CHAPTER II

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The main objective of the present study was to get an insight into factors affecting adoption of a new improved cooking technology-Mamta Chulha (MC) promoted under NPIC by Government of India with the primary aim of biomass conservation.

Though attempts have been made in recent years to conceptualise factors affecting changing behaviour of people in accepting a new idea, a systematic effort to understand the underlying behaviour in relation to adoption of an IC was observed to be a rare phenomenon. The present study was an attempt in this direction. For the purpose of this research, the literature was reviewed with reference to the following aspects :

1) Conceptualisation of Adoption
2) Sectors of Energy Demand and Consumption
3) Studies Related to Energy Consumption Pattern of Urban and Rural Families
4) Studies Related to Traditional Chulha
5) Studies Related to Improved Chulha

1. Conceptualisation of Adoption

The concepts of adoption and innovation are closely linked to each other. These are relevant in the field of education, technology development and transfer, application of science for human and societal development, in process development and many other fields. Many have attempted to elaborate the concepts of adoption and identify processes involved in it. The underlying idea in all the different descriptions of adoption is that, there is an acceptance of the item in question, be it an idea, process, method, or product, and its use or application in day-to-day life.

Oxford dictionary defines innovation as the act of innovating, the introduction of novelties, the alteration of what is established by the introduction of new elements or forms. According to Barnett (1953) innovation is any thought, behaviour or thing that is new, because it is qualitatively different from existing forms. Katz (1961) and Rogers (1962) defined innovation as an idea or a thing perceived as new by the individual concerned, perception of newness is more important rather than the real novelty of the idea. Innovations arise out of the need felt to improve, conserve or preserve natural and man-made resources through human behaviour. An innovation is conceptualised as something new emerging out of thought processes and actions. Miles (1964) defined innovation as a deliberate, novel, specific change, which is thought to be more efficacious in accomplishing the goals of a system. Havelock, et al., (1975) defined that innovation is usually in the form of a product or practice, is presented or brought to the attention of a potential receiver population. The process of innovation is a problem-solving sequence in which needs are recognized and defined as problems in which solutions are subsequently discovered and applied to those needs leading to their satisfaction (Havelock and Huberman, 1977). Adiseshiah (1977) used the term innovation in the sense, as used in the engineering sciences; referred innovation as a situation where some result of a piece of educational research is tuned into an educational process. According to Agarwal (1986), innovation includes both objects and practices perceived as being new by an individual or group, even if it has previously been in existence or in use elsewhere. The newness of the idea to an individual determines reaction to it. Unless innovations are adopted by the target group for whom it is designed or developed it would not lead to human wellbeing. Hence adoption of innovation is a concept that is of utmost importance in achieving the goal(s) of innovation.

Ryan and Gross (1943) were amongst the first to find out that adoption of a new idea consists of stages, viz, 1) awareness, 2) conviction 3) trial and 4) acceptance. Pedersen (1951) in his study of cultural differences in adoption of farm practices found that a sequence of events leads to adoption. He used acceptance and adoption as interchangeable expressions.

Wilkening (1952) reported that adoption involves decision. In his opinion adoption of an innovation is a process composed of stages or steps like learning, deciding and action over a period of time. The adoption of a specific practice is not the result of a single decision to act but of a series of actions and thought decisions.

Acceptance of an idea or technology is governed by definable controls like prestige, personality, personal relations, majority affiliation, and mastery (Barnett, 1953). To an adopter of an innovative idea, the very act of acceptance may reflect prestige especially when it is advocated by one of their groups like relatives, agemates, co-workers, or political party members. An appealing personality is a major asset in securing the acceptance of an idea, whether new or old. Adopter's interest is captured by the personality of the advocate. At times adoption occurs through the strength or weakness arising out of personal relations. In such cases acceptance or rejection of an innovation is dictated by the pre-existence of rivalries, friendship, and enstrangements between an advocate and other potential acceptors. Another factor that favour acceptance is the support of a majority to an advocate. The mere number of those supporting the advocate of a new idea is a compelling consideration for many people who waver between accepting or rejecting it. Lastly adoption of any idea or technology depends on the performance demands it makes on the user. The less the demands on the user or the easier it is to understand and operate, the wider would be its acceptance. In other words, ideas, concepts, processes or technology that can be mastered easily receives greater acceptance.

The four stages proposed by Wilkening (1953) and Rahim (1961) were awareness, obtaining information, conviction and trial, and adoption. Later on Wilkening (1956) suggested only three stages, namely, awareness, direction and action. Wilson and Gallup (1955) came out with six steps- attention, interest, desire, conviction, action and satisfaction. Emery and Oeser (1958) viewed adoption of farm practice as a consequence of communication. They used three stages- information, decision and action.

Bose and Dasgupta (1962) and Rogers (1962), on the other hand, have proposed five stages of adoption, namely, awareness, interest, trial, evaluation and adoption. Rogers (1962) defined adoption process as a mental process through which an individual passes from first hearing about an innovation to final adoption. Bhola (1967) identified four stages in innovation- diffusion process, namely, dissemination, demonstration, implementation and support. According to Singh and Pareek (1968) there are seven steps in adoption process, viz., need, awareness, interest, deliberation, trial, evaluation, and adoption.

Acceptance of a new idea depends on its functional utility in a variety of senses. People cling to traditional ways because they provide emotional satisfaction as well as meet practical needs. New ideas may be rejected if these threaten the psychologically functional cultural factors even though these may be clearly preferable for practical reasons (Griffin and Pareek, 1970). Acceptance also depends on understanding the purpose, the significance and the expected effects of the innovation. Readiness to adopt a new practice depends on the perception of the harmony among the innovation, the setting in which it is to be used, and one's own skills and abilities. Planned economic and social development implies change in traditional values and practices. Traditional culture is characterized largely by its value system, and the acceptance of science and technology depends heavily on, as well as causes, change in traditional values and related institutions and practices.

An innovation may be rejected at any stage in the adoption process. Rejection is a decision not to adopt an innovation. The individual may decide at the evaluation stage that the innovation might not apply to a particular situation and mentally reject the idea. Rejection of an innovation can also occur after adoption. This behaviour is called discontinuance and reflects a decision to cease use of an innovation after previously adopting (Rogers,1962; Rogers and Shoemaker,1971).

Rogers and Shoemaker (1971) called adoption process as innovation-decision process which is a mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject and to confirmation of this decision. When a new idea, practice, process or technology is adopted, then it replaces the old and the old ceases to be practiced or pursued. In the case of adoption of an innovation, an individual must choose a new alternative over those previously in existence. According to Rogers and Shoemaker (1971), the four stages in innovation-decision process included- knowledge, persuasion, decision, and confirmation. Innovations have five important characteristics, namely, (i) relative advantage or the degree to which an innovation is perceived as better than the idea it supersedes, (ii) compatability - the degree to which an innovation is thought consistent with local values, experience and needs, (iii) complexity refers to difficulty in understanding and using an innovation, (iv) trialability is the degree of experimentation which is possible and (v) observability is the degree to which the results of an innovation may be clearly seen and understood.

According to Bhagia (1973), adoption and diffusion of innovations are inseparable. An individual's decision to adopt and continue use of the innovation has much to do with the diffusion of that innovation. Once it is rejected, it blocks the possibility of further spread of that innovation because the unit which has been rejected will never act as a source of inspiration or motivation for later adopting units. Thus the ultimate decision of the second unit to adopt innovation paves the path for its further spread, i.e., diffusion. Dictionary of Education (Good, 1973) defines adoption of practices as the process by which an idea gets from its source or origin to its place of ultimate use, usually thought of as consisting of five stages, namely, awareness, interest, evaluation, trial and adoption.

Rai (1972), Singh (1975) and Narsian (1978) revealed that teacher educators who have been aware of innovations and practice them, developed proneness to its adoption. Vasisht and Dhesi (1976) found that age and educational level of the homemaker were negatively and non significantly related with adoption of labour saving devices. Caste was also non-significant though positively correlated, whereas educational level of the family members, social participation, income and physical facilities in the kitchen were positively and significantly related. Sharma (1979), based on his study on characteristics of the resource system and the process of developing and communicating innovation and their impact on adoption process, concluded that the more the linkages are, the more effective will be the day-to-day contact and exchange of information and hence the greater will be the level of adoption of innovations. He also found in his study that awareness of an innovation, sources of getting information and the proximity factor of educational resource system were positively and significantly related to the level of adoption of an innovation.

Gulati (1980) revealed that professionally satisfied teachers were found to be significantly more predisposed to adopt innovations than those who were professionally not satisfied. Satyavathi (1980) suggested that the adopters (teachers) should attend summer institutions, refresher courses in methods, and workshops, to learn latest trends in education inorder to cope with the changing needs of the society. Rao (1980) stated that the factors for unsuccessful functioning of innovations were lack of proper teacher-student ratio, lack of physical facilities, lack of awareness among the target population and lack of proper evaluation. He suggested that the actual adopters of the innovation should be identified and knowledge about the innovation should be disseminated without any delay among them. Bhoite and Nikalje (1983) found that education and social participation were significantly related to the adoption of dry land agriculture technologies.

To take the specific case of stoves, adoption may be blocked by the fact that fuel is gathered rather than purchased. The major benefits to users arising from adoption of improved stoves might lie in the elimination of smoke from the environment, and the improvement in health or a decrease in the domestic work of women; none of which offers a monetary return against which to off-set the initial investment (Howes, 1985). Those who use the stove were not always concerned with potential fuel savings. Owners were more interested in aesthetics than in fuel saving and gain satisfaction from the possession of an improved stove even when they use it in the wrong way or not at all (Masse, 1985). Determination of why people have or have not adopted a stove and what has been the impact of introducing a stove, is much more complex (Joseph, 1985).

2. Sectors of Energy Demand and Consumption

The term energy (from the Greekword Energia) is recorded to have been coined by Thomas Young (1773-1829) (Mehetre, 1990). Energy is the capacity to do work. The energy scene of the world is in a very critical position. The Oil Embargo of 1973-74 and the escalating prices of energy forms, especially petroleum products, have made people all over the world concerned about the energy situation. Large reserves of fossil fuels are found to exist in the industrialised countries of the world. Nevertheless, the developing countries also occupy a significant place in the world energy scene (Burch, 1978).

About 11.3 million hectares of wood fuel resources in the world are being lost annually to agriculture, grazing, commercial timbering, uncontrolled burning, consumption and other factors, with 90 per cent of the cleared land never replanted (Abakah,1990). Within 200 years of enormous use of energy, the world has realised the need for non-conventional and renewable sources of energy which include solar energy, bio-energy, wind energy, geo-thermal energy, ocean thermal energy, tidal energy, wave energy and so on. By far the largest amount of heat energy is supplied by fossil fuels, including coal and petroleum products. The source of fossil fuels is fast depleting (Veena, 1992).

Fuel energy problems are gaining importance due to shortage of fossil fuels in the world. The demand for fuelwood has grown much faster than supply. The forests of developing countries are being consumed at a rate of 1.3 per cent of the total forest area or 10-15 million ha/yr (Bansal, et al.,1990).

Food and Agriculture Organisation (FAO) of the UN in 1982 estimated that nearly 2 million tonnes of wood fuels are consumed daily in developing countries. About three quarters of the people in developing countries are dependent on wood for cooking and heating, using more than 1,500 million cu mt of wood each year (Upadhyaya,1989). The National Forest Policy, 1952 aimed at forest coverage of one-third of the total land area of the country (Desai, 1991). Yadav and Sharma (1988) and George (1989) stated that the domestic sector is a major sector of energy demand and consumption in developing countries, accounting for 50-90 per cent of a country's energy use depending on whether they are based at urban or rural areas.

In developing countries like India, energy sources may be classified into two categories (i) commercial-coal, oil, natural gas, hydro-electric power and nuclear power (ii) non-commercial - firewood, charcoal, vegetable waste/agriculture waste and dried animal dung (Mehetre, 1990). Wahi (1983) reported that commercial energy accounts for about 46 per cent of the total primary energy supply in India with balance (54 per cent) coming from non-commercial sources.

Vaidyeswaran (1987) presented the data regarding the energy consumption pattern in India. Commercial energy consumption sectorwise showed that while coal has remained more or less the same between 1953-54 to 1978-79, oil consumption doubled. Electricity consumption increased four times and consumption of agricultural wastes went up from 13.35 per cent to 40.30 per cent (Appendix Table III.1).

Rao (1987) reported about the commercial energy consumption pattern sectorwise from 1953 to 1984. It revealed that the percentage consumption by industrial and transport sectors which was more or less the same, was the highest followed by household sector. Agriculture sector accounted for a small proportion of total commercial energy consumption from 1953 - 1984. Over the period of time, there was an increase in consumption in agricultural sector, decrease in consumption in household sector and transport and more or less same in industrial sector (Appendix Table III.2).

Industrial sector continues to be the single and the largest commercial energy consuming sector, although its share has slightly declined from 52.42 per cent (1980-81)to 51.38 per cent (1987-88). Transport is the second largest consumer of commercial energy. Total non-commercial energy consumption in 1953-54 was 74.35 per cent of total energy requirement which declined to 44.43 per cent of total energy requirement in 1987-88. The ratio of non-commercial to commercial energy consumption has declined from 2.9 in 1953-54 to 0.8 in 1987-88. Though the percentage wise (in terms of calorific values) consumption of non-commercial energy resources has declined from 74.35 per cent in 1953-54 to 44.43 per cent in 1987-88, the absolute quantity wise consumption of non-commercial energy resources has increased by 78.5 per cent in 1987-88 from 1953-54 (Agrawal, 1993).

Agrawal further reported that the main consumption of coal is in the industries. It s share in industry in 1980-81 was 84.82 per cent and has increased to a level 93 per cent in 1987-88. In transport sector its consumption has decreased from 15.18 per cent in 1980-81 to 7 per cent in 1987-88. Petroleum products' share in transport sector during 1980-81 was 42.86 per cent which has increased to a level of 46.74 per cent during 1987-88. Industrial sector's consumption of petroleum products in 1980-81 was 36.17 per cent which has decreased to a level of 29.93 per cent in 1987-88. In residential and commercial complexes the consumption of petroleum products was 16.24 per cent in 1980-81 which has increased to a level of 20.13 per cent in 1987-88. Power consumption which was 58.36 per cent in 1980-81 has declined to a level of 48.8 per cent in 1987-88. In agriculture sector, power consumption has increased to a level of 73.8 per cent 1987-88 as compared to 17.59 per cent in 1980-81. Residential and commercial complexes also showed an increase of 3.47 per cent of power consumption from 1980-81 to 1987-88.

According to estimates available, of the total energy consumed by commercial, residential and public service sectors in 1984-85, 2.4 per cent was in the form of soft coke, 5.8 per cent as kerosene, 0.02 per cent as LPG, 2.0 per cent as electricity, and the rest as fuelwood (58.1 per cent), agriculture waste and dungcake (31.9 per cent) (Kadekodi,1988). In the domestic sector 60-90 per cent energy is consumed for cooking and water heating (Joshi,1988; Bhide and Takwale,1989; Karthikeyan, et al., 1989; and Mittal,1993).

Kishore (1988) and Veena (1992) indicated that for both rural and urban areas combined, 40-45 per cent of the total energy available in India is consumed for cooking. The household sector in India is reported as the largest consumer of energy, accounting for about 50 per cent of the total energy consumption (Joshi, 1988; and Moorthy, 1990).

Cooking energy demand records an increase by 2 per cent per year. The present cooking energy consumption is estimated to be about 21 per cent higher, and the future consumption to be 67 per cent higher (Kishore, 1988). By 2000 A.D. the population of India is estimated to touch one billion and fuelwood demand 250 million tonnes. According to Shah (1991), the demand in India for wood is about 200 million cu mt/annum.

The total energy supplies, including both commercial and non-commercial forms, increased from 82.7 MTOE (Million tonnes of oil equivalent) in 1950-51 to about 291 MTOE in 1990-91. The share of non-commercial fuels has declined from 74 per cent in 1950-51 to 40 per cent in 1990-91. The household sector accounts for approximately one-tenth of the final (commercial) energy consumption in India (Appendix Table III.3) (Eighth Five Year Plan, 1992-97).

According to Mittal (1993), 40 per cent of the total energy consumption is in rural areas. Of this 55-60 per cent is accounted for by cooking and other applications in the domestic sector which is relatively lower than other estimates. The energy forms comprised of firewood (68.5 per cent), animaldung (8.3 per cent), oil products (16.9 per cent), coal (2.3 per cent), electricity (0.6 per cent) and others (3.4 per cent).

Use of biomass fuels in household sector during 1978-79 was estimated by NCAER (Natarajan, 1985). Dungcake was the main fuel consumed by majority of the households, followed by twigs and crop residues. The next popular energy source was fuelwood. Charcoal was reported to be more commonly used than sawdust and woodshaving (Appendix Table III.4).

India has a total forest area of about 75 million hectares which forms only 22.8 per cent of the total geographical area of the country. The corresponding proportion of forest area in Gujarat is 8-10 per cent of the total landmass. The requirement for fuelwood by the year 2000 AD was estimated to be between 500,000 tonnes and 600,000 tonnes. To provide for this, an area of 500-600 sq km will have to be set aside exclusively to grow fuelwood (Thomas and Perabagaran, 1991).

Pressure on land resources in the state of Gujarat is more as compared to some other states. Gujarat produces 0.13 million tonnes of fuelwood against an estimated requirement of 5.7 million tonnes of fuelwood (Eighth Five Year Plan, 1992-97). In order to reduce the gap between demand and supply for fuelwood, the forest department in India has taken up a massive tree planting programme under Social Forestry Schemes and Govt. of India started introducing renewable energy technologies. Renewable energy is defined as the energy obtained by tapping continuous and repetitive currents of energy occuring in the natural environment (Roy,1992). Rao (1989) estimated that 20 per cent of all the energy needs of our country could be met through renewable sources, if appropriate steps are taken.

3. Studies Related to Energy Consumption Pattern of Urban and Rural Families

The estimates made by different experts at national and international levels showed that there is a gap between demand and supply of different fuels. The Oil Embargo of 1973 too drew the attention of polity and academia to the impending energy crisis. Domestic units loomed large as a potential sector for energy conservation. This prompted several researchers to devote their attention to family's energy consumption and expenditure pattern with reference to various end uses. The observations made in this area are briefly reported in this section.

George (1981) reported that all urban households used electricity mainly for lighting and comfort in living for which they spent on an average Rs. 55.80 per month. The average monthly outlay on all energy sources was Rs. 206.00. The average outlay on petrol was Rs.150.50 while that on diesel, natural gas and LPG worked out to be more or less the same, i.e., Rs.31.00 to Rs.33.00 per month.

George (1983) found in her study that majority of the families spent amounts ranging from Rs.101.00 to Rs.550.00 per month on energy consumption. Mean monthly outlay on all energy forms was Rs.196.00.

George (1983) and Kaul (1984) observed that all the families covered in their studies used electricity. Natural gas was the main fuel used for cooking and heating water while LPG was used by nearly one-third of the sample mainly for cooking. Nearly 62 per cent were consumers of petrol.

Mean monthly outlay of families in the urban sector was computed to be the highest on petrol with electricity following close behind. Natural gas, LPG, and kerosene commanded much less mean monthly expenditure accounting for one-seventh or less of the total (Kaul, 1984). The mean overall outlay of urban families on all fuel forms was reported to be Rs.290.00 per month (George, 1986). Homemakers' education, age and exposure to mass media emerged out as factors affecting their knowledge on energy resource and its related aspects. Furthermore, energy consumption behaviour was influenced by homemaker's age, education, exposure to mass media, attitude towards energy conservation, willingness to conserve energy resource and perception of the need to conserve energy resource.

Talati (1986) conducted a study on urban household energy resource consumption. She found that electricity and natural gas were used by 100 per cent of her sample. Sixty nine per cent used petrol and only 5 per cent used coal and kerosene.. The mean monthly outlay on cooking fuel was Rs.38.00, electricity Rs.134.60 and petrol Rs.210.70. The low monthly outlay on cooking fuel could be attributed to the flat rate at which natural gas was available to families. Gusain and Pandey (1991) reported that rural people spent Rs.100.00 to 150.00 per month on kerosene and Rs. 28.00 per month on electricity.

A study conducted by Natarajan (1985) revealed that the households consume a variety of commercial fuels. The estimates revealed a consumption of 5.5 million tonnes of soft coke, 4.2 million kilolitres of kerosene, 7,317 million kWh of electricity, and 315 thousand tonnes of LPG per annum.

Goel (1986) observed that the average expenditure incurred per month on different energy forms increased with the increase in the socio-economic status. She further reported that the perception of energy crisis was influenced by education level of homemakers.

Sharan and Gopinath (1983) in a study of energy use in rural North Gujarat found that mean per capita use of wood, twigs, crop residue ranged from 31 to 35 kg/month/person whereas Veena (1988) reported an average consumption of 11.5 to 13.6 kg/capita/month with reference to firewood.

A study on Rural Energy Survey and Integrated Energy Plan in Bhopal (1989) revealed that per capita annual consumption of firewood was 403.27 to 547.77 kg for different categories of households. Per capita annual consumption of dungcake for all the surveyed households was 118.38 kg. It has been observed that as the income rises the energy consumption goes up, particularly that of kerosene and electricity. Natarajan (1985) reported that Indian households burnt annually 95.5 million tonnes of fuelwood, 30.6 million tonnes of crop wastes, 71.7 million tonnes of dungcake, 0.6 million tonnes of charcoal and 25 thousand cu mt of gobar gas to meet their fuel requirements. Alam, et al., (1985) in their study conducted in Hyderabad reported that household sector is the main consumer of fuelwood for 40 per cent of energy use. The average household consumes 35 kg of wood monthly. The fuelwood consumption would be 1.61 to 1.91 thousand tonnes in 2000 A.D. as compared to the present consumption of 1.54 thousand tonnes in the household sector.

In India 68.5 per cent energy used is in the form of firewood (Mukherjee, 1989 and Thadani, 1990). Firewood is mainly used for cooking purpose in rural areas (Arokiaswamy, 1984; Chand and Swarup, 1985; Goel, 1986; Dheerasinghe, 1987; Gusain, 1990). Apart from firewood, crop residue, twigs and branches, cowdung, coal and charcoal were used as fuels for cooking purpose (Sharan and Gopinath, 1983; Philip and Makwana, 1985; Sharan, 1986; and Patel, 1989). Sharan (1986) reported that babul, neem and khejado as the main sources of fuelwood in rural Gujarat. Patel (1989) observed that in northern Gujarat crop residues used included cotton stalk, castor stalk and ground nut shell and fuelwood that came mainly from twigs and branches.

Philip and Makwana (1985), Patel (1989), Gupta and Ogale (1992) found in their studies that kerosene was used by 92 to 94 per cent of households as a standby fuel, because practically everyone had to keep some type of fuel for emergency.

Kerosene and electricity were used for lighting purpose, while manual and animal power were used for agriculture purpose in the rural areas (Sharan, 1986; Shah, 1988; and Report on Rural Energy Survey, 1989). Goel (1986) observed that 97.3 per cent used electricity for lighting purpose. Shah (1988) found that average expenditure on lighting was Rs.7.40 to 11.00/head/yr and kerosene consumption was 2.5 to 4.5 lt/house/month and electricity in the range of 18 to 38 kWh/house/month.

A study on Energy Census and Resource Assessment of Village Islamnagar in Bhopal (1981) revealed that firewood, dung and kerosene were used for domestic activities and 83.76 per cent of the total energy was used for domestic purposes such as cooking, fetching water, gathering firewood, washing and cleaning while only 4.66 per cent was used for farm operations. Tractor and bullock-cart were used for transporting farm inputs and outputs. Electric and diesel pumpsets were used for irrigation. The modes of transport in the rural areas of Gujarat mainly were bullockcarts, bicycles, tractors, jeeps and motor cycles (Sharan, 1986). It was further reported that transportation consumed 2.9 per cent of the total energy used in rural areas. The artisans depended primarily on manual energy and other traditional sources as coal. Joshi and Sinha (1993) reported that the use of fuelwood is higher in inaccessible villages. This is likely to be related to the higher availability of woody biomass in such villages. The daily per capita useful energy consumed varies between 397 kcal (1.66 MJ) and over 1390 kcal (5.83 MJ) for Middle Gangetic and East Coast Plains and Hill Zones respectively.

The time spent in collection of fuel was estimated to be 5 hrs to 23 hrs per week (Sharan, 1983) and at an aggregate level, it was estimated to be 11.2 hrs (Veena, 1988). The time spent for cooking 2 meals, tea and snacks once or twice a day, was 3.23 hrs/day/household (Veena, 1988).

Thadani (1990) reported that in Karnataka, to gather 1.74 tonnes of fuelwood every year, each household spent an average of 2.5 per cent hrs daily, made 172 trips in a year and each trip was about 8.5 km long whereas Rao (1990) found that men, women and children on an average spent about 3 hrs daily in fuel gathering and they walked about 4 to 5 km in search of fuelwood. It was also observed that an increase in per capita income led to an increase in the quantity of energy consumed. As income increased, people shifted their demand from inferior type of fuel to superior type of fuel and people preferred to go for purchase of fuel and male labour participation in fuelwood gathering declined. Gusain and Pandey (1991) reported that women and children walked as much as 3 to 6 km to collect fuel and spent 3 to 6 hrs depending on the distance of forest or other source of supply and scarcity of fuelwood in the area. Annabel (1991) mentioned that women were mainly responsible for fuel collection and walk long distances and carry heavy loads. The time spent will depend on the availability of the supply. However NCAER (1993) reported that in a majority of the cases (51.6 per cent), the collection is being done by the male members and the rest by female and children.

According to Alam, et al., (1985) supplies of fuelwood originate primarily from private farms. On the contrary, Mehta et al., (1987) and Veena (1988) observed that fuels were obtained by the households in 3 ways, viz., (i) raise fuel on own farms and homes, (ii) collect it from neighbourhood or nearby places and (iii) purchase it from the market. Sharan and Gopinath (1983) and Patel (1989) also observed that, the sources of fuel in rural areas are own farm, own trees and free collection. Neelakanthan (1991) indicated that on an average in Tamilnadu everyday about one lakh persons (male, female and children) remove firewood, small timber, fodder and green manure from the forest of the state mostly by headloads.

3.1 Consumption Studies Conducted Abroad

Most developing countries in Asia are consuming fuelwood as a main source of energy in the houshold sector using low efficient cooking devices. The studies undertaken abroad on domestic energy pattern, are reviewed in the ensuing paragraphs.

Around 40 per cent of Fijian households which relied on open fire, supplemented it with kerosene stove, and there was a close relationship between kerosene consumption for cooking and household income. When income increased by 1 per cent, there was a 1.5 per cent increase in kerosene consumption. In rural Gambia, cooking accounts for 53 per cent of fuelwood consumption, the balance being accounted for by water heating (36 per cent), ironing (8 per cent) and protection (3 per cent) (Dunkerley, 1980).

Joy (1980) reported that in the African countries non-commercial fuels like firewood and forest and crop residues, provide energy virtually for all domestic consumption and in India, Pakistan and Bangladesh, non commercial fuels like fire wood, cowdung, and agriculture wastes/crop residues account for about 90 per cent of total rural domestic energy consumption (Jain and Trivedi, 1981; Joshi,1988; Upadhyaya, 1989 and Mittal,1993).

In Fiji, 92 per cent cook with wood over an open fireplace. Open fire is only 5 to 10 per cent efficient, and unhealthy. About 74 per cent used kerosene for lighting (Siwatibau, 1981).

In Africa 90 per cent of the population use fuelwood for cooking. Average annual fuel consumption is estimated to be around 0.6 cu mt per capita among urban areas and 0.8 cu mt or more in rural areas (Anderson and Fishwick, 1984).

In Tanzania, Ethiopia, Somalia, Malavi, Guatemala and other Sub-Saharan countries, fuelwood was used by 80 per cent of the rural population (Foley, et al., 1984). Pakistan , Thailand and Philippines met 50-70 per cent of domestic energy needs by wood (Jah, 1986; Woravech and Panunumpa, 1986; Buenavista and Quejas, 1986; Wibulswas, 1986; and Junejo, 1991).

People walk about 2 to 4 miles to collect fuel in Nepal (Tuladhar, et al., 1986) and the fuels used for cooking were fuelwood, agriculture waste and animal dung (Tuladhar, et al., 1986 and Shrestha, 1987). Similar trend of consumption was revealed in Indonesia (Suparmo, 1986).

The total amount of energy consumed in Nepal during 1985/86 was about 244.4 million GJ, out of which 94.4 per cent was used for domestic purpose while the industry, transport, commerce and agriculture accounted for mere 2.4, 2, 1.1 and 0.1 per cent respectively. It is estimated that 75 per cent of the total energy consumed in Nepal came from fuelwood (FAO, 1991) (Appendix Tables III.5 - III.6).

About 94 to 98 per cent of energy consumption was in the form of fuelwood for domestic cooking in Sri Lanka and Bhutan (Hearth, 1986, and FAO Report, 1991). In Bhutan, the forest department gives permit to families to cut a limited number of trees for fuelwood, in case of inadequate supplies from forests, by paying a nominal royalty of one Nu per tree (FAO Report, 1991).

Per capita energy consumption in China was only one-fourth of the people of the world, on an average. Mostly crop residues and firewood were used in cooking and heating. In 1988, the annual consumption of energy in rural China was equivalent to 524 million tonnes of standard coal equivalent. Biomass such as firewood, crop residues and other organic wastes accounted for 56.8 per cent of the total energy (Mengie, et al., 1991).

In Southern Peruvian and Bangladesh, dung was used for fuel by 87 per cent of the population. The collection of fuel was often the responsibility of women and children especially in the Sub-Saharan African countries. But in parts of Senegal and Upper Volta men also participated in bringing wood home. In most places, dried twigs and branches which had died a natural death were collected. The study on charcoal cycle in Ghana found that with increased incomes and better standards of living, most of the low income urban dwellers would shift to more decent sources of fuel supply like LPG, Biogas and Kerosene (Foley and Moss, 1984).

In Myanmar 70 per cent of the energy consumption in the still comes from fuelwood. Annual fuelwood consumption per household is estimated to be 1.4 and 2.4 hoppus tonnes (volumetric measurement equivalent of 50 cu.ft) in urban and rural areas respectively (Tint and Aung, 1991).

4. Studies Related to Traditional Chulha

A chulha is a device in which partial combustion of fuelwood supplies heat to a pot placed on it. An open-fire chulha is made of 3 bricks or stones placed either in the form of an open rectangle or at 120° radially to each other. The space so enclosed forms a combustion chamber for burning fuelwood. Other chulhas are close-walled combustion chambers with openings for feeding fuelwood, for placing vessels and sometimes with chimneys for venting the exhaust gases. In the absence of a chimney, the opening for the vessel itself serves as an exhaust gas outlet. In the domestic sector a wide variety of stoves are used; there are open-fire cook stoves like 3-stone stove, 3-brick stove, one-two and three pot stoves, and bath water heater (Bhatt, 1983). The simplest form of shield / enclosure was a 3 stone arrangement in which 3 stones were arranged at 120° to one another on level ground (Shukla and Garg, 1989).

Traditional stove in Bangladesh is usually a mud-built cylinder with three raised points on which cooking utensils rest. One space in between these raised points is used as fuel feeding post and the other two for flue-gas exits. The stove may be built under or over ground. In some cases two potholes are joined together laterally using a single fuel-feeding part with an efficiency of 5 to 15 per cent. These stoves perform sub optimally due to loss of heat because of too large a distance between the pot and fuelbed (depth 30-60 cms), which reduces the heat transfer to the cooking pot, causes getting away of hot flue-gases from the stove without coming in contact with the cooking pots and the stove and accumulation of cooking fuel as charcoal since air cannot reach the bottom of the stove (Eusuf and Khan, 1991).

Various traditional biofuel conversion devices/stoves which give 2 to 7 per cent efficiency, employed in Pakistan included metallic hearth for grilling kababs and meat, milk warming chulha, ditch in ground, or temporary bricked chulha for large scale cooking, metallic-mud lined chulha, metallic bukhari for cooking, water and space heating, metallic angithi (charcoal), portable three walled and circular chulha, three ceramic masungs (stoves, large chulha (hearth) for space heating and cooking and metallic three legged chulha. Most of these TRCs are made of baked or unbaked clay with no provision for taking away smoke. In some parts of Pakistan, dry manure is burned in pulverized form to drive away mosquitoes and insects. In a number of cases, cookstoves made of clays or metal are commercially produced by rural potters or blacksmiths and majority are constructed on site from processed clay. Sometimes horse manure, straws, or even animal hair is mixed with clay to make it longer lasting and maintain the shape (Junejo, 1991).

Most of the houses in the hills and mountains of Nepal were customarily heated by a fireplace called an ageno. It is made from a pit dug in the floor of the ground floor room, with a few bricks or stones surrounding it, but no chimney. It was found that the high prevalence of chronic bronchitis among women is probably a result of their greater exposure to domestic smoke pollution due to their major responsibility of cooking the family meals (Pandey, 1992).

TRC used in Ungra village is made out of one or more local and freely available materials- namely, soil, termite mound, dirt and surki. The three pot-opening stove .is predominant in use which has dimensions of 80 - 120 cm in length, 40 - 60 cm in width and 15 - 20 cm in height. The pot openings are usually 10 - 20 cm in diameter and the width of the front opening is 12 - 20 cms. Heat output from the fire is controlled by regulating the fuel feeding rate. Since these TRCs do not contain a flue and chimney, the burning gases and combustion products are released into the kitchen (Geller, 1983).

Smith (1985) conducted a study in four villages of India. He found that the levels of particles given off, when biomass fuels burn, average more than 25 times higher than the recommended safe level in US and most other developed countries. Benzo-a-pyrene, a substance that has been linked to cancer, occurs in exceedingly high levels. It is mainly due to the absence of vents in TRCs to carry smoke out of the house. Many women inhale frightening amounts of pollutants such as CO and formaldehyde.

The conventional chulhas used in India waste considerable energy due to undirected and wavering flame, inadequate aeration and excessive fuel feed required to maintain continuous burning (Sangwan, et al., 1987 and Patel, 1989). As a result, these stoves have an overall combustion efficiency of only about 2-10 per cent (Garg and Dube, 1986; Sangwan, et al., 1987; and Raghuraman, 1989). It is estimated that in India over 133 million tonnes of firewood is burnt annually in the existing inefficient cookstoves generally made of mud (Garg and Dube, 1986; Patel, 1989 and Srivastava, 1990).

Ahsan (1985), Garg and Dube (1986), Misra (1989), and Paralikar and Patil (1990) reported that conventional chulhas produce a lot of smoke in the kitchen, causing a variety of eye and respiratory disorders to the poor women folk who inhale the smoke while cooking. Smith (1985), Mishra (1989) and Bhatnagar, et al., (1989) revealed that Indian rural woman daily inhales cancer causing smoke equivalent to 20 packets of cigarattes/day.

In most instances the traditional cookstoves used in developing countries are inefficient, physically hazardous and inconvenient. Moreover too much productive time, especially of women and children who cannot afford to buy fuel, is spent gathering fuel and is thus diverted from productive development efforts (Garg and Dube, 1986; Gandhi, et al., 1992 and Karekezi, 1989). More time consumption, high cost, labour and money, health problems, drudgery, and ineffective existing technology were the major constraints observed by rural women in conventional energy consumption system (Yadav and Sharma, 1988).

In rural areas traditional chulha suffered from various defects like release of smoke which results in eye irritation and choking of throat. The smoke which comes out of these chulhas is very hot, and also cause diseases like chronic bronchitis, tuberculosis, eye diseases and cancer (Mohan and Gupta, 1989; Gusain, 1990 and Karekezi, 1989).

In the rural areas of Ghana firewood is used mostly for cooking on the traditional 3 point cookstove which is characterised by low energy efficiency. The study revealed that there is a linkage between the utilisation of efficient energy devices and the level of income of the users (Abakah, 1990).

Srivastava (1990) and Junejo (1992) opined that the main consequence of the stove is the long hours spent in cooking in smoke filled kitchen, causing eye inflammation and consequential diseases, blackening of utensils and kitchen walls.

Achmadi (1992) pointed out that type of housing affects indoor air quality due to poor ventilation. Health hazards related to biomass fuels due to emissions from chimneyless pit stoves might increase during winter season.

Sims and Kjellstrom (1992) stressed the importance of house design and structure on the volume of smoke present. The closer together the houses are placed, and the smaller and lower they are, the greater will be the volume of smoke retained. The majority of rural houses consist of only two rooms, and some consist of only one where all activities take place. Poor ventilation and relatively high population density entails exposure to smoke for all family members. A Chinese study found the highest levels of indoor air pollution, which exceeded outdoor levels, in traditional single storey homes, levels declined slightly in 20-storey blocks, and dropped to 50 per cent in high-rise apartment buildings (Xu, et al, 1989). This finding may have significance for biomass smoke investigations as many rural homes are single-storey dwellings.

According to Mittal (1993) TRC consumes 2000-2500 kg of wood per annum for an average family with an efficiency of 8 to 12 per cent. Maiti and Gupta (1993) reported that the thermal efficiency of TRC is 10-15 per cent. One of the major defects is the lack of control on the air supply. Air is supplied over the fuelbed and the same mostly acts as secondary air. Primary air supply from the bottom of the firebed is non existent. Hence, the fuel at some places and particularly at the bottom receives less or no air supply which causes improper combustion. This results in the formation of CO, emission of black smoke and large quantities of irritants, toxins and carcinogens due to incomplete combustion of fuel. These pollutants are detrimental to the health of rural women and also pollute the kitchen environment. TRCs are mostly inefficient due to incomplete combustion and the unburnt fuel is accumulated at the bottom as charcoal. Because of large size of firemouth and the flue-gas exits, a large amount of excess air enters into the chulha and the flue-gases get out of the chulha without coming in contact with the cooking pot and thus, lowering the convective heat transfer. Women and children surrounding the cooking area are exposed to fairly large doses of toxic fumes especially when fuels are not properly dried or mixed with other lower grade biomass. Keeping in view all these problems faced due to TRC, improved stoves have been developed.

5. Studies Related to Improved Chulha

Cooking stoves all over the world evolve continuously as users improve, amend and adopt them to be more efficient, convenient and cheap (Young and Grant, 1991). An Improved Chulha is so called since its design parameters are optimised to perform with much higher thermal efficiencies than TRC. In addition smoke emissions of IC are minimal because of better combustion. The IC may be a shielded or a closed model. It is utmost essential that TRC, food habits, cooking practices, cooking needs, local social restrictions, adaptability, local resources, functions of TRC, women's work load and the like are understood properly before developing an IC (George, 1988).

The term `efficiency' is defined as the fraction of heat content of the fuel fruitfully utilized. To achieve higher efficiency, a stove should be designed such that the rate of heat input should be as high as possible during preboiling and as low as possible during simmering period. This indicates that vigilance of the fire is also an important factor in gaining a higher fuel efficiency of a stove. A feeding rate higher than necessary will only evaporate the water away but not hasten the cooking (Eusuf and Khan, 1991). Since the stoves are meant for the millions of illiterate masses, any kind of sophistication in their manufacture and also operation will act as a deterrent to their widespread applications. Attempts, therefore, have been made to develop and introduce modified versions of the traditional stove, termed as "improved stove".

The Institute of Fuel Research and Development (IFRD), Bangladesh developed 3 types of ICs (i) improved stove without chimney (ii) improved stove with chimney and (iii) improved stove with waste heat utilization (Eusuf and Khan, 1991). The first type of stove saves 50 - 55 per cent fuel when compared with TRC and is suitable for fuelwood, twigs and branches. On the other hand, the improved stove with chimney recorded a fuel saving of 60 to 65 per cent when compared with a TRC. The third type - stove with waste heat utilization is fitted with a box at the bottom of the chimney of improved double-pot stove to recover the sensible heat from the gases passing through the chimney. A maximum of two utensils can be accommodated at a time in the hot box which shows a fuel saving of 10 - 15 per cent. The cooked food can be kept warm for a longer time. In larger models, water heaters have been attached to the chimney just below the hot box for supplying hot water for tea.

National Women's Association of Bhutan (NWAB) launched a pilot project of ICs in 1983 and the National Stove Project began in 1985 (Tobgyel and Jigmi La, 1991). Stoves made of rammed earth, mud and stone for hills and plains were developed.

The ICs in China were essentially the reformation of the primeval and traditional stoves by adding grate and chimney in which the combustion and sanitary conditions were raised with the efficiencies of about 15 per cent (Mengie, et al, 1991).

Myanmar is in the early state of R & D on improved stoves. A small research work was done in 1985 under the responsibility of Minor Forest Products Section of Wood Properties and Utilization Division. "One-Stick" stove was developed, the term implied, one stick of firewood is required to cook with. This one stick fuelwood stove was initially cladded with metal sheet which was very costly but does not last long due to corrosion. Later the use of all local materials for stove has been developed. The mixture of raw materials, i.e., white clay, yellow clay, black soil, charcoal powder and river sand, is soaked for 24 hours and beaten to make it sticky. The outer shell and the inner cone are thrown on simple potter's wheel and are dried and fired in traditional kiln. In addition two types of charcoal stoves were developed with an efficiency of 39.45 per cent (Tint and Aung, 1991).

In Thailand stove development programme was initiated in 1982 by the Royal Forest Department (RFD) and National Energy Administration (NEA), with technical cooperation from USAID. Only two stoves, a charcoal stove and a portable woodstove proved acceptable to users. A ceramic-metal bucket charcoal stove consumes 40 - 50 per cent less fuel than TRC and a portable ceramic woodstove with or without metal casing is 100 per cent better than the open fire (three-stone and tripod); 35 - 40 per cent on the average better than most existing commercial wood-stoves (Joseph, 1991).

In Indonesia, ceramic stoves, locally known as "Tungku SAE", were developed with local potters. The Bureau of Energy Development, Ministry of Energy and UPLB college of Engineering and Agro-Industrial Technology started the investigation of solid biomass cookstoves during 1980-1982. About 52 local models have been developed by the end of 1986 (Joseph, 1991).

During the period 1975-1985 the Sarvodaya Sangamaya, the Ceylon Institute of Scientific and Industrial Research (CISIR) and the Industrial Development Board (IDB) took a lead role in carrying out R & D work to develop suitable stove designs. The rural stove model is a mud covered two-pot stove with a standard pottery insert. The installation requires the service of a trained stove installer (Amerasekera, 1991).

First effort was made in mid 50's for the development of IC by some organisations and individuals in India. The efforts resulted in the development of a few ICs such as, HERL chulha, Magan chulha, Jalnigam chulha and so on. (Shukla and Garg, 1989). These stoves had a chimney, at least 2 potholes (and usually more) and one or two dampers to control the air (Joseph, 1991).

In December 1983, the Department of Non-Conventional Energy Sources (DNES), Govt. of India initiated the National Programme on Demonstration of Improved Chulhas (NPDIC). Later in 1985 NPDIC was renamed as National Programme on Improved Chulhas (NPIC) which subsequently was included in the New 20 point programme and Minimum Needs Programme of Government of India (Patel, 1989, Antika, 1990 and Mittal, 1993).

NPIC has been extended to all states and UTs with about 15 million ICs installed so far (Appendix Table III.7). As many as 58 models of ICs including 40 fixed type and 18 portable type have been developed to cater to the needs of different areas and regions (Eighth Five Year Plan, 92-97). In Eighth Five Year Plan, the NPIC is expanded to cover upto 10 per cent of total rural households in the country.

Mittal (1993) reported that 120 million potential households are using biomass burning chulhas. ICs installed upto March 1992 were 12.50 million. All India coverage per thousand total/rural population was 14.91/19.98. Proposed coverage during 8th Five Year Plan is 18 million. According to Mittal (1993) actual saving by IC is 700 Kg/family per year of wood equivalent valued at Rs. 400.00 approximately.

Gusain (1990) found that the benefits from improvement in health and reduced collection time were very high due to the use of improved stove.

A study on performance and impact of IC on households revealed that IC was found to be superior and beneficial in terms of time taken for cooking and cleaning utensils and spread of smoke in the kitchen (Srivastava, 1990).

Kalra and Singh (1990) observed that majority of the respondents from project group had a high knowledge score about improved practices of IC as compared to the respondents from control group which is an indication of the favourable impact of the extension programme on the women of the project area. TBSU (1990-91) reported that Mamta chulha in Gujarat was widely accepted. Fuel saving was reported by nearly all its users and it ensured cleaner environment.

Wherever adequate user's training has been conducted and the women have understood the correct use of ICs, they were happy with ICs. Almost all the users appreciated the health aspect, i.e., being relieved from smoke related problems like bronchitis, asthma, tuberculosis and eye afflictions when switched over to ICs. They were also happy that, since the cooking vessels did not get blackened with heavy soot, ICs saved their time and effort in cleaning the vessels and thus used it profitably for some other activities. Nearly half of the beneficiaries recognized the fuel efficiency and better combustion aspects. However some women complained that IC consumed more fuel than TRC and took longer time cooking the same food. This was more so when follow-up was not done regularly. Moreover in many cases, the internal dimensions of ICs have been changed by smearing it with cowdung and mudpaste which attributed to lower thermal efficiency. In addition over-feeding of the fuel too resulted in increased fuel consumption in IC (Balakrishnan, 1991).

The improved stove promotion programme led to an awareness of other environmental and social concerns, particularly kitchen air pollution which is a serious threat to women and children who are around the stove most often (Young and Grant, 1991). George (1991) estimated that improved cookstoves have thermal efficiencies above 20 per cent and save about 40 per cent of conventional fuel with the minimum saving being 20 per cent. The average annual saving in biomass may be between 219 to 440 thousand tonnes in the worst to best conditions of operation of about 5,00,000 ICs.

Pandey (1992) conducted a study to measure the personal exposure levels to respirable suspended particulates (RSP) emitted while cooking. The air sample results proved that a cook's exposure to harmful air pollutants is markedly decreased when using the Tamang smokeless stove. The average exposure rate to RSP dropped from 8.2 mg/cu mt while using TRC to 3.0 mg/cu mt when using improved stove. ICs were effective in reducing cook's exposure to TSP and CO in comparison to the kitchens which had TRC. Lower indoor smoke concentrations rather than fuel savings was the main advantage felt by the cooks.

Ramakrishna (1992) conducted a study on IC in South East Asia and Latin America. He observed that the average lifespan of an IC is somewhat over a year longer than that of TRC. Major benefits identified by respondents in declining order were fuel saving followed by smoke reduction, time saving, income generation, health benefits, creation of jobs, money savings, increased environmental awareness and improved safety in the kitchen.

Smith (1992) estimated that IC uses 25 per cent less fuel and releases just one-third of its products of incomplete combustion (PIC) into the kitchen.

George and Yadla (1995) in their study reported that the mean daily fuel consumption on conventional and Mamta chulha were 4.88 kg and 3.75 kg respectively, thereby, resulting in fuel saving to the tune of 24 per cent on Mamta chulha.

Though the above studies revealed that IC has many advantages over TRC in terms of saving fuel, saving time in cooking and cleaning vessels and reducing drudgery of women and children in collecting fuel, and ensuring smoke free environment, some studies revealed that ICs were not as beneficial as they should be.

Tilak, et al., (1987) noted that in many cases the chulhas installed under NPIC programme were discarded and conventional chulhas were put into use. The reasons for discarding were (i) no saving in fuel (ii) difficulty in operating dampers and (iii) difficulty in baking pancake on chulha.

Shrestha (1987) reported that dissemination of technology and distribution of ICs were tried in Nepal by several institutions by installing twenty nine thousand ICs. But these are fragile and bulky for transportation, appropriate clay is not available in most of the places, and size of the stove is fixed. The author also pinpointed that there is a gap between technology developers/producers and users. Majority of the users group are not educated and they are not in a position to understand the importance of energy technology.

Njoku and Maheswari (1990) found that the improved cook-stoves have holes of fixed sizes which may not fit the available pots. In these stoves, one has to chop wood into small pieces, i.e., to feed the stove, which is more cumbersome, laborious and time consuming. Lack of flexibility in these stoves is one of the major drawbacks in areas where during certain times of the year, women like to favour cooking outdoors. After using for nine months or so, small cracks may often appear on the surface of the stove thus making it look shabby. Thus users may conclude the stove is damaged and stop using.

A few problems and difficulties related to IC's dissemination in Nepal were reported (Shrestha, 1991). These included no proper follow-up services in stove operation, maintenance and repair of ICs and expensive and ineffective policy of subsidized dissemination of cookstoves. The common reasons, as given by the rural users for reverting to TRCs, were found to be more time consumption in cooking, inappropriateness to prepare all foods and space heating, frequent occurence of chimney pipe choking and breakage, and non-availability of broken parts to be replaced.

In Sri Lanka (Amerasekera, 1991) 70 per cent of the population were either unconcerned about ICs or were isolated from the programme due to its high price for the poorest despite the subsidy, fuelwood not being a serious problem as compared to other priorities, inappropriate stove model and inflexibility of strategy which put a constraint in reaching the majority.

TBSU, Baroda (1990-91 and 1991-92) in its monitoring survey observed that tendency on the part of users to mud -wash the interior of pot holes affects the step design in firebox in Mamta chulha. The quality of work was very poor due to very poor monitoring the work of grass-root level functionaries and workers by nodal department and agency, use of untrained persons in the construction of ICs and lack of user education. Use of mould was rarely seen in chulha installations. As a result, chulhas did not comply by dimension specifications.

Joshi (1992), Sharma and Singla (1993) in their feed back survey found that dimension of the chulhas was not as per specifications. The main reason for the rejection appeared to be the faulty construction of chulhas by SEWs as well as selection of improper models for propagation by the implementing agencies.

5.1 <u>Suggestions for Improved Implementation</u>

In a review of Sarvodaya stove project in Sri Lanka, Howes, et al., (1983) highlighted four conditions applicable to any stove programme, that must be satisfied for a person to adopt a new design of the stove:

1. they must be aware of its existence and of the functions which it performs
2. they must be able to obtain access to it
3. they must regard it as superior both to existing stoves, and to other alternative stoves of which they are aware
4. they must regard it as more desirable than other goods or services which could be acquired with the same resources.

The various ways to disseminate stove technology are raising public awareness regarding fuel shortage, using mass media - tra.nsistors, radios, television, dailies, poster campaigns, organising stove building contests, stove exhibitions in fairs and festivals, training people, promoters and development workers, involving women as promoters, teachers and extension workers in introduction of stoves, evaluation and follow up of the installed improved chulhas, training users in usage of stove and the like (Aprovecho Institute, 1984).

Kamble (1984) prophesied that to make renewable energy technology socially acceptable, it is necessary to educate the community on various aspects of energy such as the depleting sources of energy and utilization of alternate sources as a possible situation. It is necessary to realise that the final consumption pattern of energy would depend on the quantity and the way energy is consumed by an individual in the society. Acceptance of renewable energy technology is therefore more of a social problem than a technological one.

Foley and Moss (1985) and Shreshtha (1991) pointed out that promoters must take into account the financial context in which the stove programme is being implemented. Where fuel is commercially traded and stoves are already on the market, it is possible to consider designing improved stoves for sale.

George (1986) implied that formal or informal education programme, and exhibitions need to be carried out to create cognizance in household members about energy crisis and relevance of energy conservation in the present context. TV network system can also play a vital role in this regard.

Tilak, et al., (1986) and Junejo (1991) suggested that for ready acceptance of new chulha by rural housewives, the chulha should satisfy the following criteria :

- it should be similar to the conventional chulha in size, shape and overall dimensions
- its price should be within reach of poor rural households
- the space occupied by it should not be large and it should fit in conveniently in rural households
- it should satisfy the needs, perceptions and cooking habits of rural housewives, and
- the manufacturing technology should be simple and amenable to speedy mass production of standard, dimensionally uniform and reproductive chulhas by housewives and rural artisans.

Joshi (1988) assumed that the possible factors affecting the adoption or rejection of IC could be :

- fuel consumption
- time taken for cooking
- flexibility, whether other fuels can also be used
- extent of smoke emitted
- extent of soot deposited on the vessels
- ease in starting the fire
- extent of heat dissipated in the kitchen
- safety
- number of dishes that could be cooked at a time and
- durability

Young, et al., (1989) and Crewe (1992) suggested that the success of improved stove dissemination depends not on tackling one single physics problem, but on the whole set of diverse issues which affect the household environment.

Mukherjee (1989), Shukla (1991), and Vasudevan (1991) commented that a technically efficient technology is not in itself self sufficient, until and unless it matches the social, cultural and economic expectations of the users. Efforts should be made to create awareness amongst women regarding each component of the cooking system; proper operation of stove, better cooking practices to conserve energy, so that they feel that the biomass energy programme is their own programme and would also strengthen their economic condition.

Hassan (1990) and Shreshta (1991) stated that it is the woman, the mother who usually keeps the traditions and insists on keeping them. The new schemes must be attractive to women if they are to be accepted and women should be involved in stove installation, maintenance and repair. They shoud be educated to use the technology to optimum advantage (Sarin, 1985).

Srivastava (1990) suggested that the popularisation programme in a locality should ensure local availability of mould, chimney, grating rods, and trained women to undertake construction. People's participation is necessary and they must contribute towards the cost in cash, labour and material. The transfer of technology should be done through women organisations and voluntary social agencies and its adoption through IRDP. All field functionaries and extension workers should first adopt the new stove themselves for their own cooking. It was further suggested that special audio-visual aids, posters, charts, brochure and other extension and publicity materials be prepared in local language.

Njoku and Maheswari (1990) strongly felt that women should be made active participants in designing and decision process. It is important that demonstrations and classes are run to make the people understand the new technology.

Kalra and Singh (1990), Sharma and Singla (1993) proposed that attempts should be made to appoint well trained chulha constructors. Intensive training with respect to construction, use and maintenance of the chulha should be imparted and follow-up action should be intensified to ensure greater transfer of technology.

Joseph (1991) felt that there is a real need to integrate stove programme within larger kitchen environment improvement, forestry and income generation programmes. Shukla (1991) and Joseph (1991) suggested that marketing, appropriate production and supply strategies and availability at decentralized levels, including in various rural markets, fairs and community centres are the other aspects to be considered.

The stove programme should set up a mechanism to maintain quality control and consumer protection forum has to be established to maintain the standard of stoves and awareness of their existence and benefits (Joseph, 1991).

Nystrom and Jere (1991) discussed about the importance of kitchen considered in relation to location of stove. The placing of a stove may affect its efficiency, by way of effects of draughts on biomass burners. To successfully motivate behavioral change through installing and utilizing a new stove in which combustion is efficient and excess smoke is eliminated, the dwelling itself should be modified to make this possible.

TBSU, Baroda (1991-92) recommended pre-installation survey, publicity, and motivational and popularisation camps, cooking demonstrations at a convenient time on IC and TRC to target population, and user involvement in NPIC to enhance functionality rate of IC. In addition follow-up of chulhas once a month in the first 2-3 months and less frequently thereafter as well as trained man-power are also stated as relevant aspects to strengthen NPIC.

Natarajan (1992) explained that dissemination of information is a process of communication which should be established on a sound footing because most of the villagers are illiterate and not knowledgeable and they are spread out all over the area in different villages. Activities to be done under dissemination of information programme are :

- publication and distribution of technical literature containing information on improved, adopted and new technology suitable for rural needs in local languages in the form of pamphlets, leaflets, brochures, posters and other audio-visual aids such as film strips, films and taped messages.

- screening of documentary films and video programmes on appropriate technology.
- conducting exhibitions to display various items of approrpriate technologies at the project area or at public places during festival days and
- organising seminars on relevant topics

User education/training and creation of awareness and publicity may be stepped up further with special emphasis on the quality of training oriented towards use, repair and maintenance and usefulness of the programme for the society in general and the household in particular (NCAER, 1993 and TBSU Annual Report 1993).

Maiti and Gupta (1993) stressed the importance of ceramic/prefab lined chulhas. According to them the novel features of ceramic lined chulhas are

- design based on optimised ratio for primary and secondary air supplies
- maximal heat transfer to the vessel through well directed flame
- standardized firebox size and shape to improve combustion efficiency
- scientifically designed chulha with combustion chamber that facilitates ignition of fresh lot of fuel without air blowing or fanning. The thermal efficiency under optimum condition lie between 40 to 50 per cent.

The merits of prefabricated ceramic liners are

- ease and speed in installation
- speedy construction
- greater durability and higher mechanical strength
- retention of dimensions of chulhas for long time
- potential as insulators to curb heat lossess, and thus, increase thermal efficiency of the chulha
- ease in maintenance and replacement of liner in the chulha without destroying the structure of the chulha
- regular mud washing of chulhas which alters the dimension can be avoided through the use of ceramic liner.

It was evident through the literature reviewed that many studies focussed on energy consumption pattern in different sectors, time and energy consumption in gathering cooking fuel and cooking meals in rural families, smoke emission due to IC and TRC and its impact, and feed back surveys on ICs to assess target achievement, functionality rate, effectiveness of ICs to conserve biomass, eliminate smoke and users' responses regarding merits or demerits of IC. Though some authors have made assumptions regarding the factors that would contribute to successful implementation and functional status of ICs under NPIC, not much systematic effort has been made to find out the factors affecting adoption of an IC like MC and perception of users regarding costs-benefits of its adoption as a cooking unit in daily life. More over, the review work done by Rogers (1962), Rogers and Shoemaker (1971) and other authors revealed that many studies were conducted in the field of farm, agriculture mangement, and education. Hence to understand the adoption process in the field of energy with reference to improved cookstoves, the present study was taken up to throw light in this direction.