Chapter 3

REVIEW OF LITERATURE
In order to formulate some firm basis for further research, a review of some earlier works, their approaches and findings becomes imperative. The review presents a pool of information available on diverse aspects of forest ecology. For the sake of convenience the review is divided into various facets of ecology in general and forest ecology in particular as delineated in the following headings and sub-headings:

3.1. SOIL

Brown and Allison (1916) stated that the determination of carbon/nitrogen ratio in soils is considered to be of much importance in fertility studies. According to them, it not only shows the organic matter content of the soils, but also throws light upon the rate at which decomposition processes are occurring in the soil. Read (1921) was of the opinion that soil productivity cannot be correlated with the organic carbon/nitrogen ratio.

Toumey and Neethling (1923) reported that shallow rooted conifers such as hemlock were killed by heat lesions resulting from high soil temperature. The authors also indicated that canopy was more effective in
reducing soil temperature. Miller (1924) reported that finer the particles the more surface is presented for the retention and solvent action of water and the greater is the absorbing area for plants. According to him, the clay particles are so finely divided that they exhibit the properties of matter in the colloidal state, one of which is an exceedingly great water-retaining capacity.

Craib (1925), while comparing soil moisture in the forest with open ground, found a decrease in depth in both habitats. According to him, during the dry periods, however, the surface was drier than lower depths in the open. The author also found that little moisture was lost by direct surface evaporation under forest cover.

Waksman et al. (1928) remarked that the nature of friction of nitrogen in forest soil has remained very vague, since neither *Azotobacter* nor legume bacteria are found to occur to any extent in these soils especially in the “raw-humus soils”. The authors suggested that most of the nitrogen present in the soils of coniferous forests has been deposited in the precipitation.

Russel (1932) noted that clay is chemically reactive in presence of water and the soil without clay would resemble a pile of sand. The author also noted that fine sands and silts are intermediate in some of the properties described for coarse sand and clay. Wilde (1934) reported that soil texture not only exerts an important effect upon water relations but also upon aeration as well as the supply of nutrients. It profoundly affects the rapidity of the processes of decay of organic matter and its retention against leaching. According to him, the nitrogen content of the soils is closely related to its texture. Weaver *et al.* (1934) proposed the C/N ratio of the soil to be considered as an index of the relative amount of undecomposed plant residues, fungi and bacteria present.
Diebold (1935) found that the structure of a soil largely determines its porosity and this in turn affects the absorption of water and, therefore, runoff and the consequent erosion. The author also found that water content and aeration as well as compactness of soil, all profoundly influence root development.

Shirley (1936) reported that surface-soil temperatures above 130°F often prove fatal to conifer seedlings. Soil temperature is thought to be one of the important factors controlling the distribution of forest types (Pearson, 1936).

Troug (1947) reported that phosphorus is available over a narrower range of pH than nitrogen, availability declines above pH 7.5 and below pH 6.5 with maximum availability at about 6.5. According to him, in acid soils (pH less than 5.0), phosphorus in the $\text{H}_2\text{PO}_4^-$ form reacts with iron and aluminium to form insoluble compounds and above pH 6.0 it reacts with calcium to form insoluble calcium phosphate, although there is generally not a great amount of free calcium in the soil until the pH rises to 7.0 or above. As a result of these processes, phosphorus is found only at very low levels in the soil solution and many forest plants depend upon mycorrhizal fungi to obtain the phosphorus they need. The author also found that phosphorus can exist in a number of organic forms including chelates of iron and aluminium phosphate and these may increase its availability to plants.

Nye and Bertheux (1957) obtained a high positive correlation between the organic carbon and organic phosphorus of Ghana forest soils. According to them, an increase in organic carbon content would lead to an increase in organic phosphorus, if the organic phosphorus is assumed to be the sum of the chelated phosphorus and the phosphorus forming the integral part of the organic materials.
Johannessen (1958) reported that the soil solution phosphate is higher in soils under a tree cover than a grass cover when the other soil forming factors have been kept relatively constant. Coaldrake and Haydock (1958) stated that soil phosphate did not determine vegetational pattern.

Seth (1960) reported that both macronutrients as well as micronutrients are influenced by soil reaction (pH) and a normal pH range promotes the most ready availability of plant nutrients. According to him it also aids in ion accumulation.

Jenny and Raychaudhuri (1960) studied organic carbon status in Indian soils and reported the effects of climate on carbon reserves in virgin and cultivated soils. According to authors the soil organic pool remains in a steady-state equilibrium under native vegetation cover, but is sensitive to anthropogenic activities.

Van der Drift (1963) described moisture as one of the most important determinants in the decomposition process. According to him there has been a lot of inconsistency in the percentage of moisture present in the top and sub-surface levels of soils of all the forest classes, which may be due to the dependency of moisture regime of a strand on different biotic and abiotic factors.

Steinbrenner and Rediske (1964) found that roots of Douglas-fir seedlings were concentrated near the surface of well-watered soils but penetrated to considerable depth when surface soil moisture was below optimum. Mathur and Bhatnagar (1964) reported that higher level of potassium in the soils was because of better dissolution from rocks and minerals in presence of organic acids.

Lyford and Wilson (1966) suggested that red maple roots grow rather well over a broken range of soil texture and fertility conditions if the soil is
maintained at near-optimum moisture levels. They found that optimum temperature for red maple root growth was reported to be about 12°C to 15 °C. The authors reported that root growth in cool-climate species begins and ceases at lower temperatures than in warm-climate or tropical species. The authors also found that day-to-day variations in the growth rate of red maple root tips were more closely related to soil temperature than to air temperature fluctuations.

Lyr and Hoffman (1967) reported that soil temperature affects root growth and distribution both directly and indirectly. According to them, the minimum, optimum and maximum soil temperatures for best tree growth vary with species and environmental conditions. They found that the minimum soil temperatures for root growth range from slightly above 0 °C to 7 °C; the optimum from 10 °C to 25 °C, and maximum from 25 °C to 35 °C.

Sharma (1967), while studying carbon/nitrogen status of soils with respect to certain communities, observed narrow ratio (0.57–4.54) in Aerva-Laptadenia and Cenchrus-Leptadenia communities and wider ratio (4.16 to 64.28) in Prosopis-Dactyloctenium community. According to him the ratio varied from 0.37–11.90 in most of the cases.

Buckman and Brady (1967) suggested that the chemical and physical properties of soils are controlled largely by clay and humus as it acts as the centre of activity around which chemical reactions and nutrient exchange occurs.

Yadav (1967) in a study undertaken in the tropical evergreen forests of Andaman Islands showed that the soils possess fairly good amount of clay fraction and show higher water holding power and cation exchange capacity, but the organic matter content is somewhat low especially at the hill tops as a result of rapid rate of its decomposition obtained under the local conditions.
Yadav (1968), while studying the physico-chemical characteristics of some typical soils of Indian forests, showed that soils under drier areas have higher pH values and are poor in organic matter and nitrogen, but possess greater quantities of bases like calcium than the soils of more humid areas. Yadav and Pathak (1969) showed that the variations in the physical and morphological characteristics exhibited are of great significance in influencing the growth and regeneration of important species. According to them, the coarse-textured soil with poor moisture regime and higher reaction carries mixed evergreen forest without *Dipterocarpus macrocarpus* and *Shorea assamica*, while as the finer textured acidic soils having satisfactory drainage and good moisture retention power support these evergreen species.

Brayshaw (1970) found that Douglas-fir was restricted to coarser soils than Ponderosa pine in the hot and dry southern interior of British Columbia because the coarser textured soil had higher soil moisture availability than the finer-textured soil.

Zimmerman and Brown (1971) found that roots of warm-climate and fast-growing species such as radiate pine and many *Eucalyptus*, apparently never completely stop growing during winter months, although their rate of growth may be slowed by low soil temperature. According to the authors, the roots may not experience true dormancy such as that of buds, but a type of quiescence may be induced by environmental factors.

Hoyle (1971) reported that deficiencies of calcium and nitrogen prevented yellow birch primary root development in the lower substratum of New England spodosols. Boyle and Ek (1973) reported that the products of mineral weathering are particularly important to plant growth and the cycling of nutrients within terrestrial ecosystems. According to them, the weathering of dolomitic parent materials beneath timber and bristlecone pines yield
relatively large amount of calcium compared to weathering of adamellite. Wollum and Davey (1975) reported good availability of nitrogen over a wide pH range, but decreasing below pH 6.0 and above pH 8.0, an important reason being the adverse effect of pH extremes on soil microbes.

Running et al. (1975) noted that species vary greatly in their response to changes in soil water. According to them, the depletion of approximately 80% of available soil water corresponds to an abrupt change in water potential in conifers of the western U.S. This could decrease stomatal conductance and, therefore, affect photosynthesis (Jarvis et al., 1976).

Zobel et al. (1976) reported that the distribution of plant communities is closely linked to the availability of water. According to them, there is a close link at the global scale between the major biomes, precipitation and temperature, which influences evapo-transpiration (Et). They also opined that the water availability often explains much of the variation in community distribution within regions. Sanchez (1976) reported that soil organic matter contains the principal cation exchange sites in acid tropical soils and is generally recognized as a major pool of biologically circulating phosphorus in the soil and the main pool of soil nitrogen. Nath and Deori (1976) reported an increase in total nitrogen content due to higher soil organic matter in high altitude soils of Arunachal Pradesh. Edwards and Grubb (1977) suggested that tropical montane forests in general are likely to suffer a shortage of nitrogen and phosphorus relative to tropical lowland forests because of a tendency to immobilization of these elements in the more characteristically organic soils.

Verma (1977) reported that black spruce, hemlock, birch etc. can grow between pH range of 3.7 to 4.5; coniferous trees and northern deciduous tree between 4.5 to 5.5, deciduous forests between 5.5 to 6.9, and grasslands between 7.0 and 8.0. Likens et al. (1977) reported that weathering of calcium
and magnesium bearing minerals represents an important input of these nutrients in many terrestrial ecosystem, satisfying 35 percent of calcium and magnesium required for the annual growth of some temperate forests. The author also found that the weathering mineral phosphates of calcium, iron and aluminium provide an important source of phosphorus for plant growth.

Brix (1979) reported that soil moisture indirectly affects productivity by affecting the nitrogen dynamics of a site, including losses by volatilization, leaching and surface run-off as well as increasing available nitrogen through mineralization. According to him, the forest nutritional status also affects the leaf area and needle retention as well as the rate of photosynthesis.

Borman and Likens (1979) reported that transpiration is the most important nutrient-conservation mechanism of the ecosystem in that it reduces nutrient losses with percolating soil water. Gates (1980) reported that the transpired water cools foliage and reduces the amount of water that would percolate through the soil in the absence of vegetation.

Chijicke (1980) found that surface soil temperature beneath forest canopies approximated to that of the air, but with the removal of the canopy surface soil temperature of 25 °C beneath a canopy increased to 50 °C or more especially during dry periods.

Gupta (1980) reported that the pH range of Kothikerh and Mecleodganj soil profiles from northwest Himalaya of Kangra reflecting good growth of Cedrus deodara was 4.8 to 5.3 and 6.2 to 8.2 respectively. The author also found that in case of Pinus roxburghii, it was from 7.1 to 8.3 for Bankhandi and 5.5 to 6.0 for Norpur soil profiles. Gupta (1980) reported that Cedrus deodara and Pinus roxburghii have been found to grow well even on clay and sand-clay-loam soil of northwest Himalaya.
Keeney (1980) reported that mineralization of organic soil nitrogen to be fundamentally linked with forest productivity, and attention is shifting from static measures of nitrogen availability to more dynamic measures of nitrogen release. Cole (1981) reported that the internal cycling of nitrogen from older to younger tissues increases with stand maturity, resulting in less nitrogen uptake from the soil to produce the same amount of foliage biomass.

Sanchez *et al.* (1982) reported that the long-term fertility of soils depends most strongly on the accumulation and turnover of soil organic carbon and nitrogen. The authors found that tropical soils tend to cycle carbon and nitrogen faster than temperate soils, but the faster turnover does not result in lower total pool sizes. According to them, the storage of soil carbon and nitrogen among 1500 soils around the world is related somewhat to soil moisture regime (wetter soils have more carbon and nitrogen), but not to latitude. McClaughetty *et al.* (1982) noted that the death and decay of live roots contribute a significant amount of organic matter directly to the soil in each growing season. Vitousek (1982) noted that for both coniferous and deciduous species, the efficiency of nitrogen conversion in the production of biomass was greater for sites of lower than higher fertility status, which he attributed to increased re-absorption of nutrients from the foliage before abscission, and to a greater capacity of foliage on poor sites to fix C per unit N compared to foliage from nutrient rich sites. Pagel *et al.* (1982) reported that the overall nitrogen balance in tropical soils was greatly dependent on the type and intensity of land use. The authors reported that nitrogen mineralization in tropical soils was enhanced by high amount of easily decomposable material.

Nambiar *et al.* (1984) reported that the amount of water held in the soil depends on soil physical properties, the amount of organic matter, soil depth and the existence of layers that may impede drainage. The author also
reported that when water is abundant, its availability to trees could be maximized through strategies including management of soil and vegetation and thinning. Pastor et al. (1984) reported that nitrogen availability limits the growth of many boreal and temperate forests. Gupta et al. (1984) while working on the biochemical characterization of some soils of Kangra district (H.P.) reported that 15 soils out of 42 contained organic nitrogen less than 80 percent of the total nitrogen. According to them, the higher organic carbon/total nitrogen ratio (8.4–12.4) supported the concept that the inorganic nitrogen contributed a considerable part of the total nitrogen. The authors found that this could be due to the higher content of native mixed NH$_4$ in these soils.

Kimmins (1987) found that particles larger than 2mm occupy a considerable portion or even the majority of the soil volume in many forest soils, and it is not uncommon to find trees growing directly on fractured bedrock or on organic layers lacking a substantial mineral particle component. According to him, the use of texture to indicate soil fertility is not always as useful in forestry as it is in agriculture.

Richter et al. (1988) found that very dilute soil solutions (conductivity of soil solution of 2mS/m) declined by about 0.3 units in pH when measured in a stronger salt solution (0.01M CaCl$_2$), whereas soils with higher salt concentration (conductivity > 5mS/m) showed no further effect of added salt on pH. Tilki and Fisher (1988) reported that the root tolerance to acidity differs widely among plant species, but it appears that many tree species are relatively tolerant to acid conditions.

Gupta et al. (1989) reported higher and significantly different organic matter, total and available nitrogen content in upper (0-30cm) layer than lower layer (30-60cm) of soils of coniferous forests at Kandyali in Himachal
Pradesh. Higher organic matter content in the soils was found where better tree density and canopy coverage were maintained (Gupta and Singh, 1990). Dyck and Skinner (1990) described the role of soil organic matter in maintaining soil productivity. The authors also opined that the quality and quantity of soil organic matter determine the performance of the soil engine, just as the fuel in our body. Turner and Gessel (1990) also made similar conclusions. Miller and Donahue (1990) found that in unfertilized soils, organic matter is the major source of 90-95 percent of nitrogen. They also found that organic matter can be the major source of available phosphorus and available sulphur. Further, they opined that C/N ratio from 8 to 10 was indicative for good quality stabilized humus. The authors reported that high C/N ratios were indicative of slow decomposition and low values suggested a high degree of decomposition or low organic nitrogen content from vegetation with a low N content. According to them, a C/N ratio of soil organic matter above 12 to 14 points to a shortage of nitrogen in the soil resulted in a stagnation of the organic matter decomposition process when humus was present in appreciable amounts. The authors also noted that organic matter had a strong positive influence on soil structure and the resistance of soils to erosion.

Mandal et al. (1990), while studying the forest sites of the eastern Himalaya, reported that the distribution of phosphorus followed no definite trend, though soils at higher altitudes showed higher available phosphorus content. The authors also found that the content of easily soluble or available phosphorus (P$_2$O$_5$) varies in virgin forest soils from 10ppm-200ppm. Cole et al. (1990) found that the response of a forest to nutrient and moisture stresses is reflected in nutritional, physiological and structural changes that include efficiency of nutrient use, translocation and cycling of nutrients, transpiration, retention of foliage, below-ground and above-ground allocation of carbon, as
well as the structural development of the forest stand and its growth characteristics.

Binkley and Valentine (1991) reported that the acid strength appears to be a key feature in determining the effects of some tree species on soil pH. The authors in a replicated set of plantations of Norway spruce, white prime and green ash, the pH was found to be 3.8, 4.2 and 4.6 respectively. According to authors the primary cause of the lower pH under spruce was the greater acid strength of the soil. They further believed that the lower base saturation (22 % under spruce, 42 % under pine and 52 % under ash) played a secondary role.

Landon (1991) reported that organic carbon and organic nitrogen content are widely used as a measure of organic matter quantity and quality in a soil, and as a wide measure of the fertility status. According to him, the interpretation of the content of organic carbon and organic nitrogen is complex, because many other factors influence soil nutrient status and soil physical characteristics. Schnitzer (1991) proposed the soil organic matter to be a mixture of plant and animal residues in various stages of decomposition, the bodies of living and dead micro-organisms, and substances synthesized from breakdown products of the above carbon-containing substances in the soil, except carbonates. Johnson (1992) described soil organic matter as a source or sink for atmospheric carbon.

Stevenson (1994) found that most of soil organic matter is insoluble and is bound as macromolecular complexes with calcium, iron or aluminum or in organo-mineral complexes. According to the author, the organic portion of these complexes is made up of diverse complex compounds called humus. The author also concluded that humic acid is that fraction of complex humic substances which is soluble in water under acidic conditions (pH < 2.0) but
insoluble under less acid conditions, while as fulvic acid is that fraction of humic substances which is insoluble in water of nearly any acidity. Tiessen et al. (1994) found that the total phosphorus concentration in the soil below 36cm is 200µg g⁻¹, nearly twice as high as the 110µg g⁻¹ found in the first 36cm. According to them, it is common for soils to show a depletion zone of phosphorus at the depth explored by roots.

Motavalli et al. (1995) found that allophonic (amorphous clay) soils had more total nitrogen than soils with smectitic clays, which exceeded the nitrogen in kaolintic or oxic (amorphous sequioxide) clay. According to the authors, the mineralizability of nitrogen from each of these different soil types was essentially constant; soils with more nitrogen mineralized proportionally more nitrogen. According to McColl and Gressel (1995) the soil organic matter occurs in solid, colloidal and soluble states. The authors also stated that the solid detritus makes up only a small part of soil organic matter and the largest and most important fractions are the colloidal and soluble fractions. Hebel (1995) reported very high amount exchangeable potassium coming from the decomposition of crop residues. According to him, the high available potassium under pasture could have been contributed by animal waste.

Waisal et al. (1996) found that texture and structure may influence rooting through physical impedance and by their influence on soil aeration. The authors found that loblolly pine apparently had a greater tolerance of poor aeration than the short leaf pine, and red and ponderosa pines were among the most sensitive of all conifers to low-oxygen conditions in the root zone. Kay (1997) observed the soil organic matter to be important for the formation of soil aggregates. According to the author, the organic compounds along with fine clays and some amorphous and crystalline inorganic compounds, form the cement between mineral grains in soil aggregates.
Folster and Khanna (1997) reported that soil variability is typically high at all scales, from region to region, within regions, and even within single stands or compartments. They found that at the scale of 5000 ha of a forestry operation in East Kalimantan, Indonesia, exchangeable soil calcium to a depth of 0.5m ranges from 60 to 3240 kg/ha of calcium across individual stands or compartments.

Nykvist (1998) reported the exchangeable calcium to be only a minor part of the total storage of calcium in the soil. According to him, most calcium is bound in organic compounds, calcium-containing silicates and carbonates. The author also reported that low amount of exchangeable calcium in soil from other parts of the world indicate that the calcium content of the soil can be an initial factor influencing forest production in other rain forest areas as well. The main reason for the low content of local calcium in the soil is that the bedrock consists of interbedded sandstones, siltstones and shales with low calcium contents.

Lal et al. (1998 a, b) observed that source-sink relationships of soil carbon are dynamic. The authors also found that the temperate forests are in general a net sink for carbon, as forests reclaim land from agricultural uses. Barnes et al. (1998) noted that soil organic matter has a profound effect on a wide variety of physical, chemical and biological properties. According to them, soil organic matter contributes to the aggregate formation, which in turn influences the amount of soil water available to plants. The authors reported that soil organic matter functions as a storehouse of plant nutrients, supplying most of the nitrogen used that the soil organic matter is the substrate used for the growth and maintenance of microbial populations in soil and it is through the metabolic activities of these organisms that nitrogen and other plant nutrient so released can be re-assimilated by plants. Soil organic matter
represents an important weigh station in the cycling and storage of nutrients within forest ecosystems (Barnes et al. 1998).

Kristensen et al. (2004) reported C/N ratio to be significantly associated with soil solution nitrate concentration under coniferous woodland, but that this relationship did not hold for deciduous woodlands. Curtis et al. (2004) found a weak relationship between the C/N ratios in upper soil horizons in nitrogen leaching for four UK woodland sites along a deposition gradient.

Chhabra and Dadhwal (2005) reported that the soil organic carbon, being the largest terrestrial carbon pool plays a very significant role in global terrestrial ecosystem carbon balance. Rowe et al. (2006) in a survey of deciduous and coniferous woodland, acid grassland and heath land sites for which both C/N ratio and nitrate flux measurements were available, found that deciduous woodland and acid grassland typically had lower C/N ratios and began leaching nitrate at a lower C/N ratio than coniferous woodland and heath land. The authors are of the opinion that the difference may be related to the reactivity of soil carbon; soils with a large proportion of recalcitrant carbon are likely to begin leaching at a higher C/N value than soils with more labile carbon.

3.2. VEGETATION

3.2.1. Species Composition

Great efforts have been made from time to time to work out the floristics of the region. Botanical explorations in Jammu and Kashmir date back to the last century, beginning with William Moorcroft’s collections from 1821 from Ladakh (Moorcroft and Treback, 1841). Lawrence (1895) enlisted some economically grown trees of Kashmir valley.
The prominent contributor to the floristic studies of the region is Prof. E. Blatter. He published a 2-Volume work, exclusively dealing with phanerogams of the region (Blatter, 1928-29). Notable features of the work include brief description of each plant species recorded and coloured illustrations for most of them.

Muthoo and Wali (1963), while making the quantitative studies of the Cedrus deodara communities, and occurrence, distribution and composition of Cedrus deodara forests in Kashmir reported that the zone 1525-2135m (a. s. l.) appeared to be a potential deodar belt. Vishnu (1963) reported for the first time the occurrence of indigenous oaks (Quercus semicampifolia and Quercus dilatata) in the Kashmir Valley. Wali and Tikoo (1964) dealt with the flora of the Lolab Valley in Kashmir. The authors presented a systematic census of 246 species, out of which 239 species are angiosperms and the other 7 gymnosperms.

Dhar (1966) provided a concise account of the distribution of conifers in India. Javeid (1966) published a key to help in the identification of families of flowering plants of Kashmir. Kaul and Zutshi (1966) studied the vegetation of Kashmir University Campus, Srinagar recording 92 species of plants distributed along a number of physiographic habitats, viz. level grounds, slopes, mounds and low lying areas. Stewart (1967) brought out a checklist of the Cyperaceae (sedges) of Kashmir. The list includes 162 taxa. Carex is the largest and important genus with 75 taxa.

Javeid (1971, 72) gave an outline and presented a systematic account of both exotic and indigenous species of Salicaceae including two genera, Salix and Populus of Kashmir valley like Salix acmophylla, Salix alba, Salix babylonica, Salix caprea, Salix daphnoides, Salix denticulata, Salix elegans, Salix fragilis, Salix hastata, Salix lindleyana, Salix oxycarpa, Salix purpurea,
Salix triandra, Salix viminalis, Salix wallichiana, Populus alba, Populus ciliata and Populus nigra. Naqshi (1971) presented his work on the angiosperm flora of the Kashmir University Campus. Included in this work are 212 species, distributed over 150 genera in 41 families. The dicots and monocots are represented by 167 species in 117 genera belonging to 34 families respectively. The relative proportion of dicots to monocots is 35:1 for genera and 3.7:1 for species. Asteraceae is the largest family in terms of number of species. Stewart (1972) reported 90 species and 4 varieties of pteridophytes, belonging to 29 genera from the Jammu and Kashmir State. According to the author, Pteridaceae has the largest number of species with a total of 61, followed by Aspleniaceae with 11 species. Lycopodiaceae, Osmundaceae, Schizaceae, Blechnaceae and Salviniaceae are represented by a single species each. Singh and Misri (1974) reported three beautiful exotics from the Kashmir valley. These include Cercis siliquastrum, Koeltreuteria paniculata and Tamarix parviflora.

Rau (1975) brought out the results of botanical trips to the Kashmir Himalaya wherein he recorded 790 species of flowering plants in 260 genera, grouped under 59 families. In dicots the largest family was Asteraceae (99 species) while in monocots it was Gramineae (110 species). Bhat (1982) published the results of his floristic studies on the vegetation of Hari Parbat Hill in Srinagar recording 56 species, consisting of 49 dicots and 7 monocots.

Dhar and Kachroo (1983) recorded 1610 species in 381 genera belonging to 64 families in the alpine flora of Kashmir Himalaya. The dicots were represented by 1405 species in 356 genera and 58 families, whereas monocots were represented by 205 species in 25 genera and 6 families respectively. Dar et al. (1983a) reported 300 species of angiosperms occurring as weeds in Srinagar district of the Kashmir valley. Except those growing
among the paddy crop, a majority of these weeds were common to different fields and orchards. Dar et al. (1983b) presented the results of his studies on the floristic composition of Ganderbal, Kashmir. He recorded 414 phanerogamic species representing 363 genera and 76 families. The dicots, monocots and gymnosperms were represented by 315 species in 199 genera and 60 families, 96 species in 61 genera and 15 families and 3 species in 3 genera and 1 family respectively. In dicots, Veronica (9 species) was the largest genus, followed by Polygonum (7 species) while as in monocots, Potamogeton (8 species) was the largest genus, followed by Cyperus (6 species).

Bhat (1984) presented the results of work on the flora of Gulmarg, Kashmir. The author recorded a total of 475 species, out of which 466 species belonged to angiosperms, 4 to gymnosperms, and the other 5 species to vascular cryptogams. The angiosperms included 398 species of dicots and 68 species of monocots.

Kaul (1986) reported 401 species belonging to 251 genera in 56 families of angiosperms growing as weeds in the Kashmir Valley. According to the author, 223 species are said to be native and 178 introduced. Navchoo and Kachroo (1986) studied phenological aspects of the vegetation of Pulwama, Kashmir. The authors gave broad phenological data on 81 angiospermic species, which reveal the vegetation to be of seasonal nature.

Sharma and Jamwal (1988) mentioned several trees and shrubs like Aesculus indica, Ailanthus altissima, Clematis grata, Crataegus songarica, Juglans regia, Pinus wallichiana, Platanus orientalis, Robinia pseudoaccacia, Salix dendiculata, Skimmia laureola, Sorbaria tomentosa, Sorbus cashmiriana, Spiraea canascens, Syringa emodi etc. in the Upper Lidder Valley of Kashmir.
Naqshi et al. (1989) published a checklist of the flowering plants from the Nubra valley in Ladakh. The authors reported 352 plant species grouped under 50 families. Compositae with 65 species was the largest family, followed by Gramineae (35 species) and Brassicaceae (31 species).

The floristic work on the Indian gymnosperms has been recently consolidated by Sahni (1990). According to the author, only 12 species of gymnosperms representing 8 genera grow wild in Kashmir.

Dar and Kachroo (1992) dealt with floristic diversity in the Sindh valley, Kashmir, based on their extensive floristic studies of the area. The authors reported 865 species of phanerogams in 419 genera grouped under 115 families.

Naqshi and Ara (1993) brought out an account of the Guraiz valley, Kashmir. A total of 447 species of vascular plants in 234 genera belonging to 70 families have been reported. Compositae with 54 species was the largest family, followed by Rosaceae (28 species) and Apiaceae (27 species).

Singh and Kachroo (1994) came out with a concise account of the flora of Pir Panjal Range (Kashmir). The plant species in this work have been mainly collected from the forest area. A brief analysis of different plant communities and their characters, vegetational pattern, floristic and phenology, along with their life forms and biological spectrum are the important features of this work. Out of the 526 species of vascular plants recorded, angiosperms were represented by 507 species in 278 genera belonging to 78 families, gymnosperms by 7 species in 6 genera belonging to 3 families and pteridophytes by 12 species in 9 genera belonging to 7 families. Ara et al. (1995) provided a list of the indigenous and exotic trees and shrubs of Kashmir, enumerating 295 species distributed over 120 genera among 60 families.
Dar and Christensen (1999) came out with the habitat diversity and zonality of vegetation in the Sindh Valley, Kashmir. The authors documented an interesting vegetation profile, revealing a sharp contrast between the vegetation of temperate and alpine zones. The authors opined that the pattern of the vegetation is due to the varied environmental conditions and habitat types present in various zones.

Dar and Naqshi (2001) published a checklist of the threatened flowering plants of the Kashmir Himalaya. The authors have assigned pre-1994 IUCN threat categories to the taxa listed. A total of 355 taxa are included, out of which 40 taxa are endangered, 50 vulnerable, 55 rare and 110 indeterminate. Nasreen and Naqshi (2001) published a checklist of some principal wild food plants of the Kashmir Himalaya, reporting therein 156 species used for such purposes.

Zaffar (2002) presented results of the floristic studies on the phanerogams of Bijhama (Uri) Kashmir, in which a total of 340 plant species belonging to 244 genera distributed over 72 families have been recorded. Khuroo et al. (2003) in their studies on floristic diversity of phanerogams in Langate, Jammu and Kashmir, reported 310 species of phanerogams. According to them dicotyledons were represented by 264 species while as monocotyledons and gymnosperms share 42 and 5 species respectively. Lone (2004), while assessing the anthropogenic impact on plant diversity of forests of Kupwara in Kashmir, reported 102 species of vascular plants.

3.2.2. Phytosociology

Raunkiaer (1918) summarized frequency data from different studies in diverse areas of Europe and found that if the total number of frequency distributions was divided into five percentage classes, the distribution of
frequency was: Class A- 53 percent of the species; B- 14 percent; C- 8 percent; D-9 percent and E- 16 percent.

Kenoyer (1927) while working on American plant communities found that the peak in Class A to be higher than for European communities as determined by Raunkiaer, while the second and lower peak in Class E was even lower than that of Raunkiaer. Kenoyer's classes, based on over fourteen hundred percentages, were as follows: Class A- 69 percent of the species; Class B-12 percent; Class C- 6 percent; Class D- 4 percent and Class E- 9 percent.

Petrie (1929) used a ten class system which mixes up all the quantitative concepts: r, rare; o, occasional; lf, locally frequent; f, frequent; a, abundant; la, locally abundant; cd, co-dominant; ld, locally dominant; sd, sub-dominant; d, dominant.

Ashby (1935) discussed the application of quantitative methods to the analysis of plant communities. According to him the J-shaped curve of frequency is due to the fact that the frequency classes included unequal density classes. The author concluded that the J-shaped distribution of species in percentage frequency classes did not indicate any exact numerical relation among the species composing a community nor was it indication of homogeneity.

Penfound (1942) found that the frequency percentages, the frequency relation among species and the number of species in the frequency class of Raunkiaer, all vary with quadrat size, number of species, and total plant cover.

Preston (1948) and Williams (1950) offered detailed mathematical analysis of the distribution of frequencies. These authors agreed that the crux of the distribution of frequencies was the number of individuals per species. Goodall (1952) noted that the shape of frequency distribution curves depends
on size and number of quadrats, the mean density and variation in density of all species present, and on the distribution of individuals of each species.

Goodall (1954) was of the opinion that organisms are distributed in nature in aggregation or communities which are homogenous within them and heterogenous between two or more such aggregations. Poore (1955) stated that the homogeneity of the stand is unquestionably the basis of plant sociology. High species diversity has been shown as an indication of maturity in the ecosystem (Margalef, 1963).

Lull (1964) suggested that forest with multilayered canopy and well developed forest floor is more protective of soil and water in comparison to a forest having lower layers. According to him the stand is less protective if all the trees are confined only to the tallest stratum with their canopies concentrated at the top. According to King (1964) the richness and diversity have commonly been described as characteristic property of a putative homogenous community and indicative of its organization. Simpson (1964) reported that the lower value of diversity and consequently greater concentration of dominance could be attributed to the lower rate of evolution and diversification of communities. According to Connel and Orias (1964) the lower value of diversity could be due to severity in environment. According to Hairston (1964) the concept of diversity is particularly important because it is commonly considered an attribute of a natural or organized community or is related to important ecological processes.

Goff and Zadler (1968) found that overall structural characteristics of a particular stand primarily depend upon the size and age of the dominant over-storey trees, which are in turn affected by soil and moisture conditions and biotic influences.
Loucks (1970) found that the diversity of species might not necessarily approach a maximum in the mature stable stages of succession; in some instance diversity may actually decline as the successional stage reaches maturity.

Odum (1971) described that under natural conditions contiguous distribution is the most common type of distribution due to small but significant variation in the environmental conditions, while random distribution is found only in very uniform environments. Connell (1971) suggested that the uniform or regular dispersion patterns of species in tropical forests largely enable maintenance of high level of diversity. Risser and Rice (1971) reported tree species diversity between 1.69 and 3.40 for temperate forests. The authors also reported concentration of dominance in the range of 0.10–0.99 for certain temperate forests. Whittakar (1972) stated that the dominance of one stratum might affect the diversity of another stratum.

Bazzaz (1975), while studying species diversity in a successional stand, found that decline in species diversity was associated with shade tolerant species and exclusion of shade-intolerant species. Knight (1975) reported tree species diversity of 5.06 for young stands and 5.40 for old stands in the tropical forests. The author also reported an average value of 0.06 for concentration of dominance in these forests. Singh (1976) suggested that the study of floristic composition and phytosociological attributes are useful for comparing one community to the other from season to season and year to year.

Singh and Misra (1978) reported tree density range of 936-1174 trees/ha and basal area of 15.12 to 17.99 m²/ha for mixed forests in north-eastern U.P. plains. Saxena (1979) reported the density of 550 to 1170 plants/ha for tropical forests and 350 to 2080 plants/ha for temperate zones.
Singh (1981) reported tree density of 1130 trees/ha and TBC as high as 80 m²/ha in hilly subtropical humid forests of Meghalaya. Saxena and Singh (1982) reported diversity index values from 0.0 to 0.436 for trees + saplings and 0.02 to 0.643 for shrubs + seedlings in the pine (Pinus roxburghii) forests of Kumaun Himalaya. The authors also reported that the species composition in tree layer differed on different aspects although the dominant species remain the same because of the difference in microclimate.

Ralhan et al. (1982) reported the value of TBC and density varying from 2686 to 6045 cm² 100m⁻² and 3.89 to 16.33 trees 100m⁻² for temperate forests of Kumaon Himalaya. Tewari (1983) reported the concentration of dominance values for certain temperate vegetation types ranging from 0.106 to 0.933. Singhal et al. (1986) reported that total basal cover varied between 1455 and 5672 cm² 100m⁻² and total density from 0.7 to 3.7 trees 100m⁻² for woody species of some forests of Chakrata Himalaya. The authors also found that the species diversity was greatest in forests followed by Quercus floribunda forests. Rawat and Gupta (1989) reported tree density of 890 trees/ha and TBC 54.59 m²/ha in mixed forests of Haryana hills.

Tripathi et al. (1991) reported that the total basal cover and density for tree layer ranged from 10.2 to 49.7 m² ha⁻¹ and 0.25 to 2.17 m² ha⁻¹ respectively in and around Nainital. The authors found that the regeneration status was fairly good on all the forest sites. Adhikari et al. (1991) while working on high altitude forest of Kumaun Himalaya noted that total density and basal cover for tree layer varied from 320 to 1600 ha⁻¹ and 44 to 98 m² ha⁻¹ respectively. The authors identified six forest types on the basis of IVI. According to them, the diversity for trees and shrub layers ranged from 0.81 to 3.55 and 0.05 to 1.33 respectively. The authors also found that most of the
tree species exhibited random distribution whereas shrub species were contiguously distributed.

Naeem et al. (1994) found that the litter, root and microbial biomass were substantially greater in the more diverse broad-leaved forest re-growths than in the pine stands having low diversity though they are even aged. According to the authors, these differences are primarily due to variations in the complementary use of resources in space and time and thus shift in community interactions from strong competition to weak competition or facilitation.

Wilsey and Potvin (2000) reported increased biomass production with increasing levels of species diversity. Bhatt et al. (2004) found that the values of density and basal cover for different species ranged from 10 to 490 plants ha\(^{-1}\) and 0.36 to 126.48 m\(^2\) ha\(^{-1}\) on different sites of a moist mixed temperate forest of Notha-Chaurikhal of Garhwal Himalaya. According to the authors, the values of concentration of dominance and diversity ranged from 0.2439 to 0.389 and 1.4470 to 2.2745 respectively. The authors also found that most of the species on different sites were contiguously distributed.

Srivastava et al. (2005) reported that the total density and basal cover values in the tree layer varied from 630 to 1590 stems ha\(^{-1}\) and 20.04 to 82.51 m\(^2\) ha\(^{-1}\) respectively in Garhwal Himalaya. According to them, the maximum number of saplings and seedlings were observed on the highest altitude, whereas the minimum number of saplings and seedlings on the lowest altitude. The study further revealed that the moist temperate forest was characterized by a patchy distribution of species and individuals with mixed species composition and the sites were represented by different dominant and co-dominant species. The authors also found that the values of diversity and
concentration of dominance oscillated between 1.33 to 2.01 and 0.27 to 0.45 respectively.

3.3. IMPACT STUDIES

Human impact is changing the environment of forest ecosystems on a global scale. The increasing population trend over the last few decades and consequent dependence on plant products has led to the vast exploitation of natural flora and fauna. The ill-effects of these pressures give rise to many irreversible ecological crises and shattered economic sustainability.

Clearing of forests causes nutrient losses which could affect the long-term productivity of a site (Hesselman, 1917a, b; Romel, 1935). Heizer (1955) found that deforestation and the diversion of manure to use as fuel are sabotaging the land’s ability to produce food and has led to an ecologically disastrous spread of treeless wastelands.

Weaver (1959) and Cooper (1960) reported that much of the scrub and grassland in the drier and warmer forest regions of the world owe their origin to the long-continued overgrazing by goats, sheep and cattle. Many of these sites could support high forest if this disturbance was controlled. Furthermore, grazing by livestock may also disrupt disturbance regimes, especially fire. Cooper (1960) concluded that grazing altered both the composition and quantity of ground cover vegetation. Removal of herbaceous composition and exposure of mineral soil by livestock helped to prepare the ground for dense thickets of pine reproduction and simultaneously reduced the likelihood of fire.

Moehring and Rawl (1970) reported that human activity is responsible for considerable deterioration of forests. According to the authors, trucks, tractors and other heavy equipments, used in logging, result in substantial soil compaction. Hatchell et al. (1970) concluded that wet weather logging could
cause soil compaction that may markedly reduce growth rates of established seedlings.

Brams (1971) reported that exhaustive management practices like clear felling or intensive logging or even shifting cultivation in North-west Himalaya generally result in declining soil organic matter levels. Grier (1975) reported that large-scale nutrient losses could occur during wild fires as a result of oxidation. According to him, as wood burns, organic nitrogen, calcium, magnesium, potassium and sodium oxidize into the atmosphere and are carried away in the ash by strong winds. Sanchez (1976) argued that shifting cultivation seldom results in substantial organic matter depletion. Patterson (1976) found that human foot itself is an effective compacting agent. According to him, the heavily trampled soils were found to have a bulk density and particle density similar to that of asphalt and concrete.

Dymess (1976) noted that the burning of litter and organic matter in the soil might be significant in causing reduced infiltration, increased surface runoff, and erosion in many areas of the Western United States where water-repellent soils have been reported. Stark (1977) reported that burning makes the soil naked which results in increased surface run-off, greater erosion and loss of nutrients. Borman and Likens (1979) reported that after clearing a forest, net loss of \( \text{NO}_3^- \), \( \text{K}^+ \), \( \text{Ca}^{2+} \), \( \text{Al}^{3+} \), \( \text{Mg}^{2+} \) and \( \text{Na}^+ \) were respectively 67, 21, 10, 9, 7 and 3 times greater than those in undisturbed forest system.

Singh and Saxena (1980) recorded that the incidence of grazing in Central Himalaya was 2.4 to 4.5 times higher than the carrying capacity of the forest. Also the annual depletion of forests amounted to 3.76 million m\(^3\)yr\(^{-1}\), i.e., at the rate of 5.8 % year\(^{-1}\). Maximum land degradation occurs in the civil forest areas because of uncontrolled and unscientific anthropogenic activities.
Misra and Dash (1980) concluded that it is easy to integrate the needs and resources theoretically but in practice it demands specific skills, finance and potential will on one hand and management skill and behavioral adjustments on the other hand thereby demanding a process of new learning and unlearning leading to real development.

Banerjee and Chand (1981) reported that burning soil becomes unable to retain any moisture beyond 8.1 bar tension. The loss of total nitrogen through volatization is widely recognized and is related to the intensity of fire (Rundel, 1981). Whitcomb et al. (1981) reported that forest fragmentation by human activities results in several major features that affect the diversity and abundance of animal species. After clear felling and burning the forest either for shifting agriculture or any other purpose, the fragile equilibrium gets destroyed and the nutrients which are not absorbed by a replacing plant cover are leached out and irreversibly lost (Sanchez et al., 1982). Shiva et al. (1982) found that the shifting cultivation leads to severe soil erosion. Tewari (1982) reported that vegetation cover provides an effective and cheap means of soil and water conservation. According to the author, vegetation cover yields relatively less and silt free run-off. The author estimated that loss of rain water from exposed surface can be 25 times more compared to well stocked forest and 8 times more as compared to poorly stocked one. Uhl et al. (1982) found significant decreases in concentrations of organic matter, total nitrogen, pH and exchangeable bases, where topsoil has been removed by bulldozing. Pagal et al. (1982) reported that the soils under land uses, which accumulate lesser organic matter, would have also lower available nitrogen.

Krishnamurthy (1983) reported that in the recent times, the forest fires have assumed greater significance probably due to the realization that the fires have a deleterious effect on forests, forest produce including timber, young
regenerations, soil and vegetation cover, rates of evaporation and transpiration, resulting in the degradation of the forests and ecosystem as a whole. According to him, the forest fires occur every year damaging the forest all over the world. He further believed that regulated and controlled forest fire is useful and used as a tool in forest management like natural regeneration of deciduous and unregulated forest fires are one of the most serious cause of forest damage. They kill every form of regeneration and burn out all organic matter resulting in poor soil and soil productivity.

Blake and Karr (1984) opined that fragmented forest ecosystems change through time as a result of isolation as well as other human and natural disturbances. The authors found that reduction of species may occur in fragments that are too small to support their original flora and fauna. According to Fearnside (1985), deforestation strongly affects carbon cycle through the decrease of growing phytomass and aboveground residues. The author also found that the total belowground carbon content also decreases and humus composition changes in close relation with decreasing soil porosity, structure and fertility.

Stevenson (1986) reported that organic matter levels usually, but not always, decline when soils are first placed under cultivation. Patric and Helvey (1986) reviewed the modern evidence for effects of livestock grazing on soil and water in the Eastern United States and emphasized that livestock grazing in moderation can have negligible effects on forest soil and water. They recognized the problems of heavy grazing, but concluded that there was no evidence that woodland grazing in the East, as typically practiced, had substantial adverse effects on water quality or on flooding in streams draining grazed woodlands. The authors, however, believed that the effects on regeneration may still be substantial.
Sharma (1987) found that the transformation of rural lands into urban areas in connection with the developmental phases causes marked impact on forest. According to him, the forest areas are diminishing owing to the carving out of more and more of agricultural land. He also found that the demand for timber has kept on increasing not only because of the ever-rising population but also because the per capita requirements of wood increased.

Sah and Pande (1987) claimed that ill-conceived, mismanaged and unplanned urbanization together with ever-increasing tourist-influx has given rise to the pressure on the fragile Himalayan ecosystem. This process has now obviously started telling upon the environment. Lal (1987) suggested that assessment and evaluation of land is the first step in rational use of forest resources on a sustained basis. According to him, some land may best be left under forest to maintain an ecological balance, because the combined limitations of climate, relief and soil make it unsuitable for sustainable agriculture, while other areas may be capable of sustained, intensive cropping. According to the author, other lands, in the intermediate situation, also should be kept under managed forest or at least under forest fallow to maintain an ecological balance.

Federer et al. (1989) pointed out that calcium is one of the plant nutrients most likely to reach levels low enough to result in a deficiency in forest soils after logging, especially when branches and leaves are also harvested.

Udhayashankar (1990) reported that the impact of deforestation on the socio-economic condition of village life and environment finds the negative impact on irrigation, fishing, fuel collection, fodder production, green manure, wood based industries and other such aspects leading to widespread poverty. Malmer and Grip (1990) reported that the use of heavy machinery in
mechanical clearing and timber extraction in forests is known to cause disturbance to forest soils. According to the authors, apart from making the soil compact, the machines also remove the looser top soil thereby exposing the more compact sub-soils. Amir et al. (1990), on the basis of random sampling design, found serious losses of nutrients down to depth of 30cm immediately after logging, particularly of calcium, magnesium and nitrogen in the case of fertile soils, and of phosphorus in all three soil associations studied. The authors found that potassium on the other hand increased, which was ascribed to slash and parent material even though the rise and concentration was observed regardless of geological substrate.

Jan (1991) found that the increase in human and livestock populations had resulted in deforestations by way of encroaching the forestland for habitation, cultivation and for grazing purposes. The author estimated that the overall encroachment on forestland in Kashmir is 5-8 percent, on the forest areas adjoining habitations it is more than 25 percent and in certain cases the entire compartments have been grabbed. The author opined that if such type of encroachments are not vacated or put to a halt, at least 50 percent of the forest area is likely to be lost within 20-30 years. Huntly (1991) reported that grazing is one of the selective forces acting on plants. According to him, herbivore grazing has a significant effect on the relative abundance and composition of species in plant communities. Shah (1991) reported that deforestation and depletion of pasture lands aggravate the problem by way of soil erosion, landslides and avalanches in the Himalayan ecosystem. According to him, about 80 percent of geographical area of Jammu & Kashmir state is affected by soil erosion in one way or the other and about 15 percent of the affected area has been completely destroyed.
Saunders et al. (1991) found that human activities throughout the ecosystem produce great changes that affect the composition and diversity of biota. According to the authors, these changes include a reduction in total forest area, conservation of natural forest ecosystem to biotically specified and often even aged monocultures of plantations and fragmentation of remaining forests into progressively smaller patches of isolated adjacent plantations, roads, or agricultural and urban development. Laurence and Yensen (1991) noted that while the reduction in species may result directly from a decrease in forest area, it is more likely due to the increased perimeter: area ratio that results from fragmentation and the modification of abiotic and biotic factors at the forest edges. Theng (1991) believed that the extent and severity of soil degradation upon clearing of forests for agriculture would depend on the cultivation system being imposed and how the soil is being managed.

Shiddieq and Badayos (1992) observed a decrease in organic matter of soils following disturbance. According to them, this can be attributed to increase in organic matter oxidation, losses from erosion and decreased quantity of plant residues returned to the soil. Lugo and Brown (1993) proposed that changes of soil organic matter in response to changes in land use follow different pathways depending upon the type of land use. Malmer (1993) observed that sodium and chlorine leaching after disturbance increased commonly. According to him, these elements originate from organic debris and are very quickly released. Dale et al. (1993) reported that the relatively high organic matter under pasture is due to the fact that pastures are not tilled hence the loss of carbon is less compared to cropland soils. Moreover, the periodic addition of organic material as animal waste could also have contributed to it.
Nykvist et al. (1994) reported that the loss of calcium when harvesting stem wood from rainforest trees larger than 20 cm dbh was about 126 kg ha\(^{-1}\). If stem wood and stem bark from all trees larger than 20 cm dbh would have been harvested, the loss of calcium would have been 400 kg ha\(^{-1}\) which is about 19% of the total calcium in the ecosystem and almost 55% of the storage of the total calcium in the soil. Aghball et al. (1994) presented exclusive evidence that tillage methods and crop sequences greatly affect available nitrogen distribution especially \(\text{NO}_3^-\) N in the soil profile.

Singh et al. (1995) found that clearing of natural forests and the subsequent plantation activities have short term and long-term effects on the soil organic carbon status of the site. Franklin (1995) pointed out that modern commercial clear cutting and timber extraction, followed by planting, generates forests strikingly simplified in structure, composition and different in function from naturally regenerated ecosystems. Park (1995) investigated the impacts of large-scale timber harvesting on the environment of the mature hardwood forest and recorded an increase in species diversity in the harvested sites. However, the similarity index value of species between harvested and non-harvested sites was close to each other. The author found that the bulk density and soil hardness were increased after timber harvesting. The author also found that the level of organic matter, total nitrogen, available \(\text{P}_2\text{O}_5\) and cation exchange capacity (\(\text{Na}^+\), \(\text{K}^+\), \(\text{Ca}^{2+}\) and \(\text{Mg}^{2+}\)) in the harvested site decreased. Furthermore, the author found that the impact of logging on the hill slope erosion in the harvested sites was larger than the non-harvested sites by seven times in the first year and two times in the second year. The above results indicate that the large-scale timber harvesting cause significant changes in the environmental factors.
Allegre and Cassel (1996) reported that slash and burn methods have less impact on soil physical conditions of forest soils compared to other methods of forest clearing, and should be preferred over bulldozer land clearing. Losses of nutrients due to leaching may be high in the first few years after burning (Juo and Manu, 1996). However, this may lead to a gradual decline of soil fertility with each slash and burn cycle. The soil organic content of ex-forest soil is of crucial importance to the productivity of subsequent crops (Palm et al. 1996). Slash-and-burn farming systems exploiting the forest for its soil fertility effects are generally viewed as having a low productivity relative to the amount of damage they do to forest resources (Brady, 1996). Apsey and Reed (1996) pointed out that forest degradation in developing countries depends on many factors such as economy, ownership and culture. The authors point out that demand for forest produce is one of the main determinants of forest degradation.

Seth (1997) pointed that due to indiscriminate and uncontrolled grazing pressure by trans-human communities, the ecology of the forests has been endangered. He opined that the vegetative cover in Shivaliks has been drastically reduced and there being very little or no regeneration of conifer forests, the alpine pastures have become the summer grounds of the flocks and cattle. The alpine pastures have also lost their productive capacity under the pressure of the nomadic grazers. The author also found that cattle and sheep grazing were the more efficient than any other treatments. The cattle caused more damage to the trees than sheep. He found that there is a close relationship between tree height and damage caused by cattle and sheep at the moment of the introduction of these animals in the underneath forest.

Boot (1997) found that tropical rain forests are rich in plant and animal species. He found that the sustainable extraction of non-timber forest products
has been advocated as a strategy to best conserve the biodiversity. However, the development and implementation of such exploitation systems, which aim to reconcile conservation and economic development, are still hampered by the lack of information on the biological sustainability of these resources, the impact of these exploitation systems on the biological diversity and the insufficient knowledge of the role of forest products in the house-hold economy of forest-dependent people and hence their prospects for economic development. It presents a case for domesticating the forest instead of species or in other words changing the forest composition without changing its structure and functioning, and maintaining acceptable levels of biodiversity. Hajabbasi et al. (1997), while studying the effects of deforestation of physical and chemical properties of soils under Oak (Quercus brontii) forests in Lordegan region of central Zagrous mountain, Iran, reported that deforestation and subsequently tillage practices resulted in almost a 20% increase in bulk density, 50% decrease in organic matter and total nitrogen, 10 to 15% decrease in soluble ions compared to the undisturbed forest sites. According to them, the tilth index coefficient of the forest site was significantly higher than the cultivated forest and the deforested sites. The authors also found that deforestation and clear-cutting of the forests resulted in lower soil quality and thus decreasing the productivity of the natural soil.

Lonergam (1998) asserted that peoples attitude towards forest resources is one of the key issues of forest degradation in developing countries. Yapa (1998) showed that people’s attitudes determine the effectiveness and efficiency of the forest policy. Although it is normal that people commit forest offenses to meet their needs, the indication of group action in the offences suggest an attitudinal change as a response to policy measures, as reported by Yapa (1998).
Sophia and Mark (2000) reported that the forest edges are to consist of microenvironments that may provide habitats for a different suite of species than forest interiors. According to them, several abiotic attributes of the microenvironment may contribute to this change across the edge of the central gradient viz. light, air, temperature, soil moisture and humidity. Raina and Jha (2000) found that exploitation of minerals like limestone and building material by mining has created environmental degradation and pollution.

Debussche et al. (2001) found that grazing promotes the coexistence of plants with different species traits. According to the authors, this is true at least when the grazer does not effectively select particular plant species for its food. Vesk and Westoby (2001) found that in Australian rangelands, plant species were more likely to increase in response to grazing at higher rainfall sites and decrease at lower rainfall sites than vice versa. According to them, these changes can be gradually explained by four broad mechanisms: herbivore preferences, tolerance to herbivory, disturbance caused by herbivores in the environment and alteration of the nutrient cycle as well as by interaction between the different mechanisms.

Pandit (2002) opined that technological interventions in mountain ecosystems due to the urbanization and modernization have drastically changed the basic fabric of the natural forests by way of the degradation of the ecosystem. Road communication through these systems is the main cause of deterioration of the forest environment.

Piirainen et al. (2002), while studying the effects of clear-cutting on the carbon and nitrogen fluxes through surface soil horizons in Norway spruce dominated mixed boreal forest in eastern Finland, reported that the removal of the tree canopy decreased the deposition of dissolved organic carbon and dissolved organic nitrogen to the forest floor and increased that of NH$_4$$^+$ and
NO$_3^-$ but did not affect the deposition of total nitrogen. The authors also found that the leaching of dissolved organic carbon and dissolved organic nitrogen from the organic horizon increased over two-fold after clear-cutting, but the increased outputs were effectively retained in the surface mineral soil horizons. Sharma and Upadhyaya (2002) found that both biomass and primary productivity of herbaceous vegetation at the unprotected hill were higher than protected hill despite of availability of more nutrients in soil in the latter. The authors found that both protected and unprotected hills differed little in species richness of herbs, but woody species were certainly higher in number on the protected hill. Their study revealed regeneration of native woody species at the protected hill, following relaxation of biotic pressure and conservation of soil and moisture.

Redding et al. (2003) are of the opinion that clear-cutting changes microclimate and soil physical and chemical conditions which may affect ground vegetation species composition and nutrient uptake. The authors found that in clear-cut areas, the availability of light increases, average air and soil temperature rises, daily temperature amplitude increases, relative air humidity decreases and the uppermost soil layers may dry out during the growing season.

Pykala (2004) found that species richness was higher among most species trait groups in old than in abandoned pastures and showed some recovery in new pastures. The author found more pronounced difference per m$^2$ than per grassland patch. The author also found that grazing increased the richness of hemicyryptophytas both per m$^2$ and per grassland patch.

Palviainen et al. (2005) reported that biomass and nutrient pools decreased after clear-cutting. According to them, the decrease in ground vegetation nutrient uptake, and the observed reduced depth of rooting may
decrease nutrient retention after clear-cutting and decomposing dead ground vegetation is a potential source of leached nutrients. The authors found that these negative effects of clear-cutting on the nutrient binding capacity of ground vegetation was short-lived since the total biomass and nutrient pools returned to the pre-cutting levels were even greater by the end of the five-year study period.

Lone and Pandit (2007), while assessing the impact of grazing on community features of herbaceous species in Langate Forest Division of Kashmir, reported that growing grazing pressures not only modify the natural forest ecosystems, but also reduce the rich biodiversity of plants and productivity of constituent species. The authors found that the species common to both the protected and unprotected areas differed in their Importance Value Index (IVI), reflecting their tolerance to grazing pressures. The authors also opined that the protected areas registered higher values for biomass as compared to the grazed ones.

Yan et al. (2007), while analyzing the impact of habitat fragmentation on biodiversity in Jinyun Mountains, reported that fragmentation had a lower species diversity index compared with continuous evergreen broad-leaved forests. The authors found that with the decrease in patch areas, the daily difference in air temperature, ground surface temperature, daily differences in relative humidity, maximum wind velocity, and differences in photosynthetic available radiation of both edges and interiors tended to increase. The authors also found that the maximum wind velocity and photo-effective radiation in forest edges were higher than those in interior forest, which presented a stronger temperature-gained edge effect.