CHAPTER II

REVIEW OF LITERATURE AND RESEARCH DESIGN

This chapter contains two sections. In the first section, a brief review of literature is presented. The research design consisting of sampling procedure, definition of concepts, tools of analysis and methods of measurement of variables is discussed in the second section.

REVIEW OF LITERATURE

Studies on rural energy can be divided into three groups based on their scope: (i) studies relating to household energy consumption; (ii) studies covering rural industrial consumption and (iii) studies on energy consumption in agriculture.

These studies have covered any one or two or all these three aspects. As the present study focuses attention on energy consumption of rural households, an attempt is made to review the studies covering household energy issues which fall under two categories viz., (1) studies covering rural household energy use alone and (2) studies covering household energy use with other related aspects of rural energy use.
This review of literature is presented on the basis of the objectives of the present study. The studies of household energy use and also the analyses of the demand and supply aspects are presented first. The studies dealing with the factors influencing household energy use are presented next. Then, the studies which have analysed the demand and supply aspects as well as the differences in energy use patterns among various household groups are presented. Two significant wide ranging surveys have been conducted at the macro level. They are, the survey conducted by the National Council of Applied Economics Research (NCAER) in 1977-78 (published in 1985) and the National Sample Survey Organisation's (NSSO) survey of the 32nd Round (1977-78). These two surveys give a comprehensive picture of energy consumption in India. Though their objectives and methodologies are different and they are not perfectly comparable, some broad conclusions with respect to the use of energy for domestic purposes in rural areas at the national level emerge from these studies. The results of these two studies are discussed first, and the review of other studies follows.

THE NCAER SURVEY

The NCAER made a survey on household fuels during 1977-78. It collected data on household energy consumption
by income groups at the national level and average energy consumption in different states. On an average, 0.43 litres of Kerosene, 0.41 kwh of electricity, 0.1 kg of soft coke and about 30 kg of various fuels per capita have been consumed by a household per month in rural areas of India. The gross fuel consumption of domestic energy in rural areas has been 1,15,800 K.Cal. per capita per month.

Around 95 per cent of the total energy used in rural areas consists of traditional fuels such as firewood, crop residues and dung cake. The consumption of both total energy and useful energy increases with increase in income. But the difference in energy consumption between different income groups is however quite small. According to the NCAER Survey results, the bulk of the energy is used for cooking which accounts for 89.7 per cent of the total energy used in the household sector. Moreover, the share of energy for cooking declines with the increase in income. The differences however, are very small. The bulk of kerosene consumption (84 per cent) in rural areas is for lighting. As regards electricity, only 14.3 per cent of rural households, mostly higher income households, used electricity for lighting.

Firewood is the most important fuel, accounting for about 54 per cent of the total energy consumption.
Animal dung and crop residues together provide about 41 per cent of the total energy.

An insight into the consumption of energy among different income groups reveals that the share of kerosene declines with the increase in income, while coal and electricity show the opposite trend. Only little variations in energy use are found among different income groups. While the share of firewood decreases with increase in income, the share of dung cakes shows the opposite trend. While commercial fuels are purchased in rural areas, the bulk of the traditional fuels are either obtained from own sources (trees, livestock, etc.) or collected by expending labour.

THE NSSO SURVEYS

The NSSO survey reveals that, on an average, per capita monthly expenditure on energy in rural areas works out to the value of Rs.7.92. The expenditure on energy rises with the rise in total expenditure. But the share of energy in total expenditure shows the opposite trend. Significantly, the share of energy in total expenditure is much more for lower income households than for upper income households. Moreover, for lower income groups, expenditure on energy is the most important non-food expenditure.
According to the NSSO surveys on consumption expenditure of the years 1972 and 1983, the per capita monthly expenditure on energy has increased from Rs.2.49 to Rs.7.92 in rural areas. Statistical analysis depicts a high correlation of expenditure on energy with expenditure on food as well as total consumer expenditure. Elasticity of energy expenditure with respect to total expenditure, for India as a whole, works out to 0.577 for rural areas. The elasticity for different states ranges between 0.511 and 0.789 in rural areas.

OTHER STUDIES

Revelle in his study, "Energy Use in Rural India" reviewed briefly the methods adopted by various studies in order to measure human and animal energy use in rural India. He assessed the use of both locally produced fuels and commercial fuels. He compared the pattern of energy use of Rural India with the U.S. pattern of energy use. An interesting feature of his study is that, "the energy use in cooking per calorie of food energy consumed (in India) was higher than the estimated U.S. energy and home refrigeration combined, because of the low efficiency of fuel use which was observed to be less than nine per cent in India. He pointed out that the present forest reserves
in India, if all were used for firewood, are enough to last only 24 years, given the present annual rate of consumption. He briefly discussed the ways of development of harnessing energy resources and increasing agricultural production in order to make the Indian rural eco-system fairly self sufficient.  

Hang Zhu et al. found in their study that the rural households in China used mostly biofuels such as agricultural residues and firewood. About 90 per cent of the rural households they studied used low efficiency cook stoves. Moreover, they observed that the rural households owned fewer home appliances. Cooking, space heating and lighting were the primary end uses for which households consumed energy. Only about 50 to 60 per cent of the rural households electrified their houses. According to them, "significant opportunities exist for more efficient utilization of energy for households in China". Such improvements, they felt, could lead to substantial improvements in the quality of life in the rural areas.

On the basis of the 18th (1963-64) and 28th (1973-74) rounds of the National Sample Survey data, Chandran found that the average per capita consumption of energy has not changed significantly during this period. Another noticeable fact is that, the per capita consumption
in the rural areas was higher than in the urban areas. The share of commercial and non-commercial energy in rural areas was observed to be 20 per cent and 80 per cent respectively. Further, he observed that collected fuels constituted a larger share. He also showed that the lowest income group consumed hardly half of the energy consumed by the higher income group.

In her study, "The Political Economy of the Domestic Fuel Crisis in Rural South Asia", Bina Agarwal compared the time taken in the past and present to gather firewood and felt that "fuel shortages are driving villagers in several regions of South Asia to shift to foods that require less fuel but are of lower nutritional value or to miss some meals altogether and go hungry." She stressed the need for fuel sufficiency. She observed that firewood is the most-used fuel and the use of inferior fuels instead of firewood usually reflects the households' poor economic status.

Her study showed that the dependency on fuel collection from sources other than one's own increases as asset holdings decline. She also showed that there exists "a positive relationship between income group and the amount of firewood consumed -- consumption decreases consistently as income levels fall in each region".
Quoting a study of households in Bangladesh, she felt that due to increasing monetization of energy resources, for poor households, "there can even be a trade-off between fuel and food". She also showed that, "while the big farmers can still afford three meals (almost all cooked) a day, the small owner cultivators and share croppers have shown a small decrease, and the landless a significant decrease, in the frequency of taking meals". She also analysed the factors responsible for deforestation. She brought out the complexity of rural problems with respect to varied use of energy resources. She pleaded for recognition of these aspects for rural planning.

Cecelski in her paper "Energy and Rural Women's Work: Crisis, Response and Policy Alternatives", with the help of F.A.O studies and other published results, concluded that two of the most time consuming activities of women in the villages (Villages covered in ILO country studies) were fuel collection and cooking. She found that kerosene was used mostly for lighting in most of the villages studied. Another astonishing outcome of her study is that in some villages, even poisonous weeds were used for cooking by the poor (Ratama in Peru and Basothi in India). She also dealt with energy shortages and policy priorities at different stages of environmental and socio-economic
degradation. She opted for a participatory approach to project design and implementation. She also opined that a coordinated approach to cooking practices, pot materials and types, diet and fuel preparation and storage may be as effective in saving fuel as are improved stoves.

In their study "On India's Biomass Budget" Pillai and Gadgil showed that the biomass base of the primitive economy in India is collapsing. The main reasons according to them for this collapse are: the coordinated effects of population pressure, alienation of access to large areas of land taken over by the State and diverted to biomass production for the commercial sector, and breakdown of community level cooperative behaviour. The end results, according to the study, are fuelwood and fodder shortages which lead to the use of dung as fuel and loss of its manurial value. It also means over-hacking of woody vegetation and overgrazing of herbaceous vegetation which they felt depresses the productive potential of the natural vegetation and further accentuates shortages. They found that substantial parts of India are currently caught up in such a situation.7

Leach in his studies8 found that in remote rural areas, especially in poorer countries, biomass typically met all energy needs, except for small amounts of kerosene used
for lighting. In South Asia, household fuel use was found to be strongly related to household income. He observed small difference in per capita energy use especially per capita biofuels, in rural areas, across the income range. He also established that, other things being equal, for most purposes, large households used much less energy per person than small households did. He found that the large farmers had greater diversity and security on fuel supplies than small farmers and the landless who typically faced fuel scarcities because of their dependence on others and on often limited and unproductive common lands. "The higher income groups in all the countries he studied, have made the biomass - modern fuel transition and have gained from it greater convenience and reduced personal costs". He also established "conclusive evidence from India that irrigation and other agricultural or dairy development schemes which increase the production of all managed biomass resources, lead to greater biomass fuel use and alleviate fuel hardships for the poorest".

Pachauri and Rao in their study on "Energy Plans and Flow in five typical villages observed that though the total units of energy used was similar, there was wide variation in the share of various fuels. The use of k... was found to be very low in all the villages.
Animal and agricultural wastes satisfied most of the energy needs. While firewood usage had been noted to be considerable in one village and fair in another village, it was low in the other three villages.  

Sagar et al., in their 'Pilot Survey on Fuel Consumption in Three Villages of Uttar Pradesh', reported higher fuelwood usage in the mountainous villages than in a village on the Indo-Gangetic plain. The use of animal waste as fuel was observed to be less in one mountainous region and more in the village situated on the plain.  

Siwatibau in her study "Rural Energy in Fiji: A Survey of Domestic Rural Energy Use and Potential" analysed the present energy use and future energy wants of Fijian villages. She also studied the availability of alternative energy sources and their socio-economic feasibility. An assessment of the social viability of biogas systems was also made. Interviews supported by questionnaire survey were her chief sources of information. The benefit cost analysis was also employed to assess the viability of biogas digestors. As family income increased, especially in situations of dwindling firewood supplies, she observed a definite swing from firewood to commercial fuels. She expected an inevitable supply bottleneck in some parts of Fiji in the next ten years. She pointed out the attitude of
households going for cheap kerosene stoves without consideration for its safety and efficiency features.

Most of the women pleaded for better cooking facilities and the researcher emphasised the need for cheap, clean wood burning stove. With respect to space heating, all of them "welcomed some means of keeping their homes warm without having to sleep in smoky, thatched bures." With respect to lighting, about 74 per cent of the sample households used kerosene and benzine lamps. Most of the people "wished to have hot water readily available at their homes for washing, heating and steam baths; for which they are willing to make cash contribution towards either community or individual systems."

Of the 16 known digestors studied, pig waste was used in 15 digestors and poultry waste was used in one digestor. Her analysis revealed that "present designs are not yet suitable for village use" and to utilize the digestors at optimum level, the installation of digestors in commercial piggeries of 30 pigs or more, is worthwhile. She concluded that "for villages and small farmers without animals, biogas possibilities lie in the utilization of vegetable wastes rather than animal wastes".11

Hyman, in his study on woodfuel consumption in the province of Ilocos Norte, Philippines, examined
household consumption of wood and other fuels. He found that three quarters of the fuelwood-consuming households relied on wood for more than 60 per cent of their domestic cooking needs. Fuelwood collection was observed to be inversely related to the level of education of the heads of households and their income. The adult male played a major role in fuel collection. Increasing hardships in fuel collection were widely reported in his survey. He threw light on the tree-growing activities of the households. He also reported that a considerable portion of households resorted to kerosene mainly for lighting. Around 90 per cent of the households used dalikan stove (a standard household stove in Ilocos Norte; a relatively open hemispherical stove made of fired clay mixed with rice hulls, without a chimney or a flue, which can only hold one pot). Around seven per cent of the households cooked over an open fire. He pleaded for a mix of policy options like tree planting programmes, adoption of more fuel-efficient woodstoves and increased substitution of other fuels, to ease fuelwood problems.\textsuperscript{12}

Maheswari et. al., in their study, "Energy Census and Resource Assessment of the village Islam Nagar in the District of Bhopal," analysed the pattern of utilization of various energy resources and assessed the total energy
needs of a village community. They estimated the resource availability of the village eco-system to examine the extent of self-sufficiency and further investigated the possibilities of the extent of recycling of biomass in the village biosphere for the preservation of the ecological balance.

They found that, "the shortage of fuelwood in the village eco-system is of the order of 20 per cent taking into consideration fuelwood consumption for cooking and for wooden tools and availability from the forest and trees owned by the farmers." They also estimated that out of the total animal dung production (dry basis), 32.2 per cent was used for composting for farm yard manure and 42.3 per cent was made into dung cakes for cooking.

They estimated the per capita consumption of various domestic fuels. The share of firewood was around 60 per cent of the domestic fuel consumption. Firewood and dung were the principal fuels used for domestic activities. According to them, out of the total energy consumed 83.76 per cent was used for domestic activities.

Households were found to use traditional earthen stoves (chulhas) for cooking with either firewood or dung. Only 18 out of 224 households used kerosene for cooking.
Datta and Singh intended to focus on the potentials of the social forestry programme in meeting the energy needs of the rural population in Bihar and surveyed 69 households in two areas. In Ranchi (traditionally a tribal area) coal and cow dung were not used as fuels. The households used mainly wood as fuel. The non-participant households used less of fuel than the participant households. The possible reasons attributed by the authors were the small size of the families and their weaker resource position. In Aurangabad (a non-tribal area), while coal was found to be the major fuel for the participant households, cow dung as fuel received the highest importance for non-participant households, because of their better cattle endowment.14

Ravindranath and Shailaja, in their survey of the Ungra village, found firewood the predominant fuel and cooking the predominant activity using firewood. Another important finding of them was that more than one-third of the households gathered firewood and gathering accounted for 33 per cent of the firewood consumed. A significant observation was that in the case of purchased firewood, not much cash was involved and it was either obtained in return for labour or collected at a nominal price. Under the existing conditions, the researchers felt, the introduction
of fuel efficient, smokeless, time saving chulhas was the only alternative in their study area. 15

Misra et al. 16 in their "Pilot Survey of Fuel Consumption in Rural Areas - V" carried out a census survey of three clusters of villages, viz., (a) villages surrounded by forests, (b) villages nearer to forests and (c) villages away from forests. Firewood was the dominant fuel used in the study area. Their study indicated a negative relationship between the distance of forests from the villages and the quantity of firewood consumption. Their study revealed that agricultural waste was not a popular fuel in their study area. However, in the villages away from the forests, agricultural wastes were also used to some extent. A peculiar observation was that no family was found to use dung cake as fuel.

Gupta et al. 17, in their study, "Domestic Energy Consumption in India (Pondicherry Region)," surveyed 200 households in and around Pondicherry from two rural areas, two semi-urban areas and one urban area. The study found that, irrespective of class (income groups), the gross energy utilized in rural areas is much greater than that in semi-urban areas. The end use cooking accounted for 97 percent of the total energy consumed in the rural Pondicherry region. The share of commercial fuels in the rural areas
was observed to be only two per cent of the total energy consumption. The per capita, per day energy consumption in rural areas was found to be as high as 8 kwh of commercial and non-commercial fuels. They also observed that children, older persons of the family and agricultural workers generally used hot water for bathing. The researchers did not observe seasonal variation in energy use in the region. The rural communities were normally found to cook only twice a day. Firewood was the dominant fuel satisfying about 76.10 per cent of the total energy consumption and cooking was the dominant end use consuming more than 95.10 per cent of the cooking fuel.

According to them, improving the efficiency of domestic hearths without making them more complicated must have first priority. They opined that instead of electricity lighting, it will be worthwhile substituting oil lamps with solar cell lighting kits. They pleaded for an increased use of the solar water heating system. They also felt that cooking with biogas, though convenient, was not economic for the average village family even if animal dung was available.

In the study "Rural Energy Consumption Patterns -- A Field Study," made in the ASTRA principally by Reddy with others, an attempt was made to carry out a census survey
rather than a sample survey in six villages, in order to study energy utilization in various activities / sectors. They obtained information by questionnaire as well as by observation surveys.

It was found that 48 per cent of the firewood used was gathered, about 33 per cent purchased and about 19 per cent procured from the consumers' own land. There were also considerable inter-village variations which depended on the accessibility of suitable tree and shrub cover within convenient distances. But in contrast only a minor inter-village variation in per capita firewood consumption was observed. They established that gathered firewood (upon which three-quarters of the households depended) did not contribute in any significant way to deforestation. In their study area, dung cakes were not burnt as cooking fuel. Their results showed that cooking was done almost exclusively on mud stoves (Chulhas) and most of the households used at any one time more than one species of and as many as five species.

With respect to lighting, only 22 per cent of the households had electric lighting, whereas 78 per cent of the households were forced to depend on kerosene lamps. The main reason why most of the households are compelled to accept a much poorer quality of light even though they spent the same
amount on kerosene lamps is the operating costs they need to bear before they secure electricity connections.

They used the linear regression analysis to estimate the firewood consumption in terms of the total cereal consumption (TCC). With the help of the specific fuel consumption (SFC), they also determined the cooking efficiency (E). Their results revealed "a high degree of correlation ($r = 0.9576$) between the average quantity of firewood consumed per household and the average holding size, but a much poorer correlation ($r = -0.4943$) between the average per capita consumption of firewood and the average land holding size". Another interesting result is that both per household and per capita consumption of kerosene and electricity depend strongly on the size of either land holdings or households. Further, a negative correlation between land holdings and kerosene consumption and positive correlation between land holdings and electricity consumption were observed which showed that with increasing affluence, kerosene for lighting is increasingly substituted with electricity. 18

Bowonder et al. made a survey of 8 villages to study the energy consumption pattern in semi-arid agro climatic regions. They found that large quantities of agricultural residues and animal wastes were burnt even by
high income groups for domestic cooking in three villages. In some villages, fuelwood usage was found to be high especially for high income group of households. They observed a close relationship of energy use with the nature of staple food cooked and land ownership. They also reported an increasing monetization of traditional fuels. More amount of collection of agricultural residues than fuelwood was reported by their study. They also found variations in fuel collection patterns among agricultural seasons.

They concluded that the landless agricultural labour and the marginal farmers will suffer because of increasing monetization of fuels and little or lack of access to biomass and plead for special programmes to improve their energy situations.¹⁹

Chakraborty et al.²⁰ studied the demand for energy in a rural economy. In their micro level sample study of the Kaikhali village (Southern West Bengal), they estimated the demand for energy in 2001 A.D. Agricultural residues and dung cake were the widely used fuels in their study area. They observed that in their study area, the higher income group consumed relatively more crop residues than their lower income counterparts. Traditional inland-digged type oven was widely used. The village was not electrified.
In spite of this, the use of kerosene was low owing to the low income and the difficulties in obtaining it. They forecasted the demand for energy by assuming different growth rates and expected a shortfall of more than 50 per cent by 2001 A.D.

Mittal et al., carried out a detailed census survey of a Tamil Nadu village, consisting of 194 households. They estimated the use of commercial and non-commercial sources of energy and the utilization pattern. They also looked into the energy use differences among different farm groups. Regarding the total energy use, the landless group was at the bottom and the large farmer group was at the top. Firewood was the primary energy source. It occupied more than 80 per cent of the total non-commercial energy. While small farmers did not purchase firewood, landless labourers purchased as much firewood as large farmers did. They did not observe much variation in firewood consumption among the small, the medium and the large farmers. In the case of lighting requirements, the medium and large farmers consumed more units of electricity, whereas the landless, the marginal and the small farmers used more kerosene. Biogas was found to be used only by large farmers. Smokeless chulhas were commonly used by small, medium and large farmers but not by marginal farmers.
and landless labourers. Marginal farmers used traditional stoves more than the rest did. The solution, according to them, rests in the introduction of energy saving household appliances.21

Bhagavan and Giriappa, on the basis of their pilot survey in two villages of Karnataka, analysed the class character of the rural energy crisis. In addition to fuel, they have extended the concept of energy to include food, fodder and fertilizer. They observed wide differences in terms of firewood consumption among the three classes of rural society they have studied.

The proportion of non-firewood biomass (eg. crop residues, twigs, leaves, bushes, etc.) to total biomass consumed is found to be more for wage labour class, than for small peasantry and the middle class. Cattle dung was rarely used as fuel by the middle class, whereas it was generally used by the other two classes as fuel. While firewood is the major traditional fuel and non-firewood biomass the minor one for the middle class and small peasantry, the situation is the reverse for the wage labour class. Another interesting outcome of the study is that the middle class used all the five forms of modern fuels (kerosene, petrol, diesel, electricity and biogas), whereas for the other two classes, kerosene was the only principal
modern fuel within their purchasing capacity and used mainly for lighting. The results showed that the middle class and the small peasantry bought half of the firewood they consumed and gathered the other half while the wage labour class gathered all the firewood they consumed. 22

REVIEW SUMMARY

The broad conclusions that emerge from the overview of the empirical studies are summarized in the following paragraphs.

In the rural areas, the household sector is the major and dominant sector consuming a lion's share of the total energy use. Mostly they use biofuels such as firewood, crop residues and dung cakes, among them firewood being the most important. Crop residues come second, while fossil fuels such as kerosene, LPG, petrol and diesel, and electricity play a limited role. Kerosene and electricity are used mainly for lighting. There are differences in the energy use pattern among villages, depending on their agro climatic conditions, the type and extent of forest cover, access to forest, proximity to urban areas, the density of population, agrarian relations and local traditions. In sum, the energy use pattern has been observed to be more region specific in nature.
The energy use pattern widely varies among various income groups. The main factors influencing energy use are income and family size. Most of the studies have also pointed out that households consume more energy because of low efficiency of chulhas. As a corollary, in terms of useful energy, the households use less quantum of energy.

Most of the studies pointed out fuel gathering as an important work for most of the poor households who cannot afford to purchase fuels. An important result highlighted by most of the studies is the increasing hardship faced by firewood collectors in meeting their fuel requirements. The demand for inferior (smoky) fuels has been observed to fall with the increase in income. The analysis of rural household energy use pattern across different groups of households does not reveal much variation with respect to per capita biofuels use and per capita energy use. However, the share of per capita biofuels in per capita energy use decreases with increase in income. With respect to access to and control over energy resources, the rich are in a better position than the poor.

Most of the studies have paid attention mainly to the level of energy use and the combination of various fuels in total energy use and also the substitution between fossil fuels and biofuels. The nature of substitution that occurs
among biofuels across various income groups has not been considered by quite a number of studies.

Only a few studies have estimated the magnitude of the influence of factors on energy consumption and that too only with respect to two factors viz., income and family size. But there are other factors whose combined effect on energy use has not been estimated by quite a number of studies.

Much insight has not been imparted by most of the studies, on the nature of problems confronting various groups of households in meeting their essential energy requirements. Only a few studies like that of Bhagavan and Giriappa have gone in depth into the class character of energy use. The present study addresses the energy issues across various income groups and farm size groups besides making an attempt to study the factors influencing energy use and the problems faced by households in meeting their energy requirements.

RESEARCH DESIGN

In this section, first the procedure adopted for the selection of the sample is explained followed by the definition of concepts used in this study. After that, the tools, with the help of which the objectives of the present
study are analysed, are presented. Then the methods of measurement of variables are discussed.

**SAMPLING PROCEDURE**

The study relies both on secondary and primary data. Two types of schedules were used for the collection of the necessary data at the primary level. One is the village schedule and the other is the household schedule. The village schedule was distributed to the respective revenue authorities, (who are designated as 'Karnams') for the sample villages and with their help, the village level details regarding economic and geographical background such as on education, occupational pattern, housing conditions, cropping pattern, irrigation facilities and details regarding village common lands were obtained.

The primary data at the household level were collected from a sample of 450 households drawn from 18 villages of Pondicherry region through a pre-tested questionnaire. Apart from energy consumption particulars, information on housing condition, family members, expenditure pattern, culinary practices, assets and other relevant details were also collected. The questionnaire was so designed as to overcome recall bias to the possible extent with various checks.
Pondicherry region of the Union Territory of Pondicherry consists of 179 census villages as per the 1981 census. Due to time constraint, it was decided to take 450 sample households spreading over a sample of 10 per cent of the total number of villages (18 out of the 179 villages). In Pondicherry region, only six communes have rural areas as per the 1981 census. Following the proportionate sampling technique, on the basis of the number of villages in each commune to the total number of villages in the region as a whole, the number of villages to be selected in each commune was fixed. The number of villages selected in the six communes are presented in Table 2.1. In the same way, the number of households was selected in each village

Table 2.1: Number of Villages Selected - Communewise

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the Commune</th>
<th>Total Number of Census Villages</th>
<th>No. of Villages Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ariankuppam</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>Bahour</td>
<td>42</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Mannadipet</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>Nettapakkam</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Ozhukarai</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Villianur</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>179</td>
<td>18</td>
</tr>
</tbody>
</table>
depending on the proportion of the number of households in that village to the total number of households of all the selected villages added together.

The census villages in each commune were arranged in ascending order with respect to the number of households in each village. Then from each commune, the required number of villages were selected with the help of Tippet's Random Number Table. The selected villages and the commune they belong, are given in Table 2.2. The map showing the location of the sample villages is given in the next page.

Table 2.2: Names of the Sample Villages Selected - Communewise

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Communes</th>
<th>Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ariankuppam</td>
<td>(a) Periavirampattinam</td>
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<tr>
<td></td>
<td></td>
<td>(b) Tavalakuppam</td>
</tr>
<tr>
<td>2.</td>
<td>Bahour</td>
<td>(a) Bahour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Manamedu</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Karaiyambuthur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Sulliankuppam</td>
</tr>
<tr>
<td>3.</td>
<td>Mannadipet</td>
<td>(a) Lingareddipalayam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Madagadipattupalayam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Suthukeny</td>
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<tr>
<td></td>
<td></td>
<td>(d) Vinayagampet</td>
</tr>
<tr>
<td>4.</td>
<td>Nettapakkam</td>
<td>(a) Kalmandapam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Karikalampakkam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Sooramangalam</td>
</tr>
<tr>
<td>5.</td>
<td>Ozhukarai</td>
<td>(a) Ganapathychettykulam</td>
</tr>
<tr>
<td>6.</td>
<td>Villianur</td>
<td>(a) Kanuvapet</td>
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<td></td>
<td></td>
<td>(b) Konerikuppam</td>
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<td></td>
<td></td>
<td>(c) Kottamedu</td>
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<tr>
<td></td>
<td></td>
<td>(d) Sendanatham</td>
</tr>
</tbody>
</table>
PONDICHERRY REGION MAP

TAMIL NADU STATE

1. Peravirampattinam
2. Tavalkuppan
3. Behour
4. Manamedu
5. Karalyambuthur
6. Sulliankuppan
7. Lingareddipalayam
8. Madagadipattupalayam
9. Suthukeny
10. Vyuyagampet
11. Kalmandapam
12. Karikalaspakkam
13. Sooramangalam
14. Ganapathychettykallel
15. Kanuvapet
16. Konerikuppan
17. Kottamedu
18. Sendanatham
For each village, a list of households based on income and occupation was prepared with the help of the records of the karnams and in consultation with the elderly and/or educated people of the villages. Households were classified into six income groups. On the basis of the list, depending upon the proportion of households in each income group, the number of households to be covered in each group in all the villages was finalised. In the final stage, the households in each group were selected randomly from all the sample villages.

The Pilot Survey was carried out during different months of the year 1988-89, with a view to make the final survey precise. Since no significant seasonal fluctuation in energy use was generally observed in the sample villages during the pilot survey, the need to analyse seasonal fluctuations in energy use did not arise in the final survey. The final survey was carried out covering the crop year 1989-90.

Every household was monitored for four days consecutively. The fuels were weighed and the sample households were requested to use from the weighed bundle of fuels. For every twenty-four hours, the measurements were recorded. Apart from this, fuel bundles carried over by adult male, female and child were weighed. The time taken
for collection of fuels, the distance covered and the frequency of visits made for fuel collection were also recorded.

Apart from questionnaire and measurement surveys in all the villages, many informal discussions were held with rural households depending on need. During discussions, women who occupied the central stage in the study were encouraged to put forth their views freely.

The secondary data regarding the number of smokeless chulhas established, wood burning stoves distributed, biogas plants established, and huts provided with power under the 'one hut one bulb scheme' and other details regarding the saplings planted and the number of houses with power connection were also collected from the records of the various departments of the Government of Pondicherry.

DEFINITION OF CONCEPTS

Energy

A variety of definitions of energy as per their requirements have been used by the studies already carried out in this field. The term energy has been defined in three ways. Sharma and Bhatia\textsuperscript{24} took into consideration, as
energy only fuels (energy to include fuels alone), (2) Reddy et al., Maheswari et al., considered energy to include fuels as well as human and animal labour, and (3) Bhagavan and Giriappa employed a concept of energy that includes food, fodder and fertilizer in addition to fuels.

The present study, by energy, takes into consideration only 'fuels'. It does not take into consideration human and animal labour used for domestic purposes as energy.

Classification of fuels

Energy resources have been classified into various sets such as animate and inanimate; commercial and non-commercial; traditional and modern; biofuels and fossil fuels; conventional and non-conventional; and renewable and non-renewable energy resources. The above sets of classification are not mutually exclusive (i.e.) two fuels may fall on the same side in one classification and in opposite sides in another classification.

Sharma and Bhatia classified energy into two kinds, viz., commercial and traditional. In commercial energy, they included coal, oil and electricity, whereas fuels such as firewood, crop residues and animal dung were
included under traditional fuels. According to Leach\textsuperscript{29}, biomass fuels are wood fuels (firewood and charcoal), crop residues and animal wastes. Fossil fuels and electricity are referred by him collectively as modern fuels. According to Janet Ramage\textsuperscript{30} fossil fuels include coal, oil and natural gas. Bhagavan and Giriappa divided the fuels into two kinds -- Modern and Traditional. Modern fuels include kerosene, petrol, diesel, electricity and biogas whereas traditional fuels consist of firewood, non-firewood biomass and cattle dung.\textsuperscript{31} 

In this study, two broad fuel classifications have been used viz., (1) Fossil fuels and electricity, and (2) biofuels. Fossil fuels include fuels such as kerosene, petrol, diesel and LPG. Biofuels in the study refer to fuels such as firewood, CRTB, CRL, dung cake, saw dust, charcoal and biogas. Solar and wind energy were not used in the study area.

**Crop Residue Twigs and Branches (CRTB)**

Crop residues in the form of twigs and branches have been classified as crop residue twigs and branches apart from the twigs and branches of trees. The major fuels which are included under this classification are: (1) Casuarina twigs and branches, (2) Babool twigs and

Crop Residue Leaves (CRL)

The leaves of various crops and bushes are classified under this category. The popular fuels categorised under this head are: (1) Casuarina leaves, (2) Coconut leaves, (3) Palm leaves, (4) Sugarcane leaves, (5) Coconut husks, (6) Groundnut shelves, and (7) Other small plants and bushes.

Gross Energy

According to Somasekara\textsuperscript{32}, gross energy refers to equivalent energy. Leach\textsuperscript{33} defined gross energy as the calorific value of the fuels used. Sharma and Bhatia considered gross energy as the energy content of fuels.

In the present study, gross energy refers to the energy content of fuels. i.e., the energy content of each fuel is multiplied by its respective quantities and thus the gross energy is arrived at. The energy content is measured on the basis of the net heating value (also called
as the lower heating value) of the fuels and expressed in Joules (MJ, GJ and TJ), in this study.

**Useful Energy**

Useful energy, according to Somasekara\(^34\), is the delivered energy. According to Sharma and Bhatia\(^35\), useful energy is, "energy actually utilised after considering the efficiency of the appliances". This definition has been retained for the present study. Useful energy was worked out only for energy used for cooking purposes. Since various equipments like scooters, car, table fan, ceiling fan, etc. with different efficiencies were used for other purposes, the study does not discuss them. It is to be noted here that wherever useful energy is to be referred, it is mentioned as useful energy. So, throughout the study, unless otherwise mentioned, energy usually denotes gross energy.

**Household**

A household is a group of persons normally living together and taking food from a common kitchen\(^36\).

In the present study, the above definition is adopted.
Domestic Purposes / Uses

In the present study, various domestic purposes for which energy is used are grouped under three heads. They are:

(i) Energy used for cooking: It includes energy used for cooking, water heating and other similar culinary requirements. It also includes electricity used in mixies and grinders.

(ii) Energy used for lighting and other purposes: Electricity used for lighting and other purposes and kerosene used for lighting were included under this head.

(iii) Energy used for transportation: Energy used by personal vehicles such as four wheelers and two wheelers is included under this category. It does not include public transportation and the Government vehicles used by the households.

Electricity for Cooking Purposes

By 'electricity used for cooking purposes', the study means the electricity consumed by mixies and grinders. (Nobody was observed to be using an electric oven for domestic uses).
Electricity Used for Lighting and Other Purposes

Electricity used for lighting the house is included under this category. It also includes electricity used for other purposes viz., electricity consumed by electric equipments such as Iron box, Fan, Refrigerator, Water heater (used to heat water for bathing purposes, including Geyser), Motor (used to pump water for domestic purposes), Radio, Tape recorder, Television set and Video Cassette Player.

Principal and Subsidiary Occupations

The principal occupation of a household is determined by the source of income. That occupation which contributes to more than 50 per cent of the total income of the household is considered the principal occupation of the household and the other as subsidiary occupation. If a household has more than two occupations (and sources of income) that occupation which contributes proportionately higher than the other occupations to the total family income is considered the principal occupation. In the same way, the next occupation in the order of its contribution to the total household income is treated as the subsidiary occupation.
Occupational Groups

The sample households are divided into six occupational groups on the basis of their principal occupation, whereas farm and non-farm household classifications are made on the basis of the extent of farm land at their disposal.

Agricultural and Farm Households

Agricultural households are those households whose principal occupation is agriculture. It is not the same as farm households. Farm households refer to the households possessing farm land irrespective of whether farming is their principal occupation or not. In the total sample of 450 households, 209 households had land at their disposal. They are referred to as farm households. Out of the 209 farm households, agriculture or farming is the principal occupation for only 144 households. So, these 144 households are referred to as agricultural households.

Non-Farm Households

Households which do not have any piece of farm land at their disposal are considered non-farm households.
Agricultural Labour Household

A household whose principal occupation is agricultural labour is referred to as an agricultural labour household.

Government-Job Household

This group contains households whose principal occupation is government job (service).

Fisherman Households

All those households having fishing as their principal occupation form this group.

Rural Service Households

Rural service households in this study encompass rural artisans, potters, washermen, petty shop owners, grocery and stationery shop owners, rural cloth merchants, tailors and tea shop owners.

Miscellaneous Occupation Group

This group includes households which do not come under the agricultural, agricultural labour, fisherman, government-job and rural service household groups. It
includes those households whose principal occupation is private service, business at urban areas and milk selling and also pensioner households.

**Manday**

A manday refers to eight hours of labour spent on fuel collection by an adult male. The average wage rate per manday in the sample villages was Rs.34.00.

**TOOLS OF ANALYSIS**

The tools used for analysing the data include conventional techniques such as percentages, averages, ratios, and multiple regression models.

This study examines the factors influencing individual household behaviour (i.e.) the factors influencing the use of energy.

**THE EMPIRICAL MODELS**

To identify the major determinants of consumption of energy by rural households, a multiple linear model was specified and empirically tested, with the help of primary data collected from 450 households, post stratified into income groups, farm size groups and occupational groups. For
each group the total energy use, measured in mega joules (MJ) per annum per household was the dependent variable (EC). Independent variables were

(i) Income status of the household as represented by the annual income of the household in rupees (Y).

(ii) Price of energy in Rs per GJ. It was measured as a simple average of values per GJ of different fuels used by the households (P).

(iii) Size of family measured in number of persons; (S).

(iv) Cooking frequency which was measured as the average number of times cooking was done per day (CF); and

(v) Stove design variable to represent fuel use efficiency in cooking (SD).

A careful study of the scatter diagrams for each of the independent variables and EC and of zero-order correlation matrix, suggested that a multiple linear regression model would be the most appropriate functional form for the household energy consumption function. Hence the following model was specified

\[
EC = \beta_0 + \beta_1 Y + \beta_2 P + \beta_3 S + \beta_4 CF + \beta_5 SD + e
\]

where the variables were as defined above and further explained below; \( \beta_0 \) and \( e \) were the regression
constant and regression error respectively and $\beta_j$'s ($j = 0, 1, \ldots, 5$) are parameters to be estimated separately.

This model was estimated, for each group of rural households (defined by income, farm size and occupation) by the ordinary least squares (OLS) method with the conventional classical normal assumptions.

MEASUREMENT OF VARIABLES

A brief description of the variables of the consumption function is presented below with special attention to show the method of measuring them.

Energy Consumption

The units of measurement of fuels are not the same. While biogas is measured in terms of cubic metres, kerosene is normally referred to in litres and most of the biofuels in kilograms. Though biofuels are measured in the same units (kgs), one kilogram of casuarina leaves is not equivalent to one kilogram of sugarcane leaves in terms of energy content. So, a common measure to overcome these deficiencies and to aggregate these fuels is warranted. Hence the energy contents of fuels (lower heating value or net heating value) expressed in Mega Joules$^{37}$ used for the purpose.
Gross Energy

There seemed to be a lot of differences in not heating values for the same fuels over different regions. In the absence of locally available data on the energy content of fuels, the energy content of fuels measured by the School of Energy, Environment and Natural Resources of Madurai Kamaraj University over more or less the same climatic regions like that of Pondicherry, were considered proxy for the present study. Table 2.3 shows the list of fuels and their energy equivalents.

Table 2.3: Energy Content (Net Heating Value) of Fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Mega Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Crop Residue Leaves</td>
<td></td>
</tr>
<tr>
<td>1. Casuarina leaves</td>
<td>17.5/Kg</td>
</tr>
<tr>
<td>2. Palm leaves</td>
<td>16.2/Kg</td>
</tr>
<tr>
<td>3. Coconut leaves</td>
<td>11.7/Kg</td>
</tr>
<tr>
<td>4. Sugarcane trash</td>
<td>11.2/Kg</td>
</tr>
<tr>
<td>5. Coconut husks</td>
<td>14.7/Kg</td>
</tr>
<tr>
<td>6. Bushes</td>
<td>11.2/Kg</td>
</tr>
<tr>
<td>7. Groundnut husks</td>
<td>14.2/Kg</td>
</tr>
<tr>
<td>II Crop Residue Twigs and Branches</td>
<td></td>
</tr>
<tr>
<td>8. Casuarina twigs and branches</td>
<td>18.6/Kg</td>
</tr>
<tr>
<td>9. Babool twigs and branches</td>
<td>17.6/Kg</td>
</tr>
<tr>
<td>Fuel</td>
<td>Mega Joules</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>10. Coconut twigs and branches</td>
<td>13.7/Kg</td>
</tr>
<tr>
<td>11. Palm twigs and branches</td>
<td>17.7/Kg</td>
</tr>
<tr>
<td>12. Betelvine</td>
<td>13.7/Kg</td>
</tr>
<tr>
<td>13. Sugarcane branches</td>
<td>16.7/Kg</td>
</tr>
<tr>
<td>14. Sugarcane roots</td>
<td>16.7/Kg</td>
</tr>
<tr>
<td>15. Gingely stalk</td>
<td>14.6/Kg</td>
</tr>
<tr>
<td>16. Brinjal straw</td>
<td>14.6/Kg</td>
</tr>
<tr>
<td>17. Cotton stalk</td>
<td>15.93/Kg</td>
</tr>
<tr>
<td>18. Castor stalk</td>
<td>15.9/Kg</td>
</tr>
<tr>
<td>19. Mat grass</td>
<td>13.7/Kg</td>
</tr>
<tr>
<td>20. Topioca</td>
<td>15.9/Kg</td>
</tr>
<tr>
<td>21. Cashew twigs and branches</td>
<td>17.6/Kg</td>
</tr>
</tbody>
</table>

### III Firewood

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Mega Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. Casuarina wood</td>
<td>19.4/Kg</td>
</tr>
<tr>
<td>23. Babool wood</td>
<td>18.2/Kg</td>
</tr>
<tr>
<td>24. Neem wood</td>
<td>17.4/Kg</td>
</tr>
<tr>
<td>25. Tamarind wood</td>
<td>20.0/Kg</td>
</tr>
<tr>
<td>26. Portia wood</td>
<td>18.6/Kg</td>
</tr>
<tr>
<td>27. Cashew wood</td>
<td>19.2/Kg</td>
</tr>
<tr>
<td>28. Other woods</td>
<td>18.6/Kg</td>
</tr>
</tbody>
</table>
### Table 2.3 Contd...

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Mega Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Other Fuels</td>
<td></td>
</tr>
<tr>
<td>29.  Dung cake</td>
<td>8.8/Kg</td>
</tr>
<tr>
<td>30.  Saw dust</td>
<td>15.2/Kg</td>
</tr>
<tr>
<td>31.  Charcoal</td>
<td>19.4/Kg</td>
</tr>
<tr>
<td>32.  Rice husk</td>
<td>12.3/Kg</td>
</tr>
<tr>
<td>V Fossil Fuels</td>
<td></td>
</tr>
<tr>
<td>33.  Kerosene</td>
<td>38/Litre</td>
</tr>
<tr>
<td>34.  Petrol</td>
<td>39.8/Litre</td>
</tr>
<tr>
<td>35.  Diesel</td>
<td>35.6/Litre</td>
</tr>
<tr>
<td>36.  LPG</td>
<td>47.95/Kg</td>
</tr>
<tr>
<td>VI Other Fuels</td>
<td></td>
</tr>
<tr>
<td>37.  Electricity</td>
<td>3.6/Kwh</td>
</tr>
<tr>
<td>38.  Biogas</td>
<td>20/M³</td>
</tr>
</tbody>
</table>


**Useful Energy**

The 'useful energy' of different fuels has been worked out in this study using the following efficiency ratios.
Table 2.4: Efficiency of Utilisation of Fuels

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Type of Oven used</th>
<th>Efficiency of utilisation (in per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firewood</td>
<td>Mud Chulha</td>
<td>14.0</td>
</tr>
<tr>
<td>Dung cake</td>
<td>Mud Chulha</td>
<td>11.5</td>
</tr>
<tr>
<td>Crop residue (leaves, and twigs and branches)</td>
<td>Mud Chulha</td>
<td>12.0</td>
</tr>
<tr>
<td>Kerosene*</td>
<td>Wick and Pressure stove</td>
<td>46.0</td>
</tr>
<tr>
<td>CSD**</td>
<td>Iron stove and mud chulha</td>
<td>16.3</td>
</tr>
<tr>
<td>LPG</td>
<td>Gas burner</td>
<td>58.0</td>
</tr>
<tr>
<td>Biogas***</td>
<td>Gas burner</td>
<td>58.0</td>
</tr>
</tbody>
</table>

Source: C.L.Gupta, et al., op.cit., p.1216.

* C.L.Gupta, et al., in their study used 45 per cent and 47 per cent efficiency for kerosene burnt in wick stove and pressure stove respectively. Since it was not possible to get data on how much kerosene is used in each stove (for households used both the stoves simultaneously), the utilization efficiency has been assumed as 46 per cent (the average of the two), for kerosene for both the stoves.

** For saw dust the same efficiency of utilization of charcoal has been assumed, since it is dealt with combinedly in this study.

*** Since households used gas burner (like that of LPG) for biogas, the efficiency of 58 per cent (as used for LPG) has been adopted for biogas in this study.
Energy Consumption for Electrical Equipment

Usually, total electricity consumption in terms of Kwh can be obtained from electricity bills. In order to arrive at the amount of electricity used for lighting and allied purposes, and cooking purposes, the following method has been employed. The total hours of use of grinders and mixies (only those two electrical equipment were used for cooking purposes in the study area) and their capacity of motors (engines) were recorded. Based on the formula of "one HP motor running for an hour consumes 0.746 Kwh of electricity", the electricity consumed for cooking purposes has been calculated. It has been deducted from the total electricity consumption for arriving at the amount of electricity consumed for lighting and other purposes.

Value of Fuels

Value of fuels used in the sample villages were calculated in the following methods.

If the households purchased fuels, then the actual price paid by the households was taken into account. In the case of households that collected fuels, the wage equivalent of the productive labour hours lost for gathering fuels had been considered as value of fuels.
Fuel Collection Hours

On an average, during a given period of time, a child collected half the amount of fuel collected by an adult female whereas an adult female collected on an average around 80 per cent of the fuel gathered by an adult male. Therefore, the ratio of conversion among male, female and child is 1:1.25:2.5. (On an average, in three hours, a child gathered 10 Kg, a woman 20 Kg and a man 25 Kg of fuels).

For self-produced fuels, three types of imputation of value were carried out. Firstly, if the self-produced fuels had been traded in the market, then the value realised in the sales was used. In case households used fuels which were not bought in the market but generally gathered in the villages, then their wage equivalent has been taken as its value. Thirdly, the fuels which were self-produced and did not fall under the above categories (neither bought nor collected) the average expenditure per MJ (in a particular village) for that category of fuels (like CRTB or CHL etc) has been imputed as value.

Prices of Fuels (P)

The price of energy for a household, including all types of fuels, has been estimated in terms of price per
1000 MJ (1GJ) of both gross and useful energy consumed. It is the ratio of total value (in rupees) of fuels to total gross as well as useful energy consumption (in MJ).

Size of Family (S)

In this study, the number of persons taking food from a common kitchen (living or not living together) is treated as family size. Family size and household size are synonymously used in this study.

Household Income (Y)

It is the income earned by the household in both cash and kind (converted into rupees) during the reference year 1989-1990.

Stove Design Variable (SD)

In the initial stages, it was decided to represent the pattern of stove used' as a variable in regression models in terms of its measured technical efficiency. Since households were found to be using more than one stove, the representation of different stoves as a single variable in regression estimations became difficult. So, it was decided to assign scores on the basis of the
proportion of energy fuelled in each stove to the total energy consumption of the household. But data on proportion of energy used in different stoves especially in the case of the same fuel fired in different stoves were not obtainable. So, irrespective of the proportion of fuels used in a particular stove, the scores have been assigned according to the following method.

In the case of households using a single stove (if a household occasionally used other types of stoves, it has been ignored), their scores are:

<table>
<thead>
<tr>
<th>Stove</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openfire</td>
<td>0</td>
</tr>
<tr>
<td>Traditional Stove (three stone Method)</td>
<td></td>
</tr>
<tr>
<td>Traditional (One or two holes) Mud Chulha</td>
<td>1</td>
</tr>
<tr>
<td>Wood Burning Stove (DRDA), Improved Smokeless Chulha, Saw Dust Stove and Charcoal (tin or cast iron) Stove</td>
<td>2</td>
</tr>
<tr>
<td>Kerosene Wick Stove (10 or 12 Threads) and Pressure (pump) Stove</td>
<td>3</td>
</tr>
<tr>
<td>LPG and Biogas (Single and Double burner(s)) stoves</td>
<td>4</td>
</tr>
</tbody>
</table>
If a household used more than one stove, then the score in that case has been calculated by adding up the individual scores of different stoves used and dividing the total by the number of stoves used. For example, if a household used a mud chulha and a pump stove, the magnitude of the stove design variable in this case is two \((1+3 = 4; \frac{4}{2} = 2)\).

**Household Groups**

(a) **Income Groups**

The sample households were classified into several income groups on the basis of the annual household income levels. The income ceilings were arrived at by indexing households into several groups, depending on homogeneity among households with respect to sources of income, their consumption pattern and their livelihood. The first batch of households having some broad homogeneous characteristics are those households having an annual household income below Rs.8,000. (It is to be noted here that, compared with the 1985 prices (retail) and the 1990 prices that prevailed in the study area, this group of households can conveniently be assumed as being households below poverty line). Likewise
other groups (income) of households were also arrived at and are given below.

<table>
<thead>
<tr>
<th>Annual household income (in Rupees)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 8000 and above and below 16000</td>
<td>IG-I Low income Groups</td>
</tr>
<tr>
<td>16000 and above and below 24000</td>
<td>IG-II - Groups</td>
</tr>
<tr>
<td>24000 and above and below 40000</td>
<td>IG-III - Middle income Groups</td>
</tr>
<tr>
<td>40000 and above and below 56000</td>
<td>IG-IV - Groups</td>
</tr>
<tr>
<td>56000 and above</td>
<td>IG-V - High income Groups</td>
</tr>
</tbody>
</table>

(b) Farm Size Groups

Farm households are classified into four groups on the basis of the size of operational total land holdings (Land owned + Land leased in - Land leased out)

<table>
<thead>
<tr>
<th>Farm Size Groups</th>
<th>Description</th>
<th>Total Land holdings of</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.S. Group 1</td>
<td>Marginal Farmers</td>
<td>&lt; 1 hectare</td>
</tr>
<tr>
<td>F.S. Group 2</td>
<td>Small Farmers</td>
<td>&lt; 2 hectares</td>
</tr>
<tr>
<td>F.S. Group 3</td>
<td>Medium Farmers</td>
<td>&lt; 4 hectares</td>
</tr>
<tr>
<td>F.S. Group 4</td>
<td>Large Farmers</td>
<td>≥ 4 hectares</td>
</tr>
</tbody>
</table>
NOTES AND REFERENCES


Initially, it was planned to have close observation for a week. Since there were constraints, such as the unavailability of households continuously for a week, lack of fuel stock during observation hours and a declining tendency of interest among households while extending survey days, it was possible to observe them only for four days.

28. Sharma and Bhatia, op. cit., p.16.
32. N. Somasekara (1985), Rural Energy, Sterling Publishers Pvt. Ltd., New Delhi,
34. N. Somasekara, op. cit., p.74.
37. Since all the major International Energy Statistics (UN, EEC and OECD), use Net Heating Value (NHV), net values are strongly recommended and prominently used. So, in this study also, only the NHV of fuels is used.

38. Differences were observed in the energy contents of fuels suggested and used by different agencies and studies (For example: NCAER and A.K.N. Reddy et al., studies). So, in the interest of precision locally measured values have been preferred. In the absence of the availability of locally measured values, measurement carried out over similar climatic regions, nearer to the study area, have been adopted in this study.

39. The lower and upper ceiling values are rounded off, for the sake of analytical convenience.