Summary of Findings and Conclusion
CHAPTER VI

SUMMARY OF FINDINGS AND CONCLUSION

6.1 Findings

In this study, the objectives set out in the introductory part, have been realized both with the help of primary and secondary data. This chapter intends to make a thematic presentation of the actual outcomes that were obtained in this study. Both the primary and secondary data were analyzed and yielded interesting results. The macro picture of the nation as a whole, followed by the state level and the district level scenario of indoor air pollution in particular is obtained with the help of the secondary source of information. This formed the basis of the subsequent exercises carried out in the study. The actual behaviour of rural household, with respect to cooking material used for domestic purposes as captured through household survey, represented the households’ affordability of low risk material. Throughout the analysis the data was compiled from the NSSO data (50th, 55th, 61st, 66th and 68th rounds of survey) and Census data (2001 and 2011) to achieve the aforesaid objectives.

Household usage of High risk material and Low risk material (Secondary data)

For the purpose of the present study only rural areas were considered. According to 2011 census, 87 percent of Indian households still rely on high risk materials for cooking and heating purposes. It has reduced from 93 percent recorded in 2001. It is imperative that they should have access to the low risk material as a source of energy. In spite of all measures taken by the state government including provision of free gas cylinder for the people, the accessibility to low risk material is very less. The state government of Tamil Nadu was the pioneer in introducing such a novel scheme. Nowadays the central government is also providing subsidized LPG cylinders for the rural poor.

In 2011, the census showed that, the districts of Ariyalur and Pudukkottai used 88 percent and 87 percent of high risk materials respectively. Nearly 10 per cent decline was recorded over the period when compared to 2001 census report which showed that both these districts used 97 percent of high risk materials for domestic purposes.

The analysis of NSSO data from 50th – 68th rounds has unfolded the overall scenario showing that various percentages of households using the high risk material for their domestic purposes like cooking and heating across the country. The rural households mostly used firewood and chips as the principal source of energy for cooking.
NSSO – High risk material

- The NSSO data has the source of energy classified into two types. One is the high risk material; the other is the low risk material. In this survey each round has shown different results. The 50th round of survey (1993-94) showed that approximately 90 percent of rural households of the fifteen major states were using high risk materials for their cooking purposes.

- According to the 55th round of the survey nearly 92.4 percent of rural households depended on high risk material, followed by 86.5 percent, 83.9 percent and 80 percent in the 61st, 66th and 68th rounds of survey respectively. Finally this entire survey has confirmed that high risk material usages were more among rural households in the selected fifteen major states including Tamil Nadu and this usage is to be reduced in the near future.

- Over the period of the survey, it is evident that there is a remarkable increase in the usage of low risk material and a corresponding decrease in the usage of high risk material in the rural households of the selected fifteen major states. Especially in Tamil Nadu, the households using high risk material was around 95.6 percent in the year 1993-94 which continued to decrease in the consecutive years. In the year 2011-2012 the high risk material usage was only 58.5. This drastic change is due to the measures taken by the government; the state government’s free gas policy and also the people’s willingness to adopt modern cooking equipments and low risk material (LPG).

Low risk material

- The usage of low risk materials in major states during the 50th round was calculated. Bihar, West Bengal, Orissa and Madhya Pradesh recorded very less percent of households using low risk material (LPG). Only in Punjab about 5 percent of the rural households used LPG as the principal source of energy.

- During the 55th round, Haryana, Punjab, Kerala and Gujarat occupied the highest places in the usage of LPG with 18.4, 14.2, 11.6 and 10.2 percent of households using LPG respectively. In the consecutive rounds of survey, the percent of households using LPG increased over the states. This may be due to the development in employment opportunities, government measures and other factors.
In Tamil Nadu the percentage of households using LPG was around 3.1 in the 50th round of survey (1993.94) but in the year 2011-2012 i.e. during the 68th round of survey the same was around 39.7. This tremendous increase in the LPG usage is attributable to the measures taken by the government, the development in employment and the corresponding increase in the income of people. For instance, the state government of Tamil Nadu introduced the free gas cylinder and stove scheme in the year 2011. In that particular year, the usage of low risk material is found to be increased in the rural households of Tamil Nadu.

Census - High Risk Material

The census data of two decades ie. 2001 and 2011 found some facts about high risk material. 2001 census showed that Ariyalur and Pudukkottai districts of Tamil Nadu were using the highest percentage of high risk material i.e. about 97 percent households were depending on it as the principal source of energy. This percentage was lowered over a decade and in 2011 these two districts had 88 and 87 percentage of households depending on the high risk material, whereas the usage of high risk material is comparatively less in districts like Chennai and Coimbatore.

It can be seen that the percentage of high risk material using households have decreased by nearly 15 percent overall. It is due to the measures taken by the government and also the growing awareness of people through media and other sources.

Low Risk Material

The usage of low risk material according to 2001 census was only 11.26 percent whereas 2011 census showed that 26.46 percent people used this material for their cooking purposes. The increase in the usage of low risk material was nearly 15 percent. It may be noted that the reduction in the usage of high risk material was also recorded at 15 percent. Thus the development process is two way. People are switching over to use low risk material and giving up the use of high risk material simultaneously. But still the problems related to women’s health owing to indoor air pollution are to be reduced. It is hoped to be achieved in the forthcoming years.
The findings that emerged from the analysis of primary household survey are as follows:

**Socio-economic aspects of Indoor air pollution**

- About 70 percent of the households using High risk material live in joint families, whereas 100 percent of the households using low risk materials are in nuclear families in the study area.

- With regard to the religion followed by the households and their respective community, the statistical methods like Chi –Square test proved that there is no significant effect of religion as well as community (caste) on the type of materials used for cooking.

- The family size is very important as it decides the consumption of fuel. If the size of the family is large, the members may not get sufficient quantity of food, education, proper drinking water. At the same time they have to take care of their basic necessities. They cannot afford to buy low risk materials which are expensive. Hence they tend to depend on high risk materials which are mostly firewood, chips and dung cake. The high risk material is collected almost free of cost from the forests, social forests, agricultural fields and in some cases the backyards of their houses.

- The households using high risk material had a large family size with an average of 7 members per household and majority of them were dependencies. On the other hand the households using low risk materials have an average of 3 to 4 members per family. In the low risk material category the average family size is about 4. Pudukkottai district (high risk material region) has a high dependency ratio, whereas in Coimbatore district (Palladam) (low risk material region) there is no old age dependency as they do not live in joint family system. When there are more dependents, it will result in the low income of the households as they are not economically productive. So the households with a high dependency ratio cannot afford low risk materials like LPG owing to their insufficient income.

- Regarding the education of the households from the social status perspective, it is understood that the level of education of low risk material using households is more; the highest percentage of family education is 58.3 percent i.e the members with education up to degree level. On the other hand, only 28.7 percent of the high risk material users have got education up to degree level. This results in
varied social status and the corresponding employment opportunities of the households. This in one way or the other plays a vital role in the choice of fuel used by the households.

- The land holding pattern is one crucial economic factor which confirms that there is significant variation among the two categories. In this regard, cost of production was compared between the two groups viz., low risk material using households and high risk material using households. In the low risk material using households, about 7.7 percent of households have marginal lands, followed by 8.4 percent and 1.4 percent of households having small and large lands respectively. The remaining 82.5 percent of households are landless people.

- Among the High risk material using households 24 out of 260 belong to marginal land holders category, followed by small and large land holders with 2 households each. This shows that the land holding capacity is comparatively higher in the low risk material using households than the high risk material using households. Lowest area of cultivation incurs high production cost but low income (Rs.5234.6) in the high risk material using households.

- The households which incur a high production cost but get a small income (Rs. 5234.6) use high risk material, whereas households were using low risk material when they have a larger cultivation area, low cost of production and high annual income (Rs.45454.5). The low risk material using households were earning more income from agriculture, so their economic status has improved considerably. This is also one of the reasons for people using low risk material for cooking purpose. The reason for the low income from land in the high risk material using households is due to the loss of monsoon or other natural causes incurred during the period of this study.

- Pudukkottai district was naturally a dry region of Tamil Nadu state. The farmers cultivate only dry crops. It was easy for the people to collect agriculture waste residual from their fields as well as from social forests as a source of energy for their cooking purposes absolutely free of cost. Hence the more dependence on high risk material.

- About the occupation, non-farm employment had tremendously increased in rural societies. This has been reflected in low risk material study area. Private sector
such as non-farm occupation is the main occupation in this region. Around 361 out of 635 family members are employed in private sector. The main occupation is small scale industry such as yarn, dyeing and bleaching in the rural region of Tirupur district. They are more interested to hold jobs in the private companies because they can get more money and as the companies normally are situated in cities, they can enjoy the city life also.

- Percapita income is also an important factor. It has a relatively inverse relationship between the number of working days and income in both the regions. If the number of working days was high like 736 days their family annual income was low (Rs.154399.3) in the high risk material using region. Whereas in low risk material using region in 715 working days they gained an annual income of Rs.265645.17 which was high. Hence their percapita income was also high. Many industries are available in the selected study area of Tirupur district (Palladam). This is the main cause for the more income of people in this region.

- Family expenditure ratio shows that food expenditure was high in the selected study area of Pudukkottai, because the number of family members was high. These households do not spend money for safe drinking water also. In the selected study area of the region where low risk material was widely used, people spent money for getting safe drinking water.

- There are numerous other aspects pertaining to housing expenditure, which this study has addressed. Fuel ratio was 1.29 in the high risk material using area; their medical expenditure ratio was 17.10. In the low risk material using region fuel ratio was increased to 10.18 and their medical ratio was decreased to 3.69. This implies that the households which spend less for fuel had to incur high expense for health. This is because low fuel cost means the fuel used will be high risk material which causes more pollution leading to airborne diseases. Hence the health cost will be high for such households. Where there is a high fuel ratio, the health cost will be low as the fuel consumed will be low risk material.

**Household Environment aspects of Indoor Air Pollution:**

- In rural areas selected for the study in Pudukkottai district 57.3 percent houses were thatched houses, 35 percent were tiled houses and rest of them were having concrete roof, Hence the kitchens in those houses were having thatched,
tiled and concrete roofs respectively. The roof of the kitchen also played an important role in increasing the exposure of women to indoor air pollution. Among the low risk material using households 54.5 percent of the houses had tiled roof for the kitchen and 43.4 percent houses had the kitchen roof laid with concrete. No thatched roof was found in this area. This shows that due to the poor economic condition, the households in the high risk material using region do not have a better kitchen which will obviously result in high incidence of air pollution.

- In this study it was understood that among high risk material using households 221 did not have a separate kitchen. Only 18 percent of the kitchen of the households using high risk material had 1 to 2 windows whereas about 97.2 percent of the households using low risk material had 1 to 2 windows. This led to proper ventilation in the kitchen in low risk material using region. Hence the incidence of airborne diseases owing to the indoor air pollution was also negligible in this region.

- The principal source of cooking material was firewood in the selected district of Pudukkottai, whereas 100 percent of households in Tirupur district were dependent on LPG and Kerosene.

- The quantity of Principal sources of cooking material used per month was 28.4 kg. in the high risk material using region and the cost of fuel per month was Rs.29 on an average. Whereas the households using low risk material were spending Rs.453 per month for fuel including the transaction cost also, for 19.50 kg of low risk material per month (one cylinder).

- A crucial factor is that female education is inversely related to the type of fuel used. When the females of the family did not get any formal education, they used high risk materials as the source of energy and vice versa in the low risk material using households.

Health damage cost play a vital role in this study and there is an inverse relationship between fuel cost and the Health damage cost. When fuel cost was decreased (Rs.253.76), the Health damage cost got increased. Thus, those who used high risk material as fuel got affected more by indoor air pollution and increased a high Health damage cost of Rs.2956.29 per capita per annum as an outcome of that, whereas in the selected study area in Tirupur region the households incurred high cost of fuel of Rs.1371 but their Health damage cost was very less.
The Independent sample ‘t’ test confirmed that there is some significant difference between the Fuel usage and Health issues with respect to use of low risk and high risk materials. The cost of fuel for high risk material was low Rs.253.76 but that of low risk material was high Rs.956.2.

About 83.5 percent of the households are reportedly unaffected by airborne diseases. The rest of them are victims of air borne diseases. 16.50 percent (289 out of 1751) were affected by airborne diseases. Among them 37 persons were affected by asthma, 15 were affected with Tuberculosis, 20 had Lung diseases, 23 suffered Cardio vascular diseases and 71 Pre-mature deaths caused by respiratory disorders.

Other common diseases due to cooking process affected 251 persons like joint ache, lower back pain, knee pain and so on. Due to the ailments, they spent money and incurred Health damage cost. The Health damage cost for air-borne diseases was Rs. 17725.9 and that spent on common diseases was Rs.1494.25.

Whereas the households using low risk material did not spend much Health damage cost. They spent only for other common diseases such as, fever, body ache, head ache and so on. Comparatively high risk material using households were spending more than 15 times of the Health damage cost than the low risk material using households.

Role of Education in the choice of fuel used for Cooking:

Education plays a vital role in the choice of fuel used. The sample households were classified into four categories based on the number of years of education obtained by the members of the households. Most of the households without any formal education never had a separate kitchen; among those households which had a separate kitchen also the plinth area was very small. Some of these households lacked proper ventilation (through windows) facilities in their kitchen. Other households had 1 – 2 windows in their kitchen.

A slight improvement in the plinth area and the number of windows in the kitchen was observed among the households belonging to the lower level education category (1-5 years of education) also had very less facilities in kitchen like ventilation etc.. In this category 84.5 percent households did not have a separate kitchen.
➢ This was followed by the middle level education group (6-12 years) which comprised of 76.4 percent households without a separate kitchen in their home. Comparatively they had a larger plinth area than the above mentioned groups. Also the number of households having windows in their kitchen was also more.

➢ The households belonging to the higher education (> 13 years) group had a proper kitchen. Only 2.2 percent of them did not have a separate kitchen. The plinth area and the availability of windows in the kitchen was more in these households, in other cases the windows were less or nil. This is because their education level decides their employability and the members of these households end up in better jobs with a better income when compared with all the other households falling under the three education groups.

➢ Their education, employment and income facilitate them to opt for houses with better kitchen facilities. The Plinth area of kitchen was 363.21 square feet for the households falling under the higher level education category which is much higher than those of middle level, lower level and illiterates groups recorded at 285.15, 271.74 and 240.38 square feet respectively. The ANOVA result suggested that there is a strongly significant variation between these groups with respect to the plinth area of the kitchen.

➢ The level of education plays a role in the construction of kitchen or opting a house with a better kitchen. When the parents or head of the household is educated to a higher level, it helps them to get better jobs, which in turn generates more income and eventually helps them to afford a better house with a proper kitchen with larger plinth area and proper ventilation facilities through windows.

➢ On the contrast, those who had lower level of education or no education at all tend to find menial jobs or employed in farm occupation only. This accounts for their low income and therefore denies them the access to a better kitchen owing to the low affordability. Thus there is a positive relationship between the level of education measured in years and the kitchen facilities availed.

➢ Expenditure pattern of these groups were analyzed and it was found that the food expenditure ratio vary among the different education groups. This is because the family size determined the expenditure on food. Similarly, the expenditure ratio on drinking water also varied to a certain extent. There is no
money spent on water among households which had lower level of education and those who had no formal education (illiterates) at all, because most of them belong to the economically backward class. So they cannot afford to buy clean water from the market. But those who had middle level and higher level of education spent .06 and .67 for drinking water purposes.

➢ The fuel ratio of people who were not educated fell below one, whereas the same was more for those who were educated for more than 13 years (higher level). The difference implies that the education plays a vital role in getting employment, thereby ensuring a handsome income which can afford expensive, clean fuels. Only when the income is higher people can afford for low risk materials otherwise they would settle to use high risk materials which are cheaper comparatively.

➢ Regarding the expenditure on education, the highest ratio 6.84 was recorded in the group of households with higher level of education. As discussed earlier, education level decides the employment and the corresponding income of the households. When the income is low it becomes difficult to fulfill the needs of the household and education is a basic need of children in any household. Only when the inflow of money through a better job is more, one can spend wisely for education of the family members (mostly children). Thus the expenditure on education is positively related to the levels of education of the households. The higher their level of education, the more they are able to spend on education of the household (children).

➢ When compared, among the four groups the entertainment ratio was the highest for the higher level education group i.e 6.43 followed by the middle level and lower level education groups with the same at 3.42 and 3.09 respectively. The entertainment ratio was relatively very less around 2.38 for the households falling under the illiterate category. This reveals that the highly educated persons are able to earn more; obviously they will not face any difficulties in fulfilling the basic necessities of the family and hence have money to spend for entertainment.

**Poverty Line Aspects of Cooking Material:**

Around 91 households out of the 403 households fall under the Below Poverty Line and the remaining 312 households belong to the Above Poverty Line category. In the BPL households, it is observed that the food ratio is 63.05
whereas the same in the APL households is 54.96. The major part of their income is spent for food.

The fuel ratio showed significant variations between the two groups. 1.17 was the fuel ratio of the households below poverty line whereas the fuel ratio of the households above poverty line was 4.76. This shows that the households under APL category spend more for fuel whereas the BPL households depend mostly on firewood and other high risk materials which are of low cost or free of cost.

- Out of the 91 households in the BPL category, 78 households did not have a separate kitchen and the remaining 13 households had a separate kitchen. This reveals that the people below poverty line are unable to afford better housing facilities and hence use the same room as a kitchen as well as bedroom. Income plays a role in opting better housing facilities with properly constructed kitchen. The average plinth area of kitchen in the households falling below poverty line was 273.40 sq.ft. On the other hand the same in the households above poverty line was 315.51 sq.ft.

- While viewing the data about the number of windows in kitchen, it was found that only 18 households had 1-2 windows in their kitchen. The remaining number of households did not have any window in their kitchen. This may result in the inhalation of the harmful gases and suspended particulate matter generated as a result of their burning of high risk materials due to the circulation of the pollutants inside the home itself. As the women are the principal cooking persons in almost all the households, their health is affected to a great extent. The children and elderly people who are inside the house during the cooking process are also victims of this indoor air pollution.

**Institutional Aspects of Indoor Air Pollution**

- Based on the family type, the willingness of the households to adopt clean fuel varied considerably between the joint and nuclear family categories. Out of the total 260 households using high risk material, 180 were living in joint families and the remaining 80 households have a nuclear family set up.

- Overall in both the family types around 138 households were revealing moderate willingness to adopt clean fuel but were hesitant due to the expensiveness of the fuel.
The willingness of the households was measured on the basis of the education level of the households measured in terms of number of years of education obtained by the households’ members. It indicated that irrespective of the levels of education people are not willing to switch over from using high risk material to clean fuels owing to the expensiveness of the fuel and the further maintenance charges that may add up to the economic burden of their family.

When viewed the willingness of the households to adopt clean fuel from the income level perspective, it was observed that most of the households belonging to the low income group were reluctant to change their principal source of energy. Their purchasing power is very less owing to their low income and large family size.

The households were classified based on their poverty level into two groups viz, below poverty line and above poverty line. It was observed that the BPL households were not at all willing to adopt clean fuel though the state government provides free gas cylinders. They are aware of the health issues they come across due to the high risk materials they use but still are not willing to adopt clean fuel. The various reasons they give can be attributed to one single reason i.e. non-affordability due to poverty.

6.2 Conclusion

The Primary household survey results unfolded many interesting factors like socio-economic aspects of Indoor air pollution among the rural households. There is a difference in fuel consumption between the two districts taken for the study. For instance, as witnessed in the primary survey most of the households in Pudukkottai district (Kandharvakottai block) were using high risk material only because this region is naturally a dry area of Tamil Nadu state. So they could not perform farm activities, if some people did farm activities they did not get maximum income. There were no industries in that area. As a result of this, the people were economically very poor. This is one of the reasons determined for the prevalent usage of high risk material for their cooking purposes.

Due to high risk material usage, the members of the households were affected to a large extent by airborne diseases so they spend heavily for the treatment of those diseases. Majority of people had no formal education, the result was their lack of awareness in choosing proper cooking material. The households depending on high risk
material have collected firewood from social forests and related resources. Family size is very important as it decides the consumption of fuel. Similarly, education is an important factor in the choice of fuel. Higher the education level, higher is the fuel cost which implies that the fuel used is low risk material. The fuel cost is inversely related to the health damage cost incurred by the household. Where there is a low fuel cost, the health damage cost is very high and vice versa. For instance, the health damage cost for the airborne diseases is nil in the low risk material region (Palladam).

It is understood from the research that the level of education also impacts the construction of kitchen or opting a house with a better kitchen. A decline in the farming sector and a simultaneous hike in non-farm sector like factories, mills, construction industry etc. has resulted in the high income of rural households which take up non-farm jobs. When the income increases their affordability to buy low risk materials will also increase. When their income increases, they opt for better housing facilities. It can be stated that education level and income are positively related to the kitchen facilities availed. A proper kitchen (with windows and concrete roof) will reduce the incidence of airborne diseases. It can be concluded that with the increase in the income level, there is a magnificent change in the lifestyle of the people resulting in the opting of better kitchen facilities and the use of low risk materials as source of energy.

With the increased usage of high risk material female children are at risk as they are often requested to help their mothers with household responsibilities. Infants are exposed to pollutants when carried on the backs of their mothers as they tend fires. Irritation that would not affect adults may result in severe obstruction or damage to children’s lungs because they are more vulnerable.

The economically active population and the overall economy face a greater burden to support and provide the household needed by children and by old age persons who are often economically dependent. Thus when the members who are economically inactive are more in the household, the income of the household will be low, causing a deficit in the cost meant for fuel use and hence the people below poverty line depend more on high risk materials leading to disastrous changes in their health owing to the indoor air pollution which they are subjected to.
Suggestions for Policy makers

- The overall view of the findings obtained from the research gives a clear picture about the fuels used by the rural households in Pudukkottai and Tirupur districts. The major cause for the high usage of firewood, cow dung cake etc. is the economic condition of the households.

- Many policy variables like family size, family type, the distance travelled for collection of fuel, time spent for collection, education of the households, income, poverty level etc, have been discussed.

- The people those who used traditional cooking stoves like chulhas, when adopt an upgraded, modern, smokeless stove can overcome the incidence of airborne diseases.

Suggestions for further level research:

- The testing of quantum of indoor air pollution measured in terms of the level of carbon deposited in the blood of the respondents of the households was planned to be conducted as a part of this research which could not be carried out successfully. The relation between the quantum of carbon emitted from the kitchen per day and its corresponding deposits in the body of the inmates followed by the health damage costs incurred could not be established scientifically.

- When inquired about the willingness to adopt clean fuel among the households using high risk material, it was found that most of them are not ready to adopt it due to the expensiveness of the fuel.