and 1.01 (autumn). The values of IVI summarized above in respective agroforestry systems for different species are well within the reported range for temperate Himalayan forests by Pande *et al*. (2001); Risser and Rice (1971) Okhlahoma upland forests.

High IVI of few species indicated their dominance and ecological success, their good power of regeneration and greater ecological amplitude. It does vary with the season. However, their dominance at a particular site could be due to the availability of optimum conditions for their growth, better adaptability of a particular species under prevailing environmental conditions. Also, disappearance of some species may be due to the mechanical damage by the man and animals. Favorable observations in support of results achieved was also reported by Bijalwan *et al*. (2011); Shameem *et al*. (2010); Kukshal *et al*. (2009). A close observation of IVI of different species in different prevalent agroforestry systems showed that there was irregular increase and decrease of this parameter in subsequent seasons with highest IVI values during autumn. It may be due to the reason that most of the available resources are being utilized by that species (having high IVI) and left over are being trapped by another species as the competitors and the associates i.e. their inter-relationships with ambient environment and associate species, light availability etc. Other factors affecting the vegetation distribution include biotic such as dispersal limitation, competition, and predation (Wright, 2002; Munzbergova and Herben, 2005). Similar findings were reported by Gupta and Dass (2007); Bunker and Carson (2005); Hall *et al*. (2004). Further, it can be maintained that the dominance of certain species in prevalent agroforestry systems in a particular period could be as the other co-dominant species do not reach maturity to complete their life cycle, dominance during autumn season owing to adverse climatic conditions that cause diminished rate of sprouting of root/seed stock, thus species number declines. It is generally argued that each individual species depends on some set of other species for its continued existence and the species have co-evolved in the ecosystem on which they depend (Paine, 1966). IVI values can also be used to prioritize species for conservation, and species with high IVI value need less conservation efforts, whereas those having low IVI value need high conservation efforts (Molla and Kewessa, 2015).

As far as wild herbaceous plants are concerned, results in Table-12, 16, 20 & 24 shows that following herbaceous communities do exist in prevalent agroforestry system of District Budgam, christened as:

1. *Cynodon dactylon- Polygonum hydropiper- Prunella vulgaris* community in Boundary plantation.
2. *Stellaria media- Poa aungustifolia- Galinsoga parviflora* in Homegarden.
3. *Stellaria media- Plantago major- Artimesia absinthium* in Horti-agricultural system.
4. *Cynodon dactylon- Oenothera rosea- Mentha arvensis* in Horti-silvi-pasture system.

The nature of plant community at a place is determined by the species that grow and develop in such environment (Bliss, 1962). Difference in the species composition from site to site is mostly due to micro-environmental changes (Mishra *et al*., 1997). Grubb (1997) reported that individual species have different resource requirements or tolerances, making effective competitors able to exist in many different micro-sites.

Data pertaining to mean density and basal area of wild plants in different agroforestry systems showed that these were significantly higher in Horti-silvi-pasture as compared to other systems (Table-25 & 26). The possible and important reasons for such high density (635.77/m^2) and basal area (22.09/m^2) value in this particular system can be less human interference in terms of ground operations like weeding, cutting, agricultural activities as in this system horticultural crop is the primary component with no agricultural component present for which these wild plants can pose threat of competition (neighbouringeffect) for resources. In all, owing to low or zero level of disturbance, this system achieved higher values for these parameters. The research findings are in agreement with Singh and Singh (1992 & 1987).

5.2.2.5 Vegetative indices of wild plants

Indices summarizing community structure are used to evaluate fundamental community ecology, species interaction, bio-geographical factors, and environmental stress. Measurement of biodiversity in a specific area (local scale) on the basis of richness alone does not provide a complete under-standing about the individuals of the species as it suffers from the lack of evenness or equitability (e). So, Shannon Wiener's index (H) is one of the most popular measures of general species diversity in a forest (Singh *et al*., 2011).

Seasonal Shannon weiner index, species evenness, Simpson index and concentration of dominance of wild plants displayed similarity with density, basal area, frequency and IVI with respect to seasons i.e. highest and lowest values exhibited during summer and autumn respectively (Table- 27). The important and possible cause for higher values during summer season can be congenial growth conditions in terms of nutrient availability, soil moisture, humidity, light and temperature, rapid microbial activity for a large number of plants as reported by Singh (2012) and Shameem *et al*. (2010). Lower rate of evolution, diversification of communities (Bhandari and Tiwari, 1997; Simpson, 1949) and severity in environment (Bhandari *et al*., 1998) cause decreased diversity index and evenness of wild plants during autumn season. The results (Table-27; Fig. 6 & 8) obtained for Shannon weiner diversity index and species evenness in prevalent agroforestry systems with respect to seasons were summarized as 2.98 and 0.87 (spring), 3.05 and 0.88 (summer), 2.52 and 0.76 (autumn) for Boundary plantation; 2.62 and 0.86 (spring), 2.87 and 0.94 (summer) and 2.17 and 0.78 (autumn) for Homegarden; 2.77 and 0.90 (spring), 2.89 and 0.95 (summer), 2.54 and 0.88 (autumn) for Horti-agricultural system; 2.97 and 0.85 (spring), 3.21 and 0.93 (summer), 2.74 and 0.82 in Horti-silvi-pasture system respectively.

Other researchers have found similar results viz., Singh (2012) reported for seasonal changes in vegetations structure around sewage drains in Jaunpur, India; Shameem and Kangroo (2011) in Dachigam National Park, Kashmir Himalaya; Eichemberg *et al*. (2009) in old urban homegardens in Rio Claro, Southeast of Brazil; Tynsong and Tiwari (2010) in homegardens of War Khasi community of Meghalaya (mean Shannon weiner index and 2.52 to 3.03 and 0.85 to 0.95); Kharkwal *et al*. (2004) in Pine forest stands of Central Himalaya.

Simpson index and concentration of dominance showed contrasting results to Shanon weiner index and evenness among three evaluated seasons in all prevalent agroforestry systems. Simpson and concentration of dominance index in boundary plantation ranged from 0.066 (spring), 0.060 (summer), 0.09 (autumn) and 0.07 (spring), 0.061 (summer), 0.10 (autumn) respectively (Table-27; Fig. 7 & 9). Correspondingly, in Homegarden, 0.07 and 0.08, 0.061 and 0.063, 0.11 and 0.13 during spring, summer and autumn were obtained for Simpson and dominance index (Table-27; Fig. 7 & 9). Likewise in Horti-agricultural system Simpson and dominance index was evaluated in the order of 0.063 and 0.068, 0.05 and 0.06, 0.08 and 0.09 in spring, summer and autumn; 0.067 and 0.07, 0.046 and 0.047, 0.08 and 0.09 during consecutive seasons respectively in Hort-silvi-pasture system (Table-27; Fig. 7 & 9). Results are in conformity with Singh and Singh (2013) for riparian corridors of Gomati at Rouza Ghat in District Jaunpur, U.P, India; Shameem *et al*.(2010) for herb layer diversity in lower Dachigam National Park, Kashmir Himalaya, India.

Among prevalent agroforestry systems, Horti-silvi-pasture system achieved highest values for Shannon weiner index in all the three seasons as depicted in Table-27 & Fig. 6, but less species evenness index values than Horti-agricultural system and Boundary plantation. It may be due to the fact of less or moderate level of human interference/disturbance with the ground cover i.e. wild herbaceous layer that otherwise is considered as weeds in other identified prevalent agroforestry system where they can create environment of competition for available resources with arable crops present over there, wider spacing between trees giving way to under storey to grow. The observations are in line with Saxena & Singh (1984) and Decocq *et al*. (2004).

There is evidence that under-storey vegetation generally becomes dense in the early stages of successional development when the site is more open to invite species invasion (Goirala *et al.*, 2008). Most of these gap opportunistic species are light demanding, and once a gap is found/formed they overtake the space. The increased availability of light and water as well as the speed of decomposition of organic matter are contributing to the fast establishment of herbaceous species and whenever the size of the opening is increased, more resources are freed for the herbaceous plants to flourish.

The evenness values in Horti-agricultural system (Table-27; Fig. 8) and Homegarden are high owing to uniformity in composition of plant species. The slight decrease in evenness value in Horti-silvi-pasture may be due to high species interaction that leads to species competition. Also low evenness value means the system is dominated by some species like *Cynodon dactylon*, *Oenothera rosea*, and *Medicago polymorpha*. Other researchers have summarized similar conclusions *viz*., Darcha *et al*. (2015) in homestead agroforestry systems of Serako, Northern Ethiopia ; Guyassa and Raj (2013) in cropland agroforestry in Ethiopia; Rao *et al*. (1998) in tropical agroforestry.

5.2.3 Quantitative/phytosociological attributes of shrubs

Quantitative information on distribution and abundance of vegetation is of key significance to understand the form and structure of a community for planning and implementation of conservation strategy of the community (Raturi, 2012).

Critical investigation of the study area in prevalent agroforestry systems revealed a marked variation (Table-28) in terms of both quantitative/ phytosociological attributes viz., density (plants ha^{-1}), basal area (m^2 ha^{-1}), frequency, importance value index and vegetative indices. In Boundary plantation, the individual shrub species recorded was *Rubus niveus*, exhibiting a density (plants ha^{-1}), basal area (m^2 ha^{-1}), frequency (%) and IVI value of 133.33, 0.066, 20 and 300. Also, it was appraised that there exist no shrub species in Homegarden agroforestry system in the study site. Similarly, in Horti-agricultural system, *Rubus ulmifolius* was explored as single species existing in this system achieving 400, 0.087, 33.33 and 300 as density (plants ha^{-1}), basal area (m^2 ha^{-1}), frequency and importance value index respectively. However, in Horti-silvi-pasture system, three shrub species were evaluated viz., *Asparagus officinalis*, *Rubus niveus* and *Rubus ulmifolius. Rubus niveus* examined to be dominant with maximum values for density (483.33), basal area (0.043), frequency (66.70) and IVI (160.23). The minimum values for all the quantitative attributes were recorded for *Asparagus officinalis* as 266.67 (density), 0.0084 (basal area), 30.00 (frequency) and 54.71 (IVI). The results in terms of parameters/phytosociological attributes are in unison and well within the ranges evaluated by Bijalwan (2012); Baduni and Sharma (2001).

The preceding results indicating high density, basal area, frequency and IVI i.e. dominance of *Rubus niveus* and *Rubus ulmifolius* in particular agroforestry systems may be attributed to their environmental suitability, great ecological amplitude and good regeneration power.

Shannon weiner index, species evenness, Simpson and concentration of dominance index in three prevalent agroforestry systems (Table- 29; Fig. 10) were recorded only, since no shrub diversity was found in Homegarden. The values of indices were 0, 0, 1 and 1 in both Boundary plantation and Horti-agricultural system, however, for Horti-silvi-pasture system the values were calculated as 0.93, 0.85, 0.403 and 0.404 respectively. The recorded diversity and dominance values lie within the reported range of 0.91 to 3 for Himalayan range and 0.35 to 0.70 for Montane forests of Garhwal respectively (Sharma *et al.,* 2009; Mishra *et al*., 2003; Bhandari and Tiwari, 1997). Bijalwan (2012) reported diversity and species evenness values ranging from 0.74 to 1.05 and 1.43 to 3.06 for northern and southern aspects in agrihorticulture system of Garhwal Himalaya.

Simpson and dominance index achieved a unit value in Boundary plantation and Horti-agricultural system indicating the presence (dominance) of single species in these agroforestry systems (Table-29; Fig. 10). The present findings are similar as reported by Risser and Rice (1971) for temperate vegetations ranging between 0.01 to 1.00; Saxena and Singh (1982) for Kumaun Himalaya as 0.13 to 1.00.

Results (Table-29) of the present study shows greater shrub diversity in Horti-silvi-pasture system which is in line with the findings of Toky *et al*. (1989) for Horti-silvi-pastural system of Western Himalayan agroforestry system concluding it as more diverse due to environmental suitability of shrub species, greater regeneration power and less human interference/disturbance. The lower value for both quantitative and vegetation indices of shrubs in Boundary plantation and Horti-agricultural system indicates highly disturbed landscapes having tremendous anthropogenic pressure in terms of agricultural activities, negative attitude of the farmer towards prickly nature of these plant species causing harm to them while working in their fields, very low regeneration potential in the prevailing environmental conditions. These observations are also in agreement with Yaqoob *et al*. (2014); Bhuyan *et al*. (2003); Longhi *et al*. (2000); Barik *et al*. (1996) and Mc Minn (1992).

5.2.4 Quantitative/Phytosociological attributes of trees

Species diversity is considered one of the key parameters characterizing ecosystem functioning. It is considered to be the outcome of the evolution of species in a bio-geographic region is often a synthetic measure of the structure, complexity and stability of the ecosystem (Hubble and Foster, 1983). The data on phyto-sociological status recorded in the present study (Table-30; Fig. 11), illustrated that in Boundary plantation density of 100 ha^{-1}, basal area of 2.41 m^2 ha^{-1}, 100% frequency value, importance value index (IVI) as 118.01 was illustrated by *Populus deltoides* with minimum density, basal area, frequency and IVI value achieved by *Salix fragilis* as 50 ha^{-1}, 0.84 m^2 ha^{-1}, 50% and 49.86 (Fig. 11). In Homegarden agroforestry system, *Malus domestica* proved to be dominant tree species exhibiting highest density (66.67 ha^{-1}), basal area (0.57m^2 ha^{-1}), frequency (83.33%) and IVI (57.09), while as, lowest values were demonstrated by *Juglans regia* 6.66 ha^{-1}, 0.03 m^2 ha^{-1}, 8.34%, 7.22 for density, basal area, frequency and IVI respectively. In Horti-agricultural system, the maximum and minimum values for density, basal area, frequency and IVI was exhibited by *Malus domestica* and *Pyrus communis* as 466.67 and 200 per hactare; 4.91 and 2.76 m^2 ha^{-1}; 100 and 66%; 134.50 and 72.48 respectively (Fig. 11). Similarly, in Horti-silvi-pasture system, *Malus domestica* was the major contributor achieving 300 individuals/ha, having 4.40 m^2/ha of basal area with 100% frequency and IVI of 72 (Fig. 11). However, *Robinia pseudoacacia* in Horti-silvi-pasture system was evaluated as least contributor with density of 34 ha^{-1}, 0.69 m^2 ha^{-1} basal area, 14% and 12 of frequency and IVI correspondingly. Several researchers have documented the similar ranges for these quantitative parameters in tropical evergreen and deciduous forests in Uttara Kannada District, South India (Murthy *et al*., 2016), *Oxytenanthera abyssinica* based homestead agroforestry systems of Serako, Northern Ethiopia (Darcha *et al*., 2015); Traditional agri-horticulture system in mid hill situation of Garhwal Himalaya, India (Bijalwan, 2012); in woody vegetation of Garhwal Himalaya (Bhandari *et al*., 1998).

The higher values for quantitative or phytosociological attributes indicated by certain species like *Populus deltoides* in Boundary plantation, *Malus domestic*a in Homegarden, Horti-agricultural and Horti-silvi-pasture system may be due to ecological/environmental adaptability, farmers preference for their subsistence requirement fulfillment and variety of multipurpose uses such as fuelwood, timber, soil fertility, easy propagation and management, commercial purposes (*Populus deltoides*) (in case of broad leaved species) (Maikhuri *et al*., 2000; Rawat *et al*., 2010; Vishvakarma *et al*., 1998) and fruits trees utilized as cash crops. As per the results summarized in Table-30 & Fig. 11. *Malus domestica* was found to be frequently distributed achieving high IVI values across three different agroforestry types *viz*., Homegarden, Horti-agricultural and Horti-silvi-pasture system i.e. frequent occurrence of apple tree was recorded. It is because, this fruit tree species have greater economic value i.e. it provides additional monetary benefits to farmers along with agricultural crops, good market value, long shelf life than other fruit tree species evaluated of the farmer in Kashmir because of its great demand locally and nationwide. Several researchers have documented similar results in woody species diversity in traditional agroforestry practices of Dellomenna District, Southeastern Ethiopia (Molla and Kewessa, 2015); traditional agroforestry systems evaluation in Tripura, North East, India (Deb *et al*., 2014); Bijalwan (2012) for horticulture trees under traditional agri-horticulture system in mid hill situation of Garhwal Himalaya, India; Cocoa agroforest of Cameroon portraying use of exotic and native plant species (Sonwa *et al*., 2007).

Vegetative indices *viz*., Shannon weiner index, species evenness, Simpson and concentration of dominance index in prevalent agroforestry systems (Table-31; Fig. 12). The recorded values were 1.17, 0.84, 0.30 and 0.31 for Boundary plantation; 1.60, 0.64, 0.22 and 0.24 for Homegarden; 1.04, 0.95, 0.35 and 0.36 for Horti-agricultural system and 1.64, 0.84, 0.207 and 0.208 for Horti-silvi-pasture system respectively. Results of the present study lie more or less within the ranges documented by Akinbisoye *et al*. (2014) 1.26 to 1.58 as Shanon weiner index for native woody species in Nigeria; Allahyari *et al*. (2014) evaluated diversity index as 1.06 to 2 for horticultural crop biodiversity in Kermanshah Province, Iran; Bijalwan (2014) in traditional agri-silvi-horticulture systems found diversity index of 0.58 to 1.12, Simpson index from 0.08 to 0.27 and evenness from 0.38 to 0.43; Ghimire *et al*. (2008) have recorded index of diversity and dominance ranging from 0 to 0.96 and 1 to 0.52 respectively for *Juniperus indica* forest in Southern Manang Valley, Nepal; 0.83 to 1.96 diversity index, 0.23 to 0.61 evenness, 0.91 to 0.93 for Simpson index in Himalayan Subtropical forests of Bagh District, Kashmir (Shaheen *et al*., 2011); Shannon weiner index and species evenness ranged from 2.10 to 3.14 and 0.75 to 0.85 respectively by Sharma *et al*. (2009) for temperate mixed broad-leaved forest in Garhwal Himalaya; Shannon diversity index, Simpson index, and evenness as 2.22, 0.83, and 0.64 correspondingly by Kumar *et al*. (1994) homestead gardens of Kerala in India. Concentration of dominance (cd) values between 0.11 and 0.93 for tree layer in the temperate forests of Kumaon Himalaya by Tewari and Singh (1985).

Critical investigation (Table-31) of the study area with respect to tree diversity in prevalent agroforestry systems revealed that diversity and dominance indices was higher in case of Horti-silvi-pasture system than other systems as already discussed above. It may be attributed to the easy management in terms of input management than in other three systems, farmer's preferences to keep diverse trees in this system for their subsistence and economic needs. The results are in agreement with the findings of Bobo *et al*. (2006) species richness patterns of trees in Southwestern Cameroon. The low evenness in Horti-silvi-pasture than Horti-agricultural system could be attributed to the dominance of some species in terms of total population such as *Malus domestica and Prunus domestica* which farmers often plant/retain and tend deliberately in high density i.e. more equal abundance of species in Horti-agricultural system as also investigated by Gupta and Prasad (2013) for tropical evergreen and moist deciduous forests of the middle Andaman Islands, India. As agroforestry is a system that blends production (food and income security at household and community level) with ecosystem services. Our findings are in concurrence with Guyassa and Raj (2013).

The low Shannon diversity index of Horti-agricultural system despite having more total density of trees ha^{-1} than Boundary plantation and Homegarden seems to be related to the higher dominance of *Malus domestica* in Horti-agricultural system. Diversity of an ecosystem not only depends on the number of species but depends also on the abundance of species. In fact species diversity consists of two components, namely species richness and species evenness, which the latter point to the evenness of individuals within different species (Allahyari *et al*., 2014). The other reason for low diversity values for Horti-agricultural system under present investigation may be attributed to the sharing of large proportion of resources by few species and follow niche pre-emption hypothesis which is indicative of low competition among the species because of IVI of species is proportional to the amount of resource that they utilize as stated by Whittaker (1965), Pascal (1992) and Swamy (1998).

5.2.5 Similarity Index

The results summarized on similarity index in Table-32 showed a high percentage (51.35%) of species being shared between the boundary plantation and Horti-silvi-pasture agroforestry system and is comparable to the observations made by Pokhrel *et al*. (2015) for agroforestry system in Nepal; Roy *et al*. (1993) in tropical forest community. The high degree of similarity between the two agroforestry types indicates their close association, without a broad ecotonal fringe, allowing the dispersal and survival in each community of species from the other. Akinbisoye *et al*. (2014); Seta and Demissew (2014) and Suyal *et al*. (2010) has opined that close proximity, similar agro-climate/climatic conditions, same tree combination results in high similarity of vegetation. Similarity values provide support to the hypothesis that climatically and biogeographically close agroforestry systems have comparable richness and species composition, and in this sense species richness and similarity could be partly predicted as a function of a pool of variables including climatic ones (Garcia del Barrio *et al*., 2014; Laughlin and Grace, 2006; Stevens, 2006).

Aerts *et al*. (2006) studied that environmental gradients determine the development of appropriate agroforestry management strategies for a given site. Agroclimate, local needs, indigenous knowledge, management intensity and extension access, population density, landuse intensity and market access also affect farmers' decisions of species choice (Sonwa *et al*., 2007). These have a far-reaching impact on species introduction, and affect species composition. Similar findings were reported from Western Kenya (Negash *et al*., 2012; Kindt *et al*., 2008). The differences in topographical aspect of the farms may also contribute to species composition and abundance. The impact of topographical aspect is related to microclimatic differences and associated environmental factors, such as the soil moisture and organic matter content of the sites (Yimer *et al*. 2006). In contrast to above statements, geographical distance alone cannot be used to explain similarity of species of plants tended or cultivated in different landuse systems (Milow *et al*., 2013). High similarity may be between relatively close and distant landuse systems. Owner's preference and availability of planting stocks are believed to have profound effect on the diversity of plant species tended or cultivated. Similar opinion has been given by Aguilar-Stoen *et al*. (2009) on species diversity of similarity in Candelaria Loxica and Oaxaca in Mexico.

5.3 Socio-economic evaluation and contribution of prevalent agroforestry systems

Agroforestry is an integrated production system and a stable ecosystem that maintains the diversity of life as well as the biological wealth. It is the main source of food, fruits, vegetables, timber and fuelwood for the household and is a reliable source of household income. The major functions of agroforestry system particularly in rural areas are subsistence production and income generation (Kumar and Nair, 2004). They also fulfill many social, cultural and ecological needs in a sustainable way. For example, studies from South-west Bangladesh (Motiur *et al*., 2006) and North-eastern Bangladesh (Motiur *et al*., 2005) reported that on an average 15.9 and 11.8 per cent of household income is derived from homegardens respectively.

5.3.1 Demography, education level, occupation, income, land use patterns management expenditure and livestock in District Budgam

The results summed up in Table-33 revealed that the total area of the sampled study site i.e. sample from six blocks from three tehsils is 136.84 ha including dwellings of the farmers which are made up of pucca houses only. Three categories of age groups *viz*., < 18 years (young aged), 19-50 years (middle aged) and >50 years (old aged) were interviewed during investigation (Table-34). It was assessed that the majority of the respondents occurred in the middle age category (139; 55.15%) as this age group is more involved with the agroforestry/farming activities. The present findings are well in line with Kabir and Webb (2009) who have also reported most farmers (about 53%) of middle aged engaged with in homestead agroforestry activities in southwestern Bangladesh. According to Namwata *et al*. (2012), household members are considered economically productive from the age of 16 to 64 years. The age group below 16 years is children some of whom may be attending schools and others too young to participate in farming activities. The age group above 64 years is considered less economically active because the members are too old.

Data presented in Table-35 indicated that 68.25 per cent respondents have medium size family structure consisting of 5-10 members which was also a representative of typical family size in Kashmir valley (India). In India it is very common to live together with parents and with brothers and sisters and sometime with relatives (Joint family). The results are in consonance with Zaman *et al*. (2010a & b) who have documented similar results of having medium sized family in Bangladesh.

The levels of education among the farmers were categorized into five groups *viz*., illiterate (no schooling), primary level (1 to 5 years of schooling), secondary level (6 to 10 years of schooling), higher secondary level (10 to 12 years of schooling) and higher study (college and university level) (Table-36). From the reconnaissance of the study area, it was concluded that 50% of the respondents had availed education upto secondary level (25.83%). This implies that, introduction of modern agroforestry technologies and innovations in the study area are likely to be successfully adopted because the majority could not only be trained by the extension but also read from books and newsletters and other sources of information. However, maximum percentage of respondents in District Budgam were found to be illiterate (50%) either due to poor financial conditions or lack of interest of a person to get educated. Similar observations on educational level was reported for northern Bangladesh, where a higher proportion (49%) of respondents had secondary education (Hasanuzzaman *et al*., 2013); Anonymous, 2013). The occupations of respondents were classified into five major groups i.e. farmer (agriculture), business, service and daily labour and the proportions were 24.60, 23.01, 21.03 and 31.34 per cent respectively. The large proportion of the persons fall in the labour category, the main reason behind this could be illiteracy as stated above. Data summarized in Table-37 showed that agriculture is the important land use pattern but farmers have involved their lands for cultivating horticultural and vegetable crops also. Zaman *et al*. (2010a & b) and Kabir and Webb (2009) reported that agriculture was the main occupation of the farmers in southwestern and northern Bangladesh.

Total income of the people in the study area was assessed to be maximum from doing daily labour work (41.87%) of the total income (Table-38). This could be probably due to more people involved in daily labour because of low financial status of the family, illiteracy and educated youth not getting jobs in government run organizations/offices.

Perusal of the data in Table-39 & 40 summarized that the agriculture is mainly practiced in the district as the land holding under this land use system is more (55.16 ha) than other land use patterns followed by horticulture (32.14 ha). As per the investigation done in the study area, the farming category range from marginal (< 1 ha of land) to small (1.0-2.0 ha of land) (Chundawat and Gautam, 2006) practicing various agroforestry systems *viz*; Boundary plantation, Homegardening, Horti-agricultural and Horti-silvi-pasture system (Table-40). While, having in depth discussion with farmers about land use pattern in the District, it was clear that they have been practicing agroforestry from long to meet their basic requirements either at subsistence or low commercial level. In total 4 agroforestry systems were identified as prevalent in the study area being practiced by the farmers in order to meet their diverse needs in terms of food and money. Various plant species both cultivated as well as wild (both medicinal and aromatic in case of herbage) form the structural components of identified agroforestry systems (Table-40) *viz*., Poplar sp., Willow sp. Paddy, Mustard, Oats and Peas in Boundary plantation; Poplar sp., Willow sp., Kikar, Ulmus, Almond, Apple, Peach, Plum, Pomegranate, Quince, Brinjal, Bottle gourd, Carrot, Cucumber, Garlic, Kale, Knol-khol, Maize, Peas, Potato, Rajma/ Beans, Tomato, Turnip, radish, spinach, in Homegarden; Apple, Plum, Pear , Rajma/ Beans, Kale, Maize, Potato, Radish, Turnip in Horti-agricultural system; Poplar sp., Willow sp., Kikar, Apple, Plum, Pear and naturally grown grass/herb species in Horti-silvi-pasture system. Mughal and Bhattacharya (2002) and Bhat *et al*. (2010) have also reported similar components of various agroforestry systems in Kashmir valley (J&K).

Critical view of annual expenditure incurred on different non agroforestry and agroforestry land use systems presented in Table-41 revealed that total amount of money spent by the farmers for management of various land holdings including expenditures related to collection and processing of plant products from these systems was found to be Rs 9, 62,242 yr^{-1}. It was also evaluated that both family as well as skilled labour (@ Rs 350-400 per day) is being employed for the purpose. Tynsong and Tiwar (2010) have documented a total expenditure of Rs. 8,66,438 on standard daily wages of workers to be Rs.150 for Men (skilled laborer) and Rs.100 (unskilled laborer), Rs. 45 for women and Rs.30 for boys for Homegardens in Meghalaya.

Perusal of the data in Table-42 revealed that that farmers who own large land holdings (> 1 ha in the study area) keep more animals than the farmers who own small properties (< 1 ha). However, from the investigation it was also evaluated that poultry was the most preferred (total number = 205) because it is relatively easy and cheap to manage and needs only small initial capital compared to other livestock species. Also, disinclination is arising among people towards keeping the livestock owing to rapid urbanization, expensive feed material and/or maintenance of animals is considered as tiresome job. Similar findings have been reported by Arifin *et al*. (2012) for small-scale homestead agro-forestry systems (*"pekarangan"*) on household prosperity in Indonesia; Namwata *et al*. (2012) in agroforestry systems of Tanzania.

5.3.2 Fuelwood

Data presented in Table-43 revealed that the fuelwood is being used by all the families in the study area besides other energy alternatives. During survey, it was evaluated that farmers collect fuelwood from trees available in various land use patterns they practice *viz*., Elm, Poplar, Willow, Kikar, Apple, Pear, Plum, etc. It was also documented that species like Celtis, Mulberry etc. are now confined to either holy shrines or graveyards because of myth of having spiritual power.

5.3.3 Fuel usage ranking

From the appraisal of the study area, it was concluded that during two seasons *viz*., summer and winter, people of the District Budgam use various sources of fuel/energy as per there availability and preference for different purposes i.e. cooking, heating, lighting, festivals, marriages etc. As far as the availability and inclination towards a particular energy source is concerned, people of the District Budgam were questioned to rank the fuel usage from 1-6 during summer and winter season. It was concluded, that fuel wood as a source of energy dominated and is ranked first among all the available sources for meeting the energy requirement of the studied site for both the seasons (Table-44). Interaction with farmers revealed that fuelwood dominates among households, with electricity kerosene oil being second or third source of energy either due to unscheduled power cuts during both seasons or due to inaccessibility to the Depots and black marketing of the fuel (kerosene). Fuel wood is one of the most important source of energy in the developing countries and responsible for about

60.00 per cent of total energy requirement in rural areas (Banyal *et al.*, 2013). Animal dung and crop residue is ranked as the least amongst different sources of energy as neither animal dung nor agricultural waste is being used as fuel by the people of the area which are otherwise used as manure. The use of LPG was somewhat at lower side due to its higher cost which was afforded by only those belonging to upper middle or elite class families. About 50 per cent of the people in the study area were using fuelwood as a main source of energy, 30 per cent using fuelwood and LPG and remaining 20 per cent rely on electricity and LPG for cooking, heating, lighting etc.

The current sustainable production of fuelwood from forests is 17 million tonnes and from farm forestry and other areas 98 million tonnes. Hence, there is net deficit of 86 million tonnes of fuelwood, which, as compulsion, is being removed from the forests. A number of estimates of fuel wood consumption have been made over the years by different workers like Joshi and Sinha (1995) and Mukherji (1994).

5.3.4 Alternate fuelwood sources

Data pertaining to Table-45 showed that agroforestry systems prevalent in District Budgam are contributing towards fulfillment of fuelwood needs of the people and can be complementary to forests. It was evaluated that households meet out their fuelwood needs from various sources either from pure forestry wood lots located nearby, market or from alternate sources i.e. different agroforestry systems being practiced by the people directly for burning into chulhas and/or making charcoal for use in Kangris during winter season. Perusal of the data Table-45 evaluated that the major contributor of fuelwood in the study area is Horti-silvi-pasture system (40.54%) followed by Boundary plantation (24.34%) and least is Homegarden agroforestry system (12.92%) of the total quantity of fuelwood production. This may be due to presence of more number of broad leaved species in former agroforestry systems which are and can be pruned at much higher extent without affecting growth and production of a tree. Results are more or less in conformity with Banyal *et al*. (2013).

5.3.5 Production and income contribution of prevalent agroforestry systems in District Budgam

Critical examination (Table-46) of the production and income generation by various components in prevalent agroforestry systems of District Budgam explicated the gross production per annum contribution of worth Rs 74450 yr^{-1} in Boundary plantation with *Oryza sativa* generating 55.74% (Rs 15,000 yr^{-1}) out of to the household income. Likewise in Homegarden, the total gross production was worth Rs 114725 yr^{-1} with *Allium sativum* (Garlic) (10.45%), *Brassica oleracea* (Kale) (7.90%) and *Capsicum annum* (Chilli) (5.90%) as the important plant species supporting the household income.

With respect to horticultural crops in Horti-agricultural system, *Malus domestica* (Apple) contributed most (35.10%) towards the annual income of the famers in District Budgam followed by *Prunus domestica* (Plum) (32.01%). In terms of agriculture/ vegetable crops in Horti-agricultural system, *Brassica rapa* (Turnip) (1.14%), *Phaseolus vulgaris* (Rajma) (0.38%) and *Brassica oleracea* (Kale) (0.22%) contributed highest gross production percentage to the families. From the evaluation, it was concluded that in this agroforestry system, both horticultural and vegetable crops had a production of worth Rs 15,71195 per annum. Likewise, in Horti-silvi-pasture system, *Malus domestica* is the prime contributor towards income of the people practicing this particular agroforestry system. The gross production percentage contribution of this crop (Apple) was evaluated to be 36.33%, generating an annual income of Rs 58,0500 yr^{-1} followed by *Prunus domestica* Rs 54,5000 yr^{-1} (34.14%) (Table- 46). Prunings of tree species present in these agroforestry systems were used to make coal for use contributing about one per cent to the total gross production. Also, the wild herbage e.g. *Cynodon dactylon*, *Convolvulus arvensis*, *Medicago polymorpha*, and *Poa pratense* growing naturally in this system, were consumed as forage by the animals, occasionally taken for grazing by the land owners. As per the land owners, the gross annual expenditure per head of the animal feeds amounts to Rs 27,300 yr^{-1}. By grazing the livestock in the Horti-silvi-pasture system, the saving of about Rs 4,360 yr^{-1} is achieved which accounts upto 0.27 per cent of the gross annual expenditure. The present findings are in conformity with Bijalwan (2012) for traditional Agri-horticulture system in mid hill situation of Garhwal Himalaya, India; Niehaus (2011) in Cacao (*Theobroma cacao* L.) agroforestry systems in Panama.

5.3.6 Economic returns to farmers

Data presented in (Table-47) showed that income returns from prevalent agroforestry systems ($hectare^{-1}$ yr^{-1}) were either at low or high profit levels. It was evaluated that an income of Rs 10,76.03/farmer (Rs 3,335.71/ha) was achieved from Boundary plantation, fulfilling less than 10% of the total income of the household of about 11.82% of the farmers. From Homegarden Rs14,54.32/farmer (Rs 70,42.96/ha) was calculated as to uphold 14.4% of the farmers. Similarly, in Horti-agriculture system, income returns per famer was examined to be worth Rs 22,529.98/farmer (Rs 13,0417.65/ha). Horti-silvi-pasture system was found to maintain the household economy @ Rs 53,855.50/farmer (Rs 26,9652.17/ha) summarized to contribute largely to the total household income (67.46%) to the farmers out of all systems. The average annual gross production of the agroforestry systems are comparable to the income contribution by the homegardens in south west Bangladesh (Rs.11,435) (Motiur *et al*. 2006), north-eastern Bangladesh (Rs.97,441) (Motiur *et al*. 2005) and South Africa (Rs.6,661) (High and Shakleton, 2000). In terms of per hectare area, the average annual gross income in south Meghalaya was Rs. 44,241 and also the homegardens of South Africa (Rs.16,520) (High and Shakleton, 2000). The percentage contribution of homegardens towards people's annual income are in line reported by Tynsong and Tiwari (2010); Kabir and Webb (2009); Mendez *et al*. (2001); Soemarwoto (1987).

5.3.7 Preference and quantity of tree Fodder

Table-48, 49 & 50 presents the data pertaining to the fodder usage by farmers at three different seasons (spring, summer and autumn). It was evaluated that the fodder that farmers use to give as feed to their livestock was supplied from either trees i.e. Poplar, Salix and Robinia or agricultural crops viz., oats and paddy straw and sometimes both in different ratios in order to meet the nutrient and energy requirements of the animal as per season. Farmer's preference ranking of different fodder trees was found to be associated with nutrient contents of the foliage. The highly preferred species were found to have high nutrient contents as shown by the findings of fodder nutrient analysis. Farmers used their conscience to select species and harvesting season for particular species. Farmers value fodders that can have better nourishing quality for livestock.

Critical examination of the data in Table-49 revealed that the farmers give first ranking to Robinia as best feed in terms of health and reproduction of the animal. Second preference given to Salix and least to Poplar species. As far as Celtis and Mulberry are concerned they are confined to sacred places only. Several authors have described tree species used to supply animal feeds to different categories of livestock. Bouazza *et al.* (2012); Emmanuel and Tsado (2011) noted that in all fodder development works, legumes play the major role as they enrich the soil with nitrogen and produce highly digestible and protein rich fodder.

Farmers preferred three tree species along with other feed components i.e. oats and rice straw as fodder in different quantities in order to feed their livestock at fullest. Farmers use these feed sources either as sole supplement or in an amalgam of different fodder components *viz.*, sometimes 100 per cent of the feed requirement is met by giving a mixture of 50 per cent of any of the fodder material (e.g oats) + 50% of another feed component e.g tree leaves. However, at times livestock is being fed with 50% (as amalgamation of 25% of any of the fodder material e.g leaves of Robinia + 25% of another feed component e.g leaves of Salix) and for rest of the 50 per cent, cattles are grazed either in nearby open lands or in the land owned by the farmer (Table-50). Obua (2014) has reported that feeding a variety of plants available in a locality would ensure adequate dry matter and nutrient intake from the forage and contribute to overcoming low dry matter intake, a constraint to the use of browse plants in ruminant feeding.

Fodder production is one of the major objectives for maintaining agroforestry systems with a hope to reduce the labour of village women to travel long for its collection. Hence, trees in or around the agricultural and horticultural fields supplement the fodder requirement substantially, which depends on the number of palatable species available in existing agroforestry systems.

5.3.8 Fulfillment of subsistence needs of farmers through different agroforestry systems

From the results, it was apprised that prevalent agroforestry system in the study area supports only about 50 per cent of the household needs in terms of food, fodder, fuelwood, timber and medicinal plants (Table-51). This may be attributed to involvement of small land holdings by the farmer as agroforestry land use system because of their negative approach towards agroforestry system to affect the production of crops growing under trees, higher frequency of few cash crops more liked and preferred by the households like Kale, Maize, Rajma etc. Besides having a diversity of cash crops (vegetables and fruits), these agroforestry systems harbor many wild growing plants/medicinal plants like Artemisia, Dandelion, Mint, Rumex which have high market value, should also be considered for large scale cultivation, so that these valuable bio-resources can become the alternate source of extra income in addition to other sources of revenue to upgrade their socioeconomic status.

5.4 Fuelwood Value Index of Preferred Tree Species in District Budgam

From little more than one century ago, the use of wood for the production of cellulose pulp for papermaking has increased progressively, reaching levels of consumption of wood similar to the oil. This has led to a wood supply problem, which worsens over time. For this reason, many of the investigations carried out in recent years have focused on finding new raw materials to avoid uncontrolled deforestation with serious ecological problems that occur in ecosystems. In this way the study of various materials has appeared such as agricultural, agro-industry and forest residues and alternative plants to those achieved in agri-food crops (Gonzalez *et al*., 2012).

In the present investigation, quantitative analysis of five broad leaved and four fruit trees were undertaken for assessment of various parameters of fuelwood value index (FVI) *viz*., moisture content (%), wood density (g/cc), ash content (%) and calorific value (KJ/g) in order to rank the tree species as per their evaluated fuelwood value index. The results summarized in Table- 52 & 53 revealed significant variation among tree species used as fuelwood in District Budgam. As far as broadleaved trees are concerned, *Robinia pseudoacacia* achieved minimum moisture content of 59.07%, maximum wood density (0.64 g/cc), ash content (1.50%) and calorific value (22.22 KJ/g), thereby attributing highest fuelwood value index (FVI) among all evaluated/screened species followed by *Salix alba* (Table-52). In terms of all parameters calculated, *Populus deltoides* achieved 64.63%, 0.41 g/cc, 1.48% and 18.53 KJ/g of moisture content, wood density, ash content and calorific value respectively, which was however at par with *Populus nigra*. However, among fruit tree species *Prunus dulcis* exhibited highest values as 34.25%, 0.89 g/cc, 1.56% and 18.71 KJ/g of moisture content, wood density, ash content and calorific/energy value followed by *Malus domestica* and lowest was evaluated for *Pyrus communis* as 47.40% (moisture content), 0.67 g/cc (wood density), 1.98% (ash content) and calorific value of 15.54 KJ/g (Table-53). The results are in line with the findings documented by Klasnja *et al*. (2015) who have reported almost similar values of willow, poplar and black locust wood density and heating /calorific values for Fuel Wood Value index (average values) which was higher for black locust (17.186) than for poplar and willow clones, which were similar: 11.31 and 11.42 respectively. Likewise, Bilandzija *et al*. (2012) found more or less similar calorific value for *Prunus dulcis* as 17.63 MJ/kg but higher ash content 3.88 per cent than the present study.

In general, an ideal fuelwood species should have high calorific value, high density, and low ash and moisture content. The species screened in the present investigation exhibited comparative quantitative values which are in conformity with the earlier findings of Cuvilas *et al*. (2014); Kumar *et al*. (2011); Mishra *et al*. (2010); Negi and Todaria, 1993; Bhatt and Todaria (1992b); Purohit and Nautiyal (1987). Species like *Robinia pseudoacacia* and *Prunus dulcis* had low moisture content and high wood density, thereby indicated high calorific values compared to other species investigated (Sotelo Montes *et al*., 2014 & Zhang *et al*., 2011). However, the ash content of the *Robinia pseudoacacia* (black locust) was higher compared to that of Poplar and Willow species, which influenced the values of the FVI index of the studied tree species (Table-52). Similar conclusions were given by Klasnja *et al*. (2015 & 2002) and Kraszkiewicz (2013).

Effective calorific value also depends on the moisture content, higher the moisture content, the less efficient is the wood as a fuel since the net calorific value for heating is reduced (Bhatt *et al*., 2010; Kumar *et al*., 2010; Bhatt *et al*., 2004). Moreover, it has been recorded that the moisture content of wood varies with the dimensions of branches, season of the year, and so on. Thus, water content cannot be considered as part of the intrinsic value of a species as a fuel since it can vary (Sotelo Montes *et al*., 2011; Bhatt and Todaria, 1992b). Similarly, high wood ash content is less desirable for fuel, as it is non-combustible and reduces the heat of combustion (Saravanan *et al*., 2013; Obernberger *et al*. (2006); Bhatt and Tomar, 2002**)**. Therefore, for the estimation of ideal fuelwood species, a fuelwood value Index was calculated as calorific value x density/ash (Bhatt and Todaria, 1992a). Keeping this in view, a combination of three factors (calorific value, density, and ash) will be most appropriate in determining the suitability of a wood as fuel. Similar observations were stated by Saravanan *et al.* (2013) in *Melia dubia*; Deka *et al.* (2007) for ranking fuelwood species of Assam; Goel and Behl (1996) in *Acacia auriculiformis*, *Acacia nilotica*, *Prosopis juliflora* and *Terminalia arjuna*; Jain (1994) in tree and shrub species of India.

5.5 Seasonal variation in fodder values of preferred tree species in District Budgam

Seasonal changes in the nutritional composition *viz*., crude protein(%), crude fibre (%), ether extract (%) and ash content(%) of evaluated tree species i.e. *Populus deltoides*, *Populus nigra*, *Robinia pseudoacacia*, *Salix alba* and *Salix fragilis* were found significant (Table-54) i.e. decreasing and increasing trend in crude protein and crude fibre, ether extract, ash content respectively with successive seasons. The results (Table-54) showed that mean values for crude protein content concentration was significantly maximum in spring (13.33%) followed by summer (10.87%) and minimum during autumn season (10.05%) among all the species evaluated. Likewise, mean values of crude fibre, ether extract and total ash content investigated revealed a marked significant variation among different seasons in all preferred trees (Table-54 & 55). The mean values obtained during spring, summer and autumn are 15.00, 17.02 and 17.77 (crude fibre); 3.34, 3.96 and 4.31 (ether extract); 12.12, 12.42 and 12.87 (total ash content). Among fodder species screened, maximum mean value of 18.10 and 5.03 and minimum mean value of 9.35 and 3.06 correspondingly for crude protein and ether extract was recorded for *Robinia pseudoacacia* and *Populus deltoides*. *Robinia pseudoacacia* achieved highest mean value for crude protein and ether extract in three seasons in decreasing and increasing mode as 18.73 and 4.86% (spring); 18.58 and 5.10% (summer); 17.01 and 5.12% (autumn), however, these parameters were found to be lowest in *Populus deltoides as* 11.52 and 2.28% (spring); 8.80 and 3.03% (summer); 7.73 and 3.38% (autumn) respectively. While evaluating trees for crude fibre and ash content, it was appraised that *Populus nigra* achieved maximum mean values as 18.50 and 13.48, whileas, *Robinia pseudoacacia* exhibited minimum mean values as 13.40 and 9.46 respectively for these parameters. Maximum crude fibre value was recorded as 15.92, 19.65 and 19.93% for *Populus nigra* and minimum value of 12.91, 13.16 and 14.11% in *Robinia pseudoacacia* for spring, summer and autumn season respectively. Likewise, it was investigated that *Populus nigra* also exhibited highest ash content value as 13.23,13.40 and 13.82 in spring, summer and autumn, whereas, *Robinia pseudoacacia* as lowest in the order of 8.91, 9.51 and 9.98 for consecutive seasons(Table-54 & 55).

From the preceding results of present investigation, it is concluded that crude protein content in tree foliages decreased while crude fibre, ether extract and ash content increased with successive seasons. The possible reasons (Table-54) may be ascribed to to the dilution effect, i.e., the rate of inflow of nutrient into the leaves may be lower than the amount of dry matter produced at a particular growth stage, thus decreased level of crude protein with season and/ or maturity of the leaves (Khosla *et al*. 1992; Singh and Todaria, 2012). Furthermore, there is close relationship between physiological activities of plants and water content. Physiological events slow down in drying plants and DM increases as the amount of water inside the cells decreases. Plants need more nitrogenous food for vegetative growth and therefore they efficiently store protein in early stages of growth, which is later on consumed during flowering and fruiting followed by dormant phase whereby their nutritional status reduces (Hussain and Durrani 2009). These findings are in conformity with Ahmed *et al*. (2013) for various forage plants for ruminants investigated in a semi-arid region of Punjab, Pakistan; Bamigboye *et al*. (2013) for assessment of seasonal nutrient composition of predominant forages in Nigeria; Parlak *et al*. (2011) for forage quality of deciduous woody and herbaceous species at different seasons in Mediterranean shrublands of Western Turkey; Azim *et al*. (1989) for nutritional evaluation of maize fodder at two different vegetative stages.

Several workers have stated that protein synthesis is stimulated as the plants starts to grow in the spring. Number of young cells increase and the physiological events are induced (Kacar *et al*., 2006). These events are the results of enzyme activities derived from proteins. Young cells also have high ratio of protoplasm. Most of the proteins in a cell are located in the protoplasm. Fibrous compounds are found in the cell wall. Cell wall components are more abundant in the older cells than the younger ones (Lyons *et al*., 1999). Cell wall development is related to plant development and as the plant matures wall compounds, crude fibre increases and protoplasm compounds like crude protein decreases (Hashmi and Waqar, 2014; Kaplan *et al*., 2014; Haddi *et al*., 2003; Parissi *et al*., 2005).

Parlak *et al*. (2011) observed lowest Ca and P in the two shrubs viz., gall oak (*Quercus infectoria* Oliv.) and Christ's thorn (*Paliurus spina-cristi* Mill.) of western Turkey during april which then shows high level during November as calcium involves in the structure of harder tissues (cell walls) and is important constituent of ash. This was because protoplasm compounds of the cell were high at the beginning of plant growth, therefore, Ca was low in the young shoots of the shrubs taken during fast growth in April and May. Cook and Harris (1950) attributed increase in ash with maturity to dust accumulations. Likewise, Blair and Epps, (1969); Kamalak *et al.* (2005); Hashmi and Waqar (2014); Haddi *et al*. (2003) found increased ether extract with increasing maturity in the shrubs (Kermes oak and halophyte shrubs) under study and attributed this to increased uptake of mineral elements from the soil at this time and later deposition of an important part of these elements into the cell walls.

Data in Table-54 & 55 also revealed variation in nutrient compositions among trees species viz, high crude protein (18.10% = mean value) as and ether content (5.03% = mean value) in *Robinia pseudoacacia* and decreased level in other species. However, crude fibre values were found to be maximum in *Populus* *nigra* (18.50% = mean value) and total ash (13.48%= mean value) than other 4 species which were under investigation. *Robinia pseudoacacia* and *Populus nigra* showed higher crude protein and crude fibre content, it may be due to leguminous character of *Robinia pseudoacacia* and high lignifications in *Populus nigra* respectively (Zhang *et al*., 2012; Rubanza *et al*., 2005). The findings lie within the ranges reported by Dhungana *et al*. (2012) *as* 11.5% ash content and 18.13% crude protein for *F. roxburghii*; crude fibre content of 1.06 and 12.98% by Umar *et al*. (2010) for *Faidherbia albida and Parkia biglobosa* respectively ; crude fibre as 13.50 and 18.51% for *Desmodium oojeinense* and *Mallotus phillippinensis* by Prajapati (2008).

Hafty and Kebede (2014) & Nahand *et al*. (2012) recorded that the high variability in the composition of different fodder trees and shrubs could be attributed to within species variability owing to factors such as plant part, harvesting regime, season and location, soil and some of environmental/climatic factors though plants are dependent upon the soil for their mineral nutrients, climatic factors affect respiration, assimilation, photosynthesis and metabolism to the extent that the mineral and organic matter content of plants may be strongly modified by climatic factors even though grown on the same soil that control accumulation of forage nutrients (Cook and Harris, 1950). Physical properties of soil such as texture and porosity affect the nutritive quality of forage more or less indirectly. Poorly aerated soils greatly limit or decrease the absorption of essential elements, especially phosphorus (Daniel, 1934). Soils rich in biotic life show enhanced aeration and fertility. The difference in chemical composition between species and within genera associated with the inherent nature of the species (genotypic factors) (Belete *et al*., 2012). Inline to this study, high CP content of different browse species ranges 17 to 22% *for Morus alba* species reported by Vu *et al*. (2011). However, Shaheen *et al*. (2015); Niknam and Ebehrahimzadeh (2002); Bowers and Stamp (1992) have stated that these genetic variations modified by a variety of biotic and abiotic features.

The continuous supply of protein is required by ruminant animals for normal metabolism. Ruminants require a minimum of 6-8% of crude protein for lactation and 10 to 12% for efficient fermentation of plant tissue by rumin bacteria (Onyeonagu and Eze, 2013; Azim *et al*., 2011; Moh'd Khair *et al*., 2000). The high crude fibre in present study shown by *Populus nigra* relative to other species indicated importance of having their mixtures in the animal diet as supported by Tudsri *et al*. (2002). Ether extract is the lipid component and the energy derived from it is utilized by the animal for body maintenance and production. All the plant parts have nutritional qualities which when used in the right proportions could be of tremendous benefit to the body (Ahmed *et al*., 2013). As the percentage of crude fiber increases, digestibility usually decreases because crude fiber is resistant to decomposition and it often envelops digestible nutrients rendering them unavailable.

5.6 Proximate analysis of agricultural crops as feed for ruminants

The results presented in Table-56 showed a significant variation using t-test among two agricultural crops used as fodder viz., *Avena sativa* and *Oryza sativa*. Among these two feed sources *Avena sativa* found to achieve highest crude protein content (2.34%), crude fibre (36.52%), ether extract (3.23%) and ash (14.28) compared to *Oryza sativa* recorded 2.09, 11.07, 2.36 and 3.40% as crude protein, crude fibre, ether extract and ash content respectively. The findings are in line with the findings of Gebremichael (2014) and Khan *et al*. (2014).

These variations could be a result of agronomic factors such as application of various levels of nitrogen fertilizers, time of harvest, ensiling, field drying and storage. Similar findings have been reported in Italian rye grass (Bittante and Andrighto, 1982). The value obtained for crude protein in *Oryza sativa* are lower than the value 3.2% reported by Rekib *et al.* (1970). Like crude protein, other nutrients could also vary in different feeds due to agro climatic conditions, cultural practices and postharvest processing and storage conditions. Differences in crude protein content between the evaluated species may arise due to differences in protein accumulation in them during growth (Abebe *et al*., 2012; Salem *et al.,* 2006). Fiber in forages is often the main source of energy for fore-gut fermenters (Graham and Aman, 1991).

The nutrient compositions of forage grass species have been shown to depend among other factors, on their structural compositions which vary among species (Hockensmith *et al*., 1997). According to Shenkute *et al*. (2012), the high variability in the nutrient content of browse could be attributed to within species variability owing to factors such as plant part, harvesting regime, season and location, and these factors appear to influence chemical composition, palatability, rumen degradability, digestibility, voluntary intake and nutrient utilization by animals.

Chapter – 6

SUMMARY AND CONCLUSION

Agroforestry – a judicious/delibrate integration of tree species with agricultural crops and/or animals has been practiced since ancient times across the world in both the tropics and temperate regions. Traditionally, people resorted to agroforestry practices for the inter-dependent benefits of the three components, *viz*., trees, crops and livestock in addition to the 6Fs, i.e. food, fruit, fodder, fuel, fertilizer and fibre (Chavan *et al*., 2015). In modern times, the intangible benefits often referred to as ecosystem services rendered by the agroforestry systems have been widely recognized in different countries. These services include microclimate moderation, biodiversity conservation, carbon sequestration, protecting water sources, soil erosion and pollution control. Agroforestry practices are also linked with economic aspects of farmland production. Studies reveal that these agroforestry systems have the potential to generate employment opportunities of 450 man-days per hectare per year (Dhyani *et al*., 2013). Agroforestry leads to a diversified and sustainable rural production system than many treeless farming alternatives and provides increased social, economic, and environmental benefits for land users at all levels (Pandey, 2007). According to Noble and Dirzo (1997), agroforestry systems conserve 50-80% of biodiversity comparable to natural systems and also acts as buffer to parks and protected areas. The present investigation entitled "Plant diversity in prevalent agroforestry systems of District Budgam" was undertaken during the year 2013 & 14 with the main objectives:

1. To assess the status of plant diversity in prevalent agroforestry systems of District Budgam.
2. To analyze and evaluates the contribution of agroforestry in fulfillment of individual household needs in District Budgam.
3. To determine the fuelwood and fodder values of preferred tree species in District Budgam.

The thesis encompasses five chapters which are as under:

Chapter I, II and III presents agro-biodiversity concept, potentials of agroforestry systems, importance of evaluating community structure, socioeconomic overview of various agroforestry systems, objectives/purpose of the research study, work done in country and abroad on various aspects of phyto-sociology and community structure in both agroforestry as well as in natural systems, description and methodology applied in the study area respectively.

Chapter IV and V present the results which are discussed with interpretations and supported by the influences on the aimed quantitative and socioeconomic parameters viz. vegetation structure, evaluation of agroforestry systems in fulfillment of socioeconomic needs and fuelwood and fodder values of tree species found in prevalent agroforestry systems of District Budgam. The summary of these results recorded with respect to specific objectives of the study along with some interpretations are presented as under:

- For evaluation and documentation of plant diversity status and composition in prevalent agroforestry systems of District Budgam, the first phase of the research included the collection of information regarding land use management and prevalent agroforestry systems in the said district based on the pre-prepared questionnaire (Annexure-IV). The second phase of the study was to further evaluate the plant diversity status taking identified prevalent agroforestry systems into account and their contribution for fulfillment of the socioeconomic needs of the farmers.
- From the investigation, it was appraised that four agroforestry systems are prevalent in the District Budgam *viz*., Boundary plantation, Homegarden, Horti-agricultural and Horti-silvi-pasture system being carried out by about 184 (73.01%) farmers constituting 30 ha of land area out of total of 136.84 ha in possession of total sample size (grand total) of 252 farmers.
- For objectives-I i.e. for assessment of plant diversity status, composition

and quantitative attributes in prevalent agroforestry systems in the said District, only 20% of the selected farmers (i.e. 252) were considered *viz*; 51 farmers.

- Cultivated plant species were assessed in only three prevalent agroforestry systems as in Horti-silvi-pasture system cultivated species were absent. However, wild plants/herbage, were evaluated in all four agroforestry systems identified in the study area.
- The vegetation in prevalent agroforestry systems in the study area (District Budgam) comprised of trees, shrubs and herbage layer (both cultivated and wild). Among broad leaved trees species and fruit trees, a total of 4 genera, 6 species of 3 families and 6 genera, 8 species of 3 families were recorded respectively. While 2 genera having 3 species belonging to 2 families were of shrub layer, however, herbage represented 70 genera belonging to 75 plant species and 37 families.
- The study area hosts a remarkable floristic richness in four prevalent agroforestry systems with majority of taxa belonging to family Salicaceae in broad leaved trees, Rosaceae in fruit trees, Poaceae and Fabaceae in wild and cultivated herbage respectively. The other prominent botanical families represented in study area were: Alliaceae, Amaranthaceae, Apiaceae, Asteraceae, Balsaminaceae, Brassicaceae, Cannabaceae, Caryophyllaceae, Chenopodiaceae, Compositae, Convolvulaceae, Cucurbitaceae, Fabaceae, Geranaceae, Hypericaceae, Lamiaceae, Leguminosea, Liliaceae, Malvaceae, Onagraceae, Plantaginaceae, Polygonaceae, Portulaceae, Primulaceae, Punicaceae, Ranunculaceae, Rosaceae, Rubiaceae, Salicaeceae, Solanaceae, Ulmaceae, Juglandaceae, and Violaceae.
- Species composition in four prevalent agroforestry systems revealed maximum number of species in Homegarden and Horti-silvi-pasture

followed by Horti-agricultural system and Boundary plantation with respect to cultivated and wild plants respectively.

- Seasonal evaluation of ground flora comprised of both cultivated and wild herbage species on the basis of density, basal area, frequency and IVI showed that these quantitative/phytosociological attributes increased from spring with the advancement of growing season and attained peak values during summer and decreased abruptly thereafter in autumn.
- Among cultivated herbage species in three consecutive seasons i.e. spring, summer and autumn revealed that *Brassica campestris* and *Oryza sativa* were dominant species during spring and summer season respectively in Boundary plantation. Correspondingly, in Homegarden, *Brassica oleracea var. acephala and Brassica rapa* showed dominance during spring, summer and autumn seasons. Similarly, in Horti-agricultural system, *Phaseolus vulgaris* demonstrated dominance in terms of quantitative parameters over other cultivated species during spring and summer and by *Brassica olearacea var. acephala* in autumn.
- Seasonal evaluation of quantitative/ phytosociological attributes in wild herbage present in prevalent agroforestry systems revealed that *Cynodon dactylon* was the dominant species in Boundary plantation and Horti-silvi-pasture system. However, in Homegarden and Horti-agricultural system, *Stellaria media* explicated dominance over other species investigated during three different growing seasons *viz*., spring, summer and autumn.
- The IVI values of constituent species in prevalent agroforestry system of District Budgam suggested that the wild herbage communities present in respective agroforestry systems can be named as *Cynodon dactylon- Polygonum hydropiper- Prunella vulgaris* community in Boundary plantation, *Stellaria media- Poa aungustifolia- Galinsoga parviflora* in Homegarden, *Stellaria media- Plantago major- Artemisia absinthium* in

Horti-agricultural system and *Cynodon dactylon- Oenothera rosea- Mentha arvensis* in Horti-silvi-pasture system.

- Shanon weiner index for wild plant species was evaluated maximum in Horti-silvi-pasture system, whereas, species evenness in Horti-agricultural system. Simpson index and concentration of dominance was higher in Homegarden agroforestry system.

- Among broad leaved tree species, *Populus deltoides*, *Populus nigra* and *Salix alba* were common between Boundary plantation, Homegarden and Horti-silvi-pasture. While, amongst the fruit trees, *Malus domestica*, *Prunus domestica* and *Pyrus communis* were common to Homegarden, Horti-agricultural system and Horti-silvi-pasture system.

- Among shrub species, *Rubus niveus* was common between Boundary plantation and Horti-silvi-pasture system, however, *Rubus ulmifolius* was common to Horti-agricultural and Horti-silvi-pasture system.

- *Brassica oleracea var. acephala, Brassica rapa, Raphanus sativus, Solanum tuberosum, Phaseolus vulgaris and Pisum sativum* present in respective systems were similar to Boundary plantation, Homegarden and Horti-agricultural system among cultivated species. With respect to wild species, *Conyza canadensis* and *Galinsoga parviflora* were present in all four prevalent agroforestry systems of District Budgam.

- The critical examination of data on density, basal area, frequency and IVI of shrub species revealed that *Rubus niveus* was the only shrub species present in Boundary plantation attaining a density value of 133.33 plants ha^{-1}, basal area of 0.066 m^2 ha^{-1} with 20% frequency and importance value index of 300. Likewise, in Horti-agricultural system, only *Rubus ulmifolius* was found there with density, basal area, frequency and IVI of 400 plants ha^{-1}, 0.087 m^2 ha^{-1}, 33.33% and 300 respectively. In case of

Homegarden agroforestry system, no shrub was found growing in this particular system.

- In Horti-silvi-pasture system, three shrub species were present viz., *Rubus niveus*, *Rubus ulmifolius* and *Asparagus officinalis*. Out of these three species, *Rubus niveus* was found to be dominant achieving a density value of 483.33 plants ha^{-1}, 0.043 m^2 ha^{-1} of basal area, with a frequency value of 60.70% and IVI as 160.23.

- Shanon weiner index and species evenness for shrub species was found to maximum in Horti-silvi-pasture, however, Simpson index and concentration of dominance was evaluated maximum for Boundary plantation and Horti-agricultural system in study area.

- The preceding results on quantitative/phytosociological attributes of trees revealed that *Populus deltoides* was dominant in Boundary plantation exhibiting density as 100 ha^{-1}, basal area 2.41 m^2 ha^{-1} with frequency of 100% and importance value index (IVI) as 118.01. *Malus domestica* demonstrated its dominance in remaining three agroforestry systems viz., Homegarden, Horti-agricultural and Horti-silvi-pasture system exhibiting density value as 66.67 ha^{-1}, 466.67 ha^{-1} and 300 ha^{-1}; basal area of 0.57 m^2 ha^{-1}, 4.91m^2 ha^{-1} and 4.40 m^2 ha^{-1}; frequency value as 83.33, 100 and 100%; IVI as 57.09, 134.50 and 72.00 respectively.

- Data pertaining to vegetation indices of tree species explicated that Shanon weiner index was higher for Horti-silvi-pasture followed by Homegarden. However, species evenness, Simpson index and concentration of dominance was found to be correspondingly maximum in Horti-agricultural system and Boundary plantation.

- Data pertaining to similarity index of vegetation revealed that Boundary plantation and Horti-silvi-pasture had 51.35% similarity between them followed by Horti-agricultural and Horti-silvi-pasture system with 43.07% of resemblance in vegetation.

- The points summarized above indicated that among four prevalent agroforestry systems evaluated, Horti-silvi-pasture system conserved more number of species i.e. is rich in floristic diversity of herbs, shrubs and trees.
- Overall view of vegetation indices described that Shanon weiner index and species evenness was in the order of herbs > trees > shrubs. Whileas, Simpson index and concentration of dominance was in sequence of shrubs > trees > herbs in prevalent agroforestry systems.
- More than one benefit than sole crop system i.e. food, fodder, fuelwood & medicine from all prevalent agroforestry systems.
- Regarding socioeconomic evaluation, results revealed that all agroforestry systems support the farmers in terms of income either at low or high profit levels. It was recorded that from Boundary plantation Rs 3,384.05/ha (Rs 1,076.03/farmer), Rs 7,042.96/ha (Rs 1,454.32/farmer) from Homegardens, Rs 13, 46, 62.10/ha (Rs 23,263.23/farmer) from Horti-agricultural system and Rs 26, 77, 39.10/ha (Rs 53,473.42/farmer) from Horti-silvi-pasture system were obtained.
- The data also summarizes that Horti-silvi-pasture system (64.86%) contribute most to the total household income to farmers from all systems followed by Horti-agricultural system (32.62%) of the total income and least from Boundary plantation (0.80%) in the study area.
- Maximum income was incurred from *Malus domestica* in Horti-agricultural and Horti-silvi-pasture because of long shelf life and thus great demand locally and countrywide.
- Results explicated that agroforestry as such is still not adapted on large

scale, as the main subsistence needs met from different prevalent agroforestry systems in the District Budgam is only about 50 per cent because the land holding per farmer in the said district is small. So, half of the produce is marketed for income to support the family needs and half they consume to fulfill their feeding requirements.

- Perusal of data on Fuelwood Value Index (FVI) of preferred tree species in District Budgam displayed that among 5 broad leaved species and 4 fruit trees evaluated, *Robinia pseudoacacia* and *Prunus dulcis* elucidated highest FVI values as 948.05 and 1067.42 respectively.
- The preceding results on seasonal variation in fodder values of preferred tree species in District Budgam explained that crude protein decreased during spring, summer and autumn, whereas, crude fibre, ether extract and ash content increased with advancing season among all the 5 (five) evaluated preferred tree species. Among species investigated, *Robinia pseudoacacia* and *Populus nigra* proved to be an excellent source of protein, fat, fibre and ash for efficient maintenance of ruminants.
- Proximate analysis of agricultural feed crops used in District Budgam explained that *Avena sativa* achieved highest values in terms of crude protein (2.34%), crude fibre (36.52%), ether extract (3.23%) and ash content (14.28%) compared to *Oryza sativa*.

CONCLUSION:

The interest behind the selection of the area was unexplored plant diversity with respect to prevalent agroforestry systems of District Budgam as till date no research study was undertaken by any worker. The overall results of this study can be concluded as under:

- ❖ Four prevalent agroforestry systems do exist in District Budgam with rich floristic diversity viz., Boundary plantation, Homegarden, Horti-agricultural and Horti-silvi-pasture system.

- Community structure of prevalent agroforestry systems depicts that these systems are mosaic/assortment of three physiognomic forms i.e. cultivated and wild herbs, broad leaved and fruit trees and some shrubs.
- Vegetation in prevalent agroforestry systems comprised of 82 genera, 92 species and 45 families. The number of species in different plant categories as: herbs > trees > shrubs.
- Seasonal evaluation of quantitative attributes *viz*., density, basal area, frequency and IVI of both cultivated and wild herbage explicated increase from spring to summer and decreased thereafter.
- In terms of quantitative /phytosociological attributes and vegetation indices Horti-silvi-pasture was found to contribute more both in terms of conservation of biodiversity and income generation source compared to other agroforestry systems.
- The quantitative/phytosociology of trees in the study site revealed that *Populus deltoides* with highest IVI was the dominant species in Boundary plantation, *Malus domestica* in Homegarden, Horti-agricultural and Horti-silvi-pasture systems respectively.
- Among shrubs *Rubus niveus* was common to Boundary plantation and Horti-silvi-pasture system.
- Shrub species were absent in case of Homegarden agroforestry system.
- Based on importance value index (IVI), *Cynodon dactylon* was found to be dominant in Boundary plantation and Horti-silvi-pasture system whileas, *Stellaria media* in Homegarden and Horti-agricultural system.
- IVI values can also be used to prioritize species for conservation, and species with high IVI value need less conservation efforts, whereas those having low IVI value need high conservation effort.
- Farmers are inclined towards retention of fruit based trees on their fields for additional monitory gain from the fruits and therefore, Horti-

agricultural and Horti-silvi-pasture system practice were the priority of most of the farmers in District Budgam.

- More than one benefit was derived i.e. food, fodder, timber, fuelwood & medicine from all prevalent agroforestry systems.
- These prevalent agroforestry systems are an important element of rural landscape and play a vital role in the predominantly bio-resource based economy of the region. As 50 per cent (%) of the family needs in terms of money and food are being fulfilled by the farmers of District Budgam from existing prevalent agroforestry systems adopted on smaller scale, which when established on large magnitude can prove to be a sustainable and regular food and income source of each farmer interested and presently adopting various agroforestry activities.
- Among broad leaved species *Robinia pseudoacacia* scored best in terms of FVI than other species. Likewise, *Prunus dulcis* showed best performance among fruit trees achieving maximum calorific value.
- So, ranking of trees as best and efficient fuelwood as per their low moisture content and ash content, high wood density and high calorific value is in the order of *Robinia pseudoacacia* > *Salix alba* > *Salix fragilis* > *Populus nigra* > *Populus deltoides among broad leaved species.* However, the order in fruit trees is as: *Prunus dulcis* > *Malus domestica* > *Prunus domestica* > *Pyrus communis.*
- *Robinia pseudoacacia* was evaluated as best fodder than other species in terms of crude protein which decreased with successive seasons within all preferred species.
- In terms of crude fibre and ash which increased with spring, summer and autumn the results were achieved as *Poplar nigra* >*Popular deltoides* > *Salix alba* > *Salix fragilis* > *Robinia pseudoacacia*.
- *Avena sativa* was evaluated better as fodder than *Oryza sativa*.

RECOMMENDATIONS

The following recommendations were proposed for further research in the area:

- ✓ Agroforestry systems prevalent in District Budgam currently serves as a repository of plant diversity and is comprised of comprehensive rich ecological niches as they preserve some of the valuable bioresources/medicinal plants like *Artemisia absinthium, Hypericum perforatum, Rumex* sp. *Taraxacum officinale, Thymus linearis, Viola odorata* etc. which are in great demand in market for various therapeutic and commercial exploitation and are listed as endangered/vulnerable in IUCN Red Data Book. Thus these agroforestry systems are gene pools of medicinal plants (life saving drugs) and also in real sense buffer for forests and protected areas. Creating awareness among farmers and local inhabitants about the importance of invaluable genetic diversity and sustainable use of resources can definitely lead to a secure future of these reservoirs.
- ✓ As bio-geographical islands, role of identified prevalent agroforestry systems in maintaining biological diversity is crucial. Issues of scale are central to this role and thus in a landscape mosaic, areas of agroforestry are potentially complementary, especially when considering the need for ecological equilibrium and population size vis a vis genetic diversity. Plant resources in these agroforestry systems are limited that require efficient and wise use. Necessary steps should be taken not only to store the original vegetation but also to improve it.
- ✓ Documentation and conservation programme seeking maintenance of high biodiversity values within these buffer zones, minimizing biodiversity losses due to any developmental activity and integration of biodiversity conservation with the economic and environmental services should be

made with a detailed management programme for sustainable economic benefits that can be harvested from these agroforestry systems.

- ✓ Creating awareness at the grass roots level about wise utilization of the woody species in the area is crucial in order to prevent the loss of valuable tree species. The governmental and nongovernmental organizations should promote different agroforestry practices to conserve indigenous woody species through circa-situm conservation.
- ✓ Local people must be provided information and awareness on biodiversity conservation. These projects will not only conserve the local flora but also improve the socio-economic conditions of the area.
- ✓ *Euphorbia helioscopia* should be handled with due care by the farmer while working in the field because of its latex like substance causing serious allergy problems, swelling, severe skin and eye irritation.
- ✓ One possibility for conserving valuable and worthless species diversity at sustainable scale may be to acknowledge and reward farmers for the biodiversity conservation service that they provide to the global community so that they will take keen and firm interest further to give his best in conserving the natures unsurpassed gift - " the agro-biodiversity".
- ✓ Be custodians of large agroforestry land holdings by keeping positive attitude towards these activities in order to enhance livelihood at both subsistence and commercial levels.
- ✓ As the present research was to compare various tree species in the study area for assessment of trees as per their fuelwood characteristics, *Prunus dulcis* and *Robinia pseudoacacia* proved to be best among other fruit trees and broad leaved species evaluated.
- ✓ Extensive farming of *Robinia pseudoacacia* and *Prunus dulcis* under scientific supervision particularly for *Robinia pseudoacacia* for firewood

production could bridge the gap between the demand and supply which people are facing today.

- ✓ Conducting research to identify other environmental variables and geographical coordinates such as available soil water, soil fertility and temperature that affect fuelwood properties must be taken into account for future research.
- ✓ To alleviate shortage of feed, in addition to supplementation for crop residues with browse species, efficient utilization of the available feed resources should be encouraged. Improving the feeding value of crop residues, and especially on upgrading their quality through chemical (urea) treatment that could improve their utilization (intake and digestibility) should be developed for the production system only after careful consideration of the opportunities and constraints inherent in the system.
- ✓ Combinations of tree fodder and agricultural crops can yield a better result than feeding singly to the ruminants.

LITERATURE CITED

A.O.A.C. 1999. *Official methods of analysis of AOAC,* International Association of Official Analytical Chemists (26th Ed.). Washington D.C. pp. 401-420.

Abdullah, M.B., Sanusi, S.S., Abdul, S.D. and Sawa, F.B.J. 2009. An assessment of the herbaceous species vegetation of Yankari Game Reserve, Bauchi, Nigeria. *American European Journal of Agricultural and Environmental Sci*ence **6**(1): 20-25.

Abebe, A., Tolera, A., Holand, O., Adnoy, T. and Eik, L.O. 2012. Seasonal variation in nutritive value of some browse and grass species in Borana rangeland, Southern Ethiopia. *Tropical and Subtropical Agro ecosystems* **15**: 261-271.

Acharya, K.P. 2006. Linking trees on farms with biodiversity conservation in subsistence farming systems in Nepal. *Biodiversity and Conservation* **15**: 631-646.

Aerts, R., Van-Overtveld, K., Haile, M., Hermy, M., Deckers, J. and Muys, B. 2006. Species composition and diversity of small Afromontane forest fragments in north Ethiopia. *Plant Ecol*ogy **187**: 127-142.

Agni, T., Pandit, A., Pant, K. and Tewari, A. 2000. Analysis of tree vegetation in the Tarai-Bhabhar Tract of Kumaon, Central Himalaya. *Indian Journal of Forestry* **23**(3): 252-261.

Aguilar-Støen, M., Stein, R.M. and Camargo-Ricalde, S.L. 2009. Home gardens sustain crop diversity and improve farm resilience in Candelaria Loxicha, Oaxaca, Mexico. *Human Ecology* **37**: 55-77.

Ahmad, K.S. and Habib, S. 2014. Indigenous knowledge of some medicinal plants of Himalayan region, Dawarian Village, Neelum Valley, Azad Jammu and Kashmir, Pakistan. *Universal Journal of Plant Science* **2**(2): 40-47.

Ahmed, K., Shaheen, M., Mirzaei, F., Khan, Z.I., Gondal, S., Fardous, A., Hussain, A., Arshad, F. and Mehmood, T. 2013. Proximate analysis: Relative feed values of various forage plants for ruminants investigated in a semi-arid region of Punjab, Pakistan. *Agricultural Sciences* **4**(6): 302-308.

Ahmed, M.F.U., Rahman, S.M.L., Ahmed, A.S.M.M. and Quebedeaux, B. 2004. Agroforestry as it pertains to vegetable production in Bangladesh. *Journal of Agronomy* **3**: 282-290.

Aiba, S. and Kitayama, K. 1999. Structure, composition and species diversity in an altitude-substrate matrix of rain forest tree communities on Mount Kinabalu, Borneo. *Plant Ecology* **140**: 139-157.

Akinbisoye, O.S., Oke, S.O., Adebola, S.I. and Mokwenye, A.I. 2014. Influence of taungya agroforestry system on diversity of native woody species and soil physico-chemical properties in Nigeria. *International Journal of Scientific and Research Publications* **4**(3): 1-15.

Alavalapati, J.R.R., Shrestha, R.K., Stainback, G.A. and Matta, J.R. 2004. Agroforestry development: an environmental economic perspective. *Agroforestry Systems* **61**: 299-310.

Alhamad, M.N. 2006. Ecological and species diversity of arid Mediterranean grazing land vegetation. *Journal of Arid Environments* **66**: 698-715.

*Alhassan, A.B., Chiroma, A.M. and Kundiri, A.M. 2006. Properties and classification of soils of Kajimaram Oasis of Northeast Nigeria. *International Journal of Agriculture and Biology* **8**: 256-261.

Allahyari, S., Khoramivafa, M., Honarmand, S.J. and Mondani, F. 2014. Assessment of horticultural crops biodiversity in Kermanshah Province. *Journal of Biodiversity and Environmental Sciences* **4**(6): 96-105.

Amberber, M., Argaw, M. and Asfaw, Z. 2014. The role of homegardens for *in situ* conservation of plant biodiversity in Holeta Town, Oromia National Regional State, Ethiopia. *International Journal of Biodiversity and Conservation* **6**(1): 8-16.

Amjad, M.S. 2015. Ethnobotanical profiling and floristic diversity of Bana Valley, Kotli (Azad Jammu and Kashmir), Pakistan. *Asian Pacific Journal of Tropical Biomedicine* **5**(4): 292-299.

Amjad, M.S., Arshad, M. and Chaudhari, S.K. 2014. Structural diversity, its components and regenerating capacity of lesser Himalayan forests vegetation of Nikyal valley District Kotli (A.K), Pakistan. *Asian Pacific Journal of Tropical Medicine* **7**(1): 454-460.

Ammar, H., Salem, A.Z.M. and Lopez, S. 2010. Impact of inter and intra-annual drought on chemical composition of some Mediterranean shrubs in natural rangelands. **In**: *The contributions of grasslands to the conservation of Mediterranean biodiversity* Zaragoza: CIHEAM / CIBIO / FAO / SEEP. pp. 219-222.

Anonymous. 2013. Digest of Statistics, Jammu &Kashmir. pp. 52-56.

Anonymous, 2010. Annual Progress Report, Faculty of Forestry, SKUAST-Kashmir, Shalimar, Srinagar.

Arifin, H.S., Munandar, A., Schultin, K.G. and Kaswanto, R.L. 2012. The role and impacts of small-scale, homestead agro-forestry systems *("pekarangan")* on household prosperity: an analysis of agro ecological zones of Java, Indonesia. *International Journal of Agricultural Science* **2**(10): 896-914.

Asfaw, B. and Lemenih, M. 2010. Traditional agroforestry systems as a safe haven for woody plant species: a case study from a topo-climatic gradient in Southcentral Ethiopia. *Forests, Trees and Livelihoods* **19**: 359-377.

Asfaw, Z., Linger, E. and Zewudie, S. 2015. Plant species richness and structure of homegarden agroforestry in Jabithenan District, North-Western Ethiopia. *International Journal of Environmental Sciences* **4**(2): 52-58.

Ashley, R., Russell, D. and Swallow, B. 2006. The policy terrain in protected area landscapes: challenges for agroforestry in integrated landscape conservation. *Biodiversity and Conservation* **15**: 663-689.

Atta-Krah, K., Kindt, R., Skilton, J.N. and Amaral, W. 2004. Managing biological and genetic diversity in tropical agroforestry. *Agroforestry Systems* **61**: 183-194.

Azim, A. Naseer, Z. and Ali, A. 1989. Nutritional evaluation of maize fodder at two different vegetative stages. *African Journal of Agricultural Sciences* (AJAS) **2**(1): 27-34.

Azim, A., Ghazanfar, S., Latif, A. and Nadeem, M.A. 2011. Nutritional evaluation of some top fodder tree leaves and shrubs of District Chakwal, Pakistan in relation to ruminants requirements. *Pakistan Journal of Nutrition* **10**(1): 54-59.

Babayemi, O.J. and Bamikole, M.A. 2006. Supplementary value of *Tephrosia bracteolate*, *Leucaena leucocephala* and *Giliricidia sepium* hay for West Africa dwarf goats kept on range. *Journal Central European Agriculture* **7**(2): 323-328.

Baduni, N.P. and Sharma, C.M. 2001. Population structure and community analysis on different aspects of Sal savanna forest type in outer Garhwal Himalaya. *Indian Forester* **127**: 1001-1011.

Baig, B.A., Ramamoorthy, D. and Bhat, T.A. 2013. Threatened medicinal plants of Menwarsar Pahalgam, Kashmir Himalayas: Distribution pattern and current conservation status. *Proceedings of the International Academy of Ecology and Environmental Sciences* **3**(1): 25-35.

Bamigboye, F., Babayemi, O. and Adekoya, A. 2013. Feed resources and seasonal nutrient composition of predominant forages for small ruminant production in Iwo local government area of Osun state, Nigeria. *Journal of Biology, Agriculture and Healthcare* **3**(17): 1-11.

Banyal, R., Islam, M. A., Masoodi, T.H. and Gangoo, S.A. 2013. Energy status and consumption pattern in rural temperate zone of Western Himalayas: a case study. *Indian Forester* **139**(8): 683-687.

Bardhan, S., Jose, S., Biswas, S., Kabir, K. and Rogers, W. 2012. Homegarden agroforestry systems: an intermediatery for biodiversity conservation in Bangladesh. *Agroforestry Systems* **85**: 29-34.

Barik, S.K., Tripathi, R.S., Pandey, H.N. and Rao, P. 1996. Tree regeneration in a subtropical humid forest: Effect of cultural disturbance on seed production, dispersal and germination. *Journal of Applied Ecology* **33**:1551-1560.

Beaumont, L.J., Pitman, A., Perkins, S., Zimmermann, N.E., Yoccoz, N. G. and Thuiller, W. 2011. Impacts of climate change on the world's most exceptional eco regions. *Proceedings of the National Academy of Sciences* **108**: 2306-2311.

Beer, J., Ibrahim, M. and Sinclair, F. 2005. The history of future agroforestry research and development: *Policy impacts and needs*. **In**: Forests in the Global Balance-Changing Paradigms. (Eds. G. Mery, R. Alfaro, M. Kanninen and M. Lobovikov) IUFRO World Series Vol. No. 17 pp. 151-160.

Behera, M.D., Kushwaha, S.P.S. and Roy, P.S. 2005. Geo-spatial modeling for rapid biodiversity assessment in Eastern Himalayan region. *Forest Ecology and Management* **207**: 363-384.

Belachew, Z., Yisehak, K., Taye, T. and Janssens, G.P.J. 2013. Chemical composition and *in sacco* ruminal degradation of tropical trees rich in condensed tannins. *Czech Journal of Animal Science* **58**(4): 176-192.

Belete, S., Hassen, A., Assafa, T., Amen, N. and Ebro, A. 2012. Identification and nutritive value of potential fodder trees and shrubs in the Mid Rift Valley of Ethiopia. *Journal of Animal and Plant Sciences* **22**(4): 126-132.

Bengtsson, J., Nilsson, S.G., Franc, A. and Menozzi, P. 2000. Biodiversity, disturbances, ecosystem function and management of European forests. *Forest Ecology and Management* **132**: 39-50.

Bhagwat, S.A., Willis, K.J., Birks, H.J.B. and Whittaker, R.J. 2008. Agroforestry: a refuge for tropical biodiversity. *Trends in Ecology and Evolution* **23**: 261-267.

Bhandari, B.S. and Tiwari, S.C. 1997. Dominance and diversity along an altitudinal gradient in a montane forest of Garhwal Himalaya. *Proceedings of Indian National Science Academy* **6**: 639-646.

Bhandari, B.S., Mehta, J.P. and Tiwari, S.C. 1998. Woody vegetation structure along an altitudinal gradient in a part of Garhwal Himalaya. *Journal of Hill Research* **11**(1): 26-31.

Bhat, G.M., Mugloo, J.A., Rather, T.A., Singh, A. and Mir, A.A. 2010. Traditional agroforestry system practiced in Kupwara: A border and backward district of Jammu and Kashmir. *Indian Journal of Forestry* **33**(2): 173-176.

Bhatt, B.P. and Bhadoni, A.K. 1990. Fuel characteristics of some mountain fire wood shrubs and trees. *Energy* **15**: 1069-1070.

Bhatt, B.P. and Todaria, N.P. 1992a. Fire wood characteristics of some mountain trees and shrubs. *Commonwealth Forestry Review* **71**(3-4): 183-185.

Bhatt, B.P. and Todaria, N.P. 1992b. Firewood characteristics of some Indian mountain tree species. *Forest Ecology and Management* **47**: 363-366.

Bhatt, B.P. and Tomar, J.M.S. 2002. Firewood properties of some Indian mountain tree and shrub species. *Biomass and Bioenergy* **23**: 257-260.

Bhatt, B.P., Sarangi, S.K. and De, L.C. 2010. Fuelwood characteristics of some firewood trees and shrubs of Eastern Himalaya, India. *Energy Sources*, Part A **32**: 469-474.

Bhatt, B.P., Tomar, J.M.S. and Bujarbaruah, K.M. 2004. Characteristics of some firewood trees and shrubs of the North Eastern Himalayan region, India. *Renewable Energy* **29**: 1401-1405.

Bhuyan, P., Khan, M.L. and Tripathi, R.S. 2003. Tree diversity and population structure in undisturbed and human impacted stands of tropical wet evergreen forest in Arunchal Pradesh, Eastern Himalayas India. *Biodiversity Conservation* **12**: 1753-1773.

Bijalwan, A. 2012. Structure, composition and diversity of horticulture trees and agricultural crops productivity under traditional agri-horticulture system in mid hill situation of Garhwal Himalaya, India. *American Journal of Plant Sciences* **3**:480-488.

Bijalwan, A. 2014. Alteration of tree species in traditional agri-silvi-horticulture systems along altitude and aspects of the Garhwal Himalaya, India. *International Journal of Agroforestry and Silviculture* **1**(4): 37-51.

Bijalwan, A., Sharma, C.M. and Sah, V.K. 2009. Productivity status of traditional agrisilviculture system on northern and southern aspects in mid-hill situation of Garhwal Himalaya, India. *Journal of Forestry Research* **20**(2): 137-143.

Bijalwan, A., Swamy, S.L., Sharma, C.M., Umrao, R. and Paliwal, H.B. 2011. Structure, composition and diversity of tree vegetation in Sal mixed dry tropical forest in Chhattisgarh plains of India. *Indian Forester* pp. 453-462.

Bilandzija, N., Voca, N., Kricka, T., Matin, A. and Jurisic, V. 2012. Energy potential of fruit tree pruned biomass in Croatia. *Spanish Journal of Agricultural Research* **10**(2): 292-298.

Bisht, A.S. and Bhat, A.B. 2011. Effect of human activities and environmental changes in an alpine vegetation of district Chamoli, Garhwal Himalaya, Uttrakhand, India. *World Rural Observation* **3**(1): 64-71.

*Bittante, G. and Andrighto, I. 1982. Preservation of *Lolium multrlorum Lam*. 1. Quantitative and qualitative changes during hay making and ensiling. Inst. Zootocnica, Univdegli Studi, Via, Gradentigo, Italy **8**: 44-45.

Blair, R.M. and Epps, E.A. 1969. Seasonal distribution of nutrient in plants of seven browse species in Louisiana, Southern Forest Experiment Station Forest Service U.S. Department of Agriculture pp. 13-14.

Blanckaert, I., Swennen, R.L., Flores, M. P., Lopez, R. R. and Saade, R. L. 2004. Floristic composition, plant uses and management practices in homegardens of San Rafael Coxcatlán, Valley of Tehuacan-Cuicatlan, Mexico. *Journal of Arid Environments* **57**: 39-62.

Bliss, L.C. 1962. Rosine and lipid contents in alpine Tundra plants. *Ecology* **43**: 753-757.

Bobo, K.S., Waltert, M., Sainge, M.N., Njokagbor, J., Fermon, H. and Muhlenberg, M. 2006. From forest to farmland: species richness patterns of trees and understorey plants along a gradient of forest conversion in southwestern Cameroon. *Biodiversity and Conservation* **15**: 4097-4117.

Boffa, M.J., Turyomurugyendo, L., Barnekow-Lilleso, P.J. and Kindt, R. 2005. Enhancing farm tree diversity as a means of conserving landscape-based biodiversity: insight from the Kigezi highlands Southwestern Uganda. *Mountainm Research and Development* **25**(3): 212-217.

Borkhataria, R.R. 2012. Species abundance and potential biological control services in shade vs. sun Coffee in Puerto Rico. *Agriculture, Ecosystems and Environment* **151**: 1-5.

Bouazza, L., Bodas, R., Boufennara, S., Bousseboua, H. and Lopezl, S. 2012.Nutritive evaluation of foliage from fodder trees and shrubs characteristic of Algerian arid and semi-arid areas. *Journal of Animal and Feed Sciences* **21**: 521-536.

Bowers, M.D. and Stamp, N.E. 1992. Chemical variation within and between individuals of *Plantago lanceolata* (Plantaginaceae). *Journal of Chemical Ecology* **18**: 985-995.

*Bunker, D.E. and Carson, W.P. 2005. Drought stress and tropical forest woody seedlings: Effect on community structure and composition. *Journal of Ecology* **93**: 794-806.

Burner, D.M., Pote, D.H. and Ares, A. 2005. Management effects on biomass and foliar nutritive value of *Robinia pseudoacacia* and *Gleditsia triacanthos f. inermis* in Arkansas, USA. *Agroforestry System.* DOI 10.1007/s10457-005-0923-9.

CBD, 1992. Convention on Biological Diversity. Secretariat of the convention on biological diversity, United Nations environment program. Available at www.biodiv.org/convention/articles.asp.

Chavan, S.B., Keerthika, A., Dhyani, S.K., Handa, A.K., Newaj, R. and Rajarajan, K. 2015. National Agroforestry Policy in India: a low hanging fruit. *Current Science* **108**(10):1-9.

*Chen, J., Shiyomi, M. and Yamamura, Y. 2008. Frequency distribution models for spatial patterns of vegetation abundance. *Ecological Modelling* **211**: 403- 410.

Chettri, N. and Sharma, E. 2009. A scientific assessment of traditional knowledge on firewood and fodder values in Sikkim, India. *Forest Ecology and Management* **257**: 2073-2078.

Chettri, N. and Sharma, E. 2006. Assessment of natural resources uses patterns: a case study along a trekking corridor of Sikkim Himalaya, India. *Resources, Energy and Development* **3**(1): 21-34.

Chettri, N., Sharma, E., Deb, D.C. and Sundriyal, R.C. 2002. Effect of firewood extraction on tree structure, regeneration and woody biomass productivity in a trekking corridor of the Sikkim Himalaya. *Mountain Research and Development* **22**(2): 150-158.

Chiarucci, A., Bacaro, G. And Scheiner, S.M. 2011. Old and new challenges in using species diversity for assessing biodiversity. *Philosphical Transactions of the Royal Society B: Biological Sciences* **366**: 98-109.

Chundawat, B.S. and Gautam, S.K. 2006. Agroforestry systems for small holdings. **In**: *Text book of Agroforestry* **6**: 60

*Connel, J.H. and Oris, E. 1964. The ecological regulation of species diversity. *American Naturalist* **48**: 399-414.

Cook, C.W. and Harris, L.E. 1950. The nutritive value of range forage as affected by vegetation, site and stage of maturity. *Utah Agricultural Experiment Station Bulletin* pp. 344.

Criddle, R.S., Church, J.N., Smith, B.N. and Hansen, L.D. 2003. Fundamental causes of the global patterns of species range and richness. *Russian Journal of Plant Physiology* **50**: 192-199.

Cruz-Garcia, G.S. and Struik, P.C. 2015. Spatial and seasonal diversity of wild food plants in home gardens of Northeast Thailand. *Economic Botany* **69**(2): 99-113.

Curtis, J.T. and McIntosh, R.P. 1950. The interrelationship of certain analytic and synthetic phytosociological characters. *Ecology* **31**: 4343-4445.

Cuvilas, C., Lhate, I., Jirjis, R. and Terziev, N. 2014. The characterization of wood species from Mozambique as a fuel. *Energy Sources* Part A **36**: 851-857.

*Daniel, H.A. 1934. The calcium, phosphorus, and nitrogen content of grasses and legumes; and the relation of these elements in the plants. *Journal of American Society of Agronomy* **26**(6): 496-503.

Darcha, G., Birhane, E. and Abadi, N. 2015. Woody Species Diversity in Oxytenanthera abyssinica based homestead agroforestry systems of Serako, Northern Ethiopia. *Journal of Natural Sciences Research* **5**(9):1-10.

Deb, S., Sarkar, A., Majumdar, A. and Deb, D. 2014. Community structure, biodiversity value and management practices of traditional agroforestry systems in Tripura, north east India. *Journal of Biodiversity Management and Forestry* **3**(3):1-6.

Decocq, G., Aubert, M., Dupont, F., Alard, D., Saguez, R., Wattez-Franger, A., Foucault, B. D.E., Delelis-Dusollier, A. and Bardat, J. 2004. Plant diversity in a managed temperate deciduous forest: under storey response to two silvicultural systems. *Journal of Applied Ecology* **41**: 1065-1079.

Deka, D., Saikia, P. and Konwer, D. 2007. Ranking of fuelwood species by Fuel Value Index. *Energy Sources,* Part A **29**: 1499-1506.

Dhungana, S., Tripathee, H.P., Puri, L., Timilsina, Y.P. and Devkota, K.P. 2012. Nutritional analysis of locally preferred fodder trees of middle hills of Nepal: a case study from Hemja VDC, Kaski District. *Nepal Journal of Science and Technology* **13**(2): 39-44.

Dhyani, S.K., Handa, A.K. and Uma. 2013. Area under agroforestry in India: an assessment for present status and future perspective. *Indian Journal of Agroforestry* **15**: 1-10.

Djossa, B.A., Fahr, J., Wiegand, T., Ayihouenou, B.E., Kalko, E.K. and Sinsin, B.A. 2008. Land use impact on Vitellaria paradoxa C.F. Gaerten. Stand structure and distribution patterns: a comparison of Biosphere Reserve of Pendjari in Atacora district in Benin. *Agroforestry Systems* **72**: 205-220.

*Dutt, V. 1999. Production of understorey vegetation in relation to LAI and solar interception under chirpine. M.Sc thesis, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), India. pp. 122.

*Dutt, V. and Gupta, B. 2005. Interaction between trees and ground flora in different aged Chirpine stands of sub-tropical region in India: Density of herbage and LAI. *Indian Journal of Forestry* **28**(1): 28-36.

Eichemberg, M.T., Amorozo C.M. and Cunha-De-Moura, L. 2009. Species composition and plant use in old urban homegardens in Rio Claro, Southeast of Brazil. *Acta Botanica Brasilica* **23**(4): 1057-1075.

Emmanuel, L.S. and Tsado, D.N. 2011. Forage and fodder crop production in Nigeria: problems and prospects. *World Journal of Life Science and Medical Research* **1**(4): 88.

Fasae, O.A., Sowande, O.S. and Popoola, A. A. 2010. Evaluation of selected leaves of trees and foliage of shrubs as fodder in ruminant production. *Journal of Agricultural Science and Environment* **10**(2): 36-44.

Fifanou, V.G., Ousmane, C., Gauthier, B. and Brice, S. 2011. Traditional agroforestry systems and biodiversity conservation in Benin (West Africa). *Agroforestry Systems* **82**: 1-13.

*Fischer, A.G. 1960. Latitudinal variation in organic diversity. *Evolution* **14**: 64-81.

Forwood, J.R. and Owensby, C.E. 1985. Nutritive value of tree leaves m the Kansas flint Hills. *Journal of Range Management* **38**(l): 61-64.

Gairola, S., Rawal, R.S. and Todaria, N.P. 2008. Forest vegetation patterns along an altitudinal gradient in sub-alpine zone of west Himalaya, India. *African Journal of Plant Science* **2**(6): 42-48.

Ganai A.M., Ahmad H.A., Bilal, S. and Mir, M.R. 2009. Nutritional evaluation of Kiker (*Robinia pseudoacacia*) leaves in sheeps. *Indian Journal of Animal Nutrition* **26** (4): 341-344.

Garcia-Del-Barrio, J.M., Ponce, R.A., Benavides, R. and Roig, S. 2014. Species richness and similarity of vascular plants in the Spanish Dehesas at two spatial scales. *Forest Systems* **23**(1): 111-119.

Garcia-Fernandez, C. 2003. Benzoin gardens in North Sumatra. Indonesia: effects of management on tree diversity. *Conservation Biology* **17**: 829-836.

Gardner, T.A., Barlow, J., Chazdon, R.L., Ewers, R., Harvey, C.A. and Sodhi, N. 2009. Prospects for tropical forest biodiversity in a human-modified world. *Ecology Letters* **12**: 561-582.

Garrity, D.P. 2004. Agroforestry and the achievement of the millennium development goals. *Agroforestry Systems* **61**: 5-17.

Gebremichael, B. 2014. Characterization of available feed resources in South Gonder zone, Ethiopia. *Journal of Agriculture and Biodiversity Research* **3**(8): 126-136.

Ghimire, B.K., Lekhak, H.D., Chaudhary, R.P. and Vetaas, O.R. 2008. Vegetation analysis along an altitudinal gradient of *Juniperus indica* forest in Southern Manang Valley, Nepal. *International Journal of Ecology and Development* **9**(8): 20-29.

Goel, V.L. and Behl, H.M. 1996. Fuelwood quality of promising species for alkaline soil sites in relation to tree age. *Biomass and Bioenergy* **10**(1): 57-61.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agriculture research. John Viley and Sons. New York pp. 304-308.

González, Z., Feria, M.J., Vargas, F. and Rodríguez, A. 2012. Comparison of the heating values of various types of fuel from non-wood raw materials. *American Journal of Environmental Engineering* **2**(4): 91-96.

*Graham, H. and Åman, P. 1991. Nutritional aspects of dietary fibers. *Animal Feed Science and Technology* **32**: 143-158.

Grubb, P.J. 1997. The maintenance of species richness in plant communities.The importance of the regeneration niche. *Biological Review* **52**:107-145.

GSPC, 2002. Global strategy for plant conservation. Secretariat of the convention on biological Diversity, United Nations environment program. Available at http://www.cbd.int/gspc/strategy.html.

Gunasekaran, S., Viswanathan, K. and Bandeswaran, C. 2014. Selectivity and palatability of tree fodders in sheep and goat fed by cafeteria method. *International Journal of Science, Environment and Technology* **3**(5): 1767-1771.

Gupta, B. and Dass, B. 2007. Composition of herbage in *Pinus roxburghii* Sargent stands: basal area and importance value index. *Caspian Journal of Environmental Science* **5**(2): 93-98.

Gupta, S. and Prasad, P.R.C. 2013. Analysis of tree diversity patterns in the tropical evergreen and moist deciduous forests of the middle Andaman Islands, India. *Journal of Biodiversity Management and Forestry* **2**(3): 1-7.

Guyassa, E. and Raj, J.A. 2013. Assessment of biodiversity in cropland agroforestry and its role in livelihood development in dryland areas: A case study from Tigray region, Ethiopia. *Journal of Agricultural Technology* **9**(4): 829-844.

Haddi, M.L., Filacorda, S., Meniai, K., Rollin, F. and Susmel, P. 2003. In vitro fermentation kinetics of some halophyte shrubs sampled at three stages of maturity. *Animal Feed Science and Technology* **104**: 215-225.

Hafty, H. and Kebede, D. 2014. Adaptation and nutritional evaluation of fodder trees and shrubs in eastern Ethiopia. *International Journal of Chemical and Natural Sciences* **2**(5): 120-124.

Hall, J.S., McKenna, J.J., Ashton, P.M.S. and Gregoire, T.G. 2004. Habitat characterizations underestimate the role of edaphic factors controlling the distribution of Entandrophragma. *Ecology* **85**: 2171-2183.

Handayani, I.P. and Prawito, P. 2011. Agroforestry systems for sustaining rural development and protecting environmental quality. *Proceeding Seminar National Budidaya Pertanian,Urgensi da Pengendalian Alih Fungsi Lahan Pertanian,* Bengkulu p. 14.

Hasanuzzaman, M., Hossain, M. and Saroar, M. 2013. Floristic composition and management of cropland agroforest in Southwestern Bangladesh. *Journal of Forestry Research* pp. 1-8. DOI 10.1007/s11676-014-0451-4.

Hashemi, S.C., Khoshbakht, K., Mahdavi, D.A. and Veisi, H. 2013. An evaluation of agrobiodiversity in home gardens of two ecogeographically different areas in Gachsaran, southwestern Iran. *International Journal of Agricultural Science* **3**(1): 71-84.

Hashmi, M.M. and Waqar, K. 2014. Nutritional Evaluation of *Grewia optiva* and *Grewia populifolia* in different seasons and sites of Chakwal District in Pakistan. *European Academic Research* **2**(4): 1-11.

Heip, C.H.R., Herman, P.M.J. and Soetaert, K. 1998. Indices of diversity and evenness. *Oceanis* **24**(4): 61-87.

Herve, B.D.B. and Vidal, S. 2008. Plant biodiversity and vegetation structure in traditional cacao forest gardens in southern Cameroon under different management. *Biodiversity and Conservation* **17**: 1821-1835.

*Heywood, V.H. and Watson, C. 1995. Global Biodiversity Assessment. UNEP, Cambridge University press pp. 1135.

High, C. and Shakleton, C.M. 2000. The comparative value of wild and domestic plants in homegardens of a South African rural village. *Agroforestry Systems* **48**: 141-156.

*Hockensmith, R.L., Shaeffer, C.C., Marten, G.C., Halgertson, J.L. 1997. Maturation effects on forage quality of Kentucky Bluegrass. *Canadian Journal of Plant Science* **77**:75-80.

Hubble, S.P. and Foster, R.B. 1983. Diversity of canopy trees in a neo-tropical forest and implication to conservation. Tropical Rain Forest: *Ecology Management* (Sutton, L.T.C) pp. 25-41.

Hussain, F. and Durrani, M.J. 2009. Nutritional evaluation of some forage plants from Harboi rangeland, Kalat, Pakistan. *Pakistan Journal of Botany* **41**(3): 1137-1154.

*Huston, M.1979. A general hypothesis of species diversity. *American Naturalist* **113**: 81-101.

IAASTD, 2008. International Assessment of Agricultural Knowledge, Science and Technology for Development: executive summary of the synthesis report, http://www.agassessment.org/index.cfm?Page=About_IAASTD and Item ID=2.

Ilorkar, V.M. and Khatri, P.K. 2003. Phytosociological study of Navegaon National Park, Maharashtra. *Indian Forester* **129**(3): 377-387.

IPGRI, 1993. Diversity for development: the strategy of the international plant genetic resources institute. International plant genetic resource institute, Rome, Italy.

ITPGRFA, 2001. International treaty on plant genetic resources for food and agriculture. Food and agriculture organization of the United Nations, Rome, Italy.

Jacob, V.J. and Alles, W.S. 1987. Kandyan Gardens of Srilanka. *Agroforestry Systems* **5**: 123-137.

Jain, R.K. 1994. Fuelwood characteristics of medium tree and shrub species of India. *Bioresource Technology* **47**: 81-84.

Jeeva, S. 2009. Horticultural potential of wild edible fruits used by the Khasi tribes of Meghalaya. *Journal of Horticulture and Forestry* **1**(9): 182-192.

Jose, S. 2009. Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforestry Systems* **76**: 1-10.

Jose, S. 2011. Managing native and non-native plants in agroforestry systems. *Agroforestry Systems* **83**: 101-105.

Joshi, V. and Sinha, C.S. 1995. Energy use in the rural areas of India; setting up a rural data base. *Biomass and Bioenergy* TERI, New Delhi.

Kabir, M.E. and Webb, E.L. 2009. Household and homegarden characteristics in South Western Bangladesh. *Agroforestry Systems* **75**: 129-145.

Kacar, B., Katkat, A.V. and Ozturk, S. 2006. Bitki Fizyolojisi (Second Edition), Nobel Press Inc.m, Ankara pp. 563.

Kamalak, A., Canbolat, O., Yavuz, G., Erol, A. and Ozay, O. 2005. Effect of maturity stage on chemical composition, *in vitro* and *in situ* dry matter degradation of umbleweed hay (*Gundelia tournefortii* L.). *Small Ruminant Research* **58**(2):149-156.

Kaplan, M., Kamalak, A., Kasra, A.A. and Gven, I. 2014. Effect of maturity stages on potential nutritive value, methane production and condensed tannin content of *Sanguisorba minor* hay. *Kafkas Universities Veterinary Fakultesi Dergisi* **20**(3): 445-449.

*Kehlenbeck, K., Susilo-Arifin, H. and Maass, B.L. 2007. *Plant diversity in homegardens in a socioeconomic and agro-ecological context*. **In**: The stability of tropical rainforest margins, linking ecological, economic and social constraints of land use and conservation, (Eds. T. Tscharntke, C. Leuschner, M. Zeller, E. Guhardja, and A. Bidin) Berlin: Springer Verlag pp. 297-319.

Khan, F.A.S. 2007. Status of vegetation in Shankaracharya reserved forest of Kashmir. M.Sc Thesis, Faculty/ Division of Forestry, SKUAST-K, Shalimar p. 72.

Khan, S., Anwar, K., Kalim, K., Saeed, A., Shah, S.Z., Ahmad, Z., Ikram, H.M., Khan, S. and Safirullah 2014. Nutritional evaluation of some top fodder tree leaves and shrubs of district Dir (lower), Pakistan as a quality livestock feed. *International journal of Current Microbiology and Applied Sciences* **3**(5): 941-947.

Khanal, S. 2011. Contribution of agroforestry in biodiversity conservation and rural needs upliftment (A case study from Kaski District). MSc. Thesis, Tribhuvan University, Institute of Forestry, Pokhara, Nepal p. 6.

Kharkwal, G.P., Mehrotra, R.Y.S. and Pangtey, Y.P.S. 2004. Comparative study of herb layer diversity in pine forest stands at different altitudes of central Himalaya. *Applied Ecology and Environmental Research* **2**(2): 15-24.

Khosla, P.K., Toky, O.P., Bisht, R.P., Himidullah, S. 1992. Leaf dynamics and protein content of six important fodder trees of the western Himalaya. *Agroforestry Systems* **19**: 109-118.

Khuroo, A.A., Rashid, I., Reshi, Z., Dar, G.H. and Wafai, B.A. 2007. The alien flora of Kashmir Himalaya. *Biological Invasions* **9**:269-292.

Kindt, R., Kalinganire, A., Larwanou, M., Belem, M., Dakouo, J.M., Bayala, J. and Kaire, M. 2008. Tree diversity in western Kenya: using profiles to characterize richness and evenness. *Biodiversity and Conservation* **15**: 1253-1270.

Klasnja, B., Kopitovic, S., Orlovic, S. 2002. Wood and bark of some poplar and willow clones as fuelwood. *Biomass Bioenergy* **23**(6): 427-432.

Klasnja, B., Orlovic, S. and Galic, Z. 2015. Comparison of different wood species as raw materials for bioenergy**.** *South-East European Forestry* (*SEEFOR*) **4**(2): 81-88.

Kraszkiewicz, A. 2013. Evaluation of the possibility of energy use black locust (*Robinia pseudoacacaia* L.) dendromass acquired in forest stands growing on clay soils. *Journal of Central European Agriculture* **14**(1):388-399.

Krishnal, S. and Weerahewa, J. 2014. Structure and species diversity of traditional homegardens in Batticaloa District. *The Journal of Agricultural Sciences* ***9**(3): 1-8.*

*Kukshal, S., Nautiyal, B.P., Anthwal, A., Sharma, A. and Bhat, A.B. 2009. Phytosociological investigation and life form pattern of grazing lands under pine canopy in temperate zone, Northwest Himalaya, India. *Research Journal of Botany* **4**: 55-69.

*Kumar, M., Patel, S.K. and Mishra, S. 2010. Studies on characteristics of some shrubaceous non-woody biomass species and their electricity generation potentials. *Energy Sources* **32**: 786-795.

Kumar, B.M. and Nair, P.K.R. 2004. The enigma of tropical homegardens. *Agroforestry Systems* **61**: 135-152.

Kumar, B.M., George, S.J. and Chinnamani, S.1994. Diversity, structure and standing stock of wood in the homegardens of Kerala in peninsular India. *Agroforestry Systems* **25**(3): 243-262.

Kumar, M. and Bhatt, V. 2006. Plant biodiversity and conservation of forests in foot hills of Garhwal Himalaya. *Iyonia* **11**(2): 43-59.

Kumar, N.J.I., Patel, K., Rita, N.K. and Rohit, K.B. 2011. An evaluation of fuelwood properties of some Aravally mountain tree and shrub species of western India. *Biomass and Bioenergy* **35**: 411-414.

Laughlin, D.C. and Grace, J.B. 2006. A multivariate model of plant species richness in forested systems: old-growth montane forests with a long history of fire. *Oikos* **114**: 60-70.

Leakey, R.R.B. 1998. Agroforestry for biodiversity in farming systems. **In**: *The Importance of Biodiversity in Agroecosystems*. (Eds. W. Collins and C. Qualset). Lewis Publishers, New York. pp. 127-145.

Leakey, R.R.B. and Tchoundjeu, Z. 2001. Diversification of tree crops: domestication of companion crops for poverty reduction and environmental services. *Experimental Agriculture* **37**: 279-296.

Lebret, M., Nys, C. and Forgeard, N. 2001. Litter production in an Atlantic beech (*Fagus sylvatica* L.) time sequence. *Annals of Forestry Science* **58**:755-768.

Le-Coeur, D., Baudry, J. and Burel, F. 2002. Why and how we should study field boundary biodiversity in an agrarian landscape. *Agricultural Ecosystem and Environment* **89**: 23-40.

*Longhi, S.J., Araujo, M.M., Kelling, M.B., Hoppe, J.M., Miller, I. and Borsoi, G.A. 2000. Phytosociological aspects of a fragment of deciduous seasonal forest, Vol. 10. R.S. Ciencia Florestal, Santa Maria pp. 59-74.

Lundgren, B.O. and Raintree, J. B. 1982. Sustained agroforestry. **In**: *Agricultural Research for Development: Potentials and Challenges in Asia* (Ed. B. Nestel). ISNAR, The Hague, The Netherlands. pp. 37-49

Lyaruu, H.V. 2010. The influence of soil characteristics on plant species diversify and distribution patterns in Western Serengeti, Tanzania. Ser. For. Bull. **5**(3): 234-241.

Lyons, R.K., Machen, R.V. and Forbes. T.D.A. 1999. Why Range Forage Quality Changes, *Texas Agriculture Extension Serv*ices B-6036 p. 7.

M.E.A. 2005. Ecosystems and human well-being: biodiversity synthesis. World Resources Institute, Washington, DC. http:// www. millennium assessment. org/ocuments/document.354.aspx.pdf.

Mahmoud, A. 2009. Diversity and biomass production of some silvipastoral systems in mid-hill Himalaya (H.P.). MSc. Thesis, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India pp. 110-119.

Maikhuri, R.K., Semwal, R.L., Rao, K.S., Singh, K. and Saxena, K.G. 2000. Growth and ecological impacts of traditional agroforestry tree species in central Himalaya, India. *Agroforestry Systems* **48**: 257-272.

Man, V., Verma, R.K., Chauhan, N.S. and Kapoor, K.S. 2012. Phytosociological attributes of Porang valley in Lippa-Asrang wildlife sanctuary of District Kinnaur, Himachal Pradesh. *Annals of Forestry* **20**(1):1-16.

Manzoor, M. Riaz, A., Iqbal, Z. and Mian, A. 2013. Biodiversity of Pir Lasura National park, Azad Jammu and Kashmir, Pakistan. *Science Technology and Development* **32**(2): 182-196**.**

Maroyi, A. 2009. Traditional homegardens and rural livelihoods in Nhema, Zimbabwe: A sustainable agroforestry system. *International Journal of Sustainable Development and World Ecology* **16**(1): 1-8.

Marshall, E.J.P. and Moonen, A.C. 2002. Field margins in northern Europe: their functions and interactions with agriculture. *Agricultural Ecosystem and Environment* **89**: 5-21.

Mc-Minn, J.W. 1992. Diversity of woody species 10 years after four harvesting treatments in the oak-pinetype. *Canadian Journal of Forestry Research* **22**: 1179-1183.

Mc-Neely, J.A. and Schroth, G. 2006. Agroforestry and biodiversity conservation-traditional practices, present dynamics, and lessons for the future. *Biodiversity and Conservation* **15**: 549-554.

Mendez, V.E., Lok, R. and Somaribba, E. 2001. Interdisplinary analysis of homegardens in Nicaragua: microzonation, plant use and socio-economic importance. *Agroforestry Systems* **51**: 85-96.

Millat-e-Mustafa, M. and Haruni, O. 2002. Vegetation characteristics of Bangladesh homegardens. *Schweizeriche Zeitschrift Fur Forstwesen* **153**(12): 454-461.

Milow, P., Malek, S., Mohammad, N.S. and Ong, H.C. 2013. Diversity of plants tended or cultivated in Orang Asli homegardens in Negeri Sembilan, Peninsular Malaysia. *Human Ecology* pp. 1-7.

Mishra, A., Nautiyal, S. and Nautiyal, D.P. 2010.Growth characteristics, calorific and fodder value of some indigenous tree species of mountainous region of Gharwal Himalayas. *Annals of Forestry* **18**(1): 63-77.

Mishra, C., Prins, H.T. and Wieren, V. 2003. Diversity, risk mediation and change in a Trans-Himalayan agropastoral system, *Human Ecology* **31**(4): 595-609.

Mishra, D., Mishra, T.K. and Banerjee, S.K. 1997. Comparative phytosociological and soil physico-chemical aspects between managed and unmanaged lateritic land. *Annals of Forestry* **5**(1):16-25.

Mishra, R. 1968. *Ecology work Book*. Oxford and I.B.H. Publishing Co.New Delhi pp. 244.

Moh'd-Khair, J., El-Shatnawi and Mohawesh, Y.M. 2000. Seasonal chemical composition of saltbush in semiarid grasslands of Jordan. *Journal of Range Management* **53**: 211-214.

Molla, A. and Kewessa, G. 2015. Woody species diversity in traditional agroforestry practices of Dellomenna District, Southeastern Ethiopia: implication for maintaining native woody species. *International Journal of Biodiversity* 1-13.

Motiur, R.M., Furukava, Y., Kawata, I., Rahman, M. and Alam, M. 2006. Role of homestead forest in household economy and factors affecting forest production: a case study in southwest Bangladesh. *Journal of Forest Research* **11**: 89-97.

Motiur, R.M., Furukawa, Y. and Kawata, I. 2005. Homestead forest resources and their role in household economy: A case study in the villages of Gazipur Upazila of central Bangladesh. *Small-scale Forest Economics, Management and Policy* **4**: 359-376.

Mughal, A.H. and Bhattacharya, P.K. 2002. Agroforestry systems practiced in Kashmir valley of Jammu and Kashmir. *Indian Forester* **128**(8): 846-852.

*Mukherji, A.K. 1994. State of India's Forests: concepts, definitions, trends, controversies. Ministry of Environment and Forests, New Delhi.

*Munzbergova, Z. and Herben, T. 2005. Seed, dispersal, microsite, habitat and recruitment limitation: Identification of terms and concepts in studies of limitations. *Oecologia* **145**: 1-8.

Murthy, I.K., Bhat, S., Sathyanarayan, V., Patgar, S., Beerappa, M., Bhat, P. R., Bhat, D.M., Ravindranath, N.H., Khalid, M.A., Prashant, M., Iyer, S., Bebber, D.M. and Saxena, R. 2016. Vegetation structure and composition of tropical evergreen and deciduous forests in Uttara Kannada District, Western Ghats under different disturbance regimes. *Tropical Ecology* **57**(1): 77-88.

Muzaffar, S.B., Islam, M.A., Kabir, D.S., Khan, M.H., Ahmed, F.U., Chowdhury, G.W., Aziz, M.A., Chakma, S. and Jahan, I. 2011. The endangered forests of Bangladesh: why the process of implementation of the convention on biological diversity is not working. *Biodiversity Conservation* **20**: 1587-1601.

Nahand, M.K., Doust-Nobar, R.S., Maheri-Sis, N. and Mahmoudi, S. 2012. Determination of feed value of cherry, apricot and almond tree leaves in ruminant using *in situ* method. *Open Veterinary Journal* **2**: 83-87.

Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer, Dordrecht, the Netherlands pp. 499.

Namwata, B.M.L., Masanyiwa, Z.S. and Mzirai, O.B. 2012. Productivity of the agroforestry systems and its contribution to household income among farmers in Lushoto District Tanzania. *International Journal of Physical and Social Sciences* **2**(7): 369-392.

Neelamegam, R., Roselin, S., Priyanka, A.M.A. and Pillai, V.M. 2015. Diversity indices of home garden plants in rural and urban areas in Kanyakumari District, Tamil Nadu, India. *Scholars Academic Journal of Biosciences* **3**(9):752-761.

Negash, M., Yirdaw, E. and Luukkanen, O. 2012. Potential of indigenous multistrata agroforests for maintaining native floristic diversity in the south-eastern Rift Valley escarpment, Ethiopia. *Agroforestry Systems* **85**: 9-28.

Negi, A.K. and Todaria, N.P. 1993. Fuelwood evaluation of some mountain trees and shrubs. *Energy* **18**: 799-801.

Negri, V. and Polegri, L. 2009. Genetic diversity in home gardens in Umbria a cowpea case study. **In**: *Proceedings of a workshop on crop genetic resources in European home gardens*. Biodiversity international, Rome, Italy pp. 55-61.

Niehaus, L.A. 2011. Contribution of Cacao (*Theobroma cacao* l.) agroforestry systems to the household economy of small-scale producers in the Central American Isthmus: the case of Bocas Del Toro, Panama. M.Sc. Agroecology Thesis, Department of Plant and Environmental, Norwegian University of Life Sciences pp. 1-81.

*Niknam, V. and Ebrahimzadeh, H. 2002. Phenolics content in *Astragalus*species, *Pakistan Journal of Botany* **34**(3): 283-289.

Noble, I.R. and Dirzo, R. 1997. Forest as human-dominated ecosystems. *Science* **277**: 522-525.

Nogues-Bravo, D., Araujo, M.D., Romdal, T. and Rahbek, C. 2008. Scale effects and human impact on the elevational species richness gradients. *Nature* **453**: 216-210.

Obernberger, I., Brunner, T. and Barnthaler, G. 2006. Chemical properties of solid biofuels-Significance and impact. *Biomass and Bioenergy* **30**: 973-982.

Obua, B.E. 2014. Survey of the diversity and proximate composition of selected most preferred browse plants utilized for goat feeding in Imo and Enugu states of Southeastern Nigeria. *International Journal of Agriculture and Rural Development* **17**(3): 1947-1958.

Onyeonagu, C.C. and Eze, S.M. 2013. Proximate compositions of some forage grasses and legumes as influenced by season of harvest. *African Journal of Agricultural Research* **8**(29): 4033-4037.

Ouinsavi, C. and Sokpon, N. 2008. Traditional agroforestry systems as tools for conservation of genetic resources of Milicia excelsa Welw. C.C. Berg in Benin. *Agroforestry Systems* **74**: 17-26.

Padmavathy, A. and Poyyamoli, G. 2013. Role of agro-forestry on organic and conventional farmers' livelihood in Bahour, Puducherry- India. *International Journal of Agricultural Sciences* **2**(12): 400-409.

Paine, R.T. 1966. Food-web complexity and species diversity. *American Nature* **100**: 65-75.

Pande, P.K. 2000. Ecological floristic diversity and regeneration behaviour of some tree species in moist temperate western Himalayan forests of Chakrata, Uttaranchal (India). *Van Vigyan* **38**(1-4): 159-184.

Pande, P.K., Negi, J.D.S. and Sharma, S.C. 2001. Plant species diversity and vegetation analysis in moist temperate Hinalayan forest. *Indian Journal of Forestry* **24**(4): 456-470.

Pandey, D.N. 2007. Multifunctional agroforestry systems in India. *Current Science* **92**(4): 1-9.

Pandey, J.C. 2003. Vegetation analysis in a mixed oak-conifer forest of central Himalayas, India. *Biodiversity Conservation* **15**: 2263-2285.

Pappoe, A.N.M., Armah, F.A., Quaye, E.C., Kwakye, P.K. and Buxton, G.N.T. 2010. Composition and stand structure of a tropical moist semi-deciduous forest in Ghana. *International Research Journal of Plant Science* **1**(4): 95-106.

Parissi, Z.M., Papachristou, T.G. and Nastis. A.S. 2005. Effect of drying method on estimated nutritive value of browse species using an in vitro gas production technique. *Animal Feed Science and Technology* **123-124**(1): 119-128.

Parlak, A.O., Gokkus, A., Hakyemez, B.H. and Baytekin, H. 2011. Forage quality of deciduous woody and herbaceous species throughout a year in Mediterranean shrublands of western Turkey. *The Journal of Animal and Plant Sciences* **21**(3): 513-518.

Pascal, 1992. Evergreen forest of the Western Ghats structural and functional trends. In "Tropical Ecosystems, Ecology and Management" Wiley Limited, New Delhi pp. 385-408.

Peyre, A., Guidal, A., Wiersum, K. F., and Bongers, F. 2006. Dynamics of homegarden structure and function in Kerala, India. *Agroforestry Systems* **66**: 101-115.

Philpott, M.S., Bichier, P., Rice, R.A. and Greenberg, R. 2008. Biodiversity conservation, yield, and alternative products in coffee agroecosystems in Sumatra, Indonesia. *Biodiversity and Conservation* **17**: 1805-1820.

Pokhrel, C.P., Timilsina, A., Khanal, R., Ando, K. and Yadav, R.K.P. 2015. Biodiversity in agroforestry systems: a case study in homegardens of Gulmi and Palpa Districts of Western Nepal. *Journal of Institute of Science and Technology* **20**(1): 87-96.

Prajapati, A. 2008. Nutrient analysis of important food tree species of Asian elephant (*Elephas maximus*) in hot-dry season in Bardia National Park, Nepal. M.Sc. Thesis submitted to Department of environmental science and engineering school of science Kathmandu University Dhulikhel, Nepal pp. 47-50.

Pulido, M.T., Pagaza-Calderón, E.M., Martínez-Ballesté, A., Maldonado-Almanza, B., Saynes, A. and Pacheco, R.M. 2008. Home gardens as an alternative for sustainability: challenges and perspectives in Latin America. *Current Topics in Ethnobotany*. Research Signpost 37/661 (2), Fort P.O., Trivandrum-695 023, Kerala, India pp. 1-4.

Purohit, A.N. and Nautiyal, A.R. 1987. Fuelwood value index of Indian mountain tree species. *The International Tree Crops Journal* **4**: 177-182.

*Qualset, C.O., Mc-Guire, P.E. and Warburton, M.L. 1995. Agrobiodiversity key to Agricultural productivity. Genetic Resource conservation program University of California, Davis pp. 35-41.

Rai, Y.K., Chettri, N. and Sharma, E. 2002. Fuel wood value index of woody tree species from mamlay watershed in South Sikkim, India**.** *Forests, Trees and Livelihoods* **12**: 209-219.

Rao, G.R. 1998. Studies on dynamics of herbage layer in pine and khair based natural silvipastoral systems in North west Himalaya. Ph.D Thesis, Dr. Y.S.Parmar University of Horticulture and Forestry, Nauni, Solan (H.P), India pp. 131.

Rao, M.R., Nair, P.K.R. and Ong, C.K. 1998. Biophysical interactions in tropical agroforestry systems. *Agroforestry System* **38**: 3-50.

Raturi, G.P. 2012. Forest community structure along an altitudinal gradient of District Rudraprayag of Garhwal Himalaya, India. *Ecologia* **2**(3): 76-84.

Rawat, Y.S., Vishvakarma, S.C.R., Oinam, S.S. and Kuniyal, J.C. 2010. Diversity, distribution and vegetation assessment in the Jahlmanal watershed in cold desert of the Lahaul valley, north-western Himalaya, India. *Forest* **3**: 65-71.

*Rekib, A., Mangate, S., Kochar, A.S. and Bhatia, I.S.1970. Improvement of the feed value of low-grade roughages by incorporating urea and molasses into them. *Journal of Research Ludhiana* **7**: 47.

*Rico-Gray, V., Chemas, A. and Mandujano, S. 1991. Uses of tropical deciduous forest species by the Yucatecan Maya. *Agroforestry Systems* **14**: 149-161.

Risser, P.G. and Rice, E.L. 1971.Diversity of tree species in Okhlahoma upland forests. *Ecology* **52**: 876-880.

*Rosenzweig, M.L. 2003. Reconciliation ecology and the future of species diversity. *Oryx* **37**: 194-205.

Roy, P.S., Singh, S. and Porwal, M.C. 1993. Characterization of ecological parameters in tropical forest community-a remote sensing approach. *Journal of Indian Society Remote Sensing* **21**: 127-149.

*Rubanza, C.D.K., Shem, M.N., Otsyina, R., Bakengesa, S.S., Ichinohe, T. and Fujihara, T. 2005. Polyphenolics and tannins effect on *in vitro* digestibility of selected *Acacia* species leaves. *Animal Feed Science and Technology* **119**: 129-142.

Saikia, P., Choudhury, B.I. and Khan, M.L. 2012. Floristic composition and plant utilization pattern in homegardens of Upper Assam, India. *Tropical Ecology* **53**(1): 105-118.

Salem, A.Z.M., Salem, M.Z.M., El-Awday, M.M. and Robinson, P.H. 2006. Nutritive evaluations of some browse tree foliages during the dry season: Secondary compounds, feed intake and in vivo digestibility in sheep and goats. *Animal Feed Science and Technology* **127**: 251-267.

*Sanchez, P.A., Shepherd, K., Meredith, J., Soule, F.M., Buresh, R.J., Izac, A.N., Uzookuwunye, A., Kwesiga, F.R., Ndiritu, C.G. and Woomer, P.L. 1996.

Soil fertility replenishment in Africa: an investment in natural resource capital. **In**: *Replenishing Soil Fertility in Africa* (Eds. J. Buresh, P.A. Sancehz and F.G. Calhoun),. Soil Science Society of America Special Publication No. 51. SSSA, Madison, WI pp. 1-46.

Saravanan, V., Parthiban, K.T., Kumar, P., Anbu, P.V. and Ganesh Pandian P. 2013. Evaluation of fuel wood properties of *Melia dubia* at different age gradation. *Research Journal of Agriculture and Forestry Sciences* **1**(6): 8-11.

Saxena, A.K. and Singh, J.S. 1982. A phytosociological analysis of forest communities of a part of Kumaun Himalaya. **In**: *Department of Environmental Science, University of Kashmir 179 Glimpses of Ecology.* (Eds. J.S. Singh and B. Gopal). International Scientific Publications, Jaipur pp. 167-180.

Saxena, A.K. and Singh, J.S. 1984. Tree population structure of certain Himalayan forests and implications concerning the future composition. *Vegetation* **58**: 61-69.

Scurlock, J.M.O. and Hall, D.O. 1990. The contribution of biomass to global energy use. *Biomass* **21**: 75-81.

Semwal, D.N., Uniyal, P.L. and Bhatt, A.J. 2010.Structure, composition and dominance-diversity relations in three forest types of a part of Kedarnath wildlife sanctuary, central Himalaya, India. *Notulae Scientia Biologicae* **2**(3): 128-132.

Semwal, S., Nautiyal, B.P. and Bhatt, A.B. 2008. Dominance diversity patterns and regeneration status of moist temperate forests in Garhwal, part of North-West Himalayas, India. *Taiwan Journal of Forest Science* **23**: 351-364.

Senanayake, R.L., Sangakkara, U.R., Pushpakumara, D.K.N.G. and Stamp, P. 2009. Vegetation Composition and ecological benefits of homegardens in the Meegahakiula Region of Sri Lanka. *Tropical Agricultural Research* **21**(1): 1-9.

Seta, T. and Demissew, S. 2014. Diversity and standing carbon stocks of native agroforestry trees in Wenago District, Ehiopia. *Journal of Emerging Trends in Engineering and Applied Sciences* **5**(7): 125-132.

Shadangi, D.K. and Nath, V. 2005. Impact of seasons on ground flora under plantation and natural forest in Amarkantak. *Indian Forester* **131**(2): 240-250.

Shah, A.S. 2013. Honey locust (*Gleditsia* spp.): Its distribution, nursery raising and uses in Kashmir. Ph.D Thesis, Faculty of Forestry, SKUAST-K, Shalimar. pp. 101.

Shaheen, G., Zaidi, M.A., Khan, A.R., Anwer, M., Khan, M.J., Gul, P. and Fatima, M. 2015. Effect of season on mineral composition of two trees of Quetta District used as fodder. *International Journal of Pharmaceutical Science Review and Research* **34**(1): 27-30.

Shaheen, H., Qureshi, R.A. and Shinwari, Z.K. 2011. Structural diversity, vegetation dynamics and anthropogenic impact on lesser Himalayan subtropical forests of Bagh District, Kashmir. *Pakistan Journal of Botany* **43**(4): 1861-1866.

Shaheen, H., Zahid-Ullah, K.S.M. and Harper, D. M. 2012. Species composition and community structure of western Himalayan moist temperate forests in Kashmir. *Forest Ecology and Management* **278**: 138-145.

Shameem, S.A. and Kangroo, I.N. 2011. Comparative assessment of edaphic features and phytodiversity in lower Dachigam national park, Kashmir Himalaya, India. *African Journal of Environmental Science and Technology* **5**(11): 972-984.

Shameem, S.A., Soni, P. and Bhat, G.A. 2010. Comparative study of herb layer diversity in lower Dachigam National Park, Kashmir Himalaya, India. *International Journal of Biodiversity and Conservation* **2**(10): 308-315.

Shannon, C.E. and Weiner, W. 1963. The Mathematical Theory of Communities. University of of Illinois Press, Urbana, Illinois.

Sharma, C.M., Ghildiyal, S.K. Gairola, S. and Suyal, S. 2009. Vegetation structure, composition and diversity in relation to the soil characteristics of temperate mixed broad-leaved forest along an altitudinal gradient in Garhwal Himalaya. *Indian Journal of Science and Technology* **2**(7): 39-45.

Sharma, K.P. and Upadhyaya, B.P. 2002. Phytosociology, primary production and nutrient retention in herbaceous vegetation of the forestry arboretum on the Aravalli hills at Jaipur. *Tropical Ecology* pp. 325-335.

Sharma, P., Rana, J.C., Devi, U., Randhawa, S.S. and Kumar, R. 2014. Floristic diversity and distribution pattern of plant communities along altitudinal gradient in Sangla Valley, Northwest Himalaya. *The Scientific World Journal* pp. 1-11.

Shenkute, B., Hassen, A., Assafa, T., Amen, N. and Ebro, A. 2012. Identification and nutritive value of potential fodder trees and shrubs in the Rift valley of Ethiopia. *The Journal of Animal and Plant Sciences* **22**(4): 1126-1132.

Simpson, E.M. 1949. Measurement of diversity. *Nature* **163**: 688.

Singh, B. and Todaria, N.P. 2012. Nutrients composition changes in leaves of *Quercus semecarpifolia* at different seasons and altitudes. *Annals of Forest Research* **55**(2): 189-196.

Singh, B., Tripathi, P.K. and Singh, K. 2011. Community structure, diversity, biomass and net production in a rehabilitated subtropical forest in North India. *Open Journal of Forestry* **1**(2): 11-26.

Singh, E. 2012. Comparative analysis of diversity and similarity indices with special relevance to vegetations around sewage drains. *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering* **6**(9): 1-3.

Singh, J.S. and Yadava, P.S. 1974. Seasonal variation in composition, plant biomass and net primary productivity of tropical grassland at Kurukshetra, India. *Ecological Management* **44**: 357-376.

Singh, J.S and Singh, S.P. 1987. Forest vegetation of the Himalaya. *Botanical Review* **52**: 80-192.

Singh, J.S. and Singh, S.P. 1992. Forest of Himalaya, structure, functioning and impact of Man. Gyanodaya Prakashan, Naintal, India.

Singh, M. and Singh, M.P. 2013. Assessment of plant diversity indices of Gomati riparian corridors in District Jaunpur, India. *Ecological Society* **20**: 71-76.

Singh, M. 2014. Pattern, composition and vegetation dynamics of agroforestry systems in Giri catchment, Himachal Pradesh. Ph.D Thesis, Dr, Y.S. Parmar University of Forestry and Horticulture, Nauni, Solan pp. 200.

*Soemarwoto, O. 1987. Homegardens: A traditional agroforestry system with promising future. **In**: *A Decade of Development*. Nairobi ICRAF. (Eds. H. Steppler and P.K.R. Nair) pp. 157-170.

Sonwa, D.J., Nkongmeneck, B.A., Weise, S.F., Tchatat, M. and Adesina, A. A.2007. Diversity of plants in the humid forest zone of Southern Cameroon. *Biodiversity Conservation* **16**: 2385-2400.

Sorenson, T. 1948. A method of establishing groups of equal amplitude on similarity of species content. *Biologiske Skrifter K. Danske Videnskbernes Selskab* **5**: 1-34.

Sotelo Montes, C., Silva, D.A., Garcia, R.A., Muniz, G.I.B. and Weber, J.C. 2011. Calorific value of *Prosopis africana* and *Balanites aegyptiaca* wood: relationships with tree growth, wood density and rainfall gradients in the West African Sahel. *Biomass Bioenergy* **35**:346-353.

Sotelo Montes, C., Weber, J.C., Silva, D.A., Andrade, C., Muniz, G. I.B., Garcia, R.A. and Kalinganire, A. 2014. Growth and fuelwood properties of five tree and shrub species in the Sahelian and Sudanian ecozones of Mali: relationships with mean annual rainfall and geographical coordinates. *New Forests* **45**:179-197.

*Sterling, G. and Wilsey, B. 2001.Empirical relationships between species richness, evenness and proportional diversity. *American Naturalist* **158**: 286-299.

Stevens, M.H.H. 2006. Placing local plant species richness in the context of environmental drivers of metacommunity richness. *Journal of Ecology* **94**: 58-65.

Subedi, A., Suwa, R., Gautam, R., Sunwar, S. and Shrestha,P. 2004. Status and composition of plant genetic diversity in Nepalese Home Gardens. In: Home Gardens in Nepal: *Proceeding of a workshop* (Eds. R. Hautam, B.R. Sthapit and P.K. Shrestha 2006) Pokhara, Nepal. pp. 20-22.

Sultan, J.I., Rahim, I., Nawaz, H., Yaqoob, M. and Javed, I. 2008. Nutritional evaluation of fodder tree leaves of northern grasslands of Pakistan. *Pakistan Journal of Botany* **40**(6): 2503-2512.

Suyal, S., Sharma, C.M., Gairola, S., Ghildiyal, S.K., Rana, C.S. and Butola, D.S. 2010. Phytodiversity (Angiosperms and gymnosperms) in Chaurangikhal forest of Garhwal Himalaya, Uttrakhand, India. *Indian Journal of Science and Technology* **3**(3): 267-275.

Swamy, S.L. 1998. Estimation of Net Primary Productivity (NPP) in an Indian tropical evergreen forest using Remote Sensing data. Ph.D. Thesis, Jawaharlal Nehru Technology University, Hyderabad pp. 100-112.

*Tangjang, S., Deb, S., Arunachalam, A., Melkania, U., Arunachalam, K. and Shrivastava, K. 2004. Tribal communities and vegetation characteristics in traditional agroforestry system of north east India. *Indian Journal of Agroforestry* **6**: 73-80.

Tewari, J.C. and Singh, S.P. 1985. Analysis of woody vegetation in a mixed oak forest of Kumaun Himalaya. *Proceedings of Indian National Science Academy* **51B**: 232-347.

Thevathasan, N.V. and Gordon, A.M. 2004. Ecology of tree intercropping systems in the North temperate region: experience from southern Ontario, Canada. *Agroforestry Systems* **61**: 257- 268.

Tilman, D. 1999. Global environmental impacts of agricultural expansion: the need for sustainable and efficient practices. *Proceedings of National Academy of Science* **96**: 1857-1861.

Tilman, D. 2000. Causes, consequences and ethics of biodiversity. *Nature* **405**: 208-211.

Toky, O.P., Kumar. P. and Khosla, P.K. 1989. Structure and function of traditional agroforestry systems in the Western Himalaya. I. Biomass and Productivity. *Agroforestry Systems* **9**(1): 47-70.

*Tudsri, R.I., Keynolds, L. and Atta-Krah, A.N. 2002. Alley Farming. *Advances in Agronomy* **43**: 315-359.

Tynsong, H. and Das, A.K. 2010. Diversity in arecanut agroforests of South Meghalaya, north-east India. *Journal of Forestry Research* **21**: 281-286.

Tynsong, H. and Tiwari, B.K. 2010. Plant diversity in the homegardens and their significance in the livelihoods of *War Khasi* community of Meghalaya, North-east India. *Journal of Biodiversity* **1**(1): 1-11.

Udofia, S.I., Owoh, P.W., Ukpong, E.E. and Ekpo, I.E. 2012. Assessment of plant species of socioeconomic importance conserved in homegardens of Nist Ubium Local Government area of Akwa Ibom state, Nigeria. *Nigerian Journal of Agriculture, Food and Environment* **8**(1): 99-108.

Umar, T., Bello, A.G. and Kamba, A.S. 2010. Foliar nutritional composition of four indigenous trees of the Sudan Savanna, Nigeria. *Journal of Biomedical Science and Research* **2**(3):179-186.

Varadaranganatha, G.H. and Madiwalar, S. L. 2010. Studies on species richness, diversity and density of tree/ shrub species in agroforestry systems. *Karnataka Journal of Agricultural Sciences* **23**(3): 452-456.

Verma, R.K., Kapoor, K.S., Rawat, R.S., Subramani, S.P. and Kumar, S. 2005. Analysis of plant diversity in degraded and plantation forests in Kunihar Forest Division of Himachal Pradesh. *Indian Journal of Forestry* **28**(1): 11-16.

Vishvakarma, S.C.R., Kuniyal, J.C. and Singh, G.S. 1998. Indigenous agroforestry system of north-western Himalaya. Research for mountain development: some initiative and accomplishment. Gyanodaya Prakashan, Nainital, Uttarakhand, India pp. 99-118.

Vu, C.C., Verstegen, M.W.A., Hendriks, W.H. and Pham, K.C. 2011. The Nutritive value of Mulberry Leaves (*Morus alba*) and partial replacement of cotton seed in rations on the performance of growing vietnamese cattle. *Journal of Animal sciences* **24**(9): 1233-1242.

Wezel, A. 2003. Plant species diversity of homegardens in humid and semiarid Cuba and its importance for self-sufficiency of households. In: Conference on *International Agricultural Research for Development* pp. 4.

Whittaker, R.H. 1965. Dominance and diversity in land plant communities. Numerical relations of species express the importance of competition in community function and evolution. *Science* **147**: 250-260.

Wiersum, K.F. 1982. Tree gardening and Taungya on Java: examples of agroforestry techniques in the humid tropics. *Agroforestry Systems* **1**: 53-70.

*Woodward, F.I. 1988. Temperature and the distribution of plant species and vegetation. **In**: *Plants and Temperature*. *Society of Experimental Biology* (Eds. S.P. Long, and F.I. Woodward). The Company of Biologists Limited, Cambridge pp. 59-75.

Wright, S.J. 2002. Plant diversity in tropical forests: A review of mechanisms of species coexistence. *Oecologia* **130**: 1-14.

Yaqoob, A., Yunus, M. and Bhat, G.A. 2014. Comparative study of shrub diversity in lower Dachigam Kashmir Himalaya. *International Journal of Biodiversity and Conservation* **6**(12): 848-853.

Yimer, F., Ledin, S. and Abdelkadir, A. 2006. Soil property variations in relation to topographic aspect and vegetation community in the south-eastern highlands of Ethiopia. *Forest Ecology and Management* **232**: 90-99.

Zaman, S., Siddiquee, S. and Katoh, M. 2010a. Structure and diversity of homegarden agroforestry in Thakurgaon district, Bangladesh. *The Open Forest Science Journal* **3**: 38-44.

Zaman, S., Siddique, S.S., Faruq, M.A.A., Pramanik, M.R. and Katoh, M. 2010b. Composition and trends of homegarden agroforestry in Bangladesh: A case study in Dinajpur District. *Pelican Web's Journal of Sustainable Development* **6**(10): 3.

Zemede, A. and Ayele, N. 1995. Homegardens in Ethiopia: characteristics and plant diversity. *Ethiopian Journal of Science* **18**(2):235-266.

Zhang, G.J., Li, Y., Xu, Z.H., Jiang, J.Z., Han, F.B. and Liu, J.H. 2012. The chemical composition and ruminal degradation of the protein and fibre of tetraploid *Robinia pseudoacacia* harvested at different growth stages. *Journal of Animal and Feed Sciences* **2***: 177-187.*

Zhang, S.B., Ferry-Slik, J.W., Zhang, J.L. and Cao, K.F. 2011. Spatial patterns of wood traits in China are controlled by phylogeny and environment. *Global Ecology Biogeography* **20**: 241-250.

Zimik, L., Saikia, P. and Khan, M. L. 2012. Comparative study on homegardens of Assam and Arunachal Pradesh in terms of species diversity and plant utilization pattern. *Research Journal of Agricultural Sciences* **3**(3): 611-618.

Zobel, M. 1997. The relative role of species pools in determining plants species richness: an alternative explanation of species coexistence. *Trend in Ecology and Evolution* **12**: 266-269.

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* Original not seen

Appendix-I

Meteorological data for the year 2013 & 2014

Months	Temperature (^oC)				Rainfall(mm)		RH1		RH2	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
January	-2.75	-1.67	7.19	4.70	89.40	165.60	92.48	89.06	70.77	79.32
February	0.09	-0.04	9.64	9.19	137.00	68.50	87.35	88.04	63.10	61.00
March	3.76	3.08	17.11	11.09	51.60	278.20	79.87	85.00	47.77	66.48
April	6.58	6.18	19.03	17.78	135.60	124.80	80.10	78.47	59.36	61.03
May	9.22	8.86	24.04	23.11	59.00	68.90	79.74	81.29	49.29	55.74
June	14.91	11.41	29.43	29.28	107.2	24.10	79.40	72.23	50.13	44.43
July	17.75	16.83	30.90	30.47	73.6	72.80	76.61	78.87	48.12	49.29
August	17.66	14.76	28.58	29.12	178.4	80.00	80.87	79.84	62.41	53.06
September	12.14	10.72	27.65	23.73	31.2	194.90	83.40	87.96	57.93	66.27
October	8.05	6.51	24.12	21.23	21.00	23.40	84.64	92.29	58.61	66.94
November	-0.35	-0.12	15.25	14.83	17.00	19.60	86.16	87.56	65.80	64.94
December	-2.16	-1.11	10.08	9.45	25.20	26.00	89.77	87.66	69.90	67.09

(Source: Digest of Statistics 2013-14)

Annexure-II

Analysis of Variance for interaction between density of wild plants and seasons

	d.f.	Sum sq.	Mean sq.	F-value	Pr (>F)
Replication	2	1627	814	0.828	0.45
Systems	3	924100	308033	313.374	<2e-16***
Seasons	2	1619183	809591	823.627	<2e-16***
Systems : seasons	6	172742	28790	29.289	2.03e-09***
Residual	22	21625	983		

Annexure-III

Analysis of variance for interaction between basal area of wild plants and seasons

	d.f.	Sum sq.	Mean sq.	F-value	Pr (>F)
Replication	2	33.0	16.5	5.234	0.0198*
Systems	3	573.8	191.3	60.646	8.45e-11***
Seasons	2	1383.6	691.8	219.341	2.95e-15***
Systems : seasons	6	238.9	39.8	12.623	3.69e-***
Residual	22	69.4	3.2		

Annexure-IV

Questionnaire

General Information

1. **Name of decision maker :**
   Caste :
2. **Name of village :** **Block:**
   District:
3. **Total Land :** **Leased in:**
   Leased out :
4. **House No. :** **Residential** :
   Kuccha………….. Pucca………

Age of the Respondents

Category	**Respondent**	
	Number	**Percent (%)**
Young age (<18 years)		
Middle age (19-50 years)		
Old age (>50 years)		
Total		

Annexure-V

Family Size of the Respondents

Category	**Family Size**	
	Number	**Percent (%)**
2-4 members (Small)		
5-10 members (Medium)		
>10 members (Large)		
Total		

Annexure-VI

Education level of the Respondents

Category	Respondent	
	Number	Percent (%)
Illiterate (No schooling)		
Primary level (I-V)		
Secondary level (VI-X)		
Higher educated (College, University)		
Total		

Annexure-VII

Occupation of the Respondents

Category	% of the Respondents
Agriculture	
Service	
Business	
Daily labour	

Annexure-VIII

Total income from other sources

Village	Income from sources other than practicing land use systems		
	Business	Employment	Labour

<u>Annexure-IX</u>

Land Use Pattern/System

Land use pattern	Area (kanals)
Agriculture	
Horticulture	
Forestry/Compact block planting	
Homegarden	
Non- cultivable land	
Pasture	
Other	
1. Agri-silvi	
2. Agri-horti	
3. Boundary plantation	
4. Hortisilvi	
5. Hortiagrisilvi	
6. Hortisilvipasture	
7. Silvipasture	

<u>Annexure-X</u>

Components of Agroforestry Systems identified

System identified	Area (kanals)	Tree component & No.	Fruit tree component & No.	Agriculture crop component	
				Kharif	Rabi
Boundary plantation (Paddy fields)					
Agrisilviculture (Slopy lands)					
Agrisiviculture (Plain lands)					
Hortisilviculture					
Hortiagrisilviculture					
Hortisilvipasture					
Silvipasture					
Homegarden					
Forestry/Compact block planting					
Other (specify)					

Annexure-XI

Annual expenditure (Rs.) incurred in management and marketing of the products collected from all land use systems

Village	Land use pattern (Tick the system using)	Annual expenditure (Rs)
	Agriculture( ), Horticulture( ), Forestry/ Compact block planting ( ), Homegarden ( ), Non-cultivable land ( ), Pasture ( ), Boundary plantation ( ), Agrisilviculture (slopy lands) ( ), Agrisilviculture (plain lands) ( ), Hortisilviculture ( ), Hortiagrisilviculture ( ), Hortisilvipasture ( ), Silvipasture ( )	
	Grand total	

Standard daily wages of workers during the survey period was Rs…….. for Men (skilled labourers), Rs. …….for women and Rs. ….. for boys. These costs calculated by multiplying wage rate by number of days spent.

Annexure-XII

Average Number of Livestock in the study area

Village	Average Number			
	Cattle	Goat	Cow	Poultry

Annexure-XIII

Trees species used as fuelwood by the farmers

Village	Trees used as fuelwood					
	Populus	Salix	Robinia	Ailanthus	Celtis	*Other plant species

*Other plant spp- plant species other than populus, salix, robinia, ailanthus, celtis e.g apple

Annexure-XIV

Annual fuel usage (Rank 1-6)

Type	Summer Season						Winter Season					
	Electricity	Kerosene Oil	LPG	Animal dung	Fuelwood	Agricultural waste	Electricity	Kerosene Oil	LPG	Animal dung	Fuelwood	Agricultural waste
Cooking												
Heating												
Lighting												
Others (marriage, festivals)												

1= first preferred, 6= least preferred

Annexure-XV

Alternate fuelwood sources in the study area

Agroforestry systems	Fuelwood production Kgs(Qtls)*/annum	% age

<u>Annexure-XVI</u>

Production and percentage contribution of various plant species found in different land use systems towards annual income of households

Land use system	Agriculture Crop Component		Production (kg)/year		Rate (Rs/ Kg)	Amount (Rs)		Gross production (Rs)	%
	Kharif	Rabi	Self-consumption	Sale		Self-Consumption	Sale		
1. Agriculture									
2. Horticulture									
a) Apple									
b) Pear									
c) Plum									
d) Cherry									
3. Forestry (compact block planting)									
a) Poplus									
b) Salix									
c) Kikar									
4. Homegarden									
5. Boundary plantation									
6. Agrisilviculture (slopy lands)									
7. Agrisilviculture (plain lands)									
8. Hortisilviculture									
9. Hortiagrisilviculture									
10. Hortisilvipasture									
11. Silvipasture									

Annexure-XVII

Total income from prevalent agroforestry systems of District Budgam

Land use system	Income Percentage (From Total* Net income)				Income/farmer	Income/ha
	<10	10-20	20-30	>30		

Annexure-XVIII

Plant species (used dry/green) exploited for fodder as per season

Village	Season											
	Spring				Summer				Autumn			
	Poplar	Kikar	Salix	Others	Poplar	Kikar	Salix	Others	Poplar	Kikar	Salix	others

Others= oats, paddy straw etc

Annexure-XIX

Ranking of tree fodder given to each animal

Village	Ranking of tree fodder component				
	Poplar	Salix	Robinia	Celtis	Mulberry

<u>Annexure-XX</u>

Quantity of other fodder material/ component mixed with tree fodder or solely given to each animal

Village	Fodder component																											
	FCS (100 %)							FCS (50%)							MFC (100 %= 50 %+ 50 %)							MFC (50 %= 25 %+ 25 %)						
	O	RS	P	S	R	O	RS	P	S	R	P + S	P + R	S + R	P + O	P + RS	S + O	S + RS	R + O	R + RS	P + S	P + R	S + R	P + O	P + RS	S + O	S + RS	R + O	R + RS

Fodder component given solely = FCS (O= Oats, RS= Rice straw, P= Poplar, S= Salix, R= Robinia), **Mixed fodder component** = MFC (P+S, P+R, S+R, O+RS, P+O, P+RS, S+O, S+RS, R+O, R+RS

Annexure-XXI

Subsistence need fulfillment of farmers through different agroforestry systems

Land use pattern	Subsistence needs fulfillment									
	100 %					50 %				
	Food	Fodder	Timber	Fuel-wood	Medicinal plants	Food	Fodder	Timber	Fuel-wood	Medicinal plants
Boundary plantation										
Agri-silviculture (sloppy lands)										
Agri-silviculture (plain lands)										
Horti-silviculture										
Horti-agri-silviculture										
Hort-silvi-pasture										
Homegarden										
Silvipasture										
Others										

ANOVA for Broad leaved Trees

Appendix-XXII

Analysis of variance for wood moisture content

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	24.631	6.1577	6.8592	0.002052 **
Plant sp.	4	89.650	22.4125	24.9657	1.044e-06 ***
Residuals	16	14.364	0.8977		

Appendix-XXIII

Analysis of variance for wood density

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	0.008784	0.002196	1.7839	0.1814
Plant sp.	4	0.157984	0.039496	32.0845	1.850e-07 ***
Residuals	16	0.019696	0.001231		

Appendix-XXIV

Analysis of variance for ash content

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	0.0740	0.018506	0.0728	0.9894
Plant sp.	4	0.3086	0.077146	0.3033	0.8715
Residuals	16	4.0694	0.254338		

Appendix-XXV

Analysis of variance for calorific value

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	8.534	2.1336	2.5204	0.08208
Plant sp.	4	46.859	11.7149	13.8388	4.605e-05 ***
Residuals	16	13.544	0.8465		

Appendix-XXVI

Analysis of variance for Fuelwood value index

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	248461	62115	0.8354	0.522377
Plant sp.	4	2036334	509083	6.8468	0.002069 **
Residuals	16	1189650	74353		

ANOVA for Fruit Trees

Appendix-XXVII

Analysis of variance for wood moisture content

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	95.61	23.903	0.2326	0.9147
fruit trees	3	548.59	182.864	1.7796	0.2045
Residuals	12	1233.07	102.756		

Appendix-XXVIII

Analysis of variance for wood density

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	0.01127	0.002817	0.1207	0.97242
fruit trees	3	0.35684	0.118947	5.0939	0.01675 *
Residuals	12	0.28021	0.023351		

Appendix-XXIX

Analysis of variance for ash content

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	0.06303	0.01576	0.2403	0.910071
fruit trees	3	2.51062	0.83687	12.7616	0.000483 ***
Residuals	12	0.78693	0.06558		

Appendix-XXX

Analysis of variance for calorific value

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	10.422	2.6055	1.3505	0.30780
fruit trees	3	28.376	9.4586	4.9025	0.01890 *
Residuals	12	23.152	1.9293		

Appendix-XXXI

Analysis of variance for Fuelwood value index

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	4	39213	9803	0.1247	0.9707
fruit trees	3	5308482	1769494	22.5074	3.231e-05 ***
Residuals	12	943419	78618		

Appendix-XXXII

Analysis of variance for crude protein

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	3	0.26	0.086	0.0187	0.9965
Plant sp.	4	907.23	226.808	49.3898	2.418e-15 ***
Season	2	186.59	93.293	20.3156	6.733e-07 ***
Plant sp:Season	8	8.07	1.009	0.2197	0.9855
Residuals	42	192.87	4.592		

Appendix-XXXIII

Analysis of variance for crude fibre

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	3	2.985	0.995	1.3154	0.282058
Plant sp.	4	197.443	49.361	65.2459	< 2.2e-16 ***
Season	2	116.885	58.442	77.2499	8.465e-15 ***
Plant sp.:Season	8	25.826	3.228	4.2672	0.000813 ***
Residuals	42	31.775	0.757		

Appendix-XXXIV

Analysis of variance for ether extract

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	3	0.253	0.0845	0.2233	0.87970
Plant sp.	4	54.223	13.5558	35.8152	5.027e-13 ***
Season	2	13.672	6.8362	18.0616	2.187e-06 ***
Plant sp.:Season	8	6.286	0.7858	2.0761	0.06016 .
Residuals	42	15.897	0.3785		

Appendix-XXXV

Analysis of variance for total ash

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Rep	1	0.724	0.724	2.6261	0.1274183
Plant sp.	4	149.455	37.364	135.5532	5.008e-11 ***
Season	2	230.896	115.448	418.8376	3.243e-13 ***
Plant sp.:Season	8	20.252	2.532	9.1843	0.0002055 ***
Residuals	14	3.859	0.276		

Appendix-XXXVI

T-test for crude protein for *Avena sativa* and *Oryza sativa*

Variance	0.107373	0.022827
Observations	10	10
Pooled Variance	0.0651	
Hypothesized Mean Difference	0	
Df	18	
t Stat	2.208488	
P(T<=t) two-tail	0.040419	
t Critical two-tail	2.100922	

Appendix-XXXVII

T-test for crude fibre for *Avena sativa* and *Oryza sativa*

Variance	0.89261	0.00464
Observations	10	10
Pooled Variance	0.448625	
Hypothesized Mean Difference	0	
Df	18	
t Stat	84.96658	
P(T<=t) two-tail	6.76E-25	
t Critical two-tail	2.100922	

Appendix-XXXVIII

T-test for ether extract for *Avena sativa* and *Oryza sativa*

Variance	0.28669	0.057533
Observations	10	10
Pooled Variance	0.172112	
Hypothesized Mean Difference	0	
Df	18	
t Stat	4.726933	
P(T<=t) two-tail	0.000168	
t Critical two-tail	2.100922	

Appendix-XXXIX

T-test for ash content for *Avena sativa* and *Oryza sativa*

Variance	2.271773	0.023067
Observations	10	10
Pooled Variance	1.14742	
Hypothesized Mean Difference	0	
Df	18	
t Stat	22.72856	
P(T<=t) two-tail	1.05E-14	
t Critical two-tail	2.100922	

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CERTIFICATE

Certified that all the corrections/amendments as suggested by External Examiner **Dr. R.I.S Gill, Senior Scientist-cum-Head, Dept. of Forestry & Natural Resources, PAU, Ludhiana** during Viva-Voce examination held on **24-06-2016** have been incorporated in the manuscript entitled **"Plant Diversity in Prevalent Agroforestry Systems of District Budgam"** submitted by **Ms. Sabeena Nabi (Regd. No. 2012-427-D) (INSPIRE Fellow).**

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