India is bestowed with unique diversity in culture and natural vegetation and exhibiting rich plant diversity. Because of living in close harmony with the Mother Nature for sustenance of different activities of life, a quest to know and understand plants arose in the man’s behavior which then leads to the birth of science of Botany. First phase of this science was devoted to the recordings and observations of the naturalists and the herbalists those covered various facts of plant’s life certainly followed by subsequent developments in related field. The information was collected by them was then passed on from one generation to another. Theophrastus (372-282 BC) –the Great Greek philosopher cum scientist- later gave scientific footing to this knowledge of plants. Continual observations and studies on plant resources further kept on adding to the repository of facts and figure including discovery of new and useful products. This huge compilation ultimately necessitated the identification, classification and documentation of their status on the scientific lines and the phenomenon is still continuing. Survey, identification, inventorization and documentation of plants act as a source of information to assist planning and operation of any germplasm handling activity and are a very important step in germplasm management. The present work “Studies on Phytodiversity of Lippa-Asrang Wildlife Sanctuary in District Kinnaur, Himachal Pradesh” is based upon the survey conducted of the study area and the available literature referred for planning and execution of work and for interpretation of results is reviewed under the following headings:

2.1 FLORISTIC STUDIES

2.2 PHYTOSOCIOLOGICAL STUDIES

2.3 ETHNOBOTICAL STUDIES

2.1 FLORISTIC STUDIES

Botanical studies had reached a high standard in ancient India mainly during the Vedic and pre-Christian era which also helped the students of medicine of the times. The history of medicine in India can be traced back to the oldest
repository of human knowledge- The *Rigveda* (4500 B.C. - 1600 B.C.) where mention has been made of 67 medicinal plants. But in the *Atharvaveda* (2000 B.C. - 1500 B.C.) mention has been made about 290 plants used as charms for curing the diseases. Lord Dhanvantari, one of the disciples of emergence Lod Asvini is the originator of *Ayurveda* (2500 B.C. - 900 B.C.) who established the real foundation of earliest medical science where the properties of various drugs have been given in details. Of the eight divisions of *Ayurveda*, two Samhitas Charak (100 B.C.) and Sushruta (800 B.C.) which exclusively deal with medicine and surgery, respectively are probably the plants of Agnivesa Samhita. About 700 plants species have been mentioned here as medicinal plants (Pal and Jain, 1998).

The first floristic and an authoritative book even today is *Hortus Malabaricus* (12 volumes), published by a Dutch amateur botanist, Heinrich Van Rheede, the Governor of Dutch possession in Malabar in 1667, who made the first real attempt to explore systematically the plant wealth of India. He made 794 excellent illustrations and described about 750 plant species with the assistance of various workers from different fields including scientists, plant collectors, artists, physicians etc. (Manilal, 1980). Linnaeus prepared a *Binomial System of Nomenclature* of 265 Indian plants in his *Species Plantarum* during 1753 (Santapau, 1958). Thereafter, J.G. Koening who came to India in 1768 as a surgeon and naturalist, formed a society called ‘*The United Brothers*’, for promoting the study of Indian plants. Meanwhile, Royal Botanic Garden came into existence in Bengal under the patronage of East India Company. Col. Robert Kyd (first superintendent), followed by William Roxburgh, Buchanan Hamilton, Nathanial Wallich, William Griffith, T. Cook, C. B. Clarke are some of the names of Europeans, who took keen interest in studying the flora of this country during nineteenth century (Burkill, 1965).

Aitchison (1968) published the first account of the flora and vegetable products of Lahaull and Spiti region. Stewart (1869) explored old Punjab Provinces and named the compilation as ‘*Punjab Plants*’ comprising both the botanical and vernacular names including uses of most of the trees, shrubs and herbs of economic values growing within the province including Hazara and the Kashmir valley. Exploration of plant resources of India and preparation of floristic
accounts, took further boost by the middle of the 19th century. During this period, India was one of the best known tropical countries and the country had also the second best National Flora of the world at that time. In the year 1855, J.D. Hooker and T. Thompson published first volume of Flora Indica. However, this volume was soon given up in favour of the more comprehensive work Flora of British India’ (Hooker, 1872-1897), which includes the present day India, Pakistan, Bangladesh, Nepal, Bhutan, Sri Lanka, Burma, Singapore and Malaya. The first volume of this publication came out in the year 1872, whereas, the seventh and the last volume of the series was published in the year 1897. This flora deals with about 14,312 species, 25 sub-species, 2,302 varieties, 11 sub-varieties and 9 forma under 2, 325 genera and 171 families.

Brandis (1874), in his ‘Forest Flora of North-West and Central Indian’ described about 700 indigenous trees and shrubs those also included about 80 introduced and cultivated plants. It is pertinent to mention over here that this flora was written not only keeping in view the requirements of the botanists but also for the practical use of those people, who were given the responsibility to care for the public forests in different provinces in the country.

After completion of their field work on the orchids of Sikkim Himalaya, King and Pantling (1898) published this work in 3 volumes and while supplementing their splendid work on these orchids. The publication of J. D. Hooker’s ‘Flora of British India’ stimulated taxonomic research and as a consequence to it many provincial floras appeared. Some of the representative ones are of Collett (1902), Talbot (1909-1911), Kanjilal (1928), Haines (1916, 1921-1925), Osmaston (1927) and Fyson (1932). Besides this, there are more than 150 odd local floras which are also important in their own right and spirit as they threw light on the plants of their respective regions.

Collett (1902) ‘Flora Simlensis’, described 1326 species belonging to 639 genera under 113 families from Shimla region, covering about 800 Km², with ranges of distribution varying between 1580 m-3500 m above msl. This century old flora still holds its as a major work for the identification of plants of sub-tropical, temperate and sub-alpine parts and forests of the state.
Talbot (1909), while describing the ‘Forest Flora of Bombay Presidency and Sind’. Undoubtedly the initial best work on woody flora for the major parts of Peninsular India- profusely illustrated identification details of trees, shrubs, bamboos, palms and woody climbers and is still used widely by the botanists, foresters and naturalists. Later, Gamble and Fischer (1915-1936) described about 4516 species from Indian Peninsular region covering elevations ranging from the sea level to almost 2800 m above msl. They explored coast lines on the both sides of the country, covering Indian Ocean on the west and the Bay of Bengal on the east besides flora from Eastern and Western Ghats lying well within the influence of these water expanses and numerous other lesser connected and isolated hill masses falling in Malabar and Deccan plateau areas.

Kapoor and Sarin (1963) while conducting botanical tour of Trikuta hill (Shri Vaishno Devi Shrine, Jammu) collected 495 species of flowering plants and later described distribution pattern of minor forest products, vegetation, plant communities, phyto-geography and also the issues pertaining to the economic uplift of the area. Dey (1964) reported more than 100 medicinal plants of commercial and traditional importance by conducting a Botanical Survey of Baghrihati and Shillonger valley in Uttar Kashi Forest division of Garhwal Himalaya. Gupta (1968) in his compilation titled ‘Flora of Nanital’ gave a comprehensive floristic account of 869 species belonging to 457 genera and 124 families. Uniyal and Chauhan (1971, 1972 and 1973) described the medicinal plants of Uhal Valley in Kangra Forest division of Himachal Pradesh. They also documented the commercially important medicinal plants of Kullu Forest Division, Himachal Pradesh and also the traditionally important medicinal plants of Kangra valley in Dharamshala Forest Circle. Kachroo et al. (1977) explored Ladakh –The Cold Desert of India and described about 611 plant species.

Nair (1976) recorded 1629 species belonging to 709 genera and 137 families of vascular plants from Bashahr Himalaya. It is outcome of a comprehensive survey of flora of old Bashahr State, comprising of two present districts namely Kinnaur and Mahasu (including Shimla), in the altitude varying from 650 m to 6930 m above msl. and valleys of Sutlej, Baspa and Pabbar. Aswal
and Mehrotra (1979) recorded 12 new plant species from Lahaul-Spiti those are also new to the botanical records for the state of Himachal Pradesh.

Trivedi et al. (1981) recorded 11 species new to the state of Himachal Pradesh, some of which are *Ranunculus lingua*, *Minuartia biflora*, *Juncus laucanthus* and *Nepeta nervosa*. Chowdhery and Wadhwa (1984) published a comprehensive list of the flowering plants of Himachal Pradesh under the title, ‘Flora of Himachal Pradesh’, Analysis in 3 volumes based on exsiccate housed at various Herbaria. About 3,300 species have so far documented as a result of floristic surveys conducted by various earlier workers. Polunin and Stainton (1984) in ‘Flowers of Himalaya’ and Stainton (1988) ‘A Supplement to the Flowers of Himalaya’ described over 1500 species in their texts which also supported 689 and 606 coloured photographs respectively, besides 319 line drawings covering native, naturalized and exotic species in parts of India falling in the Western Himalaya and Nepal spreading over an area of 1450 Km².

Chauhan (1984) surveyed the wild medicinal plants of Pabbar Valley of Himachal Pradesh and collected 761 species belonging to 107 families. Out of 400 species of medicinal and aromatic plants 104 species were of commercial medicinal and aromatic value, while 85 species were of ethnobotanical importance. Aswal and Mehrotra (1984 and 1985) reported a new species *Ranunculus bikramii* from Rohtang Pass, Lahaul valley and also described phytogeographical aspects of the flora of Lahaul valley in the North-west Himalaya.

Uniyal and Murti (1985) included 51 overlooked species as new records to the flora of Himachal, whereas, Singh and Baijnath (1987) documented 29 more species found to be overlooked by the earlier workers. Ghosh and Bhattacharya (1987) explored alpine areas of Lahaual-Spiti and published three new varieties *i.e.* *Senecio peduncularis* Edgew. var. *albus*; *Thymus serpyllum* L. var. *album* and *Geranium aconitifolium* L.’ Herit. var. *album*. Sharma and Jaswal (1988) surveyed the Upper Liddar valley of Kashmir Himalaya and described 764 species comprising of 341 genera belonging to 86 families. The compilation covers up to date nomenclature and notes on the medicinal plants. Chauhan (1989) reported 100 aromatic plants from the state of Himachal Pradesh. Chowdhery and Murti
(1989) described a new species *Epilobium spitianum* collected from Gate, Spiti at 4300 m above msl. Aswal *et al.* (1990) further added one more new species of *Oxytropis shivai* to the ‘Flora of Lahaul-Spiti’.

Badhe and Pandey (1990) studied the 125 species of medicinal and economic plants from Amravati division, Amravati Circle in Vidarbha forest of Maharashtra State. They also discussed their distribution, availability, botanical, sanskrit, local and family names during floristic survey in Doda of Jammu & Kashmir. B hellum and Mangotra (1992 and 1994)) collected 83 species belonging to 77 genera and 48 families of flowering plants those later were found to be the new additions to the area. One of the species recorded during this survey was *Cyananthus lobatus* Wall. ex Benth which stood out to be an addition to flora of the state. Uniyal and Rao (1993) enumerated 360 plant species including medicinal plants, belonging to 235 genera and 77 families. The description includes up to date nomenclature, and citation with habit, flowering, fruiting period and collection details.

Aswal and Mehrotra (1994) gave descriptive ‘Flora of Lahaul-Spiti’ describing the vegetational wealth of one of the most beautiful, but botanically least known area of the country. He gave comprehensive account of the flowering plants of 985 taxa belonging to 353 genera. Singh *et al.* (1994) recorded 29 species along with their status from Mandi district, Himachal Pradesh. Sumita (1996) the study revealed 723 plant species belonging to 115 families. Of the total species dicots are represented by 97 families, 377 genera and 601 species. Monocots represented by 11 families, 62 genera and 96 species and gymnosperms are represented by 4 families, 12 genera and 26 species.

Uniyal (1998) carried out the survey of Patni hills (1500-2100 m) and collected about 65 species of medicinal plants. The plants were documented alphabetically according to their botanical, local and Sanskrit names along with their habit. Gupta (1998) worked on comparative studies on the medicinal and aromatic flora of Churdhar and Rohtang areas of Himachal Pradesh. In total, 195 plant species were collected from Churdhar belonging to 53 families, 139 genera, whereas, 182 plant species were collected from Rohtang area belonging to 58
families and 142 genera. Tewari et al. (1999) conducted the survey of Punyagiri district for the exploration of medicinal plants, which can be collected from this area in huge quantity. Sixty-seven plants were enlisted alphabetically along with their Ayurvedic and botanical names.

Dhaliwal and Sharma (1999) explored the floristic wealth of Kullu district, Himachal Pradesh and later published the ‘Flora of Kullu’ which covers about 930 species belonging to 504 genera, 126 families and is an outcome of extensive field surveys made by the authors in the valley from 1988-1992. Chauhan (1999) reported 700 species of medicinal and aromatic plants of Himachal Pradesh, India. Plants were listed in alphabetical order of Latin name and described with family name, distribution, description, flowering, fruiting, parts used, current market price, chemical composition, uses, preparation and cultivation notes. Being situated in the centre of the Western Himalayas, Himachal Pradesh is bestowed with a rich flora, the diversity of which is spread over its Shivalik belt, temperate forests, deep ravines, open grassy slopes and alpine pastures. Out of the 47, 000 plant species found in the country as many as 3245 species (7.32%) are available in the state of Himachal Pradesh (Verma, 2000). The faunal and floral wealth in the state of Himachal Pradesh is tremendous. Therefore, there is an urgent need to conserve the endemic diversity of its flora.

Chowdhery and Rao (2000) recorded the vegetational pattern and floral species of Trans-Himalaya, a region, which mainly covers the districts of Ladakh in Jammu and Kashmir, and Lahaul & Spiti in Himachal Pradesh, India and a little portion of Garhwal Himalaya. Singh and Rawat (2000) explored the Great Himalayan national Park – an important protected area network in Himachal Pradesh for assessment of its floristic diversity. Outcome of the study reflected a collection of 832 species belonging to 427 genera and 128 families. The compilation besides covering taxonomical aspects also deals with the ecology and conservation aspects of the vascular plants found in and around the National Park. The Flora of Cold Desert of Western Himalaya’ (Murti, 2001) is another addition to the series of floristic works in the North-west Himalaya describing about 347 species of monocots, belonging to 103 genera under 16 families. Sharma (2002) collected a total number of 266 species belonging to 180 genera and 71 families.
from different areas of Parvati valley in Himachal Pradesh. Meenakshi (2002) studied the phytodiversity of Shilli Wildlife Sanctuary at Solan (HP) and collected 306 species belonging to 108 families.

Kumar et al. (2001) and Jishtu et al. (2003) after studying the floristic diversity of North-west Himalaya documented the medicinal plant wealth of Cold Desert of Himachal Pradesh in particular. Chandrasekar et al. (2003) recorded 21 species from Lahaul-Spiti district, out of which five viz., Astragalus gracilipes Benth. ex Bunge, Artemisia persica Boiss., Saxifraga palpebrata Hook. f. & Thoms, Saussurea depsangensis Pamp. and S. glacialis Herd are new additions to the state. Singh et al. (2003) also recorded 9 species as addition to the flora of Cold Deserts of Lahaul-Spiti. Chauhan (2003) reported 179 species of commercial importance for drugs and phyto-pharmaceutical, 32 species yielding essential oils, 16 species utilized for manufacturing of dhoop and incense, 30 species as source of phyto-chemicals, 40 species useful for tans and dyes and 42 species, which can be used as potent substitute for exotic species, thereby discouraging their import and saving foreign exchange reserve.

Sharma et al. (2003) listed the local names, scientific names, distribution pattern, marketability and local uses of 22 commercially important medicinal and aromatic plants, observed in a survey carried out in Himachal Pradesh. Seth and Seth (2003) have reviewed the literature on early plant collectors of Himachal Pradesh from 1817-1984. Nilay (2004) conducted study on the distribution and importance of medicinal and aromatic plants of Nahan area of Himachal Pradesh and revealed that a total of 403 species belonging to 311 genera and 101 families were collected from the different parts of the study area. Out of the total 363 species belongs to dicots, 32 to monocots and 1 to gymnosperms and 7 are ferns and fern allies. Seth and Jaswal (2004) enumerated plant resources of Shimla hills and discussed about 725 dicots, 107 monocots, 14 gymnosperms and 12 ferns. Kala and Rawat (2004) explored Valley of Flowers National Park in the Chamoli district of Garhwal Himalaya during 1993-97 and recorded 520 species of vascular plants belonging to 72 families and 248 genera. Out of these collections 59 species from the valley were recorded for the first time and 4 of them were the new records for Uttarakhand Himalaya.
Joshi et al. (2004) recorded about 109 species of ferns from Mandal and adjoining localities in Chamoli district of Garhwal Himalaya including 4 new species to the area. Pusalkar et al. (2004) recorded 7 taxa of flowering plants namely, *Ranunculus stewartii* H. Riedl, *Corydalis murreana* Jafri, *Potentilla polychista* Boiss. & Hohen., *Cirsium wallichii* DC var. *glabratum* (Hook. f.) Wendelbo, *Leontopodium alpinum* Cass, *Euphrasia foliosa* Pennell and *Veronica salina* Schur, those certainly are the addition to floristic diversity of Uttarakhand state. About 5,000 plant species have been documented for medicinal value and phyto-chemically studied. Of these, 1,100 are used in different systems of medicine, 600-700 are used in indigenous industries, but only about 150 have been commercially exploited. Beside domestic use export potential of these plants is huge and given a quality up-gradation of such drugs, competitiveness and globalization is ensued (Rawat and Garg, 2005).

Chandrasekar and Srivastava (2005) described *Oxytropis immersa* (Baker ex Aitch.) Bung ex Fedtsch. (Fabaceae) as new records for the India from Tariya-Pin Parvati Pass of Pin Valley National Park, at 4100 m above msl. A documentation of some lesser known tree species of Himachal Himalaya was provided (Kapoor et al. 2005a). Besides, this, comprehensive details of medicinal plant wealth of high altitudes including Cold Deserts in Northwest Himalaya was also documented (Kapoor et al. 2005b). In this publication a comprehensive floristic account of medicinal plants including their distribution and status has been explained. Viraj (2005) conducted the studies on diversity of medicinal and aromatic plants of Sangla valley in Himachal Pradesh between an altitude ranging from 1800 m (Karcham) to 4800 m (Chhitkul Kanda) above msl and collected a total of 253 species, belonging to 171 genera and 61 families from the study area. Out of which 238 belongs to dicots, 9 to monocots and 6 to gymnosperms, which are enlisted along with their botanical names, local/common name(s), families, official parts, economic and ethnobotanical importance. Jishtu (2005) surveyed Baspa valley of Kinnaur district and documented 957 taxa belonging to 475 genera spread over 122 families of vascular plants excluding the families Cyperaceae and Poaceae. Particular area for the study was located in between altitudinal ranges
varying from 1750 m to 4750 m msl. As a result of the study, about 80 new records were added to the flora of Kinnaur, Himachal Pradesh.

Meenakshi (2006) documented about 376 species of medicinal and aromatic plants of Kinnaur Forest Division, Himachal Pradesh. Qureshi et al. (2006) enlisted 271 plants from the study area in which 206 species of plants (76.01%) are herbs, 45 species are trees (16.60%) and about 20 species are shrubs (0.738%). As for the conservation status of plant species, 8.12% are abundant, 44.65% are common, 22.14% are uncommon, 17.71% are rare and 7.38% are very rare. Subramani (2006) carried out floristic survey of Churdhar wildlife Sanctuary in District Sirmour, Himachal Pradesh and reported 793 taxa including 763 species, 8 sub-species and 22 varieties belonging to 431 genera and 143 families. Out of which 748 taxa belongs to angiosperms, 8 to gymnosperms and 37 to pteridophytes. Singh and Sharma (2006) enumerated the flora of Chamba which deals with 1005 species of seed plants (angiosperms & gymnosperms) belonging to 545 genera and 133 families, out of these 6 species represents gymnosperms belonging to 5 genera and 3 families.

Lal et al. (2006) reported Herniaria incana: addition to the flora of Himachal Pradesh. Chandrasekar and Srivastava (2009) conducted study on flora of Pin Valley National Park and enumerated 513 taxa belonging to 243 genera from 64 families of pteridophytes, gymnosperms and angiosperms. Samant and Rana (2009) recorded 637 species of vascular plants, out of which 573 species belongs to angiosperms, 8 to gymnosperms and 56 to pteridophytes. 10 species were categorized as critically endangered, 15 species as endangered and 31 species as vulnerable, 42 species as near threatened and remaining species as least concern for the Manali Wildlife Sanctuary. 7 species as critically endangered, 14 species endangered, 15 species vulnerable and 1 species data deficient have been identified for Himachal Pradesh and 2 species as critically endangered, 7 species endangered and 3 species vulnerable for the globe. Five species of angiosperms are being reported for the first time from the state of Himachal Pradesh (Lal and Rawat, 2009). These are Chonemorpha fragrans (Moon) Alston, Glycosmis arborea (Roxb.) DC., Ipomoea sindica Stapf. Polygala erioptera DC. and
*Ventilago denticulata* Willd. All species were collected from Sirmaur District of Himachal Pradesh

Viraj *et al.* (2010) enlisted the lesser known aromatic plants species of the tribal district Kinnaur of Himachal Pradesh. A total of 30 aromatic plant species belonging to 29 genera and 13 families were collected and identified from the study area. These plants species were highlighted along with their botanical name, family, local/common name(s), official parts and their uses. Rana *et al.* (2010) studied the plant diversity of Kandi region of Himachal Pradesh and documented 24 species of fibre and forage grasses, 14 of fodder legumes, 22 shrubs of medicinal value, 20 of diversified fruit and 30 of valuable agro-forestry trees have been reported. A total of 356 species have been reported from Sagareshwar wildlife sanctuary of Maharashtra, out of which, 314 belongs to dicots and 42 to monocots (Bachulkar and Awale, 2010).

Mishra and Narain (2010) conducted floristic and ecological studies of Bakhira wetland of Uttar Pradesh and recorded 119 species belonging to 42 families. Cyperaceae was reported as dominant family having 17 species followed Poaceae with 10 species and Asteraceae with 8 species. The plant diversity in the Sharavathi River basin in relation to human disturbance was conducted (Ramachandra *et al.* 2010). The study was mainly focused on the floristic structure, composition and diversity of forest with varying degree of human disturbance. Based on the investigation, various strategies for conservation and sustainable utilization of forest resources were proposed.

Subramani `and Kapoor (2011a) collected *Chusua nana* (King & Pantling) Pradhan and *Hetaeria fusca* Lindl. two little-known orchids from Churdhar Wildlife Sanctuary, Shivalik Hills of Sirmaur district, forms new distribution records and second report to the state Himachal Pradesh. Subramani and Kapoor (2011b) dealt with the floristic elements of Churdhar Wild-life Sanctuary which were the additions to the floral wealth of district Sirmaur, Himachal Pradesh. Rawat and Lal (2012) recorded the new distributional record of 11 flowering plant species for Himachal Pradesh from Sirmour District-III of Himachal Pradesh.
Murugan and Murty (2012) recorded three taxa viz; *Blumea milnei* (Asteraceae); *Strobilanthes viscosa* var. *viscosa* and *S. viscosa* var. *digitalis* (Acanthaceae) additions to the angiosperms flora of India from Western Ghats, India. Barbhuiya and Gogi (2012) enumerated a total of 29 species of gymnosperms belonging to 18 genera and 10 families from Meghalaya state. Out of which 9 species are indigenous to the state and rest are introduced. Adhikari *et al.* (2012) carried out extensive floristic survey at Tungnath area in Kedarnath Wildlife Sanctuary and enumerated a total of 433 plant species belonging to 234 genera under 71 families along the sub-alpine and alpine regions.

An inventory of the flora of Kambalakonda Wildlife Sanctuary, Visakhapatnam was carried out by Naidu *et al.* (2012) and reported 319 species of plants in 252 genera and 73 families bringing out the genus and species ratio as 1:1.26. The dominant families were Fabaceae (23), Euphorbiaceae (22), Poaceae (21), Rubiaceae and Acanthaceae (13) species each. Singh and Pusalkar (2012) recorded four taxa viz; *Androsace delavayi* Franch, *A. villosa* L. (Primulaceae); *Lindelofia longiflora* (Benth.) Baill. Var. *levingii* (C. B. Clarke) Brand and *Pseudomertensia moltkioides* (Royle ex Benth.) Kazmi var. *loichtlinii* Kazmi (Boraginaceae) are reported as new records for the flora of Himachal Pradesh, of these *Pseudomertensia moltkioides* var. *loichtlinii* Kazmi is a new record for India.

Thakur *et al.* (2012) studied the floristic composition and biological spectrum of Darlaghat Wild Life Sanctuary (DWLS), located in district Solan of Himachal Pradesh. A total 302 plant species belonging to 99 families were recorded from the study area. These include: 27% trees; 24% shrubs; 35% herbs; 5% climber; 5% fern; 2% grasses and 2% Sedges. The pteridophytes were 5 % with 14 species and gymnosperms 2% with 6 species. Chawla *et al.* (2012) provided checklist of the vascular plants of Kinnaur district in the Himachal Pradesh state of India in the western Himalaya. The checklist includes 893 taxa belonging to 881 species of angiosperms and gymnosperms distributed among 102 families and 433 genera, and 30 species of pteridophytes. The result showed that family Asteraceae was most dominant family with 122 followed by Poaceae with 69, Rosaceae with 58 and Fabaceae with 39 species each. The most diverse genera were *Artemisia* followed by *Potentilla, Saussurea, Polygonum* and *Astragalus.*
2.2 PHYTOSOCIOLOGICAL STUDIES

Plants growing together have natural relationship among themselves and with the environment. This interaction among different plants and between plants and their environment result in the outcome of different vegetation types in different areas. The quantitative relationship between rare and profusely growing species is an important structural property of a community. The quantitative study of vegetation called “Phytosociology” and its principal aim is to describe the vegetation, explain or predict its pattern and classify it in a meaningful way. Species diversity determines the distribution of individuals among the species in a particular habitat. Hence, studies of the structure and functions of the vegetations in relations to their environment certainly form the basis for complete understanding of dynamics of an ecosystem which then certainly lead towards formulation of suitable strategies. Clements (1916) developed a system of classification based on successional relations i.e., on change in time that the deduced from spatial similarities and differences in dominant species and their community environments. Plants growing together have natural relationship among themselves and with the environment.

Curtis and McIntosh (1950), Curtis (1959) and Phillips (1959), quantitatively analyzed the vegetation data for frequency, density and abundance. The relative values of frequency, density and dominance were also determined. The IVI for each plant species was determined as the sum of relative frequency, relative density and relative dominance. The ratio of abundance of frequency (A/F) has been used to analyze the distribution pattern of species within the site studied. A value below 0.025 was considered as regular distribution; 0.025- 0.05 as random and more than 0.05 as contiguous distribution pattern (Curtis and Cottam, 1956). Plant population in a community varies from habit to habitat and these characteristics play a basic role in determining the kind of a community. The ecosystem response to external stimuli follows certain common pattern regardless to ecosystem type or stimuli (Platt, 1965; Lugo, 1978). Misra (1968) carried out phytosociological analysis, through randomly laid 1m x 1m quadrates for each site, with at least 10 quadrates per sample. According to Odum (1971) contiguous distribution is common in nature. Random distribution is found only in very
uniform environment and regular distribution occurs where severe competition exists between individuals. Walter (1979) holds that the widespread assumption regarding the distribution of plant species directly depend upon the physical conditions prevailing in the habitat is incorrect.

Gupta et al. (1982) studied floristic composition of Western Himalayan sub-alpine coniferous forests in Parbati range, Himachal Pradesh. Whereas, changes in floristic composition of the herbaceous vegetation under three different forest communities was studied (Singh and Verma, 1983) in and around Summer Hill, Shimla. Gaur et al. (1985) investigated the community structure of a uranium-laden locality in Garhwal Himalaya and found a total of 62 plant species in such soils mainly dominated by species of Bauhinia, Rhus, Mallotus, Nyctanthes, Woodfordia and Carissa. Quantitative vegetation analysis of woody strata in four Cedrus deodara forests at different altitudes and aspects in Kanasar Range of Chakrata Forest Division, falling in Western Himalaya was assessed (Rawat and Kumar, 1989) and it was observed that these particular forests exhibit higher similarity amongst them. The work also included quantitative information on structure, composition and density of deodar forests and related details of the soils supporting these forests.

Variation in the distribution pattern across the slopes and vegetation strata seems to be associated with multiple factors specially micro-environment and biotic (Joshi and Tiwari, 1990). Singh et al. (1991) carried out detailed investigation on the phytosociology of tree vegetation in three selected sites around Shimla, Himachal Pradesh and on the basis of IVI values formation of the plant communities like Quercus incana- Rhododendron arboreum (Site-1); Cedrus deodara- Pinus roxburghii- Quercus incana (Site-II) and Picea smithiana- Pinus roxburghii (Site-III) were recorded at four different slopes (hilltop, upper slope, lower slope and hill base). The vegetation showed mainly contiguous distribution pattern followed by random and then regular. Singh and Gupta (1992) conducted detailed vegetation survey and ecological studies of ground vegetation under silver fir and spruce forests of Himachal Pradesh.
Gargya et al. (1998) conducted a phytosociological analysis of *Nardostachys jatamansi* DC. at three different sites at Yamnotri (3300 m), Kedarnath (3550 m) and in Dayyara meadows (3600 m). They reported that in all the three sites *N. jatamansi* had the highest values for IVI and average basal area. Singh (1998) studied vegetational structure in Temperate zone of the Western Himalayas. The species composition, distribution pattern, diversity, concentration of dominance and community coefficient of the forest vegetation were determined under two aspects (North and South slopes) in the Tirthan valley, of Himachal Pradesh.

Ghildiya et al. (1998) carried out vegetation study in a series of representative Oak forests in relation to their analytical and synthetic character in Garhwal Himalaya within the altitudinal gradient varying from 1400-2600 m above msl. Singh (1999) investigated species diversity, vegetation structure and plant community composition of Great Himalayan National Park. Rawat and Pant (1999) investigated structure of chir pine community along two aspects and four elevational zones in Garhwal Himalaya. The findings indicated that the chir pine prefers sunny slopes with xeric conditions and is a dominant species in such drier south facing slopes.

Prakash and Uniyal (1999) also studied the structure of forest vegetation along an altitudinal gradient (2550-3600 m) in the valley of Flowers and its adjoining area using 25 quadrates of 10 x 10 m for trees and 5 x 5 m for shrubs. Based upon the IVI values, three major vegetation types *i.e.* Himalayan moist upper temperate forest (2550-3000 m), sub-alpine fir forest (3000-3250 m) and sub-alpine birch forest (3300-3600 m) were identified. During investigations, average tree density was found to increase with the altitude whereas, the average basal area of tree species showed a decreasing trend with the increase in altitude. Rawat and Bhainsora (1999) studied the structure and composition of forests across the Shivaliks of Doon valley and also of outer Himalaya in Dehra Dun district covering western fringe of Rajaji National Park by using stratified random plots. Aspects like Richness of woody species, Importance Value Index (IVI) of trees and regeneration of sal (*Shorea robusta*) besides the climax species of the region were compared and discussed at great length.
Srinivas and Yadava (1999) had undertaken phytosociological studies at four oak forest with various levels of disturbance (site I low, site II and III moderate and site IV high) in Manipur, North East India. The dominant species at all the sites was *Quercus serrata*, with *Q. dealbata* co-dominant. Correlation analysis was carried out between the occurrences of the different tree/woody species and exhibits positive correlations among them in four forest sites. Phytosociological studies (Varghese and Menon, 1999) conducted in the Agasthyamalai region of Kerala, at 100-500 m altitude. Random sampling was done using census quadrat technique. In the 0.1 ha are sampled (ten 10X10 m quadrats) 18 species were recorded belonging to >12 families. The Myristica swamp forest had a comparatively low stand density 9520 trees/ha), maturity index value (18.33) and species density (18 species/0.1ha). It showed medium diversity (2.50), an absence of higher frequency classes and a high concentration of dominance (0.09). On the basis of dominance, the forest is identified as of the Gymnacranthera farquhariana, Myristica fatua var. Mangifera indica, Knema attenuata type.

The studies on phytodiversity of Kumbhalgarh Wildlife Sanctuary in Pali and Udaipur District of Rajasthan was conducted and twelve important forest community types are distinguished, and notes on the occurrence and conservation of rare and threatened plants in the sanctuary (Pandey and Singh, 2000). Phytosociological analysis of sand mines of Solan district, Himachal Pradesh (Panwar et al. 2000) revealed that mining had caused loss of biodiversity in those areas and many of the economically important plant species have been eroded and replaced by uneconomical and unwanted species.

Costa et al. (2001) carried out phytosociological and floristic inventories, with the use of 100 quadrates of 1 m², in order to determine the structural characteristics of vegetation of the oceanic dunes of Crispin, Marapanin Municipality, Para State, and Northern Brazil. A phytosociological survey on the woody and ground vegetation was conducted (Tomar et al. 2001) in the abundant Jhum fallows in the upper Shipra watershed in Meghalaya. Results revealed the presence of 34 species of woody perennials belonging to 29 families and 35 species of ground vegetation belonging to 22 families comprising the fallow lands.
The highest IVI was found in *Pinus kesiya* (81.5) and lowest in *Emblica officinalis* (1.02). IVI for ground vegetation were highest for *Lantana camera* (45.7) and lowest for *Inula cappalum* (1.02).

The phytosociological study was conducted on the vegetation structure of woody plant species along mountain flank of a montane forest in Narainbagar, Chamoli District in Garhwal Himalayas, Uttar Pradesh, India (Rawat, 2001). The flank was surveyed for floristic composition, distribution pattern, species diversity and dominance at each stratum of the woody vegetation. Plant diversity assessment in relation to the disturbances in mid-elevation forests (1300-2000 m above msl) of Nainital (Khera *et al.* 2001). During the study, higher number of trees and shrubs were recorded on the western aspect which was experiencing low erosion and great anthropogenic pressure. The tree density was recorded high at the hilltop of eastern aspect and on the hill slopes of western aspects. They observed that the presence of *Coriaria nepalensis* Wall- a non-leguminous nitrogen fixing species- in all the sites, may help in the restoration of soil and in conservation of original pine-oak forests.

Various qualitative parameters along the gradient and regeneration forests of Uttarkashi were earlier detailed by Pande (2001) who finally recorded higher density, Total Basal Area (TBA) and density values for north-east aspect. Similarly, Pande *et al.* (2001) studied the effect of plant species diversity and other parameters on vegetation analysis in moist temperate forest of Kedarnath Forest Division by dividing the whole area into 8 sub-sites as per the aspect and altitude ranging from 1800-2800 m above msl. Pandey *et al.* (2002) described plant species diversity, various parameters of vegetation analysis and resource amongst various plant species, in a moist temperate Western Himalayan forest ecosystem located in district Chamoli, Garhwal Himalaya. For this, whole of the area was divided into eight sub-sites depending upon the altitude ranging from 1800-2820 m above msl. Negi (2002) carried out studies on diversity of Woody species of Sangla Valley (HP) by using quadrate method and found that a total of seventeen tree species and nine shrub species were the dominant woody elements.
Arunachalam (2002) analyzed the species composition and diversity in two different forest types, viz., wet evergreen and dry deciduous tropical forests of Western Ghats in India. Singh et al. (2002) analyzed the phytosociology of *Solanum surattense* and observed that about 55 species were associated with these plants in the selected study site of Ganganagar district, Rajasthan. Ilorkar and Khatri (2003) conducted the phytosociological study of Navegaon National Park and measured different phytosociological attributes like density, basal area, Importance Value Index (IVI), nature of vegetation, distribution pattern and resource utilization of woody vegetation.

Pandit and Raviya (2003) studied the composition and structure of the five sites in Rana Barda (Porbandar district). In each site frequency, density, relative dominance, IVI, coefficient of variation, and relative growth index were worked out. The characteristic species in the area were *Acacia senegal, Lantana camara* and *Premna herbacea*. Verma et al. (2003a) studied all the relevant details of phytodiversity including chemical properties of soil under the *Betula utilis* D. Don forest in Gramphu- a Cold Region of Lahaul–Spiti–Himachal Pradesh. The study revealed that the number of species comprising ground flora were (38) within the forest area when compared to their number outside the forest (14). Similar studies were also conducted by Verma et al. (2003b) in Man Lunga valley (north-east aspect) and Khamengar valley (southern aspect), falling in Pin Valley National Park.

Samant and Joshi (2004) gave comprehensive information on site and habitat characteristics, community diversity and distribution pattern, vegetation composition, (species richness, richness of native, endemic and economically important species), and structural pattern of woody species. Further, communities have been prioritized based on their conservation value of Nanda Devi Biosphere Reserve, Western Himalaya. Bhatt et al. (2004) reported community structure and diversity of a moist mixed temperate forest of Notha-Churikhal, situated in Pauri district of Garhwal Himalaya on the altitude ranging from 1700-2300 m above msl. The values of density and basal cover for different species in the study area ranged from 10 to 490 plants ha$^{-1}$ and 0.36 to 126.48 m$^{-2}$ ha$^{-1}$ in different sites respectively.
Srivastava (2004) gave an overview of the state-of-the-art, forest (sal, mixed, riparian, deciduous and miscellaneous forests) and vegetation type (grasslands, aquatic vegetation), floristic composition, endemic species and ethnobotanical studies in Uttar Pradesh, India. The status and conservation of algae, fungi, lichens, bryophytes (liverworts) and pteridophytes in the state are discussed. Reassessment of the phytodiversity of Gujarat state was conducted and described the quantified representation of the richness and diversity of the flora; and the different threatened and rare plants including means of conservation (Meena and Pandey, 2004).

The studies on phytodiversity was conducted in Bethuadahari sanctuary, Nadia, West Bengal and revealed that the vegetation of the area comprises 300 species which includes 3 species of Cycadaceae (gymnosperms) and 6 species of pteridophytes (Chakraborty et al. 2004). Anita (2005) studied the effect of *Lantana camara* on floristic diversity in chir pine forests of Himachal Pradesh and revealed that *Lantana camara* invasion reduce the number of herbaceous plant species in study sites, it change the distribution pattern of the species. Most of the species have contiguous distribution followed by random, only a few species have regular distribution pattern in the control sites as compared to the invaded site.

Kumar et al. (2005) analyzed quantitative study of herbaceous vegetation on elevation ranging from 1900-2400 m above msl in the temperate region of Garhwal Himalaya. Floristic composition, diversity, dominance and distribution pattern of herbaceous species were studied in three different stands viz., undisturbed (UD), mildly disturbed (MD) and highly disturbed (HD), during three different prominent seasons (winter, summer and rainy) in the temperate forest along disturbance gradients. Mishra et al. (2005) conducted studies on species diversity in Bhitarkanika Mangrove ecosystem in Orissa, India and concluded that the Bhitarkanika forest block contains highest number of tree species followed by Dagmal, Kakranasi and Thakurdia blocks. Bhitarkanika and Dagmal are part of core area of Bhitarkanika wildlife sanctuary.

Kharkwal et al. (2005) conducted ecological studies in the central Himalayan regions of India and concluded that the distribution and species
richness pattern in this region largely depends on the altitude and climatic variables like rainfall, temperature. Galav *et al.* (2005) carried out study to determine the effect of climatic variation on the phytosociological parameters of grassland communities of Southern Aravalli hills, Rajasthan, India. Verma *et al.* (2005) conducted study to assess the plant diversity around Renuka lake of Renuka wildlife sanctuary of Himachal Pradesh. A total of 109 species including regeneration of 15 trees and shrub species were recorded from the area. The distribution of all the plant species except two was contiguous and index of dominance was recorded 0.021, whereas, index of diversity was 5.976.

Verma *et al.* (2006) conducted studies on plant diversity in alpine pasture of Shikari Devi Wild Life Sanctuary of District Mandi, Himachal Pradesh. Sharma *et al.* (2006) carried out phytosociological studies of tree species and physicochemical properties of soil in traditional Agroforestry of Chhattisgarh (Bilaspur and Raipur Districts), India, which demonstrated that the distribution of tree species was contagious and random. Tree species such as *Acacia nilotica*, *Albizia procera* and *Butea monosperma* were found to be most successfully grown. Samant and Shreekar (2006) studied the diversity, distribution pattern and conservation status of the plant species used for treating liver diseases/ailments in the Indian Himalayan region. They reported 34 species are native, 3 are endemic and 15 near endemic, 7 species are categorized as critically endangered as per IUCN criteria.

Phytosociological study was carried out (Sahu *et al.* 2007) in tropical dry deciduous forest of Boudh District, Eastern Ghats of Orissa, India and inventoried a total of 187 species (trees 91, shrub 10, climbers 12 and herb 74) with in a four hectare sampled area. The predominant species are *Shorea robusta*, *Madhuca indica*, *Buchanania lanzan*, *Cleistanthus collinus* and *Diospyros melanoxylon*. Study area shows species rarity (Those represented by ≤ 2 individuals) of 18%. The Shannon-Weiner diversity index is 4.51, with Simpson’s value 0.92 infer that tropical dry deciduous forests are also species diverse systems. Mean stand density was 591 ha⁻¹ and mean basal area was 25.50 m² ha⁻¹ stand density and species richness have consistently decreased with increasing girth class of tree species. Girth class having <30 cm gbh contributed to about 68.13% of species richness.
Species diversity and community structure of ferns and fern allies were studied in Tarai forest, which are characterized by tropical deciduous forests, in the Balmikinagar, District West Champaran of Bihar and Kusumi forest, District Gorakpur of Uttar Pradesh, India situated adjacent to India-Nepal border (Alka Kumari and Tripathi, 2007). These forests consist approximately 45 fern species belonging to 16 families in which maximum species are of the family Selaginellaceae (63%) followed by Adiantaceae (38%) and Thelypteridaceae (31%). Selaginella had the maximum number of species while Dryopteris cochleata was found to be the most dominant. Viraj et al. (2007) conducted a survey of Sangla valley of district Kinnaur in Himachal Pradesh. A total of 26 threatened plant species, belonging to 16 families and 22 genera of which 5 critically endangered, 7 endangered and 14 vulnerable plant species were recorded as per IUCN classification. Samant et al. (2007) identified a total of 643 species of medicinal plants and are classified according to nativeness, endemism, and rarity and prioritized for cultivation.

The investigation was undertaken to characterize the floristic composition, vegetation diversity and distribution pattern of medicinal and aromatic plants (Dutt et al. 2007) at different altitudinal zones of Sangla valley in Himachal Pradesh. The study revealed that the important value index (IVI) of different species varies from site to site. Majority of herb species exhibited contiguous distribution pattern, followed by random distribution pattern. Whereas, most of the shrub species showed random distribution pattern followed by the contiguous distribution pattern. Viraj and Dutt (2008a) conducted studies on diversity and distribution pattern of high altitude medicinal and aromatic plants of Sangla valley in Himachal Pradesh. The Population ecology of the Himalayan Yew (Taxus baccata subsp. wallichiana) was studied (Shreekar and Samant, 2008) in Khokhan Wildlife Sanctuary of North Western Himalaya for conservation management by sampling six forest communities of the wildlife sanctuary.

Verma et al. (2008) recorded 75 species of plant, comprising of 7 grasses, 4 sedges, 4 leguminous forbs and 60 non-leguminous forbs from the Talra wildlife sanctuary of district Shimla, Himachal Pradesh. The distribution of all the plant species was contiguous. Index of dominance was 0.036 and index of diversity
The Phytosociological study in natural forests of Hastinapur has been conducted (Khurana and Kalpana, 2008) and the species richness, biodiversity index and total number of plants of three forests sites were measured.

Species composition and diversity of tree species were analysed (Khare and Thakur, 2008) in 10 representative forests sites occurring in Sagar district (Madhya Pradesh). The composition of forest vegetation along an altitudinal gradient (400-525 m and 525-650 m) in Simbalwara wildlife sanctuary was studied (Verma et al. 2009). The forest is composed of 53 species of trees, 32 of shrubs and 175 of herbs. The distribution pattern of plant species was random and contiguous at both the altitudes.

Tripathi and Singh (2009) studied species diversity, structure and concentration of dominance of woody plants at various strata of natural and plantation forests within the Katerniaghat wildlife sanctuary, North India. The tree densities were higher in plantation as compared to natural forests. The vegetation composition and diversity was studied in the reclaimed mines in Sirmour district of Himachal Pradesh (Saxena and Soni 2010). A chronosequence of four reclaimed sites and an adjoining stands of natural forest were selected and periodical phytosociological studies undertaken.

Rohit and Sharma (2010) ecological studies were carried out and revealed the dominance, diversity and species richness of tree species along an altitudinal gradient of Mandakini catchment of Garhwal Himalaya. The study revealed that diversity/ha and total basal area values of the selected stands ranged between 2084 and 600 trees ha\(^{-1}\) and 55.44- 6-.36 m\(^2\) ha\(^{-1}\) respectively. The ecology of medicinal plants were carried out and observed that (Ram et al. 2010) the most frequent medicinal herb was *Artemisia nilagerica* while large number of medicinal herbs was rarely distributed in these forests. It was concluded that the natural distribution and their associations would be important for growing and covering the medicinal herbs in the Uttarakhand Himalaya.

The present study was conducted to study the floristic diversity and vegetation types of Rawa district in Madhya Pradesh (Shukla et al. 2010). The floristic analysis of data revealed that the family Poaceae shows maximum
diversity represented by 101 species, followed by Fabaceae with 65 spp., Cyperaceae with 37 spp., Asteraceae with 36 spp., Euphorbiaceae 31 spp. etc. A brief account of area, climatic conditions, vegetation types, floristic analysis and brief note on economic plants, invasive and threatened taxa have been discussed.

Srivastava and Banerjee (2010) three monitoring locations were selected in the vicinity of industrial estate and data were collected to compute species richness, Evenness, Importance Value index (IVI), Shannon-Wiener diversity Index and Simpson’s Index of biodiversity. The Simpson’s Index of biodiversity varied at a range 0.28 to 0.41, signifies the presence of less biodiversity. Species Evenness, a measure of relative abundance of the different species was at a range of 0.36 to 0.46. Verma and Kapoor (2010) carried out assessment of floristic diversity in Pooh valley of cold desert of district Kinnaur, Himachal Pradesh and reported that the distribution pattern of most of the plant species was contiguous. The index of diversity for herb species was reported 3.89, 3.86 and 3.81 for 2700-3200m, 3200-3700m and 3700-4200m elevation ranges respectively. The study was undertaken to understand to community behaviour of *Nardostachys jatamansi* in three density classes (Vasistha *et al.* 2011) viz; maximum, moderate and minimum in sub alpine and alpine areas of Yamunotri region of Uttarkashi district in Uttarakhand.

A study was conducted by Verma and Kapoor (2011a) to understand the plant diversity along an altitudinal gradient with elevations varying from 3000 m to 5000 m above msl in Ropa- Giavung valley falling in cold desert area of Pooh sub division of district Kinnaur, Himachal Pradesh during 2008. The dominant families were Asteraceae, Polygonaceae, Rosaceae and Ranunculaceae. On the basis of Importance Value Index (IVI), *Ephedra gerardiana, Artemisia brevifolia, Bistorta affinis* and *Potentilla argyrophylla* were the dominant herbs dotting different elevational ranges and distribution pattern of plant species was mostly contiguous in all the altitudes. Index of similarity for herb species between different altitudes was low indicating more dissimilarity of species between different altitudes.
Verma and Kapoor (2011b) conducted study to assess the plant at elevation varying from 300 m to 4500 m above msl in Murti Pang Valley of Rakchham-Chitkul Wildlife Sanctuary of District Kinnaur, Himachal Pradesh. A total number of 131 plant species belonging to 46 families and 91 genera was collected. The dominant families were Asteraceae, Rosaceae, Polygonaceae, Lamiaceae and Ranunculaceae. The dominant tree species was recorded as *Populus ciliata* and *Juniperus polycarpos*, whereas among the shrub species, *Berberis jaeschkeana* and *Juniperus indica* were dominant at 3300-3700m and 3700-4100m above msl respectively. The herb species *Sibbaldia cuneata*, *Thymus linearis* and *Heracleum lanatum* were recorded as dominant at 300-3700m, 3700-4100m and 4100-4500m above msl respectively. Index of diversity for herb was 4.02, 3.78 and 3.67 for 3300-3700m, 3700-4100m and 4100-4500m above msl respectively. A study was conducted (Verma and Kapoor, 2012) to understand the plant diversity along an altitudinal gradient elevation varying from 2400-2625m above msl in alpine areas of Dainkund in Kalatop Khajjiar Wildlife Sanctuary in District, Himachal Pradesh. The total number of shrub and herb species was recorded 10 and 53 respectively. The dominant shrub and herb was recorded as *Vibernum erubescens* and *Erigeron multiradiatus* respectively. The richness index for shrub and herb species was recorded 1.463 and 7.148 respectively.

Pant and Samant (2012) conducted the studies on diversity and regeneration status of tree species in Khokhan Wildlife Sanctuary of Kullu district, Himachal Pradesh. Rawat and Chandra (2012) carried out tree layer vegetational analysis in temperate forest of Uttarakhand and recorded the maximum species richness was at moist habitat, while minimum at stream bank habitat and ridge habitat. *Lyonia ovalifolia*, *Quercus leucotricophora*, *Rhododendron arboreum* and *Myrica esculenta* was the dominant tree species. Species diversity was maximum on moist habitat. The present study concludes that the distribution and species richness pattern in this region largely depend on the altitude and climatic variables like rainfall and temperature.

The investigations were carried out by Mishra et al. (2012) to record the annual variation in phytosociological status and population dynamics of herbaceous flora of Anapara region in Sonebhadra district of U.P. The
phytosociological aspects viz. Relative Frequency, Relative Density, Relative Dominance as well as the Importance Value Index (IVI) of three representative genera namely *Vernonia*, *Tridax* and *Parthenium* of family Asteraceae were studied thoroughly for three successive years. Banarjee *et al.* (2012) documented biodiversity of the two fenced area of Dhanolti reserve forest of Mussoorie forest division with the view of long term ecological monitoring of biodiversity with inventory of its floral and faunal diversity.

2.3 ETHNOBOTANICAL STUDIES

The role of traditional and folk medicines is well known and plays a vital role in the treatment of various human ailments. For many centuries the aborigines had a traditionally self managed system of folk medicine mainly based on herbal remedies. Modern medical facilities could not reach as yet in the remote and far flung areas. Ethnic people have deep belief in the traditional system of native folklore-medicine for remedies and rely exclusively on herbal cures.

The plant remedies of primitive societies, handed down by word of mouth from generation to generation, gradually became part of the knowledge of ancient civilizations. They were described in ancient books, on Egyptian Papyri, on Babylonian clay tablets, and on temple walls. Plant drugs were written about in China 5000 years ago. The first God of healing was Emperor Shen Nung, who, according to legend, tried out the medicinal value of hundreds of herbs. He is supposed to have described 250 plants in the first Chinese herbal, written about 2700 B.C. This work became the foundation of all latter Chinese works on plants. The most famous of these later work is the Great Herbal, the Pen-Ts’ao of Kang-Mu published in 1596 during the Ming Dynasty. All the plant of China was collected in this fifty-two-volume work. Over a thousand plants were listed, with their history, the prescribed dosage, and the methods of preparation. Some of these herbal remedies are being used in China today, along with the most modern twentieth-century medicines (Selsam, 1959). The Greeks learned much from the ancient writing in Egypt and Babylonia. Hippocrates, called the father of medicine, described the use of many plant drugs in the fifth century, B.C. Aristotle’s pupil, Theophrastus, wrote, about 300 B.C., an Inquiry into Plants.
These book sums up the knowledge of plants gained up to that time and the section on medicine lists 500 plants.

The superstitions in the sixteenth century were called the Doctrine of Signatures. According to this, every plant showed some sign of its intended use. If a plant had leaves shaped like the lobes of the liver, it was undoubtedly meant for diseases of the liver. If it had heart shaped leaves, it was surely beneficial to the heart. Yellow plants must be for the cure of yellow diseases like jaundice. *Saxifraga*, which grew among broken rocks and crumble them, would crumble the stones in a man’s kidney. We still have remains of the Doctrine of Signatures in the common names of many plants like heartsease, liver leaf etc. The first book about medicinal plants actually written in America was the Aztec Herbal of 1552. The author was an Aztec Indian Doctor, Martin de la Cruz, who was studying at the college of Santa Cruz in Mexico. The book was translated into latin by a fellow Aztec, Juannes Badianus. The curative value of hundreds of native Mexican plants was pictured and described in this beautiful manuscript.

The Rigveda believed to have been written about 5000 B.C. and regarded as first authentic record of human civilization, mentioning many plants for their beneficial effects. The systematic study of Indian vegetable drugs was carried out in early nineteenth century. Probably the botanical observations of selected plants are the first step in such a direction. *The Catalogue of Indian Medicinal Plants and Drugs* was followed by the *Bengal Dispensary* and *Pharmacopoeia of O’Shaughnessy* (1841) where in the properties and uses of the medicinal plants were mentioned. The *Pharmacopoeia of India* was published for more understanding about the indigenous medicinal plants. Some important drugs of India from this work were incorporated in *British Pharmacopoeia*. The *Translation of Sanskrit Materia Medica* and the *Materia Medica of Madras* brought a good account of drugs used by the then Hindu physicians. *The Vegetable Materia Medica* of Western India was also a good contribution to indigenous drugs work conducted by different people (1890-93) as *Pharmacographia India* were practically the *Compendium of Indigenous Medicinal Plants*. 
Later on encyclopedia work (1889-1890) *The Economic Products of India* was completed and this catered a information on vegetable drugs. *The Indigenous Drugs of India* (1896), *Indian Medicinal Plants* (1958), *Indian Meteria Medica* (1954) and *The Wealth of India* (1948-74, 1994) are the note-worthy publications in this field of study (Pal and Jain, 1998). Western Himalayas being an emporium of medicinal plants holds great references to ethno-botanical studies. There is a rich wealth of information on the identity and distribution of different plant species of the region in the form of regional floras, reports of botanical expeditions floras, monographic accounts of families, genera and similar other publications. Different workers have carried out such studies in Himachal Pradesh (Shabnam, 1954 and Gupta, 1961).

Chauhan (1974) reported the use of *Ainsliea aptera* for curing acute gastritis by the Gujjars, Gaddies and Vaids residing in the remote parts of Himachal Pradesh. Uniyal and Chauhan (1979) reported 30 Indian medicinal plants used in Tibetan medicines at Tibetan Medicinal Centre, Mcleod-Ganj, Dharamshala, district Kangra. Murty and Sharma (1984) reported the use of some plants as narcotic by the tribals of Orissa. Among the list are included *Antherochelamus chinensis*, *Ardisia solanacea*, *Musa paradisiaca*, *Holarrhena antidysentrica*, *Clerodendron indicum* etc. Similarly, Ommachan and Maish (1991) enumerated 233 flowering plants from tribal dominated district of Madhya Pradesh and brought out valuable information regarding the local use of plants. Among the plants used for specific purposes included *Rauwolfia serpentina* for blood pressure, *Barleria prinitis* for whooping cough and tuberculosis, *Smilax zeylanica* for venereal diseases and *Jatropha curcas* for cancer. Hosagaudhar and

Hosagaudhar and Henry (1993) reported the traditional use of plants for inducing sterility and increasing fertility in women, by the tribes of the Rangana Betta in Mysore. They reported that the roots of *Adiantum lunulatum* and *Nephrolepis cordifolia* are used in cases of permanent sterility in women. The stem bark of *Elaecocarpus tuberculatus* and *Schliechera oleosa* is used as an abortifacient and that of *Ficus* species to promote fertility in women. Aminudin (1996) highlighted the use of locally available plant wealth by the tribes of Paudi Bhuinya of Bonar hills in district Sundargarh, for day to day use. Some important

Chauhan (1997) documented the ecological and ethno-botanical studies on the flora of Spiti. Out of 477, identified species, 74 were categorized as medicinal and aromatic plants, 104 plant species with ethno-botanical importance were recorded. Similarly, Sharma (1998) did ethno-botanical studies of Gaddies- A tribal community in district Kangra of Himachal Pradesh. He collected 161 species belonging to 124 genera and 54 families. The ethno-botanical study was carried out by Chauhan and Chauhan (1988) among Paharis inhabiting the trans- Giri area of Sirmour district in Himachal Pradesh. Kumar and Pullaiah (1998) revealed first hand information gathered on 50 ethno-medicinal plants traditionally used by Chenchu, Yanadi, Suga and Yerukala tribes of Prakasam of Andhra Pradesh for the treatment of various diseases and disorders.

Bhatt *et al.* (1999) described 54 ethno-medicinal plants, which were used by tribals and rural people of Jhuni and adjoining villages near Pindari glacier of Bageshwar district. Chaurasia *et al.* (1999) conducted a ethno-medico-botanical survey of Nurba valley of Ladakh and documented 36 plant species of ethno-medicinal properties along with botanical name, local name, family, locality, altitude, brief notes and specific uses. Yonzone and Yonzone (1999) listed the ethno-botanical uses of 18 plants for food, medicine, paper, pesticides and other purposes, among the 18 tribal communities in Darjeeling Himalayas. Awasthi and Goel (1999) ethnobotanical studies were carried out among members of the Onges tribe. A brief account of geography of Little Andaman Island is presented. Seventy one plant species used for various purposes in day to day life (medicinal, food, fuel, fish poison, building materials etc.) are listed in alphabetical order of Latin name, with family and common names, part(s) used, mode of application and voucher number.

Poll (1999) carried out study on medicinal plants in area of Mayan culture, such as Guatemala, has been significant since ancient times. They found that many habitants of rural area depended greatly on the use of medicinal plants to treat diseases and disorders. Based on the results of ethnobotanical studies 10
common species of medicinal plants with hypoglycaemic effect were described. Sharma and Rana (1999) enlisted the ethno-botanical, Ayurvedic and pharmacological uses of 27 plant species used in rural areas in Himachal hills, Himachal Pradesh. Singh (1999) gave a brief ethno-botanical account of 109 plant species belonging to 41 families and 86 genera found in Kullu district of North-western Himalayas.

Natarajan et al. (2000) did ethno-pharmacological study from Kullu district and reported that local women in hamlets of Banjar Taluka, Kullu district, used 34 plant species. Singh and Kaushal (2000) gathered information on the traditional use of 14 medicinal plants, which are utilized in Veterinary medicine by the Gaddies of Kangra valley for preparing powder, paste, aqueous extract, decoction etc. for treating the sick animals. Verma (2000) carried out ethno-botanical study and collected 250 species of ethno-botanical importance under 213 genera and 80 families from different locations of Kunihar forest division of Himachal Pradesh.

Khanna and Ramesh (2000) gave an account of ethno-medicinal uses of 50 plant species known among the Gujjar tribes of Saharanpur district of Uttar Pradesh. Comparison of their uses with those mentioned in the concerned literature indicated that 22 ethno-medicinal uses of plants were not reported earlier. Silori and Rana (2000) described the indigenous knowledge on medicinal plants in Narayan Sarovar Sanctuary in the arid district Kachchh of Gujarat State. They enlisted 34 medicinal plants and their uses to cure a range of diseases. Of these, 27 species had multiple use efficiencies for treating more than one disease individually or in combination with other medicinal plants.

Rajendran et al. (2001) did an ethno-botanical survey for collection of plant samples, which were used as ethno-medicinal by Valaya tribals of Seithur hills of Virudunagar district forest division. The survey revealed the uses of 36 plant species belonging to 33 genera and 24 families of flowering plants. Similarly, Singh et al. (2001) collected a total of 39 aromatic plant species from far-flung areas and higher passes of Ladakh and Lahaul and Spiti along with their various local uses. Viswanathan et al. (2001) gave an account of 56 ethno-medicines used in 49 preparations by the Kanis or Kanikkars in the Kalakkad-Mundanthurai Tiger
Reserve of Tamil Nadu, India. The ethno-medicinal data include botanical name of the plant, family, locality, tribal names and medicinal use of voucher specimens.

Nautiyal et al. (2001) conducted a study on indigenous knowledge system of some tribes in Bhagirathi valley’s of Garhwal Himalayas and concluded that Bhotiya communities use over 220 wild plant species, either as whole plant or as their parts (including roots, tubers, leaves, stem and bark) of these 80 per cent were used for medicine, directly or indirectly. Negi and Subramani (2002) carried out an ethnobotanical survey of the tribal village Chhitkul, district Kinnaur, Himachal Pradesh, which resulted in the recording of 17 plant species of medicinal importance, 25 of edible and agricultural value, 14 of cultural religious importance and 22 species of fuel, fodder and timber values. Punjani (2002) revealed the information on 63 plant species from 60 genera and 36 angiosperms families used for the therapy of various ailments by the tribals of Danta Taluka, Banaskantha district of Gujarat State.

An ethnobotanical survey conducted in the Ayyanar Koil reserve forest of Tamil Nadu, India, revealed 43 plants with different medicinal properties were tabulated. Of these 14 plants were used for treatment of fevers including malarial fevers and also to treat cuts and wounds. Similarly, about 12 species were used for treating bronchial asthma and acute coughs, respectively (Rajendran et al. 2003). The Ethnobotanical studies were conducted in Melpattu Reserve forest, Javvadhu Hills of Eastern Ghats, Tamil Nadu, India to document the floristic composition and population in the area. A total of 63 species were enumerated. Each species is provided with a brief description, frequency of occurrence, habitat followed by information on medicinal uses (Ravi and Sankar 2003). An ethnobotanical survey of the Igede-speaking area of Nigeria indicated that over 30 taxa of plants were used in traditional medicines, a total of 31 prescriptions for different kinds of ailments or therapeutic indications were noted (Igoli et al. 2003).

Pakia and Cooke (2003) carried out the ethnobotanical studies on medicinal plants uses of three Midzichenda tribes and found that a significant proportion (56%) of all plant species used were employed for the basic health care system and
magical rituals while other medicinal plants were used only on the basis of mythical beliefs within the society. Out of 5856 flowering plants recorded in Nepal, 690 species are identified as medicinal plants. A vast majority of rural people in Nepal still practice traditional knowledge and depend on medicinal plants for primary health care. Collection and trade of medicinal and aromatic plants has also been the source of their income (Sharma et al. 2004). Medicinal plants of commercial value are in a state of threat due to deforestation and over harvesting. For this reason conservation, management and sustainable utilization of medicinal plants is necessary for Nepal.

Singh and Pundir (2004) collected some information on the ethnomedicinal plants used by the tribal people of Jaunsar-Bawar and also listed their botanical name, family, English name, vernacular name, habit and habitat, flowering and fruiting season and their ethno-medicinal uses. Singh (2004) conducted the studies on indigenous knowledge and conservation practices of biological resources among the tribal society. Similarly, Gonzalez et al. (2004) conducted a study on traditional therapeutic use of 84 species belonging to 38 families of medicinal plants with the aim to resecure and preserve a part of the traditional culture in Galicia and Spain.

Chatterjee (2004) conducted a study on the ethnobotanical resources of India, their utilization patterns in the tribal dominated areas in general and in the North-eastern Himalayan region in particular. He concluded that tribe of North-Eastern region uses more herb species, whereas Western Indian tribes would prefer more tree and shrubby species. Bhattacharya and Krishna (2004) gave the significance and potential of medicinal plants for rural women and child health care. The trend and the existing use of the major species of medicinal value for the cure of women and children diseases were described. Bondya and Sharma (2004) conducted ethnobotanical studies on plants used for the treatment of diabetes in the Bharagora Block of Jharkhand, India and concluded that 11 Ethnomedicinal plants used in the treatment of diabetes along with their local names and mode of preparation and administration.
Singh and Chauhan (2005) also recorded the plant habit, plant characteristics, plant part used of 43 plant species belonging to 25 families and also there local use in curing different diseases in Lahaul valley. Pandey and Verma (2005) study revealed marvellous aspect of ethnom botany, ‘remedy through plant wreath’ has been explored out from the aboriginals of sub-himalayan Tarai region of Uttar Pradesh, India. The study provides an enumeration of 16 plants with their pharmacognostic features and uses in a novel way with clinical confirmations in some cases. Sharma and Lal (2005) gave the indigenous therapeutic application and other traditional uses of 9 plant species that are used by natives of Himachal Pradesh, India. The information provided includes scientific name, family name, vernacular name, distribution and ethnobotanical use along with the common used are recorded from relevant literature.

Rajiv and Vijendra (2005) enumerated some medicinal plants used for common diseases by traditional healers Central India. Khumbongmayum et al. (2005) ethnobotanical studies carried out in the four sacred groves of Manipur (India) revealed therapeutic applications of 120 plant species representing 106 genera and 57 families. Tree species contributed the maximum having 42% while herbs recorded 33% of the total medicinal plants. These plants are used for a wide range of common ailments such as skin disorders, ulcer, rheumatism, and bronchitis. Leaves are the major plant parts used for the preparations of medicine by the medicine-men (‘Maibas’). Most of the plant parts are harvested from the wild. It has been observed that the species that are scarce locally in the forest due to various developmental activities, deforestation and over-exploitation are abundant in the sacred groves.

The use of plants by the native people of the Saurashtra region of Gujarat, India for the cure of diarrhoea is described (Jadeja et al. 2005) uses of 162 plant species, along with their local names and other information. An ethnobotanical study (Begum et al. 2005) revealed that 44 species of 31 families are being used by the local people of Dheri/Julagram Malakand Agency (Pakistan). These plants were invariably used as crude drugs for treating various diseases. Local name and disease treated is recorded. The information collected shows that the people
mostly use allopathic medicines. The ethnobotanical knowledge about the use of medicinal plants rests mainly with the elders.

Exploration trips (Reddy et al. 2005a) were undertaken for ethnobotanical studies and germplasm collection of the traditional Ayurvedic medicinal plants. 36 medicinal plant species belonging to 21 families have been enumerated, highlighting local medicinal uses practiced by local tribals and villagers since ages. Similarly Reddy et al. (2005b) conducted ethnobotanical studies in the Eastern Ghats region of Andhra Pradesh, India, covering Chittoor, Cuddapah, East Godavari, Guntur, Khammam, Krishna, Kurnool, West Godavari and Visakhapatnum districts and the tribal populations of Chenchus, Erukalas, Koyas, Konda Reddis, Lambda’s (Sugalis), Nukadoras, Valmikis and Yanadis. The studies brought to light the ethnic uses of 21 epiphytic and terrestrial orchids.

The study on weeds as medicinal plants used by the traditional healers in Bhojpur district of Bihar, India, for treating ailments and also discussed the medicinal and other useful weed species with their name and its medicinal uses. Information on other general economic importance of medicinal weeds is also described (Rai and Pandey, 2005). The investigation were carried out to enumeration of plants with medicinal values, which are used by the Valaiyans, an ethnic group, residing in and around Piranmalai Hills, Tamil Nadu, South India (Sandhya et al. 2005). The study elucidates a rich and unique profile of Phytodiversity of the area surveyed, with 63 species of medicinal plants belonging to 59 genera and 38 families.

Viraj and Dutt (2007) carried out survey in the Sangla valley of tribal district Kinnaur in Himachal Pradesh and collected information on plants of religious beliefs. A result of interaction with the local people the information on 8 plant species belonging to 7 genera from 7 families was collected. Chauhan et al. (2007) gave the information on 241 multipurpose plant species found in Kullu valley of Himachal Pradesh along with their botanical name, local name along with uses. Kumar et al. (2008) conducted the studies on ethno-medicinal values of plant species used by Sahariya tribe of Lalitpur district in Bundelkhand region and
revealed 29 plant species that are used for treatment of various day to day diseases.

The ethnobotanical studies have been carried out among the tribes of Sangla valley of district Kinnaur in Himachal Pradesh (Viraj and Dutt, 2008b). As a result of interaction with the local people the traditional information on plant species were recorded and are presented along with their botanical name, local name and their local uses. Balakrishnan *et al.* (2009) conducted ethnobotanical studies among villagers from Dharapuram Taluk, Tamil Nadu and reported that thirty one formulations incorporating 31 plant species as being used for treatment of female reproductive disorders. Gupta *et al.* (2010) conducted ethnobotanical survey in villages of Deoband tehsil of Saharanpur district of Uttar Pradesh. During the study 74 plant species from 69 genera belonging to 42 families were found of ethno-medicinal value. The plant species are enumerated in alphabetical order with families and local names, followed by their ethno-medicinal uses.

The investigation was attempt for the documentation of MFP’s (Ranjeet and Joshi, 2010) used by local of the Govind wildlife sanctuary and National Park of Uttarakhand. The study revealed that the 173 plant species belonging to different families were used for various purposes by the local people. Reddy *et al.* (2011) an ethnobotanical survey was carried out among the ethnic groups of Yerukala, Yanadi and Sugali tribals inhabited in Sheshachala hill range of Kadapa district, Andhra Pradesh, Indian. A total of 60 plant species belonging to 33 families of ethnobotanical interest upon enquiry from these tribal informants between the ages of 50-82 years were reported. The study shows a high degree novelty in the use of plants among the tribal people reflecting the revival of interest in traditional medicine.

Sawan *et al.* (2011) studied the ethnobotanical shrubs used by the Golatappar fresh water swamp forest of Dehradun, Uttrakhand. The investigation revealed medicinal properties of 24 species belonging to 23 genera under 16 families. The taxa with ethno-medicinal uses are arranged alphabetically with botanical name, local name, family and fruiting/flowering period and their uses.
Avasthe et al. (2012) studied the ethnobotanical edible plant biodiversity of Lepcha tribes in Sikkim.

Santvan et al. (2012) carried out the studies on status and uses of tree flora of Darlaghat Wildlife Sanctuary, Solan (H.P.) used for various purposes which include house construction, furniture, agricultural implements, fuel etc. Kumari et al. (2012) studied the non-timber forest products used for mother and child health care in tribal and non tribal communities located in Kinnaur, Lahaul, Bharmour and Pangí (tribal area) Shilai, Churah, Parvati valley and Chhauhara (non tribal but remote area) in Himachal Pradesh revealed that 9 species are used as tonic by the expecting mothers. Rana et al. (2012) carried out studied on extraction, utilization pattern and prioritization of Fuel resources for conservation in Manali Wildlife Sanctuary, Northwestern Himalaya.