"What is envisioned is nothing less than a complete energy research and development organization. It will be one, which will fill in the gap in our present research effort and provide a balance in national research program. It will give proper emphasis to each energy source according to its potential and its readiness for practical use."

- Ford
Energy is essential to life and facilitates all human endeavour. It is the life-blood of industry and the vital factor in domestic comfort, like heating and cooling, illumination, health, food, and education (Hartley, 1984). Energy is also a vital commodity in transportation. Energy shapes the development of human society and civilization. Energy is considered a prime agent in the generation of wealth and also a significant factor in economic development (Demirbas, 2003).

Larger quantities of energy and better quality of energy are equally necessary for raising living standards in the face of a rising population and for providing energy for economic development (FAO, 2000; World Bank, 1998; Dincer and Dost, 1997). According to Uchiyama (2002), stable energy supply is absolutely essential for leading a high quality of life. The process and progress of economic development of a country lie with enhancing the productivity and efficiency of human labour, which is fueled by utilization of more energy. One of the best indices to assess the economic status of a country is the energy consumption per capita. Adoption of a “better” fuel has also been perceived as a status symbol (NIRD, 2002).

Energy contributes to widening opportunities and empowering people to exercise choices. Access to energy is essential for economic, social and political development. Changes in the way energy is produced and use can be instrumental in socio-economic development, poverty alleviation, and social change, as well as in improving the living conditions of women (Goldemberg and Johansson, 1995). It encourages individual development via an improvement in educational and sanitary conditions (Kauffmann, 2005). Conversely, its absence can constrain both men and women from contributing to economic growth and overall development.

Growth cannot be ensured with the mere availability of energy, but rather with the quality of energy services that emphasize efficiency, equitable social
distribution and minimum environmental impact (Mak and Shearer, 1996). Energy is a key input for sustainable development and is rather a means to achieve the goal of sustainable human development (Larson and Kartha, 2000).

Increased demand for upgraded energy in a more sophisticated forms such as electricity, tailored liquid fuels and smokeless fuels that are easy to distribute, handle and use was in greater demand by both industrial and domestic sectors during 20th century and has led to major change in the energy consumption pattern, which is being visualized till today. The pattern of energy consumption depends partly on the availability of indigenous energy sources (Hartley, 1984).

Developing countries often face constraints to growth and development that are directly related to the un-sustainability of current patterns of energy production and use. At present, energy sue patterns are skewed towards conventional energy sources, which not only hamper economic growth and conservation of the environment, but also aggravate social and gender inequities (Shailaja, 2000). The shortage of energy in rural areas has made people living in these areas to become trapped in subsistence level economies characterized by inefficient use of non-commercial energy, low agricultural productivity and poor standards of living (Best, 1992).

Cooking energy has the major share in total household energy consumption (Laxmi et al., 2003). Two main transitions can be distinguished in the history of the energy system (Grubler et al., 1995; Grubler, 1998). From the past several years, the biomass fuel has been replaced by a much cleaner energy sources, such as conventional fuels (kerosene, LPG, CNG etc.) and now renewable energy sources (solar, wind, biogas etc.). Amidst the changing energy sources, wood or biomass fuel stands as the dominating energy source used for domestic purposes in the rural and poor households, especially in the developing countries (Singh et al., 1987; WHO, 1997 and WRI, 1998).
Biomass for energy use, according to the time and method of harvest and to economy, includes roots, tubers, stems, or branches, leaves, fruits and seeds or even whole plants (Bassam, 1995).

Income is the main driver in choosing energy (Leach, 1992 and Reddy and Reddy, 1994). Low incomes and the lack of access to alternative, modern fuels explain their choice of traditional energy supply (Victor and Victor, 2002). Most of the populations in the developing countries are peasants, living in a subsistence economy and their energy needs for cooking, heating, protection (a fire keeps away unwanted insects and wild animals), and cottage industries are met almost entirely by burning wood which is collected from the surrounding countryside (Cross, 1984).

There is a natural and universal hierarchy in the use of domestic fuel (Martinez-Alier, 1995). As income increases, wood and charcoal are replaced by kerosene and butane gas or LPG, which are in turn replaced by natural gas or electricity (Martinez-Alier, 1995). The highest income group of households significantly reduced biomass use (Jiang and O’Neill, 2003). Jungbluth, 1995, reported that when choosing between kerosene and LPG, the latter is preferable, on the basis of the environmental impacts of the entire fuel cycle (extraction of petroleum and natural gas, processing, transport, and distribution), and cooking. Cleaner fuels like LPG, kerosene, electricity and other modern fuels being a costly form of fuel are used by families in urban areas (Andrea et al., 2001) and by relatively affluent segments of the society (Behera et al., 2001). Kerosene is used by many rural poor households for lighting and to a limited extent, for cooking (Kebede, 2001).

Household fuel use can be viewed along an “energy ladder”, beginning with traditional biomass, and proceeding to fuel-stove combinations that are cleaner, more convenient and more efficient, but increasing in capital costs as the ladder is ascended (OTA, 1992). Each rung of the ladder corresponds to the dominant
fuel used by a particular income group, and different income groups use different fuels and therefore occupy different rungs of the energy ladder (Hosier and Dowd, 1987). Unfortunately, while households around the world have moved to higher rungs of the ladder, as alternatives because affordable and available, many in developing countries are still dependent on fuel-wood, and some have been forced down by local fuel-wood shortage to even shrubs and grasses (UNDP et al., 2000). The fossil energy sector mainly serves the high-income households (Kebede, 2001). Lack of appropriate pricing and distribution policies has kept cleaner fuels far away from the poor rural community.

The transition away from reliance on collected wood as a fuel and toward increased purchase of commercial (often fossil) fuels tends to occur as people’s standards of living improve (Smith et al., 1992). However, the “switch” between fuels is often found to be incomplete in both rural and urban areas (ESMAP, 2001). Many households use more than one fuel and with that used for cooking the main meal not necessarily used for supplementary meals and heating (D’Sa and Murthy, 2004). A mass of evidence now supports an alternative view mentioning that, rather than completely switching to alternative fuels, many households actually follow a “multiple fuels” strategy, which allows them to get the advantages of both traditional and modern fuels, which further helps the households to be more resilient to an uncertain and rapidly changing economic development (Masera et al., 2000).

Residential energy use in developing countries has traditionally been associated with incomplete combustion as a result of combustion devices of poor energy efficiency, which have been shown to produce substantial health-damaging pollution, contributing significantly to the global burden of disease, and greenhouse gas (GHG) emissions (Edwards, et al., 2003). The current level of energy consumption and production threatens the ecosystem, economic growth, and human survival (Johansson and Goldemberg, 2002).
With increasing human population and increasing diversification of his activities, the energy requirements have increased manifold. Per capita energy consumption in the world is increasing at the rate of 1.3% per year (Awasthi, \textit{et al.}, 1980). The appetite for energy has often exceeded the capacity of local sources of supply.

The fuel structure amongst the countries of the region varies significantly. The world’s energy resources are now generally agreed to be sufficient for as long as anyone can foresee. But the fact remains that they are badly and unfairly distributed demographically (William and Davidson, 1984). The International Energy Outlook (IEO) (2004) projects strong growth for worldwide energy demand over the 24-year projection period from 2001 to 2025. Total world consumption of marketed energy is expected to expand by 54 percent, from 404 quadrillion British thermal units (Btu) in 2001 to 623 quadrillion Btu in 2025.

Energy issues and policies in the countries around the world have been concerned mainly with increasing the supply of energy. People living in poverty have benefited very little from conventional energy. However, a continuous search is on for alternatives to cope up with the ever-growing energy demand, and to mitigate adverse environmental and human health.

Globally, almost 3 billion people rely on biomass (such as wood, charcoal, crop residues, and dung) and coal as their primary source of domestic energy (Smith, \textit{et al.}, 1983; Aristanti, 1996; Ezzati and Kammen 2002), for cooking and heating (EC-FAO, 2001). In some cases, when fuel wood is not available the households rely on cow dung and crop residue for energy (TNFP, 2004). In the scientific literature, the total global potential of biomass energy and material supplies is estimated to range between 80 to 1250 EJ/year in the long term (Hoogwijk \textit{et al.}, 2003), while the global primary energy consumption in the year 2001 was about 420 EJ/yr. (IEA, 2003). However, most studies expect
a contribution of 50-200 EJ from biomass energy in 2050 with the largest part from dedicated energy crops and limited contributions from biomass residues (Berndes et al., 2003).

In the past 10 years, there has been renewed interest, worldwide, in biomass as an attractive alternative to fossil fuels. Especially in developing countries, as it is readily available and when properly managed the resource is renewable and provides an indigenous fuel supply at lower cost (Cuiping et al., 2004). Biomass fuels remain the primary source of energy for more than half the world’s population and account for 14% of the total energy consumption in the world (McKendry, 2002), and especially in poor rural communities (Nathan, 1996), derived from natural forests, plantations, woodlots, and trees around the homestead (Agarwal, 1998). Biomass accounts for more than one-half of domestic energy in many developing countries and for as much as 95% in some low income ones (Reddy, et al., 1996 and Ezzati and Kammen 2002). Biofuels are used widely in south Asia for cooking (Venkataraman et al., 2005).

It is also the most widely used source of primary energy for cooking in the rural areas of south Asia (Venkataraman et al., 2005), in Sri Lanka (Wijayatunga and Attalage, 2002), in Nepal (Sharma and Bhattacharya, 1997), in Bangladesh (Sarkar and Islam, 1998) and in Pakistan (Anwer, 2001). In china, 63% of households still use biomass for heating and cooking, this accounts for more than 70% of total fuel use among the rural population (Jiang and O’Neill, 2003). Saharan African countries continue to rely on biomass energy to meet the bulk of their household energy requirements and in Nigeria, it is estimated that about 91% of the household energy needs are met by biomass (Karekezi, 1999). The high levels of poverty prevalent in sub-Saharan Africa are reflected low level in the consumption pattern of modern energy (World Bank, 2001, Karekezi et al, 2001).
Use of fuelwood, a biomass fuel is a traditional one. Fuelwood is the most common energy source in rural Third world population (Allen et al., 1988). With increased oil and gas prices in the world market and, hence, increased LPG prices in the local market, it is likely that a certain portion of the population will shift to indigenous energy sources, such as fuelwood, to satisfy household cooking energy requirements (Wijayatunga and Attalage, 2002). Shortage of energy supply has led to the increased dependence on fuel wood by rural communities in order to meet their energy demands (Kgathi, 1992).

More than 1 billion of the world’s females (women and their daughters) whose poor families must rely on “free” solid fuels (fuelwood and dung) for cooking and heating (Goldemberg et al., 2004). In the total resources, including traditional fuels, wood fuel is dominant in Sub-Saharan Africa (Ardayfio-Schandorf, 1986). There is linkage between the burden of carrying fuelwood over increasingly greater distances and the progressively greater dependency on dung as fuel (Eckholm, 1975a, 1975b and 1976). Studies conducted by Pandey 1984, shows that in many areas of the Himalaya, and especially in Nepal, the use of dung for fuel is more closely related to the ethnic origin of the community rather than shortage of fuelwood.

Wood is likely to continue as the most important universal fuel for rural areas of developing countries and the demand will increase enormously in the coming decades, as the underground fuels become more scarce and expensive (Das and Sarkar, 2005). About 6 out of 10 African women living in rural areas have to deal with the scarcity of supply of firewood, compared with 8 in Asia and 4 in Latin America (Kauffmann, 2005).

Energy consumption in India has assumed paramount importance in the recent years. India is the world’s sixth largest energy consumer, consuming about 35 percent of the world’s total commercial energy demand in 2001. Although rural electrification had made steady progress in the past decades, the
availability and consumption of electricity in rural areas are extremely low at present (Kishore and Bansal, 1988). Rajvanshi (2003) has reported that the poor grid infrastructure has resulted in electricity shortage in rural areas. It has been shown that 59% of households rely on wood for cooking fuel, 13% on crop residues and dung cakes, 17% on liquid petroleum gas, 8% on kerosene, and rest on other fuel sources (GOI, 1994). Some 700 million biomass energy consumers are estimated to live in India alone (ESMAP, 2001).

It is estimated that in India, non-commercial form of energy such as firewood, agricultural wastes, forest wastes and animal dung constitute 40-46 percent of the total energy consumed (TERI, 2001). According to TERI (1998), in India biomass alone currently meets 57% of the national energy demand. Wood is the major source of energy in rural India (Datey, 1981 and Jain, 1992). In India, where almost 75% of the total population lives in rural areas, dependency on natural resources is common since varied biomass needs are met from surrounding vegetation (Ranjithsingh, 1979; Kothari et al., 1989).

According to TERI (1998), commercial fuels like LPG have achieved little penetration into the domestic sector, with only 1.3% of households using the fuel for cooking in rural India. ASTRA (1982) has reported that use of commercial energy (e.g., kerosene, electricity) accounts for a very small percentage of the energy used in villages, the remaining energy coming from fuelwood, which is typical of South Indian villages. Firewood is the primary energy source for cooking and is used by 78% of the rural households (TERI, 1999).

Meeting rural energy demand is of high importance in India. Cooking fuels in the rural areas of India are predominantly unprocessed bio-fuels, such as fuelwood, crop residues and animal dung (Sinha et al., 1994; Parikh et al., 1999; Saxena, 1999; Barnes and Sen, 2000). Utilization of fuels such as dung cakes and agriculture residues are also quite popular in the lower plains of
Northern India (Barnard, 1985). Studies conducted by Mahat et al., (1987) explain that crop residues often form a significant component of fuel. India has a huge biomass potential owing to the large quantities of agricultural, forestry, and agro-industrial residue produced (MNES, 2002) and the total quantity available biomass fuel is 350 million tonnes per annum (TERI, 2001).

According to Census of India, 2001, in the rural areas of India where 72 % of household reside, firewood is used by 64.10 % of households, which is by far, the most important fuel, followed by crop residue used by 13.10 % and cow dung used by 12.80% of households, so that over 90 % depend on these traditional fuels. Acute shortage of fuelwood and the resultant high price leads to the burning of more than 80 to 100 million tones of dry cow-dung cakes annually, representing 400 to 500 million tones of wet dung, which could increase our agricultural production substantially (Das and Sarkar, 2005). According to UNEP (1980), about 150 Million tonne (dry) of cow dung are used for fuel each year across the globe, 40% of which is in India.

The easy availability of wood makes it one of the most popular sources of fuel for cooking, as well as other household and non-agriculture needs in the rural areas of India (Chakravarti, 1985; Monga and Lakhanpal, 1988; Rawat and Nautiyal, 1988). It has come increasingly clear that many of the rural households are not only using fuelwood to cook their daily meal, but are in the wood fuel business (part time, seasonal, contingency driven, or permanent) (Panya et al., 1991).

The total fuel wood requirement in the country is about 201 million tons and out of this 103 million tons (51%) come from forest (including Plantation) thus, nearly 86 million tons of fuelwood is being removed from the forest and plantation of India every year in excess of what they are capable of producing on sustainable basis (Rai and Chkraborty, 1996). Ever increasing human
population, commercial demand on wood resources also has increased manifold (Silori, 2004).

Fuelwood is dominantly consumed by the lower income group households. Fuelwood has the largest share in total final energy consumption as the majority where the population still lives in rural areas where wood fuel is mostly used (Kgathi et al., 1994; Zhou 2001). Fuelwood demand is inversely related with the socio-economic status of the people. Higher the socio-economic status, lower will be the fuelwood requirement and vice-versa (Das and Sarkar, 2005). There is a high level correlation between poverty and the amount and quality of energy consumed (Karakezi, 2002).

India has a dynamic economic development (Kamath, 2005) and rapid population growth (U.N., 2005). The net effect of population growth, coupled with continued economic growth is that India’s energy demand has grown rapidly almost every year and is expected to drive energy demand to levels above the country’s production capacity, resulting in energy supply shortfall. The use of modern fuels like LPG, kerosene, electricity, solar cookers and biogas in rural areas is either recorded infrequently or totally absent, mainly because of lack of proper extension work by Government agencies towards popularizing and promoting these devices.

EIA (2004) has reported that LPG supplies may not be adequate to satisfy all of this demand. The irregular supply during utilization of LPG is hampering its role in minimizing the dependency of local people on the wood for fuel (Silori, 2004). The shortage of energy, especially the domestic cooking fuel and its consequences is often underestimated. Adequate energy supply is, therefore, a major challenge facing the economies in the region (Kumar, 2000).

It can be seen that Karnataka State depends both on commercial and non-commercial forms of energy (Subramanian, 1985 and Ramachandra, 1998).
Non-commercial energy provided over half the supply from sources such as firewood, agricultural residues, charcoal and cow dung, while the commercial energy provided the rest, mainly through electricity, oil and coal (Ramachandra, 1998). Source wise energy consumption in Karnataka reveals that 53.20% of the total energy is met by non-commercial sources of energy like firewood (43.60%), cow dung cake (1.40%) and agro-wastes (8.20%), while commercial energy, which constitute about 46.80% include fuels like coal (5.80%), oil (11.60%), kerosene (2.60%), LPG (0.70%) and electricity (26.10%).

A significant part of these non-commercial energy sources cater the heating (domestic) needs of the rural population (about 70–80%), followed by village industries. This demonstrates a high dependency on biomass to meet rural energy needs (Census of India, 2001). In Karnataka, 25.5 million tones per year of biomass is consumed, which includes 12.7 million tones per year of firewood, 8.8 million tones per year of crop waste, 3.0 million tones per year of dung cake and 1.0 million tones per year of forest biomass. The largest single source is firewood. Sector-wise energy consumption shows that industrial sector has a major share of 51.4% similar to the national scene. This is followed by transport sector (23.0%), household (11.2%), and agriculture (3.5%).

In Mysore district, the fuel consumption in 2002 includes 34.55 million liters per year of kerosene, 25.18 million kilogram per year of Liquefied Petroleum Gas, 1689.67 MKWh per year of electricity and 0.87 million tones per year of firewood.

Women are the prime users of energy resources (both traditional biomass and modern fuels) for household, subsistence and income-earning activities. Women also have large roles as producers of traditional biomass fuels and providers of "human energy" services. Wood cycle like collection, processing
and use of wood fuel (unwaged labour) are largely the activities undertaken by women and to an extent, by children, particularly girls. Women and children are the primary collectors of fuelwood, other household fuels, and other forest products for household consumption as well as for sale to urban markets. For example, 48% of women in Fazoum Province, Egypt, work in minor forest industries, and some 250,000 women are employed in collecting forest products in Manipur, India (FAO, 1992). Ardayfio-Schandorf (1981) has reported that women collect fuelwood on their return from the farm while they do other things as well.

Studies in Uttar Pradesh, India found that nearly 50% of poor women’s incomes originate from common land, compared to about one-eighth of the incomes of poor men (FAO/SIDA, 1981). Women fuelwood carriers surveyed in Gujarat, India use most of their income for buying food (FAO, 1989). In Lombok, Indonesia, women spend about three hours each day cooking and four hours each week collecting dead wood or agricultural residues to be used as fuel and in areas of Kenya, women spend seven hours a day on the same tasks (Aristanti, 1996).

Hundreds of millions of people mainly women and children spend several hours per day in the drudgery of gathering firewood and water, often from considerable distances, for household needs (WEA, 2004). The collection of wood is mainly done by women and children and it is brought from a distance on head, shoulder or back (Anonymous, 1986-87). ASTRA (1982) has reported that the children contribute approximately one-third of the labour for gathering fuelwood.

Based on FAO estimates of the percentage of household energy provided by fuelwood, the proportions of rural women affected by fuelwood scarcity are estimated to be 60% in Africa, nearly 80% in Asia, and nearly 40% in Latin America and the Caribbean (HDR, 1995). Women often bear the burden,
literally and figuratively, walking farther for wood, carrying loads a longer distance and suffering ills associated with cooking when wood is scarce (Gardner-Outlaw and Engelman, 1999).

The base for our energy supply today is constituted by a variety of different energy sources (Reiss, 1994). Firewood gathered from the forested commons is the most important source of domestic energy in the rural areas of many developing countries (Cecelski et al., 1979). Zhou (2001) noticed that rural fuel wood consumers mainly depend on collecting dead wood but fuelwood scarcity may cause consumers to resort to cutting live trees. According to Mahat et al., (1987), generally fuelwood that is cut green from the forest and dried, is the primary fuel source during the wet season (summer monsoon), but the proportion of forest to non-forest combustible material will vary from season to season and from one altitudinal belt to another.

There are several problems associated with its collection and use as a household fuel (Nathan, 1996). There are also serious gender and health implications arising from rural energy consumption patterns (Batliwala, 1982; Batliwala, 1984 and Batliwala, 1987). Studies conducted by Ballard-Tremeer, (1999), have shown to cause health impacts, climatic change and other environmental impacts due to consumption of different cooking fuels. According to Hulscher, (1995); Braakman, (1996); Aristanti, (1996) and WHO, (1997) the whole cycle of activities from production to harvesting or collection, processing, transportation and combustion of biomass fuels involves a variety of health hazards in the rural areas of the developing countries including India.

The use of these biomass fuels causes considerable hardship and health hazards among rural women folk (Raiyani et al., 1993; Smith, 1993; Cecelski, 1995; Parikh, 1995; Parikh and Laxmi, 2000). The women in the poor families, assisted by their children, spend arduous hours every day gathering fuel, e.g., trekking ever longer distances to find and carry back heavy loads of
increasingly scarce firewood and using it to prepare meals using crude stoves, the inefficiency of which aggravates the fuel-gathering task (Reddy, et al., 2000 and Goldemberg et al., 1988).

In Nepalese women, excessive firewood load lifting on the back causes flattening of the intervertebral discs and high incidence of prolapse is observed in women collecting and carry heavy wood loads during the early postpartum period (Pandey, 1997). The estimated 10,000 women fuelwood carriers in Addis Ababa, who supply one third of the wood fuel consumed in the city, suffer frequent falls, bone fractures, eye problems, headaches, rheumatism, anemia, chest, back and internal disorders, and miscarriages, from carrying loads often weighing 40-50 kg, nearly as much as their own body weights (Haile, 1991).

In some circumstances, physical and psychological violence against women can be related to energy systems. Where fuel must be collected in areas of contested access or civil disturbances, women may face violence.

Current biomass energy production and use entails occupational hazards for women. Biomass energy cycle, time spent and hardship suffered in fuel collection, health hazards suffered from air pollution, increased burden of cleaning utensils, walls, floors and clothes, ecological changes are negative externalities in economic terms (Laxmi, et al., 2003). There can also be direct negative impacts on children's participation in education as they are increasingly drawn into fuel-gathering activities. Family obligations to gather fuelwood or dung in poor rural households often keep children from school (Reddy, et al., 2000 and Goldemberg et al., 1988).

Combustion of biomass is the last step in the rural household cooking energy cycle. The combustion products of unvented heaters and cookers are an important, potentially adverse, component of indoor air in many homes. Wood
smoke is a complex mixture of substances produced during the burning of wood. Biomass products produce a large volume of visible smoke containing a variety of toxic chemicals and high proportions of unburnt SPM as compared to other processed fuel (Dekoning et al., 1985).

The biomass smoke contain a large number of pollutants and known health hazards, including particulate matter, carbon monoxide, nitrogen dioxide, sulfur oxides (mainly from coal), formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[a]pyrene (Spengler and Sexton 1983; Traynor et al., 1985; Samet et al., 1987; Smith, 1987; Zhang and Smith, 1996; Ezzati et al., 2000 and Smith et al., 2000). Also produced are many gaseous compounds which are carcinogenic, such as benzene, aldehydes, alkenes, and numerous semi-volatile organic compounds (Lewis et al., 1988).

Traditional stoves are often used, where the domestic sector relies heavily on traditional sources of energy, mainly for cooking (FAO, 1993). Emission contributions from cookstoves to indoor, regional, and global air pollution largely depend on stove and fuel types (Tsai et al., 2003). Wood stoves create pollutants both indoors and outdoor because they generate suspended particulate of respirable size and gases including polycyclic aromatic hydrocarbons (Aggarwal et al., 1982 and Smith et al., 1983).

Uma and Oanh (1999) have measured the average emission factors for the CO₂, CO, CH₄, TNMOC and N₂O, PAHs and particulate matter from different fuels and stove. The particulate fraction is composed of solid or liquid organic compounds, carbon char (elemental or soot carbon – similar to charcoal), and inorganic ash (Ammann, 1986). Large amounts of carbonaceous aerosols, including “soot” or black carbon are emitted per kilogram of bio-fuel burnt in India (Venkataraman et al., 2005). The amount and concentration of particulate matter and other toxic gases emitted during biomass combustion while cooking in houses are more than those emitted during LPG combustion (WHO, 1992).
Under low combustion efficiency, hundreds of gaseous and aerosolized compounds are emitted in addition to methane (CH₄), non-methane hydrocarbons (NMHCs), CO₂ and water (Smith, 1987, UNDP, 2000). The greenhouse concentration in the atmosphere has increased significantly from pre-industrial concentration. We have clear evidence that human activities have affected concentrations, distributions and life cycles of these gases (IPCC, 1996 and IPCC, 2001). Many substances on the U.S. Environmental Protection Agency's (EPA) priority pollutant list, include many suspected human carcinogens, co-carcinogens (cancer initiators or promoters), and cilia-toxic agents (poisonous to the hair-equipped cells which filter most particles out of the respiratory tract) have been identified from wood smoke particles (Jenkins, 1986).

Air pollution from smoky cooking fuels has been identified as a serious health hazard in developing countries over at least three decades (Cleary and Blackburn, 1968). As shown in a growing number of air pollution monitoring studies, the resulting human exposures to the pollutants often exceed recommended World Health Organization (WHO) limits by factors of 10, 20 or more (Smith, 1987; Pandey et al., 1989).

Indoor air pollution is a serious health hazard in developing countries (Smith, 1993; Chen et al., 1990; Smith et al., 2000; Dekoning et al., 1985 and Florig, 1997). Most serious health problems are caused by indoor air pollution associated with the burning of biomass and coal in residences (Smith et al., 2004; Holdren et al., 2000; Ezzati and Kammen, 2001). Available studies indicate that indoor air pollution (IAP) from household cooking and space heating apparently causes substantial ill-health in developing countries where the majority of households rely on solid fuels (coal or biomass as wood, crop residues, and dung), but there are many remaining uncertainties (Smith, 2002).
Indoor air pollution causes serious health hazards, especially for women and children (Cliff, 1992 and Pandey, 1984). Exposure to smoke from biomass fuel is associated mainly with nonmalignant disorders, including acute lower respiratory illness in children (Smith et al., 2000 and Pandey et al., 1989), chronic respiratory illness and symptoms in adults, especially in the women (Perez-Padilla et al., 1996; Norboo et al., 1991 and Ellegard, 1996), pulmonary hypertension and consequent right-sided heart disease called cor pulmonale (Pandey et al., 1988 and Sandoval et al., 1993), lung function changes (Norboo et al., 1991 and Pandey et al., 1985), possibly eye disorders, such as cataract and blindness (Mohan et al., 1989) and adverse pregnancy outcomes (Mavalankar et al., 1992), human cancer risk (Claxton et al., 1988) and Allergic reactions (Ammann, 1986).

Infants, children, pregnant women, senior citizens, cigarette smokers and ex-smokers, and all those suffering from allergies, asthma, bronchitis, emphysema, pneumonia, or any other heart or lung illness are most affected by wood smoke and are sensitive to low levels (Jenkins, 1986; Pierson, 1989 and Morris et al., 1990). Pulmonary function studies also revealed that various such parameters are affected by domestic cooking fuels both in adults and children (Behera et al., 1998). Kossove (1982), Armstrong and Campbell (1991) and DeFrancisco et al., (1993) observed children being carried on their mother’s back while cooking as one of the behavioural practices, which is the cause for respiratory diseases in children. The Gambia children carried on their mother’s backs as they cook over smoky stoves contract pneumonia at a rate 2.5 times higher than unexposed children (WRI 2005). Incidence decreased with increasing age but remained relatively high in 24- to 29-month-olds for pneumococcal infections (Godwin, 2006).

Domestic cooking is an important source of air pollution and is associated with significant morbidity and mortality (Samet et al., 1988). There is mounting evidence that exposure to IAQ is the cause of excessive morbidity
and mortality (Sundell, 2004). Exposure to smoke has emerged as one of the major concerns in the rural areas of the developing countries (WHO 1992). The World Health Organization (WHO) (2000), has identified indoor air pollution as a global environmental risk causing some 1.6 million premature deaths per year worldwide; an average life-shortening of more than 20 years is associated with these premature deaths, and the overall mortality risk is about 50% higher for women (who do most of the cooking) than for men. These premature deaths are mostly a result of lower respiratory infections (LRI) in young children and chronic obstructive pulmonary disease (COPD) in adults over age 20.

A community based study suggested a prevalence of 18% of rural children between 6 and 12 years suffer with symptoms suggestive of asthma (Chakravarthy et al., 2002). Children exposed to indoor air pollution from household solid fuel use have 2 to 3 fold higher risk of COPD (Mehta and Shahpar, 2004). Over the last 10 years there have been enormous advances in understanding human health damage from air pollution, especially chronic mortality associated with small particle (PM$_{2.5}$) (Goldemberg et al., 2004). Conservative estimates of global mortality due to IAP from solid fuels show that in 2000, between 1.5 million and 2 million deaths were attributed to this risk factor (Smith et al., 2002 and Schirnding et al., 2002).

Long-term exposure may lead to emphysema, chronic bronchitis, arteriosclerosis, and nasal, throat, lung, blood, and lymph system cancers (based on animal studies) (Ammann, 1986; American Lung Association, 1990; Morris et al., 1990). Chronic exposure to biomass fuel combustion produces significant bronchial hyperresponsiveness (Jindal et al., 1996). Wood smoke adversely affects the cardiovascular system and heart patients, as well as those suffering from lung disease (Ammann, 1986; American Lung Association, 1990 and Pierson, 1989).
Wood smoke exposure causes a decrease in lung function and an increase in the severity of existing lung disease with increases in smoke concentration or exposure time (Ammann, 1986). Duration of cooking food was strongly and positively associated with lung cancer incidence (Lan et al., 2002). The particle or soot component of air pollution has been clearly implicated as a human carcinogen from studies of human cancer victims (Lewtas, 1985).

Earlier studies have shown that exposure to such domestic cooking fuels produces significant air pollution and are associated with a number of respiratory problems (Behera and Jindal, 1991), asthma, emphysema, bronchitis and pneumonia (Selwyn, 1990). According to Behera and Jindhal (1991), studies have shown that 13 percent of females exposed to biomass fuels have different kinds of respiratory symptoms. Among the 3701 women using different types of cooking fuels, it was found that women using mixed fuel experienced more respiratory symptoms (16.7%), followed by biomass (12.6%), stove (11.4%) and LPG (9.9%), users. However, there is no sufficient information about the conditions in which the mixed fuels cause more respiratory problems.

An increased incidence of chronic bronchitis, lung cancer, and acute respiratory infections has been attributed to cooking with biomass fuel (Omar, 1981 and Bauer, 1984). Exposure to irritant gases produced during cooking on Chula (indigenous-cooking stove where biomass is used as fuel is considered a primary cause of bronchitis and chronic cor-pulmonale (Wig et al, 1964 and Malik, 1977). Qureshi, (1994), looked at domestic smoke pollution and the prevalence of chronic bronchitis in rural Kashmir among Gujjar community. Cor pulmonale (right-side heart failure) has been found to be prevalent and to develop earlier than average in non-smoking women who cook with biomass in India and Nepal (Pandey et al., 1988).
Studies conducted by Ellegard (1996), in Maputo, Mozambique showed that the wood users were exposed to significantly higher levels of particulate pollution during cooking time (1200 (g/m$^3$) than charcoal users (540 (g/m$^3$) and users of modern fuels (LPG and electricity) (200-380 (g/m$^3$). Even ambient concentrations of particulates have been shown to cause respiratory symptoms such as chronic bronchitis, acute respiratory infections, and acute changes in lung function (Folinsbee, 1992), and especially increased symptoms in asthmatic persons (Pope and Dockery, 1992).

Asthma is the most prevalent chronic disease in childhood (Boner and Martinati, 1997) with increasing morbidity in most countries globally (Myers, 2000), making it a major public health problem. Epidemiological studies have shown an increasing trend in the prevalence of childhood asthma in different parts of the world (Peat et al., 1992; Shaw et al., 1990; Gerden et al., 1988; Perdizet et al., 1987; Aberg et al., 1995). The risk of asthma is 1.59 times (women 1.83 and men 1.32 times) among rural households that use biomass fuel for cooking (Misra, 2003). The study also revealed the effect of cooking smoke on the prevalence of asthma in the elderly (>60 years) based on NFHS-II conducted during 1998-1999 (GOI, 1994). Asthma and bronchitis take a major toll in India and have been recorded highest in Karnataka and lowest in the Punjab (RGI, 1994).

Wood smoke interferes with normal lung development in infants and young children. In addition, several studies have found that home use of wood burning stoves increases the risk of lower respiratory tract infections (LRTIs) such as bronchiolitis and pneumonia in young children (Morgan, 1988), which are major causes of disease and death in young children at chronic stage (Larson et al., 1993). Childhood LRTIs have also been linked with chronic lung disease in later life. Wood smoke exposure causes a chronic reduction in lung function, increasing the rate of decline with age in adults (Lewtas et al., 1991).
A 1990 study of American Indian children found that those living in homes with a wood burning stove have a higher risk of bronchiolitis and pneumonia (lower respiratory tract infections) than children living in homes without wood stoves (Anderson, 1986; Denny and Clyde 1986; Morgan, 1988). Anderson (1978) in his studies in Papua New Guinea has shown a possible relationship between domestic smoke pollution and chronic bronchitis. Researchers at the University of Washington in 1990 documented more symptoms of respiratory disease in Seattle preschool children living in high wood smoke residential areas than in children living in areas with lower wood smoke levels (Browning et al., 1990).

Approximately 5 million infants die each year from ARI, majority occurring in developing countries (Aristanti, 1996). Children and infants are passive inhalers of smoke, which may contribute to respiratory infection. A South African hospital-based study of 132 infants with severe lower respiratory tract disease found that 70 percent had a history of heavy smoke exposure from cooking and or heating fires (Kossove, 1982). Approximately 1 million of these deaths were due to childhood ALRI, with the remainder due to other causes, dominated by COPD and then lung cancer, among adult women (Smith et al., 2002 and Schirnding et al., 2002).

Women are more biologically sensitive to carbon monoxide (CO) emissions (Aristanti, 1996). High levels of carboxyhaemoglobin are achieved in such women (Dash and Malik, 1988 and Behera et al., 1991). Studies in India showed that women cooking with biomass had substantial amounts of carbon monoxide in their blood and had almost 50 percent greater chance of still birth (Mavalankar et al., 1991). A study from Ahmedabad, India, showed a significant increase in stillbirth (OR = 1.5) in those women exposed to domestic smoke during pregnancy compared to those who were not (Mavalankar et al, 1991). Increasing evidence of the role of maternal exposure to indoor air pollution (IAP) as a risk factor for low birth weight (Boy et al.,
2002) illustrates that perinatal/neonatal conditions, in particular low birth weight, are also likely to have large and long-term health effects and to be an important source of burden of disease due to this risk factor.

A large-scale study suggests that biomass cooking fuels may be strongly associated with the risk of Tuberculosis (TB) (Mishra et al., 1999). In Indian TB prevalence is 138 per 100,000, while the world average is 59.7 per 100,000 (Chaudhury and Thatte, 2003). India has a 30% global TB burden; in India one person dies every minute from TB (Gill, 1987). Tuberculosis is often observed to be a lung cancer risk factor (Zheng, 1987 and Ernster, 1996). Asthma and bronchitis also take a toll in India, and have been recorded as highest in Karnataka and lowest in the Punjab (RGI, 1994).

The magnitude of the health loss associated with exposure to indoor smoke and its concentration among the marginalized socioeconomic and demographic groups (women and children in poorer households and rural populations) have recently put preventive measures high on the agenda of international development and public health organizations (Bruce et al., 2000; Schirnding et al., 2002; World Bank, 1993; McMichael and Smith, 1999; WHO, 2000; Rahman et al., 2001; Bruce, 2001 and Torres, 2001).

Health effects does not solely depends on the type of fuel (biomass) used, but also other processes in the fuel cycle, kitchen environment, cooking stoves used, etc (Aristanti, 1996). In low resource setting in rural areas asthma, bronchitis, tuberculosis and pneumonia may be attributed to exposure to indoor pollution, solid-cooking fuels, poor housing, low nutritional status and poor sanitary conditions (Saxena and Dayal, 1997). Measurements in homes around the world have shown that health impairing concentration of products of incomplete combustion (PICs) are often found when people use wood or poorly ventilated spaces (Smith, 1987).
In India, the National Family Health Survey (NFHS-I) 1993-1994, revealed that only 11% people live in pucca (good) houses while others live in Kaccha houses (made of mud, thatch and other low-quality materials) and semi-pucca houses with mud walls and roofs. Respiratory disorders are mainly due to unfavourable housing and living conditions (GOI, 1994). The relationships of socio-economic development with behavioural and environmental factors of these diseases are predictable (Smith, 2000). Recently, to counter these problems at field level, partnership was sought with non-governmental organizations to ensure the optimum use of existing resources (Rangan, et al., 2003).

Biomass fuel is burnt in traditional and inefficient cooking stoves, particularly in the rural households. Around 180 million tons of biomass fuel is used for cooking with inefficient and smoky cook stoves or chulhas (Rajvanshi, 2003). Indoor and outdoor air can be degraded significantly by the use of poorly designed non-certified airtight stoves and non airtight stoves (Kamens et al., 1984). Alternate or optional wood cooking-devices and associated health, climate changes and other environmental impacts have already been studied by (Ballard-Tremeer, 1999). Pandey et al., (1990), reported that the morbidity and mortality the harmful indoor air pollutants caused, could be significantly reduced by installation and use of improved stoves. According to Lan et al., (2002), stove improvement reduces indoor air pollution exposure and thereby reduces the risk of lung cancer in users of Xuanwei smoky coal.

There have been many attempts in the past to introduce improved fuelwood stoves with higher efficiencies for household cooking (Wijayatunga and Attalage, 2002). Though these attempts have been mainly focused on efficient energy use in cooking, it has also contributed to reduction in indoor air pollution, which is considered a major health risk exposure of rural women. Because of the appalling smoky working environment of many Indian kitchens in which women had to cook, improved multi-pot stoves were introduced (Raju
1957). Fuel consumption and reduction of smoke levels to mitigate the adverse effects of indoor air pollution are the two basic objectives motivating replacement of traditional, inefficient and smoky stoves (Mande and Lata, 2000 and Mande and Lata, 2001).

Government of India initiated a National Program on Improved Chulha (NPIC) in 1985, through Ministry of Non-conventional Energy Sources (MNES). The Government of India’s National Program of Improved Cookstoves has introduced some 33 million biomass-based improved stoves in rural areas during 1984-2000 (Mahapatra, 2003). Higher levels of household fuelwood stove efficiencies can be achieved in presently available improved fuelwood stoves (Ramakrishna, 1991 and Singer, 1961). However, the available studies indicate that problems, such as design failure, lack of public acceptance, and quality control difficulties plague the program.

The experience gained from the successes and, particularly, from the failures in the field of improved wood burning cookstoves has nurtured a new generation of cookstove programs. Field evidence from many countries in Asia, Africa and Latin America shows that the introduction of improved cookstoves (ICSs) has brought considerable benefits to rural and poor urban households (Foley and Moss 1983; Foley et al., 1984; FAO/RWEDP 1991 and Ramakrishna 1991). Reid et al., (1986) have also demonstrated the beneficial impact of the new stoves in terms of health and efficiency. It has been shown that careful and constant maintenance is essential for efficient operation.

A global “crusade” on improved and clean cookstoves is slowly peaking again, pushed now strongly by health concerns (IAP, 2000; Bruce et al., 2000; Masera et al., 2005). Over the last two decades, improved stove designs have been introduced in several countries for a different reasons such as fuel saving capacities, reducing smoke, cooking faster, improving status of women,
generating jobs and income and environmental considerations. Household stove design is still in its infancy from the point of view of public health.

In spite of millions being affected on exposures to wood smoke and indoor smoke pollution, little attention has been received in this relation from the state, national governments and international agencies. This is due to large numbers of confounding factors and the modest resources available for such research (Braakman, 1996).

In addition to health problems, biomass burning exhibits other environmental problems, such as deforestation leading to desertification and global warming. Energy policies were mainly driven by the assumption that energy consumption is related to deforestation, which may eventually lead to desertification (Karekezi and Turyareeba, 1995). Wood cutting exposes the soil to accelerated erosion and increase run off (Singh et al., 1987). Repeated extensive cutting for firewood and extraction of other minor forest products bring about changes to habitat (Driscoll et al. 2000).

Fuelwood consumption not only causes deforestation but also indisputably increases fast cutting into the capital stock of trees, and the effects are most clearly in evidence in the vicinity of cities (Baranzini and Goldemberg, 1996). Forest is an important source of firewood for rural households. Trees are cut for firewood at faster pace than can be grown, raising concern over the deforestation and deforestation. The use of fuelwood as a primary source of energy for domestic purpose is responsible for deforestation in north-east India to a great extent (Maikhuri, 1991), which necessitates the raising of energy plantation in unused lands and wastelands of the region (Kataki and Konwer, 2001).

Wall and Reid (1993) concluded from their study that the local forest areas were diminishing in response to firewood extraction and that it was
unsustainable in the long term without purpose-grown woodlots and plantations. Similar conclusions have been reached in many other parts of the country (Driscoll et al. 2000). A sustainable solution should adjust for environmental protection, resources availability, social welfare and economic viability of the system (Papadaki, et al., 2003). The sustainability concept should, therefore, reflect not only concern about the shortage of natural resources and environmental protection but also should be closely correlated to the society needs and economical development (Afgan, et al., 1998).

Though the biomass fuel could be an environmentally sound energy source, being renewable in principle, the current practices lead to intense deforestation, thus probably contributing to desertification (Baranzini and Goldemberg, 1996). According to the UNEP (1992), more than 100 countries and perhaps 900 million people are suffering from the ecological, economic and social consequence of desertification. The degradation of vegetative cover has the most extensive impact on the biological productivity of land, initiating the process of desertification (Dregne, 1983).

Fuelwood is the fuel that uses existing trees. Consequences of global warming due to excessive discharge of greenhouse gases to the atmosphere are intimately associated with deforestation (Jalal 1993) and reduced carbon sink. Use of biomass fuels provide substantial benefits to environment by absorbing carbon dioxide during growth, and emits it during combustion, thereby helping in atmospheric carbon dioxide recycling and does not contribute to the greenhouse effect (Demirbas, 2003).

The recent world energy shortage necessitated the development of alternative energy sources to replace fossil fuels which will be depleted in the near future (Haga, et al., 1979). Renewable Energy Sources reduce the dependence on mineral fuels, strengthen regional development and constitute a pole of development for small local communities (EWEA, 2000 and Koukios et
al., 1991). Reiss (1994), indicate that the technologies for utilizing renewable energy sources are not yet matured in many areas and are very cost-intensive.

Upgraded fuels made from biomass may have advantage in moving toward sustainable development goals and there are a number of policy implications of this work, including revelation of a range of win-win opportunities for international investment in rural energy development that would achieve cost-effective greenhouse gas reduction as well as substantial local benefits (Smith et al., 2000). Biomass is the most common form of renewable energy and its use is becoming increasingly important when it is considered to assist to alleviate global warming, and provide fuel supply (Cuiping et al., 2004).

Forests play an essential role in the global carbon (C) cycle (Brazil CC, website), and is an important means to capture and store atmospheric CO₂ in vegetation, soils and forest products (Sathaye et al., 2001). Therefore, biomass helps the atmosphere CO₂ recycling and does not contribute a new greenhouse effect (Haykiri-Acma, 2003). It also plays a major role in the livelihoods of hundreds of millions of rural people, principally as a subsistence safety net, but also as a source of cash income, a capital asset, and a source of employment (Sunderline et al., 2003).

Biomass, cultivated as well as wild, is a renewable, locally available and environmentally clean source of energy which plays an important role in the rural sector in most of the developing countries (Dahiya and Vasudevan, 1987). Also, energy plantation is a major consideration where wood energy is dominating (U.N. FAO, 2001). As the firewood issue has risen in the last few years, arguments have been put on the need to have a ‘balanced’ outcome on how wood is collected and/or do further research on how to take wood from the remaining woodland areas sustainably (ANZECC 2001).
The concept of social forestry emerged during the late 1970s (FAO, 1978; Clayton, 1985) and had its formal origins in India with the report of the National Commission of Agriculture of 1976, which recommended growing trees on lands accessible to village people in order to reduce the pressures on forests set aside for production forestry brought about by mounting rural demands for fuel, grazing and other forest products (GOI, 1976). Social forestry projects and programmes were initiated in most states during the first half of the 1980s (SIDA, 1987).

The social forestry programmes in India form one of the largest and most innovative experiments in participatory forestry anywhere; and also one of the largest interventions designed to improve the productivity and use of communal land (Arnold, 1990). Afforestation appears to be showing up on satellite images on the subcontinent (Hall and Ravindranath, 1994), but whether ultimately, more fuelwood will be available to rural communities, will be more a political question.

There is widespread evidence that village and panchayat bodies perceive the social forestry woodlots as primarily as significant sources of communal income, rather than as sources of produce to meet village needs. This has tended to hamper participatory approaches in forestry extension given the historical poor relationship between foresters and local communities as a consequence of protective forest policies of forest department (FAO, 1985).

Forest extension agents on the other hand have often perceived farmers as ignorant passive recipient of benefits of social forestry extension (Dove, 1992). The intensity of implementation of in-service remedial courses for social forestry extension agents, managers and coordinators and the development of curricula for agro-forestry training in institutions of higher learning attest to this deficiency (Zulberti, 1987 and Lassoie et al., 1994).
Non-Timber Forest Products (NTFP) activities as the main occupation for the households residing in and near the forests generate productive forest resources, employment, betterment of natural resources, environmental protection and preservation (Suma, 2005). Forest development is also considered as one of the means to improve the socio-economic status by increasing the income of the rural households. In addition to the ability to pay, increasing incomes lead to better education, awareness and social status; these also encourage fuel shifts, evidenced in the quick switching from wood and twigs to kerosene as a family moves from a slum to a tenement (Gupta and Kohlin, 2001).

Most woods burn, however there are properties that differentiate their relative value for fuel. Density is the most general gauge of wood-burning quality. The heavier the wood (when dry), the greater its calorific value (Das and Sarkar, 2005). The fuel wood characteristics of wood are attributed to its anatomical, physical and chemical properties (Tillman et al, 1981).

There is a need to review and select suitable firewood yielding species for large-scale plantation under social/agro-forestry programmes taking a holistic view on the end utilization characteristics and productivity aspects. However, for selecting the wood species for plantation under various social/agro-forestry programmes, scientific and technological data available for their end utilization has remained in the back seat (Kothiyal, et al., 2005).

Linkages between household energy technology, indoor air pollution, and greenhouse gas (GHG) emissions have become increasingly important in understanding the local and global environmental and health effects of domestic energy use (Bailis et al., 2003). In a developing country like India, the thrust of the government policies has been towards providing benefits to rural population (TERI, 2001).
In India, women are often a primary user group, and without their normal involvement in management agreements over sustainable use, access controls and strategic development will be incomplete and probably, not optimally effective (McGean et al., 1996). The quality of women's participation and the control they exercise over decision-making process is more important than the sheer number of women present in such bodies (Saxena, 1997). But, the planning process at the regional and national level often ignore the special need and role of women in meeting daily family needs (Sarin, 1996).

In many countries, the state of biomass resources is unknown, and data collection efforts are rather weak or non-existent (Ekouevi, 2001). As much traditional energy use occurs outside the commercial sector, data on it is geographically patchy and discontinuous (Kituyi and Kirubi, 2003). In addition, the enormous variety of energy use patterns, even within quite short distances, makes exploitation dangerous (WEC, 2000). Because of the difficulties associated with wood energy data collection and the decentralized nature of wood energy systems (Bhatia, 1985 and Ramani et al., 1995), wood energy consumption is not regularly monitored in the same way as that of conventional or commercial energy sources. There is a need to improve the quality of country level data on bio-fuels and to strengthen national and institutional capacities to collect, analyze and disseminate the information (Gustafson, 2001).

It is evident from the review of literature that the burning of fuels causes indoor air pollution, health hazards and environmental problems. However, little is known about the efficient utilization of natural fuel with minimal health hazards among the rural folk around Mysore city of Karnataka. There is a high degree of diversity of bio-fuel resources utilization, pattern of utilization etc, among the people of the villages based on their economic status. Hence, an attempt has been made to study, evaluate and assess the natural fuel types consumed and possible health related hazards among the rural folk. This study
endeavours to provide a management plan, tailored to the issues and needs of the domestic energy and good human health in the rural areas of Mysore, India and also at global level.

An integrated approach has been made in the present investigation to look into the domestic energy crises, health hazards and other environmental problems with the following objectives:

1. Survey of the villages and identification of sites of the study area around Mysore city.
2. Collection of data pertinent to the total geographic area of the village, population (number of houses and members in a family), energy sources of village, total natural forest area and the total man-made forest area.
3. Identification and classification of fuel sources in each village.
4. Quantification of fuel types in utilization.
5. Types of plant species used as fuel for utilization.
6. Estimation of fuel efficiency (individually and in combination) of different sources and their evaluation in different regions.
7. Purposes for which fuel is mainly used (domestic, rural industries and others).
8. Methods of fuelwood utilization and assessment of fuel efficiency (for e.g., chulas).
10. Evaluation of types of health hazards due to different fuel sources utilization.
11. Possible suggestions for sustainable utilization and management of fuelwood resources and better health.