ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

DEMOGRAPHIC AND SOCIO-ECONOMIC CORRELATES OF FUEL SAVING TECHNOLOGIES IN TEHULEDERE WEREDA: THE CASE OF "MIRT" STOVES

By:

ABDU KASSAW

JUNE, 2009

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ABDU KASSAW ABEGAZ

A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN POPULATION STUDIES (POPULATION, ENVIRONMENT AND DEVELOPMENT)

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By

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Institute of Population Studies
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DECLARATION

The thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Abdu Kassaw		01/07/09
Student	Signature	Date

This thesis has been submitted for examination with my approval as a supervisor of the same.

Berhanu Adenew		01/07/09
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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Agroeco	Agro-Ecology
CSA	Central Statistics Agency (Formerly Authority)
df	Degree of Freedom
EEA	Ethiopian Energy Agency (Formerly Authority)
EFAP	Ethiopian Forestry Action Programme
ESMAP	Joint UNDP/World Bank Energy Sector Management Assistance Programme
FAO	Food and Agricultural Organization
Femlefm	Number of Female Family Members
FGD	Focus Group Discussions
GTZ	German Technical Cooperation
ha	Hectares
HEPNR	Household Energy / Protection of Natural Resources Project
HH	Households
HHH	Household Heads
Housize	Household Size
IEA	International Energy Agency
LPG	Liquefied Petroleum Gas
Maritalsta	Marital Status of the Household Head
MDG	Millennium Development Goals
MME	Ministry of Mines and Energy
MOA	Ministry of Agriculture
SPSS	Statistical Package for Social Sciences
TJ	Tera Joule
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
VIF	Variance Inflation Factor
WHO	World Health Organization

ABSTRACT

The major goal of this study is to analyze the demographic and socio-economic correlates of owning fuel saving technologies in Tehuledere Wereda. Here the household fuel technologies particularly focus to the ownership of improved "Mirt" stoves.

This study is carried out using quantitative and qualitative data obtained from the survey of 403 households in Tehuledere Wereda. A multilevel logistic regression is fit to analyze the demographic and socio-economic correlates of the ownership of improved "Mirt" stoves using the SPSS 15.0 version software. Qualitative data were also collected to facilitate the interpretation of results of the analysis of the quantitative data.

The descriptive analysis of the study revealed that only 54.6 percent of the sample households owned the improved "Mirt" stoves and those households that do not own the improved "Mirt" stoves constituted 45.4 percent. Ownership of improved "Mirt" stoves is determined by different demographic and socio-economic factors. The results on the bivariate analysis shows the demographic variables like age, household size and marital status of the household heads significantly correlated with ownership of household improved "Mirt" stoves. Among the socio-economic variables, literacy status, income and asset are also strongly correlated with ownership of the improved "Mirt" stoves. Moreover, the exposure related variables agro-ecology, training, and perception of prices are significantly associated with ownership of the improved "Mirt" stoves, whereas the multivariate analysis results indicated that age, literacy status, income, asset, marital status, number of rooms of the house, training, number of females in the household, perception of prices and agro-ecology are significantly correlated with household ownership of improved "Mirt" stoves

In conclusion, modern technologies such as improved stove technologies can reduce environmental degradation through the efficient use of fuel wood for household activities. Moreover, these stoves are helpful for minimizing the number of times women and children are going to collect fuel wood from fields, and are means of reducing indoor air pollution which brings different health problems especially to women and children.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Like most African Countries, Ethiopia is experiencing high population growth. According to the World Bank (2000), in the year 1999 Ethiopia's population was estimated to be 63 million with the domination of rural population, which makes up 85 percent of the total population of the country. A very high fertility rate coupled with a growth rate of about 3.2 percent in rural areas makes the number of people increase rapidly.

According to the Central Statistics Agency (CSA), population density of the simple man land ratio at national level increased from about 22 persons /km^2 in 1975/76 to 33.6 persons /km^2 in 1984 and 40.7 persons/km^2 in 1989. The estimated population density of the country increased to 45 persons /km^2 in 1992 and it increase to 60 persons /km^2 in 2003 (CSA and ORC, 2006). This may show that population density has increased at a rate of about 1.4 persons /km^2 per annum since 1984. This high population of Ethiopia is directly or indirectly dependent on forest in order to fulfill its day-to-day activity.

With rapid rate of growth of population in the country, the carrying capacity of the environment is declining. Obviously, a high growth rate of population creates demand for more resources. It also influences the rate at which resources are exploited. In a situation where technology lags behind the demand for resources, primitive method of exploiting of land and other resources continue to operate in order to meet the basic needs. The traditional means of explicating natural resources have proved to be environmentally harmful and economically unproductive. Moreover, man-made and natural disasters have ravaged the country.

At the beginning of the twentieth century around 42 million hectares (35% of Ethiopia's land) was covered by forest (EFAP, 1994). But recent research indicates that forest cover is now less than 4.2% due to population growth (FAO, 2001). Despite the growing need for forested lands, lack of education among locals has led to a continuing decline of forested areas, (Parry, 2003).

1.2 Statement of the research problem

According to CSA (1998), at the beginning of the 20th century the population of Ethiopia was estimated to be 11.8 million and its growth rate was only 0.2 percent per year. It reached 39.1 million and 53.1 million in 1984 and 1994 respectively. The population of Ethiopia reached about 73.9 million with an average annual growth rate of 2.6 percent between 1994 and 2007 a decrease of 0.2% from the annual growth rate of the previous period of 1984-1994 (CSA, 2007).

Environmental degradation in the country, on the other hand is reported to be severe (Ayalneh, 2002; Singh, 1998). The problem of high population growth and environmental degradation are making the use of forest resources unavailable for energy related purposes. Clean, safe and efficient energy is a merit good that greatly enhances consumer welfare. Therefore, improving access to and use of clean and efficient energy is therefore an important part of the struggle against poverty and underdevelopment (Smith, 2002).

According to GTZ-SUN energy (2004), the decreasing amount of firewood from time to time affects women and children. This is because it increases the time spent on collecting firewood and the increase in the price of firewood. Besides, women and children are suffering from high toxic emissions from the traditional open fire stoves which cause serious health problems.

Tehuledere Wereda, the study area is characterized by relatively high population density and degraded land. The population density in the Wereda is 256.83 people per square kilometer (CSA, 2007). The majority of the people are rural dwellers. This shows that the above mentioned problems for the country are also problems in the wereda. To alleviate forest degradation in the wereda, minimizing the collection of firewood and improving traditional stoves are the major concerns. This is done by introducing fuel efficient technologies such as improved stoves that can save the amount of fuels efficiently used for cooking. These improved stoves emit significantly less smoke (Yosef, 2007).

The improved stove technologies are well known in China, India and Guatemala. In Ethiopia the technologies are being adopted by the GTZ- SUN energy project in collaboration with the Ethiopian Rural Energy Development and Promotion Center since

1990's (Dawit, 2007). This is true in the wereda too. Adopting the improved stove technology faces certain challenges. And once adopted, they are not necessarily owned and used to their full extent because of issues of affordability to buy the improved stoves, cooking habits of households, and preferences accustomed to traditional wood stoves (Heltberg, 2003). Some factors related to the demographic and socio-economic aspects may hinder or aggravate households' ownership of fuel saving technologies like the improved "Mirt" stoves.

Therefore, the aim of this paper is to assess the demographic and socio-economic correlates of ownership of fuel saving technologies in Tehuledere Wereda in the case of the improved "Mirt" stoves.

1.3 Objectives of the study

The general objective of this study is to assess the main demographic and socio-economic correlates of ownership of fuel saving technologies in Tehuledere Wereda using evidences from the improved "Mirt" stoves.

The specific objectives of this study include to:

- Assess the demographic and socio-economic correlates of ownership of fuel saving technologies in Tehuledere Wereda by using evidences from the improved "Mirt" stove technologies.
- See factors that help households to acquire information on fuel-efficient technology.
- Evaluate the effectiveness of the improved stove technology in conserving energy, fuel wood and other energy sources.

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- Evaluate the effectiveness of the improved stove technology in conserving energy, fuel wood and other energy sources.

1.4 Research Questions

Based on the above research objectives this study tried to answer the following key research questions:

1. What are the demographic and socio-economic correlates of fuel saving technologies in Tehuledere Wereda by using evidences from the improved "Mirt" stoves?
2. What factors help households to acquire information on fuel efficient technology?
3. How effective is the improved stove technology in conserving energy, fuel wood and other energy sources?

1.5 Significance of the study

The study site, Tehuledere Wereda, is selected as a study area due to the following main reasons. The area is one of the weredas in South Wollo administrative zone. Moreover, no relevant study especially concerning the demographic and socio-economic correlates of fuel saving technologies has been conducted yet in the wereda. Therefore, the study would serve as a baseline for further investigation in the areas of factors related to ownership of fuel saving mechanisms in the wereda or the region as a whole.

This study focuses on the main demographic and socio-economic correlates of fuel saving technologies in Tehuledere Wereda. In addition to focusing on demographic and socio-economic correlates of fuel saving technologies, the result of the study would help to have a good understanding about the problems related to energy, environment and resources and to design appropriate methods of dissemination of these fuel saving technologies.

Thus, the finding of this study helps to assist student researchers, development workers, both governmental and non-governmental organizations that are interested in alleviating poverty satisfying the energy need of poor households and protecting natural resources. The study also helps to give some clues on policies regarding energy, environment and natural resources. In general, this study could be used as a stepping-stone for further investigations towards specific or related fields.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1 Theories on People-Environment Interaction

Population growth and the resultant human activities have been viewed as generating a pressure to the natural resource base and environment in developing countries. So there is a high interaction between people and environment in such countries where most people live in rural areas. This interaction between people and the environment has resulted in different views among different scholars. This section tries to review some of the views.

1. Pessimistic Views: These views see population as a threat to the environment and economic development.

a. Robert Malthus's View: Thomas Robert Malthus is one of the pessimists that says population growth is a threat to environment. In his book, Essay on the Political Economy of Population first published in 1798, stated that population grows geometrically while agricultural production grows arithmetically.

But Malthus's view was criticized by different writers like Ester Boserap (1965) for not considering the effect of technology in his model.

b. The multiplicative View: This view tries to show the critical linkage between environment and population. The relation between the two can be given by four principal components as I = PAT. That is, impact on environment (I) is the multiplicative effect of population growth (P), per capita affluence (A), and the environmentally harmful technology (T) (Ehrlich and Ehrlich, 1990). From this equation it is possible to understand that the impact on the environment will double as the population doubles in number holding affluence and technology constant.

However, this model is criticized for ignoring the difference of culture and environment. Given the same size of population, different cultures respond to the environment differently. The other critic is the impact of population on the environment is different based upon its structure and dynamism, which the model does not take into account (Dula, 2007).

situation in Ethiopia is not different. In Ethiopia, massive environmental degradation has occurred during the last decades due to natural factors, unwise use of its natural resources, unsound ecological practices and population pressure.

The main activities that are responsible for environmental degradation in Ethiopia include the removal of vegetation cover and over cultivation as a result of the rapidly increasing population requirements for crop production and fuel wood (Carla B. *et. al.*, 2001).

2.3 Population Growth and Fuel wood consumption

Fuel wood has become increasingly difficult to obtain in both rural and urban areas in many Sub-Saharan African countries with rapidly growing populations using much more fuel wood than in the past (World Bank, 1990). On the subcontinent, the fuel wood shortages in many regions have three primary causes; an increase in fuel wood consumption; expansion of agriculture into forests or woodlands which reduces available tree stocks; and overgrazing caused by an increase in the cattle population which often parallels human population growth (Carla B. *et. al.*, 2001). Fuel wood is the main source of household energy in Sub-Saharan Africa, with 90 percent of households using them for cooking. An increase in population translates directly into an increase in demand for fuel wood. As a result, in some parts of Africa the demand for both fuel wood and agricultural land has led to deforestation and desertification (World Bank, 1990).

In Ethiopia where more than 80 percent of the people live in rural areas, traditional fuels contributed a high percentage of the energy consumption, with fuel wood being the most important source, followed by dung, crop residues and of charcoal. Within the households, traditional fuels contribute 93.7 percent of the total household energy consumed. with fuel wood (78.7 percent), dung (8 percent), crop residues (7 percent) and the remainder contributed by modern fuels. Due to the relative importance of cottage industries, the contribution of the traditional fuel for industry sector is the highest, 75.7 percent (MME, 1999).

Though fuel wood is the most important source of energy in Ethiopia, its supply is steadily collapsing in most parts of the country, because it is being collected faster than it can regrow (Carla B. *et. al.*, 2001).

a. **Impact on production**: The use of biomass fuels such as animal dung for fuel purposes minimizes production of the soil in such a way that the animal dung could be used as a fertilizer to replenish soil nutrients instead of utilizing it as a household fuel. For instance, excessive reliance on animal dung as source of household fuel is estimated to have reduced Ethiopia's grain production by 550,000 tones annually (Anonymous, 1997).

   The other impact on production is that the time spent to collect and transport the fuel wood is too long. This minimizes the time remaining to accomplish other household and community activities, and development endeavors. This absenteeism in participating in other activities affects productivity and production.

b. **Impact on Health**: The use of solid biomass fuels for household cooking have a great influence on polluting the surrounding air and affects the health of household members especially mothers and children resulting in severe respiratory infections, cancer of the lung and eye problems.

   1. **Indoor air pollution**: Indoor air pollution is caused by households burning solid fuels such as wood, charcoal, coal, cow dung, and crop residues in traditional stoves with inadequate ventilation (Alemu and Gunnar, 2008). The World Health Organization ranks indoor air pollution from solid fuels the world's 8th largest health risk, causing 2.7 percent of global losses of healthy life (WHO, 2002). The World Health Organization (WHO) also estimates that 1.5 million premature deaths per year are directly attributable to indoor air pollution from the use of solid fuels (IEA, 2006).

   2. **Outdoor air pollution**: Outdoor air pollution from the use of solid fuels for household cooking also occurs when smoke is vented through chimneys and windows and contributes high concentrations of particulates. This is type of pollution is especially a problem in densely populated urban areas, and in cities relying heavily on coal (Heltberg, 2003). Hence outdoor air pollution is not a major concern in this study since the study considers only rural households.

2.8 GTZ-SUN Energy Project and the "Mirt" Stove

The GTZ-SUN project is a project financed by the German Development Cooperation for sustainable Energy and Protection of Natural Resources and Environment, and Food Security. The MOA and GTZ, in 1998 have launched an improved stove dissemination program with the aim of promoting biomass energy efficiency in households in Ethiopia (GTZ, 2000). The major goal of the project is to contribute to environmental protection and sustainable environmental development. The project focuses on the dissemination of improved "Mirt" stove fuel saving for "injera"[i] baking. The technology choice has been taken on the ground that baking "injera" alone takes a significant share of the primary energy consumption (Dawit, 2007).

2.8.1 Features of the "Mirt" Stove:

The stove has certain features which is suitable for commercial dissemination. It saves up to 50 percent of biomass fuel and reduces smoke emission and fire hazard compared to the traditional stove (Mika and Elmissiry, 2003). The design of the stove is so modern that the stove is clean and convenient to use. Since the fire is protected the risk of burns is also reduced. It can be produced from locally available materials and it is a marketable product which allows production and marketing by small and micro enterprises.

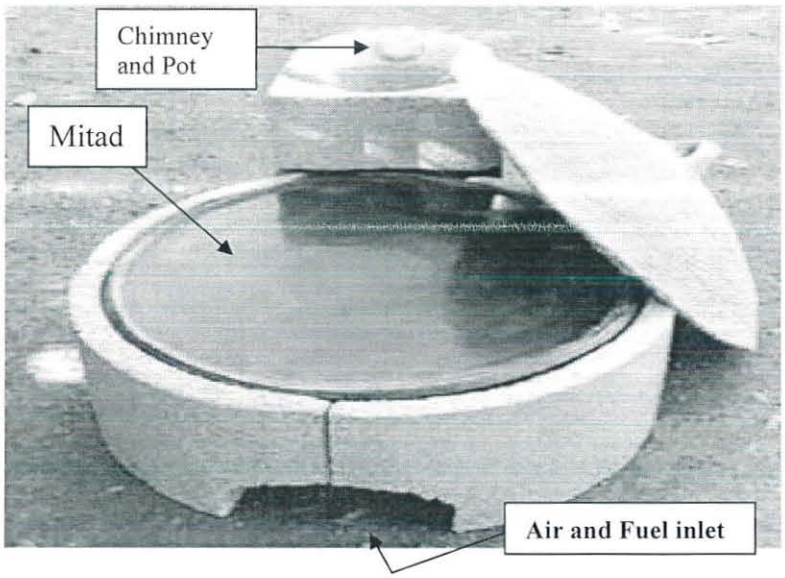

Figure 1: The diagram of the "Mirt" Stove (Obtained from GTZ-SUN energy)

[i] Injera is a staple food in Ethiopia which is a pancake like bread.

2.8.2 Importance and Efficiency of Improved Stoves:

The "Mirt" stove is important from different aspects. It saves on fuel inputs and foreign currency which can be used for other activities. Employment and business opportunities can also be other advantages gained from the production and sell of these stoves. Reduction of biomass fuel demand will be there through the use of such stoves. This again implies that improved soil fertility and productivity of land could be attained if the amount of fuel wood consumption is minimized by the use of the "Mirt" stoves. The stoves can also reduce the net carbon emission to the atmosphere (GTZ, 2000).

The "Mirt" stoves reduce the work load of women and the time required for fuel wood collection. This in turn brings more time for women to participate in other household and community activities (GTZ, 2000). Hence the stoves improve the status of women in the household in particular and in the community in general.

Table 2.3: Efficiency of cooking devices

Type of Appliance	Efficiency (%)
Three stone fire stove	5-10
Improved "Mirt" injera stove	18-25
Improved "Lakech" injera stove	20-30
Kerosene stove	30-40
LPG stove	60-70
Electric stove	70-80

Source: Renewable Energy and Development, GTZ-SUN Energy, April 2004.

According to Table 2.3, a 5-10 percent efficiency of the three stone fire stove means that 90-95 percent of the fuel is useless and its energy does not reach the cooking material.

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2.9 Empirical Review on Demographic and Socio-economic Correlates of Fuel-saving Technologies

Many studies have been conducted all over the world to assess factors determining the use fuel saving technologies. Some of these set of empirical findings are presented as follows.

Tadelech (2001) revealed that the probability of owning the technology is higher in male headed than female headed households. In this study, the decision to adopt new technology is directly related to income level, education level and family size of the respondents. But this study focused only on urban households in Addis Ababa.

Alemu and Gunnar (2008) explained in their paper that households with more members are more likely to use charcoal and less likely to use kerosene. The likelihood of households' use for non-solid fuels (kerosene and electricity) is directly proportional to education. It is also indicated in the paper that female headed households were more likely to use wood, while those with older heads were more likely to use wood and charcoal and less likely to use kerosene.

According to Heltberg (2003), Education is the main determinant of fuel switching. That is, the more the person is educated, the larger is the probability of using only LPG in both urban and rural areas. He also showed that small households are likely to use LPG as their only fuel. This means household size has no significant effect for the probability of using wood as the only fuel. Rural households are less likely to use only LPG and more likely to use only wood. Gender has no effect in that a high share of females significantly reduces the likelihood of single fuel LPG while it does not affect the choice between only wood and joint wood/LPG.

Erick Boy *et al.* (2000) studied on the comparative fuel saving efficiency of a popular wood burning stove ("Palancha") with the traditional open fire stove in western

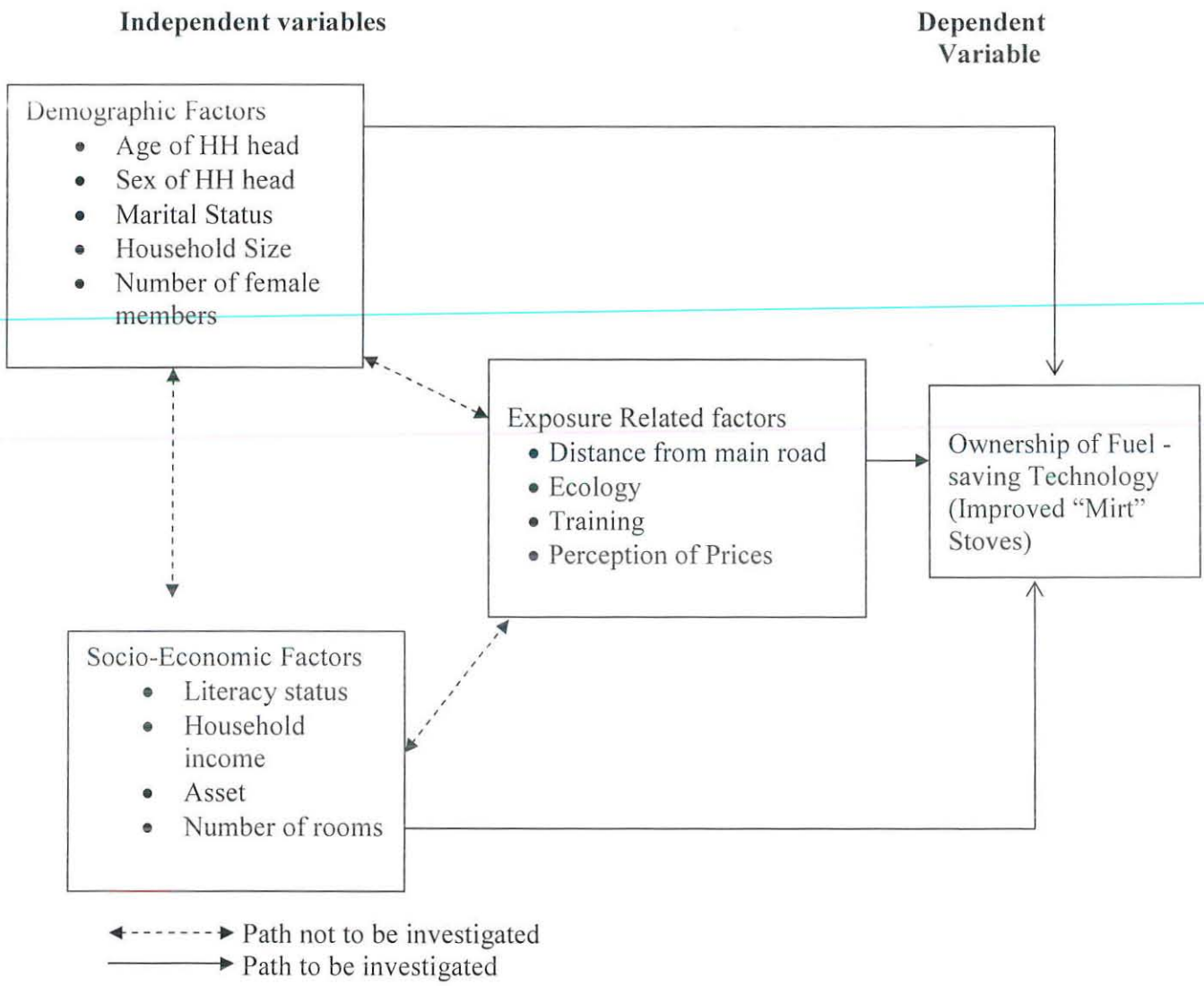
Guatemala using a five-day routine cooking using both stoves. The result shows the improved "Plancha" is found to use 39% of less fuel wood than the open fire.

Reddy (1995) studied on household energy carrier choices for households living in the city of Bangalore, India using a binomial Logit Model. It is indicated on the paper that households ascend an energy ladder and choice is largely determined by income. In addition, factors such as family size and occupation of household head are also seen to play a significant role in fuel selection amongst households.

The study by Hoiser and Dowd (1987) test the energy ladder hypothesis empirically for household fuel choice in Zimbabwe using a multinomial Logit Model. According to the study, in addition to economic factors, a large number of other factors are also important in determining household fuel choice. The energy ladder fuel switching process is often not complete and it is a gradual process with many households often using multiple fuels. The reasons for using multiple fuel use are varied and not dependent on economic factors alone although cost of energy has an important bearing on the households' choice. For instance, households choose to use more than one fuel to increase security of supply and the choice might be dependent on social, cultural, and preferences.

As indicated above, the works are mostly done on factors determining fuel use, factors on fuel switching, and factors on the energy ladder model. Some works compare the efficiency of improved stoves and open air stoves without going into the details. Even though there are works on factors determining fuel saving technologies, they are restricted to urban centers.

But, these literatures lay a corner stone to the study of the demographic and socio-economic factors determining the ownership of fuel saving technologies in both rural and urban areas. Hence, this paper tries to fill the gap by assessing the demographic and socio-economic correlates of fuel saving technologies in Tehuledere Wereda.



Source: Developed by Researcher

Figure 2. Conceptual framework for the study

CHAPTER THREE: DATA SOURCE AND METHODOLOGY

3.1 Data Source

To have a basic concept in the area of the research concern, both primary and secondary data sources were served in the study.

3.1.1 Primary Sources of Data

Primary data was collected from the subjects of the study through questionnaires and focus group discussion. As there will hardly be a problem in communication, the Amharic version of the questionnaire was used in accordance to the respondents' level of education to avoid communication barrier. The respondents were encouraged to ask for clarification on any question that they had trouble in understanding. Focus group discussions were held with beneficiary community representatives.

a. Survey Questionnaire

This method was the most important means of data collection to get information on demographic and socio-economic characteristics of the study population. The questionnaire was administrated for 403 household heads. It consists of five parts (See Annex I) with a total number of 70 questions. The questionnaire was primarily prepared in English and translated into Amharic for the purpose of avoiding ambiguity, meaning and concepts of questions for interviewers and interviewees.

Before conducting the actual data collection process, the first draft of questionnaire was pre-tested in some selected sample areas, which were not included in the final research study. This was done to evaluate the accuracy of the questionnaire such as missing of data and inconsistency of data, to understand interviewers' concepts on questions and their ways of surveying procedures, to evaluate the nature of respondents and to estimate the time required to fill a single questionnaire. Finally the actual data collection process from sample population was conducted after every correction or comments had made on information obtained from pre-test results.

b. Focus Group Discussion

The focus group discussion highly supplements the information gathered through the survey questionnaire. It is again suitable to discuss sensitive issues to acquire detailed and unaddressed information (via questionnaire method) from the groups who have different level of knowledge. To make the discussion more interesting and resourceful, guiding questions were prepared in advance.

The focus group discussion participants were selected from beneficiaries or community representatives. In this case, three groups from the three Kebeles were selected from different categories according to sex and age. Each group consisted of 5-7 members. The principal investigator was the moderator. Co-moderators have been selected from each FGD. The role of co-moderators was to initiate discussants to express their opinions freely on the issues under consideration. One of the data collectors was the script writer.

The discussions were held in the offices provided by the respective development agents and health extension workers and no problem encountered during the discussions. In order to gain the confidence of the discussants, explanation was made about the objective of the study.

3.1.2 Secondary Sources of Data

As to complement and supplement results from the primary sources, pertinent documents to the study like books, journals, magazines, statistical data collected form CSA, Ministry of Mines and Energy and GTZ- Household Energy and Protection of Natural Resource Project (currently known as GTZ- SUN Energy), articles and internet sources were referred and relevant related literatures were reviewed.

3.2 Sample Size and Sampling Technique

3.2.1 Sample Size

The sample size is determined by the formula:

$$\text{Sample size, } n = \frac{N}{1+N(E)^2} + C \quad \text{(Yamane, Taro 1967).}$$

informed that they have full right not to respond to any of the questions or not to participate in the study at all. Hence, 403 voluntary household heads have participated in the study and the questionnaires were administered to them based on their verbal consent.

3.4 Method of Data Analysis

Data collected from the survey was entered into the computer for analysis using SPSS 15.0 (Statistical Package for Social Sciences). Before running the analysis, some internal consistency checks were made to assess the quality of data. These include cross tabulation of various variables.

The analysis comprised of simple description of the demographic, socio-economic and other variables. The bivariate analysis was made to examine the relationship between the dependent variable and independent variables by using chi-square.

Finally, multiple analysis was carried out to assess simultaneously the relationship of several independent variables with the dependent variable. The dependent variable in this study is the ownership of improved "Mirt" stoves. Thus, multiple logistic model was run to analyze the net effect of each predictor entered into model on the dependent variables.

To examine the relationship between the dichotomous dependent variable and the independent variables, the logistic regression model was used as the most appropriate method. The logistic regression predicts the logs of odds of the dependent variable as a linear function of independent variables.

The model is expressed as;

$$l_n(p_i/\ 1-\ p_i) = \beta_o + \beta_1 X_{i1} + \beta_2 X_{i2} \ldots\ldots\ldots \beta_k X_{ik}$$

Where pi = chance of the i^{th} household for owning the "Mirt" stove technology.

$1-p_i$ = chance of the i^{th} household for not owning the "Mirt" stove technology.

$(p_i/\ 1-\ p_i)$ = the risk or odds of the i^{th} household for owning the "Mirt" stove technology.

$X_1, X_2, X_3 \ldots X_k$; represents predictor variables.

β_o is the intercept

informed that they have full right not to respond to any of the questions or not to participate in the study at all. Hence, 403 voluntary household heads have participated in the study and the questionnaires were administered to them based on their verbal consent.

3.4 Method of Data Analysis

Data collected from the survey was entered into the computer for analysis using SPSS 15.0 (Statistical Package for Social Sciences). Before running the analysis, some internal consistency checks were made to assess the quality of data. These include cross tabulation of various variables.

The analysis comprised of simple description of the demographic, socio-economic and other variables. The bivariate analysis was made to examine the relationship between the dependent variable and independent variables by using chi-square.

Finally, multiple analysis was carried out to assess simultaneously the relationship of several independent variables with the dependent variable. The dependent variable in this study is the ownership of improved "Mirt" stoves. Thus, multiple logistic model was run to analyze the net effect of each predictor entered into model on the dependent variables.

To examine the relationship between the dichotomous dependent variable and the independent variables, the logistic regression model was used as the most appropriate method. The logistic regression predicts the logs of odds of the dependent variable as a linear function of independent variables.

The model is expressed as;

$$\ln(p_i/ 1- p_i) = \beta_o + \beta_1 X_{i1} + \beta_2 X_{i2} \ldots\ldots\ldots \beta_k X_{ik}$$

Where pi = chance of the i^{th} household for owning the "Mirt" stove technology.

$1-p_i$ = chance of the i^{th} household for not owning the "Mirt" stove technology.

$(p_i/ 1- p_i)$ = the risk or odds of the i^{th} household for owning the "Mirt" stove technology.

$X_1, X_2, X_3 \ldots X_k$; represents predictor variables.

β_o is the intercept

$\beta_1, \beta_2, \ldots, \beta_k$ are the logit parameters of the equation in the model.

The logistic regression coefficient was obtained by the maximum likelihood. A positive value of βi means the value of the factor by which the odds change (Exp. (βi)) is greater than 1, implying an increase in the odds. A negative value of βi means the factor by which the odds change (Exp. (βi)) is less than 1, indicating a decrease in the odds. A zero value βi means the factor by which the odds change (Exp. (βi)) is equal to 1which means the odds remain unchanged.

Before using this model for analysis, different methods such as classification table and Hosmer and Lemeshow were used to see whether it fits the data or not. To check multicollinearity effect, coefficient of contingency, tolerance and Kendall's correlation matrix were used among predictor variables.

The data analysis also involves document review and analysis of qualitative responses gathered through focus group discussion and open-ended questions of the questionnaire by making comparisons and contrasts of themes and categories that emerged from the data.

3.5 Definition of Variables and Hypothesis setting

Dependent Variable

The dependent variable of the study is the ownership of improved "Mirt" stoves. This study assessed the ownership a fuel saving technology (improved "Mirt" stoves) of households by coding 0 if the households' response is own the technology and 1 otherwise.

Predictor variables

In this study, the predictor variables were demographic and socio-economic correlates that are assumed to have relationship with ownership of improved "Mirt" stoves.

Demographic variables

Sex of household head: In this study, it was assumed that the probability of owning the improved "Mirt" stoves is higher for female headed households than those headed by males. It was coded as 1 if the head of the household was a female and 2 if not.

$$Maritalsta = \begin{cases} 1, Currently married \\ 2, Widowed \\ 3, Others \end{cases}$$

Socio-economic variables:

Literacy status: The probability of owning improved "Mirt" stoves is high for households headed by a literate person as compared to those households headed by illiterates. It is assumed here that as a person is more educated, he/she is susceptible to read and know about new technologies and use them. It was coded as 1 for literates and 2 otherwise.

$$Literacy = \begin{cases} 1, Literate \\ 2, \geq Illiterate \end{cases}$$

Income: refers to the total annual income of a household in Ethiopian Birr. It is obtained from sell of animals, crops, cash crops, and remittance. It is assumed that households with high income have a greater probability to own the "Mirt" stove technology. This assumption is due to the fact that, as a household has more income, it is likely to buy the improved stoves easily. The sample households were categorized as ≥2500, 1500-2499 and <1500 and were coded as 1, 2 and 3 respectively.

$$Income = \begin{cases} 1, \geq 2500 \\ 2, 1500 - 2499 \\ 3, <1500 \end{cases}$$

Asset: This includes the ownership of unsold animals and crops which were estimated and expressed in Ethiopian Birr. Hence, those households with high assets have a greater probability of owning the "Mirt" stove technology. It was categorized as ≥20000, 15000-19999 and <15000 Birr with codes of 1, 2 and 3 respectively.

$$Asset = \begin{cases} 1, \geq 20000 \\ 2, 15000 - 1999 \\ 3, <15000 \end{cases}$$

Number of rooms: the number of rooms that a household owns is an important factor in determining the ownership of the technology. Hence, as the number of rooms increase the probability of owning the technology increases. It was coded as 1 for those households having rooms ≥4 and 2 for those having <4 rooms.

$$Rooms = \begin{cases} 1, \geq 4 members \\ 2, < 4 members \end{cases}$$

***Exposure related variables*:**

Distance from the main road: It is assumed that the closer the households to the main road, the more it utilizes fuel saving technologies. The households were categorized as near and far based on their location from the main road. In this study, those households with in a distance of about 30 minutes from the main road are considered as near and those with in a distance of more than 30 minutes from the main road are considered as far. Hence, near was coded as 1 and far 2.

$$Distance = \begin{cases} 1, Near \\ 2, Far \end{cases}$$

Agro-Ecology: The sample households were classified into the three agro-ecological zones based on their forest cover. It was coded as 1, 2 and 3 for Kolla, Woina-Dega and Dega ecological zones respectively.

$$Agroeco = \begin{cases} 1, Kolla \\ 2, Woina - Daga \\ 3, Dega \end{cases}$$

Training: The probability of using household fuel saving technology for those who took training is greater than those who did not take training. It was coded as 1 for household heads who have got training as "yes" and 2 otherwise.

$$Training = \begin{cases} 1, Yes \\ 2, No \end{cases}$$

Perception of price: The prices of the "Mirt" stoves also play an important role in using them over the traditional open fire stoves. The actual price of the stoves is 60 Ethiopian Birr. It was assumed that the smaller the price of "Mirt" stoves, the higher the probability to own it and vice versa. There were price perceptions given by respondents. These perceived prices were categorized as <50, 50-60 and ≥60 and coded as 1, 2 and 3 respectively.

$$Price = \begin{cases} 1, \leq 50 \\ 2, 50\text{–}60 \\ 3, \geq 60 \end{cases}$$

CHAPTER FOUR: BACKGROUND OF THE STUDY AREA AND THE STUDY POPULATION

4.1 Physical Setting of the Study Area

4.1.1 Location

The study site, Tehuledere Wereda, is located in South Wollo Zone of Amhara Region having a total area of 458.9 square kilometer (45800 ha). The wereda is found at a geographical coordinate of 11° 19' 0 N and 39° 45' 0 E. Haik, the capital of the wereda is located 430 km from Addis Ababa to the north on the main highway of Addis Ababa-Dessie- Mekelle road and 30 km to the north from Dessie, the zone capital.

The Wereda is bordered by Kallu and Werebabo Weredas in the East, Ambasel Wereda in the West, Kutaber Wereda in the Southwest, Dessie Zuria Wereda in the South, and North Wollo Zone in the North.

Topographically, the wereda is composed of 26.4 percent mountain, 48 percent undulating, 13.3 percent plain and 12.3 percent valley.

4.1.2 Agro-Ecology

The altitude of the wereda ranges from 1400 m to 2900 m above sea level that shows altitudes ranging from lowland to highland. Hence, the agro-ecology of the study area includes highland ("Dega"), mid-altitude (Woina-dega") and lowland ("Kolla") areas.

About three-quarter (72 percent) of the wereda is categorized under the mid-altitude while the remaining 13 percent and 15 percent of the wereda are categorized under the highland and lowland agro-ecological zones respectively. This is shown in Table 4.1 below.

Table 4.1: Proportion of Agro-ecological Zones of Tehuledere Wereda

Agro-ecological Zone	Area (ha)	Percentage
Lowland	6870	15
Mid-altitude	32976	72
Highland	5954	13
Total	45800	100

Source: Tehuledere Wereda Office of Agriculture and Rural Development

Regarding to the land use of the Wereda, Table 4.2 illustrates that 47.0 percent is cultivated, 1.5 percent grazing land, 7 percent plant and natural forest, 24.2 percent bush, shrub and others, 8.3 percent water body, 9.8 percent village and home stage, and the remaining 2.2 percent is waste land.

Table 4.2: Land use pattern of Tehuledere Wereda

Type of land	Area (ha)	Percentage
Cultivated land	21,539.0	47.0
Bush and Shrub	11,098.03	24.2
Plant and Natural Forest	3210.2	7.0
Village and home	4490.8	9.8
Water body	3800.0	8.3
Waste land	1000.0	2.2
Grazing area	662.0	1.5
Total	45800	100

Source: Tehuledere Wereda Office of Agriculture and Rural Development

4.2 Population Characteristics of the Wereda

4.2.1 Age-Sex Composition

According to the Wereda Agriculture and Rural Development Office, there are 25,237 households in the Wereda of which 18 percent women headed households living in 19 rural and 4 urban Kebeles. The average household size is about five persons per household.

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According to the Wereda Information Office, Table 4.3 shows the percentage distribution of the population of the Wereda by sex and broad age group. The data in Table 4.3 show that the Wereda had a total population of 159,351. Females constituted slightly more than half (50.81 percent) of this population. The sex ratio was 97 males for every 100 females. The largest part of the population, i.e. nearly 87.34 percent resides in rural areas.

Table 4.3. Age-Sex Composition of the Population in the Wereda

Age group	Rural			Urban			Grand Total			Sex Ratio
	Male	Female	PR	Male	Female	PU	Male	Female	Sum	
0-34	50790	50243	86.91	7038	8185	13.09	57828	58428	116256	0.99
35-49	8674	10007	87.57	1262	1390	12.43	9936	11397	21333	0.87
50+	9616	9850	89.45	1005	1291	10.55	10621	11141	21762	0.95
Total	69080	70100	87.34	9305	10866	12.66	78385	80966	159351	0.97

PR- Percent Rural, PU- Percent Urban

Source: Tehuledere Wereda Information Office, 2008.

4.2.2 Ethnic Group

According to the Wereda Agriculture and Rural Development Office, the predominant ethnic group living in the Wereda is Amhara, 99 percent. The rest include 0.35 percent Tigrie, 0.5percent Agew, 0.07 percent Oromo and others groups constitute 0.08 percent.

4.2.3 Religion

According to the Wereda Agriculture and Rural Development Office, the majority of the population, 89 percent, is Muslim followed by Orthodox Christians, Protestants and Catholics in decreasing order.

4.2.4 Educational Level

According to the Wereda's Millennium Development Status Report, 66.3 percent of the population in the Wereda are illiterate, 15 percent can read and write, 10 percent have primary education and the rest 8.7 percent have junior and above level of education (Table 4.4).

Table 4.4: Educational Background of Household Heads in the Wereda

Educational Level	Percentage
Illiterate	66.3
Read and Write	15.0
Primary School	10.0
Junior Secondary School	4.2
Senior Secondary School	4.5
Total	100

Source: Tehuledere MDG Status report

CHAPTER FIVE: RESULT AND DISCUSSION

5.1. Background Characteristics of Respondents

5.1.1. Demographic characteristics

5.1.1.1Age and Sex composition

According to the field survey, 80.6 percent of the household heads covered in the sample survey were males and the rest 19.4 percent were females. That is, female headed households constitute about one-fifth of the sample respondents (Table 5.1).

5.1.1.2 Marital Status of Heads of the Households

Information collected on marital status shows that 86.1 percent of the sample household heads were in marital union at the time of the survey. The rest 13.9 percent comprises divorced, widowed and separated household heads (Table 5.1).

5.1.1.3 Household Size

According to the field survey, Table 5.1 shows a distribution of the household by the number of persons per household head. The households with less than and equal to 5 members make up 65.3 Percent, households with greater than 5 members constitute 34.7 percent.

The sample survey of 403 households of Tehuledere Wereda implies that many rural households (87.34 percent) had at least an average of 5.16 household members.

5.1.1.4 Number of females in the household

Table 5.1 shows a distribution of the household by the number of females in the household. The households with less than and equal to 3 female members make up 86.1 Percent. households with greater than 3 female members constitute 13.9 percent.

According to the sample survey, households in the Wereda had at least an average of 2.66 female household members.

Table 5.1: Demographic Characteristics of Respondents

Variable	category	Frequency	Percent
Sex	Male	325	80.6
	Female	78	19.4
Age	<35	104	25.8
	35-49	183	45.4
	≥50	116	28.8
Marital Status	Currently Married	347	86.1
	Widowed	36	8.9
	Divorced	4	1.0
	Separated	16	4.0
Household Size	≤5	263	65.3
	>5	140	34.7
Number of females in the household	> 3	56	13.9
	≤ 3	347	86.1

Source: Field survey, 2009

5.1.2 Socio-economic characteristics

5.1.2.1 Literacy Status of Heads of Households

As far as literacy level is concerned, 48.5 percent of the respondents were illiterate, 11.9 percent can read and write, 34.7 percent had elementary education and the remaining 6.9 percent had secondary education (Table 5.2).

5.1.2.2 Religion of Head of the Household

More than three-fourth (87.1 percent) of the respondents were Muslims while 9.9 percent were Orthodox Christians and the rest 3.0 percent were Protestants (Table 5.2).

5.1.2.3 Household Income

During the survey, the respondents were asked about the mean annual income of the households. The data given in table 5.2 show the percentage distribution of the sample population by household income. Accordingly, the respondents' mean annual income was 2925.11 birr. As it is indicated in table 4.6, about 47.4 percent and 26.8 percent of respondents had mean annual income of ≥2500 birr and 1500 to 2499 birr, respectively while the remaining 25.8 percent had below 1500 birr.

5.1.2.4 Assets

During the survey, the respondents were asked question to reply mean property assets of the households. The data given in table 5.2 show the percentage distribution of the sample population by the property assets they have. Accordingly, the respondents mean property asset was 21,921.11 birr. As it is indicated in table 4.6, about 61.3 percent and 23.8 percent of respondents had mean property asset of ≥20,000 birr and 15,000 to 19,999 birr, respectively while the remaining 14.9 percent had below 15,000 birr.

5.1.2.5 Number of rooms

According to Table 5.2, 65.3 percent of the sample households own houses with rooms greater than or equal to four while 34.7 percent of the sample households own houses with rooms less than four.

Table 5.2: Socio-economic Characteristics of Respondents

Variable	Category	Frequency	Percent
Religion	Muslim	351	87.1
	Orthodox	40	9.9
	Protestant	12	3.0
Literacy Status	Illiterate	235	58.4
	Literate	168	41.6
Income (Eth. Birr)	≥2500	191	47.4
	1500-2499	108	26.8
	<1500	104	25.8
Property Assets (Eth. Birr)	≥20000	247	61.3
	15000-19999	96	23.8
	<15000	60	14.9
Number of rooms	≥4	263	65.3
	<4	140	34.7

Source: Field Survey, 2009

5.1.3 Exposure Related Characteristics of Respondents

5.1.3.1 Agro-ecology

According to Table 5.3, 34.7 percent of the households were from Kolla, 36.7 percent were from Woina-Dega and the remaining 28.5 percent of the sample households were from Dega.

5.1.3.2 Distance to main road

During the sample survey, households were sampled based on their distance from the main road. According to Table 5.3, households were categorized as near and far based on their location from the main road comprising 49.6 percent and 50.4 percent respectively.

4.1.3.3 Perception of prices of stoves

Households were asked about the price of "Mirt" domestic stoves and responded that 28.8 percent, 32.8 percent and 38.5 percent for prices below 50 Birr, 50-60 Birr and above 60 Birr respectively (Table 5.3).

5.1.3.4 Training

As Table 5.3 illustrates 63.3 percent of the sample household members has got training while in 36.7 percent of the households there was no training.

Table 5.3: Exposure Related Characteristics of Respondents

		Frequency	Percent
Agro-ecology	Kolla	140	34.7
	Woina Dega	148	36.7
	Dega	115	28.5
Distance to main roads	Near	200	49.6
	Far	203	50.4
Perception of Prices of Stoves (Eth. Birr)	<50	116	28.8
	50-60	132	32.8
	>60	155	38.5
Training	Yes	255	63.3
	No	148	36.7

Source: Field Survey, 2009

5.2 Household Fuel Consumption and Related Issues

According to the sample survey result, 30.5 percent of the interviewed households use wood, dung, branches and leaves as their main source of energy for injera baking. Those households who use woods, branches and leaves constitute 24.8 percent. Branches and leaves constitute 19.9 percent which is similar to the percentage of the fuel consumption from wood and dung. The rest 10 percent of the households use only wood as their main

source of energy for injera baking (Table 5.4). Here, it is clear to understand that households use multi-fuel system (fuel stacking) rather than single fuel consumption system for baking injera.

Table 5.4: Type of fuel most utilized by the respondent for injera baking

Fuel Type	Frequency	Percent
Wood	44	10.9
Branches and leaves	68	16.9
Wood and dung	68	16.9
Wood, branches and leaves	100	24.8
Wood, dung, branches and leaves	123	30.5
Total	403	100.0

Source: Field Survey, 2009

It is apparent from Table 5.5 that 40.4 and 62.3 percent of households use wood for wot cooking and coffee making respectively. On the other hand, 59.6 and 37.7 percent of the households use wood and dung together for wot cooking and coffee making respectively.

This result showed that there is an over utilization of the biomass resources which might in turn causes depletion of natural resources and environmental degradation.

The participants in the FGD regarding this issue agreed that:

> *As wot cooking and coffee making in the area are common day to day activities, households use wood and dung excessively. This excessive use of wood and dung causes forest depletion and soil infertility respectively.*

Hence, the FGD result confirms that households' excessive exploitation of wood brings a bare land and over exploitation of dung for household cooking makes the soil infertile and thereby production of crops low.

Table 5.5: Type of fuel most utilized by the respondent for wot cooking

Fuel use	Fuel Type	Frequency	Percent
Wot Cooking	Wood	163	40.4
	Wood and dung	240	59.6
	Total	403	100.0
Coffee Making	Wood	251	62.3
	Wood and dung	152	37.7
	Total	403	100.0

Source: Field Survey, 2009

Households were also asked to give information about the consumption patterns of fuel wood, charcoal, kerosene, electricity and LPG. About 50.6 percent of the households responded that the consumption pattern for fuel wood has increased for the last two years and 49.4 percent responded that there was no change in their fuel wood consumption. Regarding the consumption pattern of charcoal in the last two years, 81.1 percent of the households responded that they never utilized charcoal; 14.9 percent pointed out that there was no change in utilizing charcoal. The rest 3 percent and 1 percent of the households confirmed that their consumption increased and they stopped utilizing respectively. Accordingly, electricity and LPG were not utilized by the sample households. The consumption pattern of kerosene indicates 83.1 percent of the households showed that their consumption decreased while 15.9 percent of them responded that their consumption increased and the remaining insignificant 1 percent of the households replied that there was no change in their consumption pattern (Table 5.6).

From this result, one can conclude to the decrease in consumption of kerosene by most households is that there is an increase in the price of kerosene which again leads to the use of other substitute fuels like fuel wood.

The FGD result supports this situation by pointing out the following:

> *For the previous years, the price of kerosene which families in the area used for lighting purpose was increasing. This increase in price makes most households to minimize their consumption of kerosene and shift to traditional fuels like fuel wood. This time the consumption of fuel wood for lighting increases besides using it for baking and cooking purposes.*

Table 5.6: Consumption pattern fuels in last two years in percentages

Type of Fuel	Increase	Decrease	No change	Never Utilizing	Stop Utilizing	Total
Fuel wood	50.6	-	49.4	-	-	100.0
Charcoal	3.0	-	14.9	81.1	1.0	100.0
Kerosene	15.9	83.1	1.0	-	-	100.0
Electricity	-	-	-	100.0	-	100.0
LPG	-	-	-	100.0	-	100.0

Source: Field Survey, 2009

As indicated in Table 5.7, those households who used fuel wood were asked for the reason why they utilize fuel wood for household cooking. More than four-fifth (84.1 percent) responded that it was due to the easy availability of fuel wood and the rest one-fifth (15.9 percent) responded that no other choice was there other than fuel wood.

Table 5.7: Reason for utilizing fuel wood for household cooking

Reason	Frequency	Percent
Easily available	339	84.1
No other choice	64	15.9
Total	403	100.0

Source: Field Survey, 2009

As it is described from Table 5.8 that the study has identified all sample households obtain fuel wood and branches and leaves through collecting freely from field. Only about a quarter (24.8 percent) of the respondents obtain and use charcoal from utilized fuel wood and the rest three fold (75.2 percent) of households do not use charcoal at all.

Table 5.8: Sources of fuel

Source of Fuel	Type of fuel by frequency and percentage		
	Fuel wood	Branches and leaves	Charcoal
Collecting freely from field	403 (100)	403 (100)	-
Got from Utilized fuel wood	-	-	100 (24.8)

Numbers in brackets are percentages

Source: Field Survey, 2009

5.3 Kitchen Environment and Frequency of Cooking

This section discusses whether the households have a permanent place for cooking and whether the place of cooking is inside or outside of the house. It also emphasizes the number of times the household bakes and cooks per week and per day.

Almost all (94 percent) of the sample respondents have a permanent place for cooking. Among these, 30.6 percent have a separate kitchen from the main house while the remaining 69.4 percent have kitchen with in their house. Those who do not have a

permanent place for cooking constitute only 6 percent sharing a common kitchen with their neighbors (Table 5.9).

Table 5.9: Frequency of permanent place for cooking and it's relation to the main house

	Permanent Place		Separate from main house		Use common Neighbor Kitchen	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	379	94.0	116	30.6	24	100.0
No	24	6.0	263	69.4	-	-
Total	403	100.0	379	100.0	24	100.0

Source: Field Survey, 2009

Regarding the frequency of injera baking, 90.1 percent of the respondents bake every 2-3 days having 15-30 injeras per session; and the rest 9.9 percent bake every day having less than 15 injeras per session (Table 5.10).

As the FGD result shows that baking injera every 2-3 days is more advantageous than baking every day even if the numbers of injeras baked are almost similar in ratio. The participants agreed that:

Baking every 2-3 days is time, fuel and human power saving than baking every day in that baking every day needs much fuel to heat the stove each time they start to bake. The time saving is also another important thing in this regard.

Table 5.10: Frequency of injera baking

Frequency of baking	Frequency	Percent	Number of injeras per session	Frequency	Percent
Every day	40	9.9	<15	40	9.9
Every 2-3 days	363	90.1	15-30	363	90.1
Total	403	100.0	Total	403	100.0

Source: Field Survey, 2009

Another investigation was done to compare the number of households who cook wot and make coffee at different times (Table 5.11). There were large number of households that cook wot and make coffee twice every day. About 9.9 percent of the households make coffee once every day while none of the households cook wot once every day. The remaining 3 percent of the households were non-participants at any time in coffee making. This piece of study showed that there might be high fuel wood consumption for cooking wot and making coffee since a number of households make these things twice every day. Hence, wot cooking and coffee making can be among the considered causes of deforestation.

Table 5.11: Frequency of Wot cooking and coffee making

	Wot Cooking		Coffee Making	
	Frequency	Percent	Frequency	Percent
Once every day	-	-	40	9.9
Twice every day	403	100.0	351	87.1
Do not make wot or coffee	-	-	12	3.0
Total	403	100.0	403	100.0

Source: Field Survey, 2009

5.4 Information about Stoves

The study showed that most households obtain traditional open fire stoves by purchasing. As Table 5.12 illustrates, about 98 percent of the sample households obtain traditional stoves by purchasing and only 2 percent make the traditional open fire stoves themselves.

Table 5.12: Source of traditional open fire stoves

Source	Frequency	Percent
Purchasing	395	98.0
Self made	8	2.0
Total	403	100.0

Source: Field Survey, 2009

The "Mirt" is among the improved stove technologies, which was introduced and being disseminated by GTZ-SUN energy. According to the study, 77.2 percent of the sample

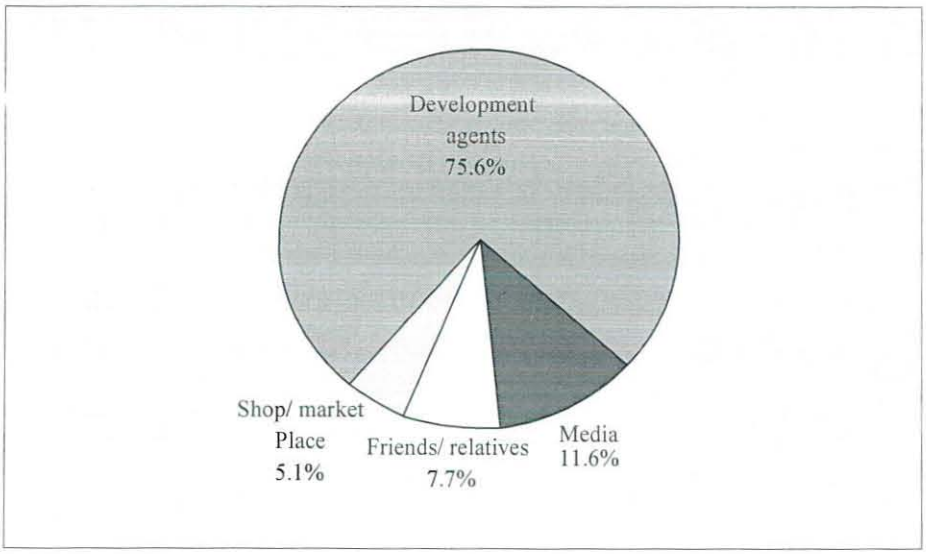
households had got information regarding the efficiency of the improved "Mirt" stoves while the remaining 22.8 percent did not get any information (Table 5.13).

Table 5.13: Information about efficiency of the improved "Mirt" fuel saving stoves

Got Information	Frequency	Percent
Yes	311	77.2
No	92	22.8
Total	403	100.0

Source: Field Survey, 2009

There are various sources of information about improved stoves. From those who got information, 75.6 percent got the information either from development agents or health extension workers. 11.6 percent of them got the information from media such as television or radio; and the remaining 7.7 percent and 5.1 percent got the information from relatives or friends and from market places, respectively (Figure 4).



Source: Field Survey, 2009

Figure 4: Source of information about improved"Mirt" Stoves

Out of the households that own the improved "Mirt" stoves, 49.1 percent of them learn the technology from development agents or health extension workers; and 45.5 percent of them learned the technology from friends or relatives. The remaining 3.6 percent and 1.8 percent of them learned the technology from market places and media respectively (Table 5.14). From the result one can see how the development agents or health extension workers are working in transferring new technologies to the people thereby participating in the fight against poverty and environmental degradation.

Table 5.14: Major Mechanisms to learn the technology

Mechanisms	Frequency	Percent
From friends	100	45.5
From Media	4	1.8
From market places	8	3.6
From development agents	108	49.1
Total	220	100

Source: Field Survey, 2009

According to the study, 65.5 percent of the sample households responded that the improved "Mirt" stoves are installed by the respondents themselves and 25.5 percent of them responded that it was installed by professionals. The remaining 9 percent pointed out that the installation was done by other people (Table 5.15).

Table 5.15: Information on installation of "Mirt" stoves

Response	Frequency	Percent
Self built	144	65.5
Professional	56	25.5
Other	20	9.0
Total	220	100

Source: Field Survey, 2009

The sample households were asked whether there is a difference between the traditional open fire stoves and the improved "Mirt" stoves, and 99 percent of them responded that

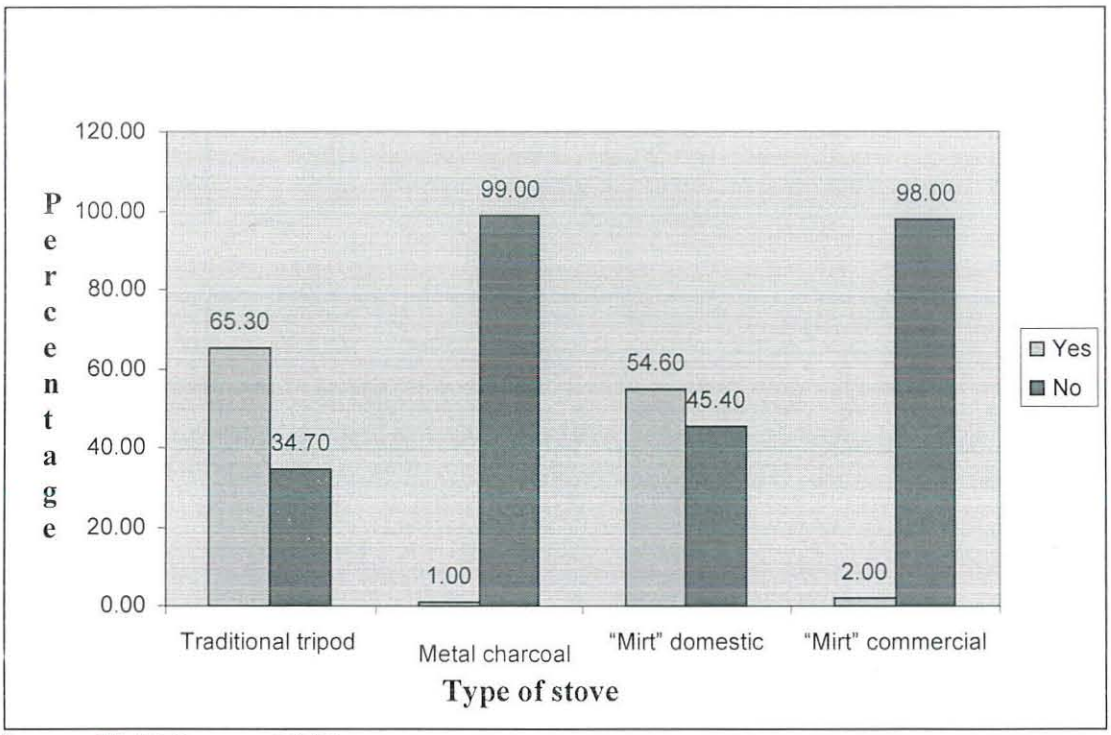
there is a difference. Only 1 percent of them responded there is no difference between the two types of stoves (Table 5.16).

Table 5.16 Response on the difference between improved stoves and traditional stoves

Response	Frequency	Percent
Yes	399	99.0
No	4	1.0
Total	403	100.0

Source: Field Survey, 2009

Among the sample households, 54.6 percent own "Mirt" domestic stoves and the rest 45.4 do not own these stoves. 65.3 percent of the respondents own traditional stoves. Household ownership to metal charcoal stoves and "Mirt" commercial stoves constitute only 1 percent and 2 percent respectively (Figure 5).



Source: Field Survey, 2009

Figure 5: Ownership status of households by type of stoves

5.5 Efficiency of improved "Mirt" stoves and their impact

Respondents were asked to tell the advantages of the traditional (tripod and charcoal) stoves and improved ("Mirt" domestic and "Mirt" commercial) stoves. According to the result, traditional stoves are low cost and easily available. Both owners and non-owner households responded that traditional tripod stoves are low cost and easily available. Almost all (98.2 percent of owners and 100 of non-owner respectively) of the respondents replied that charcoal stoves are cheap and easily available and only 1.8 percent of the owners responded that they are efficient in fuel, time and power saving. Regarding the advantages of the improved (both domestic and commercial) stoves, all respondents have responded that they are cleaner (healthier), convenient to use, efficient in saving fuel, time and human power (Table5.17).

Similar result was shown in the FGD. It is described as follows:

> *All participants agreed that the "Mirt" stove is convenient to use. They indicated improved stoves produce less smoke as compared with that of the traditional stoves which implies that the improved stoves conserve energy properly which was emitted and lost through smoking in the traditional stove. They also showed that the stoves enabled them to be free from smoke and heat that comes from the open air combustion of biomass fuel in the traditional stoves.*

Table 5.17: Sample households' perception on advantage of stoves

Type of stove	Perception between owners and Non-owners on Advantages of stoves					
	Owners			Non Owners		
	Low cost and easily available	Efficient	Efficient and healthier	Low cost and easily available	Efficient	Efficient and healthier
Traditional tripod	220(100)	-	-	-	-	183(100)
Metal charcoal	216(98.2)	-	4(1.8)	183(100)	-	-
"Mirt" domestic	-	-	220(100)	-	-	183(100)
"Mirt" commercial	-	-	220(100)	-	-	183(100)

The numbers in parenthesis are percentages

Source: Field Survey, 2009

5.6 Correlates of Fuel Saving Technologies

In this section effort has been made to explore those demographic and socio-economic correlates of fuel saving technologies with regard to the ownership of improved "Mirt" stoves. The bi-variate and multivariate statistical models are used.

5.6.1 Bi-Variate Analysis

To see the association between each predictor variable and the ownership of household improved "Mirt" stoves, the analysis used cross-tabulation of each predictor variables against the outcome variable.

Chi-square test is also used to examine whether significant correlations exist between the dependent and predictor variables where the dependent variable is ownership of improved "Mirt" stoves, which is expected to be influenced by different predictor variables.

Table 5.19: Association between household ownership of improved "Mirt" stoves and selected predictor variables in Tehuludere Woreda

Variables	Category	n	Own "Mirt" domestic stoves		Pearson Chi-square	df	P-value
			Yes (%)	No (%)			
Demographic Variables							
Sex of HH	Female	78	55.13	44.87	1.883	1	0.170
	Male	325	58.15	41.85			
Age of HH	<35	104	84.62	15.38	64.122	2	0.000
	35-49	183	61.20	38.80			
	≥50	116	27.59	72.41			
Marital status	Currently married	347	53.03	46.97	9.868	2	0.007
	Widowed	36	77.78	22.22			
	Others	20	40.00	60.00			
Household size	≤5	263	69.96	30.04	35.679	1	0.000
	>5	140	34.29	65.71			
Number of females in HH	≥3	56	35.71	64.29	3.612	1	0.057
	<3	347	61.10	38.90			
Socio-economic Variables							
Literacy status	Literate	212	86.79	13.21	112.581	1	0.000
	Illiterate	191	25.13	74.87			
Asset	≥20000	247	53.44	46.56	10.428	2	0.005
	15000-19999	96	58.33	41.67			
	<15000	60	73.33	26.67			
Income	≥2500	183	63.39	36.61	58.833	2	0.000
	1500-2499	108	77.78	22.22			
	<1500	112	28.57	71.43			
Number of Rooms	≥4	263	56.27	43.73	0.008	1	0.929
	<4	140	60.00	40.00			
Exposure Related Variables							
Distance to main road	Near	200	56.00	44.00	0.318	1	0.573
	Far	203	53.20	46.80			
Agro ecology	Kola	140	71.43	28.57	11.801	2	0.003
	Woina-Dega	148	56.76	43.24			
	Dega	115	41.74	58.26			
Training	Yes	255	78.43	21.57	102.559	1	0.000
	No	148	21.62	78.38			
Perception of price	<50	116	79.31	20.69	38.103	2	0.000
	50-60	132	63.64	36.36			
	>60	155	36.13	63.87			

Significance (P-Value): P<0.05

Source: *Calculated from Field survey data, 2009*

5.6.1.1 Household Demographic Characteristic and Ownership of Improved "Mirt" Stoves

Attempt is made to provide an overview of the relationship between demographic variables and ownership of improved "Mirt" stoves of households.

Age of Household Head

Age of household head is one of demographic factors that determine ownership of improved "Mirt" stoves of the household. As it is shown in Table 5.19, large proportion of household heads (84.62 percent) that own the improved stoves is found in the age group less than 35 years old. About 61.2 percent of households headed by persons of age between 35-49 years old own the improved "Mirt" stoves. While 72.41 percent of those headed by 50 years old and above did not own the improved stoves.

The Pearson chi-square is also showing statistically significance association between the age of the household head and ownership of improved "Mirt" stove of households with $X^2 = 64.122$ and $P<0.001$. The reason is that younger people are relatively more exposed to new technologies like "Mirt" stoves.

Sex of Household Head

As Table 5.19 indicates female headed households and male headed households are almost the same in owning the technology with 55.13 percent and 58.15 percent respectively. Similarly, the proportions of female and male respondents who do not own the technology are approximate with 44.87 percent and 41.85 percent respectively. The Pearson chi-square tests has also implied that there is no significant statistical association between sex of head of the household and ownership of improved "Mirt" stove status of households ($X^2 =1.883$ and $P>0.05$).

Household size

As shown in Table 5.19, the association between household size and ownership of improved "Mirt" stoves of the household is statistically significant ($X^2 = 35.679$ and $P<0.01$). The proportion of improved "Mirt" stove owners increase when household size decreases; which fits to the assumption that 'small household size is positively correlated

with ownership of improved "Mirt" stove of households. On the other hand the proportion of improved "Mirt" stove non-owners increase when household size increases.

Number of female households:

As it is confirmed in Table 5.19 the association between number of female members in the household and ownership of improved "Mirt" stove of households is not statistically significant (X^2 = 3.612 and P>0.05). Moreover, the proportion of Mirt" stove owner households increase when number of females in the household decreases; which is opposite to the assumption that presence of large number of females is positively correlated with ownership of improved "Mirt" stove. On the other hand the proportion of improved "Mirt" stove non-owners increase when the number of females in the household increases which opposes the assumption. This result needs further investigation.

Marital Status

Marital status is also one of the variables which affect household ownership of improved "Mirt" stove. According to Table 5.19, widowed households have the higher proportion, which is 77.78 percent; in owning improved "Mirt" stoves while divorced or separated households have the larger proportion (60 percent) in not owning improved "Mirt" stoves. The Pearson chi-square tests has also implied that there is significant statistical association between marital status of head of the household and ownership of improved "Mirt" stove status of households (X^2 = 9.868 and P<0.05).

5.6.1.2 Household Socio-economic Characteristics and Ownership of Improved "Mirt" Stoves

In this sub-section the researcher argues that households' ownership of improved "Mirt" stoves is correlated with socio-economic characteristics.

Literacy Status of Household Head

There is statistically significant difference between illiterate and literate household heads in their ownership status of improve "Mirt" stoves. From the total illiterate household heads, 74.87 percent and 25.13 percent do not own improved "Mirt" stoves and own improved "Mirt" stoves respectively. On the other hand, from the total literate household

heads 13.21 percent and 86.79 percent of literate household heads do not own improved "Mirt" stoves and own improved "Mirt" stoves respectively. Thus, the likelihood to own improved "Mirt" stoves exceeds by 61.66 percent among literate household heads compared to the illiterate household heads (Table 5.19).

The Pearson Chi-square test also shows statistically significant association between ownership of improved "Mirt" stoves of household heads and literacy status (X^2 = 112.581 and P<0.001).

Income

As shown in Table 5.19, the association between income and ownership of improved "Mirt" stoves of the household is statistically significant (X^2 = 58.833 and P<0.001). The proportion of improved "Mirt" stove owners increase when income increases and proportion of improved "Mirt" stove non-owners increase when income decreases; this fits to the assumption that 'larger income households are positively correlated with ownership of improved "Mirt" stove of households.

Asset

As shown in Table 5.19, the association between assets and ownership of improved "Mirt" stoves of the household is statistically significant (X^2 = 10.428 and P<0.05). However, the proportion of improved "Mirt" stove owners increase when asset decreases and proportion of improved "Mirt" stove owners decrease when income decreases; which opposes to the assumption that 'larger asset households are positively correlated with ownership of improved "Mirt" stove of households. This shows that the result needs further investigation.

Number of rooms

The association between the number of rooms a household owns and ownership of improved "Mirt" stoves is insignificant (X^2 = 0.008 and P>0.05). But in Table 5.19, the proportion of improved "Mirt" stove owners increase when number of rooms decrease and proportion of improved "Mirt" stove non-owners decrease when number of rooms decrease; which opposes to the assumption stated 'more number of rooms is positively correlated with ownership of improved "Mirt" stoves'. This shows that the result needs further investigation.

5.6.1.3 Household Exposure Related Characteristics and Ownership of Improved "Mirt" stoves

Distance from Main Roads

According to Table 5.19, among those households who are near (30 minutes walking distance) to main road, 56 percent of them own of improved "Mirt" stoves. And from those households, who are far (more than 30 minutes walking distance) from the main road, 53.2 percent of them own of improved "Mirt" stoves; and result indicates that the association between ownership of improved "Mirt" stoves and distance from main road is not statistically significant ($X^2 = 0.318$ and $P>0.05$).

Agro-ecology

It is assumed that Kola and Woina-Dega are positively associated with owning improved "Mirt" stoves than the Dega agro-ecology since the Dega ecology has relatively some amount of forest in the area. As shown in Table 5.19, the proportion of households who own the improved "Mirt" stoves increases as we go from Dega to Kola and the proportion of those households that do not own those stoves increases from Kola to Dega which fits to the assumption and shows a significant relation ($X^2 = 11.801$ and $P<0.05$).

Training of a household member

There is statistically significant difference between trained and non-trained households in their ownership status of improve "Mirt" stoves ($X^2 = 102.559$ and $P<0.001$). As can be seen from Table 5.19, out of the total non-trained households, 21.62 percent and 78.38 percent of non-trained households own improved "Mirt" stoves and do not own improved "Mirt" stoves respectively; where as from the total trained households 78.43 percent and 21.57 percent of trained households own improved "Mirt" stoves and do not own improved "Mirt" stoves respectively. Therefore, the probability to own improved "Mirt" stoves exceeds by 56.81 percent among trained households compared to the non-trained households.

Perception of prices

Perception regarding price of stoves is one of the variables to be considered in affecting households' ownership status of improved "Mirt" stoves in this study. According to Table

the model is adequate to describe the data is accepted. Besides, if Omnibus test of model coefficients is significant, it implies that the model fits the data adequately (Annex V).

In general, the goodness-of-fit assessment of the multivariate logistic regression model implied that the model fits the data well.

5.6.2.2 Checking Multi-collinearity

Multi-collinearity is a high degree of correlation among several independent variables. Multicollinearity may be induced due to poor sampling method, misspecification and over fitting of a model as well as improper use of dummy variables (failure to exclude one variable from the model).

In this study, three methods are used to detect multicollinearity. These are the coefficient of contingency, the Variance Inflation Factor (VIF) and the Kendall's correlation matrix.

Coefficient of contingency is used to avoid multi-collinearity since all the predictor variables are categorical. The coefficient of contingency ranges between 0 and 1. The larger the value of the coefficient of contingency indicates strong association between predictor variables and the smaller the value indicates weak association between predictor variables. According to the result, variables that have strong correlation are either merged or dropped out. (Annex III)

The other method used is the VIF or tolerance; where

$$tolerance = 1 - R^2 \ , \ VIF = \frac{1}{tolerance}$$

A tolerance of less than 0.20 and/or a VIF of 5 and above indicates a multicollinearity problem (O'Brien, 2007). As Table 5.21 shows, all values of the tolerance values are close to 1 and no value of the VIFs exceed 5 implies that multicollinearity may not be a cause of concern.

According to the Kendall's correlation matrix shown in Annex IV, none of the bivariate correlations between any two predictor variables exceeded 0.8 indicating that multicollinearity is not a serious problem among the categorical predictor variables.

Table 5.21: Results of collinearity statistics

Model Coefficients	Collinearity Statistics	
	Tolerance	VIF
Distance to main road	0.923	1.083
Training	0.584	1.711
Perception of Prices	0.863	1.158
Sex of HHH	0.463	2.158
House size	0.541	1.850
Income	0.645	1.551
Asset	0.769	1.300
Marital status	0.464	2.154
Literacy status	0.562	1.778
Number of Rooms	0.799	1.252
Agro-ecology	0.852	1.174
Number of Female family members	0.716	1.397
Age of HHH	0.679	1.472

Source: Field survey, 2009

5.6.2.3 Model Results

Based on the results of univariate analysis, a model containing 13 selected predictor variables and some selected interaction terms were included in the multivariate analysis. Using the Enter method, 13 predictor variables were selected and have a significant joint impact in determining household ownership of improved "Mirt" stoves, and the last category was used as a reference category. The multivariate logistic regression result is summarized in Table 5.19.

The Omnibus tests of models coefficients had a chi-square value of 316.063 on 19 degrees of freedom, which is highly significant beyond 0.001 levels indicating that the predictor variables presented in Table 5.19 have a joint significant importance in predicting household improved stove ownership. The model chi-square value was 316.063 on 19 degrees of freedom and was highly significant beyond 0.001 level indicating that the inclusion of the explanatory variables contributed to the improvement in fit of the full model as compared to the constant only model. The Cox and Snell and Nagelkerke pseudo R-square values of the model were 0.544 and 0.727, respectively. The Hosmer-Lemeshow test result reported chi-square value of 10.029 with p-value of 0.263 on 8 degrees of freedom. However, this p-value is greater than the 0.001 and 0.05 levels

showing that there is no difference between the observed and the model predicted values and hence estimates of the model fit the data at an acceptable level (Annex V).

In general in multiple regression analysis, R^2 is used to explain the amount of variation of dependent variable explained by change in independent variables. However, in the case of logistic regression R^2 can not be directly calculated. Hence, instead of R^2, Nagelkerke R^2 statistics is used. According to this result, the value of Nagelkerke R^2 is 0.727, which implies that 72.7% of variation in the dependent variable is explained by the independent variables included in the model (Annex V).

As it has been observed in Table 5.22 the model is estimated by considering household demographic and socio-economic variables on the improved "Mirt" stove ownership status of sample households. In the model the odds ratio indicate whether a particular variable is associated with the ownership of improved "Mirt" stoves. The level of influence (both negative and positive) of predictor variables on dependent variable presented based on the value of odds ratio and given in the last column of Table 5.22. If the value of the odds ratio is greater than 1, the probability to own an improved "Mirt" stove is high for that group in relation to reference category; whereas if the odds ratio is less than 1, the probability to own an improved "Mirt" stove is low for that particular category. Moreover, if the odds ratio is 1, the given variable has no effect on the improved "Mirt" stove ownership status of the given household.

Age of Household Head

Age of the household was found to be negatively and statistically significantly related to the probability of households' ownership of improved "Mirt" stoves. As shown in Table 5.22, households headed by persons aged less than 35 years old have better chance to own "Mirt" stoves than households headed by age greater than or equal to 50 years old. Thus, the probability to own improved "Mirt" stoves is greater by 0.022 among households headed by age less than 35 years old compared with households headed by greater than or equal to age 50 years old ($P<0.001$). Those households headed by persons aged 35-49 years were also significant compared with the reference group at $P<0.05$.

Therefore, the hypothesis which stated the age of household head is negatively correlated to owning improved "Mirt" stoves is accepted.

Sex of Household Head

As indicated in Table 5.22, sex of household head is found to be statistically insignificant in determining household ownership of "Mirt" fuel saving stoves ($P>0.05$). But the likelihood of owning improved "Mirt" stoves is greater by 0.631 among female headed households compared to male headed households.

Household Size

The model indicates that the relationship between household size and ownership of "Mirt" fuel saving stoves is statistically insignificant. Then, the hypothesis that states small family size is positively correlated with ownership of "Mirt" fuel saving stoves is rejected as shown in Table 5.22 with a $P>0.05$.

Number of Female family members

As Table 5.22 depicts that the relationship between the number of females in the household and ownership of "Mirt" fuel saving stoves is statistically significant ($P<0.05$). Then the hypothesis which states that the presence of more number of females in the household leads to the ownership of "Mirt" fuel saving stoves is accepted.

Marital Status

Marital status of the household head was used as an indicator of household's ownership of fuel saving technologies. According to the results of the study in Table 5.22, widowed heads were more likely to own improved "Mirt" stoves as compared to those separated or divorced ($P<0.05$). The currently married household heads did not have a significant relation with ownership of the improved "Mirt" stoves as compared to those separated or divorced ($P>0.05$).

Literacy Status

Literacy status of the household head has negative and significant relationship with ownership of improved "Mirt" stoves ($P<0.001$). This indicates that households headed by literate persons are more likely to own improved "Mirt" stoves than households headed by illiterate ones. Accordingly, the probability to own improved "Mirt" stoves increased by 0.119 among households who attained some level of education compared with households that did not. Then, the hypothesis which states that high educational attainment is correlated with owning improved "Mirt" stoves, is accepted (Table 5.22). This result is the same as the work of Tadelech (2001).

Income

This sub-section deals with the relationship of households' income which is obtained from sell of animals, crops, cash crops and from remittance) with ownership of improved "Mirt" stoves. Households with larger income are significantly related with ownership of improved "Mirt" stoves ($P<0.05$). This shows that higher income households are more likely to own improved "Mirt" stoves than lower income households (Table 5.22).

Asset

In this sub-section, the relationship of households' asset (obtained from the number of animals they have and the amount of crops they produced and changed into Ethiopian Birr) with ownership of improved "Mirt" stoves is presented. The larger the asset of households is positively and significantly related with ownership of improved "Mirt" stoves ($P<0.05$). This shows that the higher the asset households have the more likely to own improved "Mirt" stoves than those with lower assets (Table 5.22).

Training of a household member

Training of a household member has a significant relationship with ownership of improved "Mirt" stoves ($P<0.001$). This indicates that the more the household members get training, the more the probability to own improved "Mirt" stoves than those members that does not have training. Accordingly, the probability to own improved "Mirt" stoves increased by 0.019 among households who have some trained members compared with households that do not have. Then the hypothesis which states that training of hosehold members is correlated with owning improved "Mirt" stoves (Table 5.22).

Distance to main road

The closer the distance of households to main roads, the more exposure to a new technology; that is the nearer the household to main roads, the higher the probability to own improved "Mirt" stoves. The model indicates that the relationship between distance to main roads and ownership of "Mirt" fuel saving stoves is statistically insignificant. Then the hypothesis, which states the closer the households to main roads is positively correlated with ownership of "Mirt" fuel saving stoves, is rejected as shown in Table 5.22 with a $P>0.05$.

Perception of prices of "Mirt" stoves

The actual price of the stoves in the area is about 60 Ethiopian Birr. The probability of owning of the improved "Mirt" stoves increases as the perception in the price of stoves decrease. The result in Table 5.22 depicts that perception in prices of stoves is negatively and significantly related with owning the improved "Mirt" stoves ($P<0.001$). The probability to own improved "Mirt" stoves increased by 0.215 among households who have less perception of prices compared with households that do not have.

Agro-ecology

The probability of owning of the improved "Mirt" stoves increases as the agro-ecology becomes hotter and hotter and bare land. The result in Table 5.22 depicts that households in Kola and Woina-Dega areas are negatively and significantly related with owning the improved "Mirt" stoves ($P<0.05$). The probability to own improved "Mirt" stoves

increased by 0.335 and 0.197 among households who live in Kolla and Woina-Dega respectively than those who live in the Dega area.

Number of rooms of the house

Here, the researcher argues that the more the number of rooms a household has the more likely to own improved "Mirt" stoves since as more rooms are there it is possible to have a class for kitchen. The result of the logistic regression in Table 5.22 shows that there is a significant relationship with ownership of improved "Mirt' stoves ($P<0.05$). Hence, the hypothesis is accepted.

Generally, the multivariate analysis results indicated that age, literacy status, income, asset, marital status, number of rooms of the house, training, number of females in the household, perception of prices and agro-ecology are significantly correlated with household ownership of improved "Mirt" stoves, whereas sex, distance to main road and household size are not statistically significant.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The main objective of the study is to identify demographic and socio-economic correlates of fuel saving technologies in Tehuludere Woreda with a particular emphasis on improved "Mirt" stoves. As it is indicated earlier, the Wereda is one of the most densely populated areas in the Amhara Regional State with 256.83 persons per square kilometer. On top of this, an ever increasing population in the area leads to imbalance between population and resources. The increase in household energy demand is one of the peculiar examples for accelerating rate of environmental degradation, particularly due to soil erosion and deforestation. To minimize the household energy caused environmental degradation, it is crucial to adopt technologies that save fuel energy used by households. But there are some demographic, socio-economic and exposure related factors and household characteristics which are related to the issue. Thus, the study focuses on identifying demographic, socio-economic and exposure related correlates which affect the ownership of fuel saving technologies in the Wereda.

The study used both primary and secondary data. The process of data collection involved a stratified random sampling method which was employed to select the final sampling units. Information was gathered from 403 households. Qualitative and quantitative methods of analysis were employed. Different methods were employed to examine the possible association and correlation of each of the 13 independent variables with the dependent variable. For the quantitative method, the bivariate and multivariate analyses were made. In the qualitative aspect, focus group discussions were held to support the results that were gained from the quantitative analysis and to incorporate some additional information regarding household improved "Mirt" fuel saving stove technologies. The background characteristics of the respondents were also presented in simple statistics. The dependent variable analyzed is households' ownership of improved "Mirt" stoves. Logistic regression model was used for estimation.

The descriptive analysis revealed that 54.6 percent of the sample households owned the improved "Mirt" stoves while those households that do not own the improved "Mirt" stoves constituted 45.4 percent. Males constitute the substantial figure 80.6 percent of the sampled households. The average household size was 5.16 and the average number of females in the household was 2.66. Regarding marital status, about 86.1 percent were currently married. The literate respondents make up 41.6 percent of the sample population. About 45.4 percent of the sample households are in the middle age group (age 35-49).

The results of bivariate analysis indicated that sex, number of females in the household, distance to main road and number of rooms owned were insignificant, while the other nine predictors such as Age, Marital status, household size, literacy status, asset, income, training, perception of prices, and agro-ecology were significantly correlated with ownership of improved " Mirt" stoves.

The goodness of fit assessment and significance test of each predictors of the multivariate logistic regression model were adequate to describe the data and statistically significant respectively. This implies that the predictor variables have significant joint and separate influence in explaining the variation in the outcome variable. Colinearity diagnostic tests show that multicollinearity was not a great threat to the reliability of estimated model coefficients. The logistic regression analysis was applied in order to define the individual effects of the different predictor variables. This analysis also confirmed with the result observed in the bivariate analysis except in number of rooms of houses owned and sex of household heads.

6.2 Conclusion

This study focused on the sample households demographic and socio-economic correlates of fuel saving technologies which in turn helps to minimize environmental degradation.

One of the major outcomes from the FGDs held in this study is that the improved "Mirt" stoves are more efficient in saving time, fuel wood and human power. Households say they save fuel wood and other energy sources by half (50 percent) so that the remaining fuel can be used for another time.

One of the findings obtained in this study shows most households are kitchen users inside their house which in turn means they are exposed to indoor air pollution. This problem particularly hurts mothers and children.

In general, the ownership of improved "Mirt" stove technologies is very important in saving time, saving fuel wood, saving women power, improving the health of household members. This leads to minimized environmental degradation thereby conserving forests. And women can also participate in other development activities. Hence, owning the technology is unquestionable.

6.3 Recommendations

As environment is interlinked to population, environmental degradation is affected by many demographic and socio-economic statuses of the people as well as the natural calamity. There is no single self governing factor that causes the over depletion of the existing limited natural resources at local level, rather it is the commutative effects of man made and natural phenomena.

The growth of population in the rural area of the study area is rising up where the land and amount of forest available for additional people is declining. If it continues like this, resource to man ratio becomes lower and lower and reach at a critical stage.

Based on the results of the study the following possible recommendations are forwarded.

- As it is shown in the finding, ownership of improved "Mirt" stoves is high for households who have better income and asset status. Hence, concerned bodies should facilitate ways of improving the income and asset statuses of the people.
- Literacy status of the people is also a crucial factor in the ownership of technologies like improved "Mirt" stoves which decrease environmental degradation through the efficient use of fuel wood. Therefore, expansion of schools and improving teaching environments in the rural areas is necessary to increase the literacy status of the people.
- Increase awareness of the people through training on environmental, economical and social values of improved stoves.

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Annex-I

Addis Ababa University
College of Development Studies
Institute of Population Studies

Survey Questionnaire on Demographic and Socio-Economic Correlates of Fuel Saving Technologies in Tehuledere Wereda: The Case of "Mirt" Stoves

Verbal Consent

Hello! My name is _____. I am data collector in this study.
This questionnaire is designed and prepared to collect data from households by the student of Addis Ababa University for the partial fulfillment of Master of Science (MSc) in Population Studies. The data collected is kept under confidential and only for academic purpose and result.

The main objective of the research is to assess the main demographic and soco-economic correlates related to fuel saving technologies in Tehuledere Wereda.

Therefore, to show your direct contribution, provide the information honestly and responsibly. I sincerely express my utmost thanks for your undeserved cooperation.

Notice: 1. Please follow the directions carefully to choose answers for each question.
2. Use the code for each question

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1. General Information

101. Local Identification

Zone: South Wollo Wereda: Tehululedere Kebele: _____

Agro-Ecology: 1. Dega 2. Woina Dega 3. Kolla

102. Distance to main road: 1. Near 2. Far

103. Interviewers Name: _____

104. Date of Interview: _____ 1.5 Time of Interview: Starting time: ___ Finishing time: ___

2. Household's Demographic and Socio-economic Characteristics

201. Sex of the household head: 1. Male 2. Female

202. Age (in completed years) _____

203. Marital Status: 1. Single 2. Currently married 3. Widowed 4. Divorced
5. Separated 6. Other; specify__

204. Ethnic background: 1. Amhara 2. Oromo 3. Tigre 4.Others

205. Religion: 1. Muslim 2. Orthodox 3. Protestant 4. Catholic 5. Traditional

206. Total family size: _____ Male_____ Female_____

207 Place of residence 1. Urban 2. Rural

208. Educational level of household head

1. Illiterate 2. Read and write 3. Elementary 4. Secondary school 5. Certificate
6. Diploma and above 7. Other; specify_____

209. Please provide us the following information on the characteristics of your HH members

No	Name (Optional)	Relation to household head 1. Husband 2. Wife 3. Son 4. Daughter 5. Relative 6. Other (Specify)	Sex 1. Male 2. Female	Age	Educational Level(for those aged 7 and over) 1. Illiterate 2. read and write 3. Elementary 4. Secondary school 5. Certificate 6.Diploma and above 7. Other; specify
1					
2					
3					
4					
5					
6					
7					
8					
9					

210 Occupation of the respondent

1. House wife 2. Government employee 3. Private sector 4. NGO employee

5. Own business 6. Pensioned 7. Unemployed 8. Daily laborer 9. Agriculture

211 Ownership of the house you live: 1. Own 2. Rented 3. Other; specify_____

212 Number of rooms of the house you live: 1. 1 2. 2 3. 3 4. 4 5. 5 6. 6

213 The wall of the house is made of: 1. Bricks/stone 2. Wood and 'Chika' 3. Other; specify___

214 The roof of the house is made of: 1. Corrugated iron 2. Grass 3. Other; specify___

215 Give us your annual family income obtained from (in Ethiopian Birr):

1. Sale of crop ____ 2. Sale of livestock ____ 3. Daily labor ____

4. Remittance____ 5. Trade_____ 6. Other, specify_____

216 Number of livestock in the house

1. Cattle_____ 2. Horse____ 3. Donkey____ 4. Chicken____

5. Sheep and goat___ 6. Camel_____

217 Amount of production in quintals

1. Sorghum____ 2. Teff___ 3. Wheat____ 4. Barley_____ 5. Other, specify___

218 How do you evaluate the trend of the following in your area?

	1=Increasing	2=Decreasing	3=Not changed	4=Unknown
Population Size				
Forest				

3. Household Fuel Consumption Pattern and Related Issues

301 Types of fuel you most utilize for injera baking?

1. Wood 2. Branches and leaves 3. Wood and BLT 4. Saw dust 5. Dung

6. Electricity 7. Wood and dung 8.Wood, dung, Branches and leaves 9. Other_____

302 What type of fuel do you most utilize for wot cooking?

1. Wood 2. Charcoal 3. Wood and Charcoal 4. Kerosene

5. Charcoal and kerosene 6. LPG 7. Wood and dung 8.Others; specify_____

303 What type of fuel do you most utilize for coffee making?

1. Wood 2. Charcoal 3. Kerosene

4. Charcoal and kerosene 5. Wood and dung 6.Others; specify_____

304 Fuel consumption pattern of major fuels for the last two years?

No	Type of fuel	Consumption pattern				
		1=Increase	2=Decrease	3=No change	4=Stop utilizing	5=Never utilizing
1	Fuel wood					
2	Charcoal					
3	Kerosene					
4	Electricity					
5	LPG					

Questions 305 – 317 are based on the answer of Qn. No. 304

305 Why do you utilize fuel wood for household cooking?

1. It is cheap 2. Easily available 3. No other choice 4. Others; specify_____

306 If you don't utilize fuel wood for cooking, what is your main reason?

1. Scarcity 2. No external kitchen 3. Health problem 4. Others; specify_____

307 How do you obtain the fuel wood?

1. Collecting freely 2. Purchasing 3. Collecting and purchasing 4. Others; specify_____

308 If you obtain the fuel wood by collecting freely, who is responsible for the job?

1. Children 2. Mother 3. Father 4. Other family members

309 If you obtain the fuel wood by purchasing, from whom do you purchase most of the time?

1. Women load 2. Donkey load 3. Local market retailers

4. 1 and 2 5. Others; specify_____

310 From where do you obtain charcoal?

1. Charcoal retailers 2. Charcoal whole sellers 3. From utilized fuel wood

4. Others; specify____

311 If you utilize branches and leaves, how do you obtain the fuel?

1. Collecting 2. Purchasing 3. Collecting and purchasing 4. Others; specify_____

312 If you utilize saw dust, how do you obtain the fuel?

1. Collecting 2. Purchasing 3. Others; specify_____

313 What kind of fuel did you utilize before you started to consume kerosene for household cooking?

1. Fuel wood 2. Charcoal 3. Fuel wood and charcoal 4. Electricity 5. LPG

314 From where do you purchase kerosene?

1. From petrol station 2. From petrol retailers 3. Others; specify_____

315 Has the increment in the price of kerosene affected your consumption? 1. Yes 2. No

316 What measure did you take to cope up?

1. Minimize consumption 2. Shift to traditional fuel 3. 1 and 2

4. Taking out without properly cooked 5. Others; specify_____

317 For how long did you utilize LPG?

1. For less than two years 2. 3-5 years 3. More than five years

4. Kitchen Environment and Frequency of Cooking

401 Do you have a permanent place for cooking? 1. Yes 2. No

402 If the answer for Qn. No. 401 is yes, is your kitchen separate from the main house?

1. Yes 2. No

403 If the answer for Qn. No. 401 is no, where do you cook?

1. In the open air 2. In the living room 3. Use neighborhood kitchen 4. Others; specify_____

404 What is the frequency of injera baking?

1. Every day 2. Every 2-3 days 3. Every 4-6 days

4. Once in a week 5. Other; specify_____

405 How many injeras do you bake per session?

1. Less than 15 2. 15-30 3. 30-40 4. Do not know

406 Do you sometimes buy injera? 1. Yes 2. No

407 If the answer for Qn. No. 406 is yes, why do you buy?

1. To minimize fuel consumption 2. Irregular injera consumption

3. Kitchen problem 4. Other; specify _____

408 What is the frequency of Wot cooking?

1. Once every day 2. Twice every day 3. Once every 2-3 days 4. Other; specify_____

409 What is the frequency of coffee making?

1. Once every day 2. Twice every day 3. Once every 2-3 days 4. Never 5. Other; specify___

5. Information about Improved Stoves

501 How do you obtain traditional stoves?

1. Purchasing 2. Self made 3. Gift 4. Freely available 5. 1 and 4

502 If your answer for Qn. No.501 is self-made, do you sell your products? 1. Yes 2. No

503 Are you familiar and well informed about improved ("Mirt") fuel saving stoves?

1. Yes 2. No

504 If your answer to Qn. No. 503 is yes, from where did you get the information?

1. TV/Radio 2. Display in shop/market place 3. Friends/relatives

4. Development agents/Health extension workers 5. Other; specify_____

505. Has a member of the household too training about the use improved stoves? 1. Yes 2. No

506 If you are utilizing improved stoves, how did you learn about the technology?

1. From friends 2. From Media 3. From market places 4. Development agents / Health E.W

507 From where do you purchase the improved stoves?

1. From shops 2. From local producers 3. From local markets 4. Other; specify_____

508 Who did the installation work of your injera ("Mirt") improved stove?

1. Self built 2. Professional 3. Others; specify_____

509 Is there a significant difference between improved stoves and traditional stoves? 1. Yes 2.No

510 If "yes", what is the major difference between them? Please explain.

_____

_____

511. Please compare the advantages of the two types of stoves.

No	Types of stoves	Ownership Yes=1 No=2	Advantage Efficient =1 Low cost=2 Easily available=3 Time saving=4 Healthier=5 1, 4 and 5 =6 2 and 3 = 7 Others =8
1	Trad. Tripod		
2	Metal charcoal		
3	"Mirt" Domestic		
4	"Mirt" Comercial		

1 and 2 are traditional stoves
3 and 4 are improved stoves

512 If you do not utilize improved stoves, what is your reason for not utilizing?

1. Too expensive 2. No awareness 3. No fuel problem 4. Space problem

513 What is the price of the improved stoves (in Ethiopian Birr)? _____

514 Which type of cooking consumes more fuel?

1. Injera baking 2. Wot cooking 3. Coffee making 4. Others; specify___

515 Which type of stove do you prefer for injera baking?

1. Traditional 2. Mirt 3. Others; specify_____

516 Which type of stove do you prefer for non-injera baking?

1. Traditional tripod stove 2. Traditional charcoal stove 3. Kerosene

4. Lakech 5. Gas 6. Others; specify_____

517 Which type of cooking pot do you prefer for household cooking?

1. Clay pots 2. Aluminum pots 3. Both 4. Others; specify_____

518 If your answer for Qn. No. 517 is "aluminum pot", what is the advantage of it?

1. Time saving 2. Consumes less fuel 3. It fits modern stoves 4. 1 and 2 5. 2 and 3

519 Who is mostly doing the household cooking?

1. Myself 2. Wage cooker 3. Myself and wage cooker 4. Household members

520 Will you continue by utilizing the improved stoves in the future? 1. Yes 2. No

521 If your answer to Qn. No. 520 is "No", what other choices do you suggest?_____

522 What do you suggest for the scarcity of fuel in the future?

_____

Comment of the Enumerator

_____

_____

_____

Thank you for your cooperation!

Annex –II

Focus Group Discussion Guidelines

1. Perception about population increase (having large family size) and its merit or demerit. Is the population is increasing in the last five years?
2. What about forest resources?
3. What is the impact of the changes in the two factors over the environment?
4. Please explain about the responsibility of collecting firewood, impacts related with collection and transportation.
5. What is the difference between traditional stoves and improved stoves? Please explain.
6. Do you think that traditional way of cooking has effect on health of women?
7. Do you think improved stoves improve the work load of women? Explain.
8. What are the major strategies used to minimize fuel consumption?
9. What measures should NGOs, government organizations and private sectors take to minimize the mentioned problem?

Thank you for your cooperation!

Annex III

Coefficient of Contingency Table (Pearson's Correlations)

	Distance to main road	Training	Perception of Prices	Sex of HH	Family size	Agro ecology	Age of HH	Education Level	Income	Asset	Marital status	Rooms	Number of Female s in HH
Distance to main road	1	.180(**)	.065	.079	.015	.022	-.068	.087	.197(**)	.048	-.023	.099(*)	.003
Training		1	.188(**)	.191(**)	.352(**)	-.044	.053	.310(**)	.522(**)	-.023	-.163(**)	.006	-.170(**)
Perception of Prices			1	-.160(**)	.021	-.103(*)	.055	.207(**)	.111(*)	-.007	.146(**)	-.025	.074
Sex of HH				1	.133(**)	.168(**)	.054	-.045	.168(**)	-.223(**)	-.704(**)	-.223(**)	-.124(*)
Family size					1	-.180(**)	.281(**)	.490(**)	.140(**)	-.275(**)	-.191(**)	-.226(**)	-.490(**)
Agro ecology						1	.139(**)	-.066	-.047	.141(**)	-.095	-.048	.077
Age of HH							1	.470(**)	-.119(*)	-.229(**)	-.095	-.171(**)	-.256(**)
Education Level								1	.047	-.204(**)	-.003	-.144(**)	-.281(**)
Income									1	-.006	-.189(**)	.165(**)	-.105(*)
Asset										1	.289(**)	.289(**)	.214(**)
Marital status											1	.224(**)	.094
Rooms												1	.173(**)
Number of Female in HH													1

Annex v
Model Results

Unweighted Cases(a)		N	Percent
Selected Cases	Included in Analysis	403	100.0
	Missing Cases	0	.0
	Total	403	100.0
Unselected Cases		0	.0
Total		403	100.0

a If weight is in effect, see classification table for the total number of cases.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	316.063	19	.000
	Block	316.063	19	.000
	Mode	316.063	19	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	239.212(a)	.544	.727

a Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	10.029	8	.263