CHAPTER IX
SUMMARY & CONCLUSIONS
Energy, environment and rural regional development are interrelated, and in the present analysis, their linkages are examined. Development has a component of region, as it draws its character from the resources of a region, and not of a point location alone. Efforts for rural regional development leads to changes in the energy consumption pattern. Obviously energy is the driving force for the development process. Change in energy consumption pattern brings about an impact - very often an adverse one - on environment. An analysis into this nexus will certainly help to work out a plan for sustainable development of a rural region of the concern.

An exhaustive review of the existing literature, published in India and abroad on the theme of energy, environment and rural regional development and their linkages, was first undertaken to look into the status of research in the field outlined, and to understand the methodologies adopted to analyse the three dimensions and their linkages. It has helped to build up a theoretical back-up for the present exercise too. The review indicated that there has been a greater concern and research interest in the recent years in the areas of energy, environment and development. However, studies integrating these three dimensions are found to be infrequent. The available studies on the linkages of these dimensions are mostly restricted to the Urban Environment, and most of the research pertains to developed countries. In a developing country like India, rural regions play an important role in the economy of the nation. Their development process has a
differential consumption pattern of energy which has its own kind of effect on the environment. The growing population pressure and continuous stress on the land have brought a stress on land and water ecological system.

The present study with an aim to look into the linkages between energy, environment and rural regional development was carried out on the basis of data from North Arcot District of Tamil Nadu, India. The district is one of the developed districts of the state both industrially and agriculturally. The industrial activities were found to be concentrated in Palar basin in the taluks of the newly formed North Arcot-Ambedkar district. For the industrial activities, the district consumes a variety of commercial energy from sources like electricity, diesel and coal. Of the industrial activities, the tanneries in the taluks of Walajapet, Thirupattur, and Vaniyambadi had seriously affected the hydrological system of the Palar basin and the fertile cultivable soils of the nearby taluks. Arakonam which was once the granary of North Arcot, is losing its fertility due to the increased acidity and alkalinity.

The soil quality and fertility analysis of North Arcot clearly reveals that the district is marching towards the state of slight acidity and salinity and a moderate level of alkalinity. Most of the taluks have 'pH' value of more than 7.5. Of all the taluks, 20 percent of the blocks in Arakonam taluk and about 10 percent of the blocks in Walaja, Thirupattur and Vaniyambadi have soils with 'pH' value ranging from 8 to 9 indicating the severity
of alkalinity. Though the acidity problem is not widespread at taluk levels, some of the villages in Arakonam, have ‘pH’ value ranging from 5 to 6 and an electrical conductivity of more than 4 mmhos/cm, and this indicates the strong acidic and saline nature of the soil. The soils of the most intensively cultivated taluks like Chengam, Vandavasi, Arani and Thiruvanamalai are found with a loss of considerable amount of the major nutrients such as ‘N’ ‘P’ and ‘K’. Here the continuous mono crop cultivation and the improper soil management have deteriorated the fertility of the soil to a substantial extent.

In order to look into the energy-environment nexus in the development process, a development analysis was made to identify the levels of development among the taluks. The analysis has given five levels of development as very high, high, medium, low and very low. From these development regions, six sample villages were chosen. From the sample villages, the information regarding the economy, energy and environment were collected. The analysis on these sample villages made clear that the energy consumption pattern for cropping is largely oriented towards the cropping pattern, sources of cropping, the depth of the wells, availability of water and alternative energy sources available. Among the sample villages, the total energy consumed for cropping was very high in Agaramcheri (1.29 million kcal). This is mainly due to the cultivation of energy consuming crops like coconut, sugarcane and paddy. Irumbedu and Elagiri ranked next in energy consumption. Irumbedu cultivates groundnut and paddy on a large scale. The high amount of rainfall in these regions, permitted the farmers to
cultivate a variety of crops throughout the year. And also the developmental activities taken by IRDP and TANCOFF encouraged the farmers with funds and facilities to adopt new agronomic techniques in cropping. Elagiri preferred mechanical implements for cropping than the traditional ones. Hence the commercial energy consumption is high in this village. The energy consumption pattern among the sample villages clearly reveals that the extent of wet crops cultivated is the determining factor of both commercial and non-commercial consumption through direct (electricity and diesel) and indirect (manure and fertilisers) sources of energy.

In the household sector, fuelwood seems to be the dominant fuel in all the villages. The sources for fuelwood varies among the villages, with regard to their ecological situations. Elagiri gets fuelwood from the forests as it is situated near the Elagiri forest. For Nedumpuli, Palayanur-Kilpadi and Kunnathur, the dominant source is the thorny trees and bushes of the open and poromboke land. Agaramcheri uses much of agricultural by-products in the form of coconut shells and fronds as cooking fuel. Irumbedu uses the trees of their backyard and field as a source of fuel for their cooking.

Collection of cooking fuel is one of the important activities of the people with a lower economic status. Fuel collection not only caused an hazard to the nearby environment, but also increased the work load of the rural women folk other than their cooking activities. It is also disheartening to find that the school going children also go for fuel collection after they come
back from school. The average fuelwood consumption of the sample villages ranged from 18.5 kg per month to 52.5 kg per month.

The scarcity of fuelwood and the increased time for fuel collection, urged most of the ruralities to use dung cakes as an supplement to fuelwood. Dung is a rich farm manure, and has been diverted as a fuel for cooking, and this causes a serious concern. Excepting Elagiri, all the other villages consumed from 7.5 kg per month to 409 kg per month.

Most of the rural artisans used non-commercial energy for their activities and their energy consumption in terms of man hours ranged from 20 to 600 per month. As they are very few in number, their consumption seems to be a meagre one. Industrial units in the sample villages are found to be picking up at a faster rate, and they use electricity as the main source of energy. Their average consumption of electricity ranged between 750 kwh to 4000 kwh per year.

A factor analysis was run to look into the linkages between energy and environment in the development processes. It was first conducted for the total 680 samples from six sample villages, taking totally 39 sensitive variables selected from the three dimensions. Further it was run separately for each village with 15 variables. The analysis clearly indicated that the variables of development dimensions were the determining factors of energy and environment. In both the analyses, the dimensions of HYV farming was found to be the prime factor. And in this factor, the development variables like the wetland, wetland farmers, percent of total
land cultivated and proportion of livestock loaded heavily than the factors of other two dimensions. Energy variables formed the second and third factors which were consequent to the development variables in explaining the data set. The environment variables were found to have high positive and negative loadings in the factors of development and energy. All these findings may point out that the development determines the energy consumption pattern which has an effect on environment.

Sustainable Development: Some Policy Suggestions

The shortage of non-commercial energy and increasing use of commercial energy pose different kinds of problems and constraints. In order to overcome the growing problems with regard to energy use, an integrated energy plan has to be framed and implemented with the involvement of local people, social organisations, voluntary agencies and concerned experts. The main areas of thrust in different sectors include conservation of energy types and scientific management of energy sources, and introduction of new renewable energy sources.

For the household sector, the main alternatives available are installation of biogas plants, improved chullahs, efficient kerosene stoves and solar cookers. Excepting improved chulla all the other mediums are found to be beyond the reach of the common man of the sample villages. Of all the alternatives available for the household sector, biogas plants seem to be a promising one, in fulfilling the energy demands of the rural people. But the initial investment in the form of money, and required amount of cow dung
are the difficulties faced by the people in the installation of biogas plants. Its capital cost is around Rs. 5000 and out of the total cost, two third has to be shared by the household, and only one-third comes from the government as subsidy. It has a number of advantages such as reduction in pressure on demand for wood, crop residue etc, utilisation of slurry as manure, easy and efficient fuel for cooking and lighting etc. Despite the advantages only 15 to 18 percent of the households have the required number of animals and sufficient money. If the present dome model of biogas plant gets modified into a smaller usable one with an optimal rate of investment, then it can be of much use to most of the subsistence ruralites.

Solar cookers also have drawbacks in using it for cooking. In this case, the person has to wait till the sun comes up to heat the solar cooker. The cost of the equipment is also beyond the reach of the many subsistence households. These people go to work before sunrise and come back after the sunset and thus, solar cookers are found to be an unsuitable and unpopular alternative. Landless labourers are the ones who are severely hit with the shortage of fuel for cooking. Further either biogas plants or solar cooking are not the ideal cooking medium. Similarly, many other alternative sources also have their own limitations on technical and non-technical grounds. Thus utilisation of renewable non-conventional energy sources have so far been of low efficient and high cost. It has to be modified to suit local demands with the available sources of energy.
The social forestry programme was also found to be a failure one and it has been taken up by the large farmers from a commercial point of view, instead of having this scheme on a community lands and open and poromboke land, tree plantations have to be encouraged along the foot paths, roads, in the bunds of the fields and in the backyard of the houses. The selection of species for plantation also should be in such a way that it can fulfill the demands of household sector as fuel, as fodder for livestock and as a green manure for the farm yard.

The commercial energy consumption for cropping was found to be increasing at a rapid rate in all the sample villages. It was increasing at an alarming rate in Elagiri which prefers mechanical implements than the traditional ones. The reason is that the maintainance of animals for work was found to be a problem for the Elagiri villages. They were unable to feed the animals sufficiently and feeding the animals by commercially bought-substances was much costlier than to own or hire a mechanical implement. To increase the livestock population in Elagiri only two options may be suggested. One is to encourage the farmers to grow fodder crops on a community basis in the open and poromboke land and the other one is to provide them fodder at a cheaper rate through co-operative stores. The villages also face problems in acquiring mechanical implements at the peak of every stage of crop production both with the short supply of energy and in acquiring the implements too for hire. Hence if this village combines both the mechanical and traditional equipments, then its energy problem may get solved.
In the case of Nedumpuli, the problem is due to the higher concentration of livestock which poses an environmental hazard by their dung. The over dumping of dung near by the houses cause a variety of health problems. As the village is situated near a developing town, the disposal of dung is also a problem for most of the households owning cattle and buffaloes. In this village, if an community biogas plant is organized, then it will provide fuel for the village as well as the nearby town. The slurry from the biogas plants may also be useful to manure the fields of the village. As the village consists of higher percent of share croppers, marginal and small farmers, this cheapest rich manure of dung may be greatly useful to the subsistence farmers to get good net return from the fields. The installation of community biogas plants not only eradicates the health hazard but also fulfills the needs of the household as well as the agricultural sector.

In Agaramcheri, the main household fuel is coconut by-products, which needs dung cake as an catalyst to burn. Hence, the rate of dung consumption was higher for the household sector as fuel than as manure in the agricultural sector. As per the recommendations of the agricultural extension centres of the Agricultural Univeristy, if the coconut husk and cow dung are fermented with yeast, it can be a rich farm manure. This fermented manure is supposed to contain a doubled amount of nutrient than chemical fertilisers. As the village has sufficient quantum of coconut husk, this process of fermentation may reduce the rate of consumption of chemical fertiliser to some extent.
Irumbedu is found to be a model village for the other sample villages, wherein the modified traditional implements using the animal and manual energy have provided the villages to use both commercial and non-commercial energies in a balanced way. The modified equipments are found to be highly useful both to the dry and wetland farmers. In this village, the problem of energy is found with the household sector. Most of the installed biogas plants were under repair and this discouraged the households from preferring biogas as fuel. If the present model of dome type is modified to suit to the local environment, then it may find support from the people.

Kunnathur and Palayanur-Kilpadi are the two villages, which still follow the traditional way of cultivation. Here the animal and manual energy for cropping was more dominant than the mechanical energy. The ideal farming technology for these two villages may be a modified one which can use animal and manual energy predominately in the newly transformed traditional technique. Kunnathur cultivates dry crops in a larger extent of cultivated area. The amount of fertiliser and manures applied for dry crops is also at a lesser rate. This is mainly due to the poor economic situation of the village. If the villages are given training to produce the biofertilisers at their home or at their fields, then it will increase the production of dry crop.

As far as the transportation sector is concerned, Nedumpuli and Kunnathur households are highly involved in transportation activity. And they mainly used wooden wheeled carts which requires
nine hours and more animal energy. Tire-wheeled carts may help the farmers to save energy and time.

From the analysis, it is clear that drafting energy and environment plan on a macro scale, will not be of much use for substantial development. As each of the regions differ in their local economy with regard to their resource endowment, drafting an appropriate plan is a difficult task. Generalizing the problems, possibilities and potentialities on a macro scale may not help for planning for specific problems or problem areas. Micro level plans are the ideal ones for energy and environmental management of any region.

From the above discussions, it is clear that the rural regional environment calls for an efficient management with regard to its resource endowment and energy use. The study has succeeded in assembling and presenting the facts about energy, demand and supply and consumption pattern in the different development regions. The study has been successful in understanding the inter-relationship between energy and environment in rural regional development. The study has also demonstrated how a micro-level study can be undertaken to look into the linkages of the dimensions of development, energy and environment. Data available for the study on energy and environmental impacts were found to be limited.

As the study has been conducted for a particular period of time, measuring the changes in the consumption pattern of energy
and environmental impacts were found to be difficult, and so also, the energy consumption with regard to different seasons. The environment impact assessment of the regions were made only with regard to soil quality and fertility, and hydrological situations. The inferences that one can have from the results of the study may have some limitations because of smaller sample size and collection of household data from the memories of the respondents. The study could have been more reliable had more number of sample villages been selected from each development region; number of sample households gets increased; and data collection is planned not by a few visits to the sample villages but by systematic visits to the villages taking care of all the cropping seasons in a year.

The study looking into the interlinkages between development, energy and environment may be extended to meso and macro levels and experiences of micro level study like this may help to formulate queries and methodologies. This type of an extension from micro level studies to meso and macro levels may help to layout policy planning and strategies for proper energy use without any environment degradation during development process.
ENERGY : ENVIRONMENT AND DEVELOPMENT

APPENDIX 1: CORRELATION

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### APPENDIX .2

**ENERGY, ENVIRONMENT AND DEVELOPMENT
EIGEN VALUES AND PERCENT OF VARIANCE FOR VARIABLES**

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