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Project work submitted to the Indira Gandhi National Open University in partial fulfillment of the requirements for the award of the Degree- Master of Arts (Economics). I hereby declare that this work has been done by me and has not been submitted elsewhere.

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INDIRA GANDHI NATIONAL OPEN UNIVERSITY
SCHOOL OF SOCIAL SCIENCES
FACULTY OF ECONOMICS

"THE IMPACT OF FUEL WOOD SAVING MIRT STOVE; IN THE CASE OF GIZ-ECO: ENERGY PROJECT IN ADDIS ABABA, ETHIOPIA"

Project – Report
(MECP – 001)

By

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CERTIFICATE

I hereby certify that the project entitled "The Impact of Fuel Wood Saving Mirt Stove; In the Case of GIZ-ECO: Addis Ababa, Ethiopia" By Shuna Teshome Wakene has been done under my supervision. It is recommended that this project be placed before the examiner for evaluation.

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DEDICATION

To my family and friends for their abundant support, and for different organization that supported me by providing the necessary information for my thesis.

STATEMENT OF AUTHOR

This thesis is the result of my independent investigation. Where my work is indebted to the work of others, I have made appropriate acknowledgement. I declare that this study has not already been accepted for any other degree nor is it currently being submitted in candidature for any other degree. Therefore, I affirm that this thesis is my work and that all sources of materials used for this thesis have been duly acknowledged. Hence, this thesis is submitting in partial fulfillment of the requirements for my M.A degree at the Indira Gandhi National Open University (IGNOU).

Name	Date	Signature
Shuna Teshome Wakene	_____	_____

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BRIEF BIOGRAPHY

The researcher Shuna Teshome, Was born in Bale on January1, 1985. She attended her primary school and secondary school in Bale Dodolla. She got her Bachelor Degree in Economics from Addis Ababa Unity University in 2009. After her graduation, she worked in different Organizations such as Access bio Inc. company and JICA –QSPP. She joined School of Graduate Studies at IGNOU, Department of Economics.

ACKNOWLEGEMENTS

Designing and implementing this project presented a number of challenges. This project has also helped me to grow professionally and got knowledge of different soft wares. I also have the privilege to work and interact with treasured individuals; without this project would never have been accomplished successfully. I would like to express my sincere appreciation to everyone who helped me in various ways.

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My special thanks and heart- felt appreciations go to my family for their support throughout my study.

ACRONYMS

EREDPC - Ethiopian Rural Development and Promotion Center
EEA - Ethiopian Energy Authority
CEINFMP - Cooking Efficient Improvement and New Fuels Marketing project
DFID - Department for International Development
GoE - Government of Ethiopia
GTZ - German Agency for Technical Cooperation
GIZ - German Agency for International Cooperation
HHE - Household Energy
PNR -Protection of Natural Resources
SNNP - Southern Nations Nationalities and Peoples
SF - Shell Foundation
SUN - Sustainable Utilization Natural resource
MOARD - Ministry of Agriculture and Rural Development
DGIS - Directorate General for International Cooperation
ECO -Energy coordination

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ABSTRACT

The use of forest biomass for energy, especially for cooking by traditional stoves takes significant share in depleting the forest. The preponderate use of household energy in Ethiopia is for cooking and out of the total biomass used at household level 60% has been for baking 'Injera'(Oromiya Mines and Energy Bureau,1995). This large share goes to baking "Injera" due to the wide use traditional open- fire stoves that are less efficient and more fuel consuming.

The objective of this paper is to indicate that traditional three- stone "Injera" baking stove is inefficient and leads to forest destruction and desertification, assess the importance of Mirt stove for the improvement of social and economical status of the peoples of the country, identify the beneficial aspect of Mirt Injera stove on biomass sustainable utilization of Ethiopia and assess the intensity of rural people utilization of Mirt Injera stove for reduction of over exploitation of the rest resource.

Secondary data will be collected using review of various reports, case studies and other relevant documents concerning traditional and improved stoves and gathering secondary data from GIZ and Rural Energy Improvement Office. In the case of primary data collection methods, total customers of 37 and 40 from 2012 and 2013 respectively will take from Adids Ababa City of different Kebeles of the district. Out of the total population of each year, 8 from 2012 and 7 from 2013 a total 15 sample respondents will select and interview using personal recorder depending on the semi-structure interview formats prepared by manually.

CHAPTER ONE

1. INTRODUCTION

1.1. General

The survival of human being is very much dependent on his interaction with his environment. This interaction should be observed carefully and checked for its harmony if the quest for development is to be properly addressed. Human development, along with other factors, is very much dependent on energy resources. To satisfy the ever-increasing need for energy, man pushed way beyond what can be carried by the environment and this has been the cause for many of the problems the world is facing now a days. In developing countries the low level technology aggravates the problems leading to unsustainable use of natural resources and environmental degradation.

Ethiopia, a country with a total population of 80 million (estimated to be larger now), annual population growth rate of 3% and 87% of the total lives in rural area, the rest 13% in urban areas (Tadelech, 2001). This large population depended on natural resources for survival and due to lack of technology the resources have been used unsustainably. This in turn caused a great loss of biodiversity and environmental degradation.

In addition to the low technology, the economy of our country forced its people to depend mostly on forest biomass for energy. Apart from the need for energy, the rapidly growing population has caused a great depletion of natural forest. Expansions of agricultural land to feed the large population,

urbanization, transport and other development activities have put pressure on forestland. The overexploitation of forest has led to loss of biodiversity, deforestation and desertification and ultimately to a climate change, which affected the other parts of the globe as well.

Our dependence on traditional biomass fuel has been one of the major factors that aggravated land degradation, soil erosion and other related problems that are the main contributors to the current draught and food insufficiency in the country.

The use of forest biomass for energy, especially for cooking by traditional stoves takes significant share in depleting the forest. The preponderate use of household energy in Ethiopia is for cooking and out of the total biomass used at household level 60 % has been for baking 'Injera' (Oromia Mines and Energy Bureau, 1995). This large share goes to baking 'Injera' due to the wide use traditional open-fire stoves that are less efficient and more fuel consuming.

Until recently attention was not given to improving and modernizing traditional stoves. It is after the two oil shocks in the world market in the 1970's and the following fuel wood crises in Ethiopia that government bodies and other organizations started giving emphasis to the assessment and improvement of traditional cooking devices (Hilawi Lakew, 1999).

In the early 1990s, the improved biomass Injera stove (Mirt) was first developed by the Ethiopian Rural Energy Development and Promotion Center (EREDPC), which was called Ethiopian Energy Authority (EEA) at that time.

Until 1995, the World Bank funded the actual designing and testing of the Mirt within the Cooking Efficiency Improvement and New Fuels Marketing Project (CEINFMP). Between 1995 and 1997, the British Department for International Development (DFID) provided financial support for this project. When the DFID supported phase ended in March 1997, the government of Ethiopia (GoE) showed neither commitment nor interest in continuing and supporting this project for improved fuel saving Injera stoves.

In 1998, the German Agency for Technical Cooperation (GTZ) started supporting the processes of commercial dissemination of the Mirt within the project Household Energy / Protection of Natural Resources (HHE / PNR). At present, the project has been operating for nine consecutive years, but with differing denotations for the three different phases.

The first phase took place in the regions Amhara, Oromia, Tigray and Southern Nations Nationalities and Peoples' (SNNP) National Regional States between 1998 and 2003. Due to the Ethio-Eritrea border conflict and the consequent security concerns, the project was discontinued in Tigray and SNNPR shortly after commencement.

Between 2004 and 2006, the second phase, which was exclusively implemented in Tigray, was funded by the Shell Foundation (SF). During this phase, more emphasis was given on smoke reduction and indoor air pollution (IAP) improving aspects of this project.

The third phase, known as GTZ-SUN Energy, is a component of the Sustainable Utilization of Natural Resources for Improved Food Security Program. It is jointly implemented by the GTZ and the Ministry of Agriculture and Rural Development (MoARD) at the federal level. The 'Energizing Development' initiative of the Directorate General for International Cooperation (DGIS) of the Ministry of Foreign Affairs of the Netherlands co-finances GTZ-SUN Energy during this third phase.

Several achievements concerning the production and dissemination of the Mirt stove have been accomplished by the GTZ-SUN Energy project. It has provided technical and basic business skills training to stove producers and supported as well as set up over 370 Mirt stove production units in over 230 towns in the four regions. Furthermore, it has conducted massive awareness raising, sensitization and market promotion campaigns. To accelerate the market penetration of the Mirt stoves, the project has provided smart subsidies through issuing coupons. As a direct output of all of these promotional activities, the GTZ-SUN Energy project has caused sales of over 170 000 Mirt stoves through commercial channels until end of August 2007(Tamara Tschentscher, 2008). In addition to this the project name changed from GTZ- SUN Energy project to GIZ-ECO and sales of Mirt stoves increasing from time to time because of the increasing of the costumer interest to buy the improved Mirt Stove (information from GIZ-ECO).

1.2 Statement of the Problem

Ethiopia is one of the developing countries, which has the lowest per capita energy consumption in the world – 300 Kgoe. (Hiwote, 1997). Its abundant

natural resources the potential for water, solar, geothermal, wind power, biomass, fossil fuel, especially natural gas and coal made it rich in natural resources. But because of lack of skilled manpower, financial resource and conducive policy and planning, only 6% of the total resources are being utilized.

In same manner, the household sub- sector of Ethiopia is the major consumer of biomass energy, which reflects the agrarian and underdeveloped nature of the economy. Hence, 85-90% of the total national energy consumption is in this sector, industry, agriculture transport, service and commerce sectors together constitute the remaining 10% of energy consumption so the households sector is the major consumer of energy, biomass fuel such as wood charcoal, branches/ leaves /twigs (BLT), agricultural residues and cow dung and these are the major sources of energy in Ethiopia. For instance, in 1986, biomass fuels accounted for about 95% of the total national energy supply, while only 5%of the supply was covered by commercial fuels such as electricity and petroleum products (GTZ/ HEPNER, 1998).

The low-level energy efficient technology at the national level has put pressure on the large portion of the rural community to rely on biomass fuel wood as a source of energy specially for cooking. This brought about destruction of large hectares of forest and the destruction of forest creates the soil erosion. The erosion of soil also affects the land, in other words the fertile soil is very important for the production of crops. In addition to this because of the destruction of forest Ethiopia loss the fertile soil abundantly and the production of crops also decreasing from time to time. Among the traditional cooking stoves the three-stone 'Injera' baking stove takes a large

share, 60% of all household fuels (Oromiya mines and Energy Bureau, 1995).

This traditional inefficient three-stone Injera' baking stove along with extensive population growth resulted in a great loss of forest biodiversity, land degradation, loss of atmospheric quality, environmental pollution and affecting peoples health. The huge amount of CO_2 emission has exposed people to different types of acute and chronic diseases. Additionally during the time peoples using traditional inefficient three-stone Injera baking stove, there is to much smoke goes to their eyes. This smoke which is comes out from traditional inefficient three- stone Injera baking stove, affected many people by eye disease.

On the other hand, the improved stove also known as 'Mirt' stove has paramount importance to mitigate environmental, by decreasing the destruction of forest, soil erosion, protecting social from unnecessary disease, which comes out from smoke by using traditional inefficient three-stone Injera baking stove, economically by saving fuel wood and health problems and it can easily be disseminated in both rural and urban areas as the best solution for the problems that our country is currently facing.

1.3 Specific Objectives of the Study

To compare traditional three-stone 'Injera' baking stove and improved 'Mirt' stove with respect to their efficiency, fuel wood consumption and being economical.

- To indicate that traditional three-stone 'Injera' baking stove is inefficient and leads to forest destruction and desertification.

- To assess the importance of Mirt stove for the improvement of social and economical status of the peoples of the country.
- To identify the beneficial aspect of Mirt Injera stove on biomass sustainable utilization of Ethiopia.
- To assess the intensity of rural people utilization of Mirt Injera stove for reduction of over exploitation of for rest resource.

1.4 Significance of the Study

For a number of developing countries, including Ethiopia, issues relating to fuel choice and household energy transitions are important from a policy standpoint. Efforts at encouraging households to make substitutions that will result in more efficient energy use and less adverse environmental, social and health impacts are advocated in many of these Countries.

Hence, the devastating/ and declining tendency of fuel wood and the corresponding low economic status of the population led to a very alarming situation. To arrest the problem 1985, (Berket, 1992) stated that, three sets of measures can be under taken basically i.e. enhancing the efficiency of wood use, substituting alternative fuels for wood and improving wood and wood production systems

Since the urban and population is increasing dramatically, to update the information on this hot issue, study on household fuel consumption and ownership of fuel saving stoves in the urban and setting especially in Addis Ababa could be of help.

Moreover, the study has been anticipated to contribute for development practitioners such as governmental and non- governmental organizations that

are interested in alleviating poverty and enhancing the living condition of poor households by indicating the important determinant factors that need special attention.

Besides, focusing on the factors affecting the utilization of fuel- saving technologies at household level would be of help to understand the problems deeply and to formulate/ design methods of dissemination of these technologies in order to reach the majority.

1.5 Scope of the Study

The study is expected to cover areas with high, medium and little market accessed Kebeles of the district. The study was mainly focus on the alternative fuel wood saving Mirt stove, because of the various cooking requirements, households tend to own different types of stoves.

The study has mostly concentrated on the basic factors, which determine the household cooking in every aspect. Among the various cooking the study took the most frequented types of cooking in urban areas which are Injera making, 'Wot' or stew making and coffee making. This doesn't mean that there are no other kinds of cooking. But due to time and financial limitation it has taken the most common and frequented ones, which every household utilizes, for every day cooking.

1.6 Limitation of the Study

There are various problems to write this thesis as I expected, for instance, shortage of time, to get primary data shortage of finance, to write literature review there is not enough secondary data and the data was not properly

documented .Because of that there was some difficulty things and needed long time to gathered the document.

1.7 Organization or Structure of the Thesis

The rest of the thesis is organized as follows:
Chapter two reviews the issues of Energy that is especially relevant for understanding its impact. The chapter begins by the concept and definition highlighting to the reader the brief explanation and definition about the concept of Energy. Then the theoretical part of Energy elaborated under sub topic. The empirical review of different documents international level and some works in domestic level and these provide practical insight on the subject matter. Under chapter two the final sub topic is working fame work puts in brief the area of interest of the thesis focus.

Chapter three presents data collection methodologies, description of the study area, sampling size, type of data use and data analysis techniques.

Chapter four presented the data presentation and analysis part. The summary data in the form of tables and figures.

Chapter five is the final main body of the thesis which presented the conclusion and recommendation part. In the conclusion part the general summery presented in brief and precise way. In the recommendation part two important suggestion were made that are about the cost of cement which is very important input to produce Mirt stove and to use the advertising way to distribute the improved stove to all customers.

CHAPTER TWO

2. REVIEW LITERATURE

2.1. Concept and Definition

2.1.1. Energy Economy

Energy is neither created nor destroyed but can be converted among forms. Energy comes from the physical environment and ultimately returns there. Humans harness energy conversion processes to provide energy services.

Energy economic studies energy resources and energy commodities and includes: forces motivating firms and consumers to supply, convert, transport, use energy resources, and to dispose of residuals; market structures and regulatory structures; distributional and environmental consequences; economically efficient use.

2.1.2. Energy use

Human energy use is dominantly depleting resources; particularly fossil fuels. Market forces may guide a transition back to renewable resources. Inter- temporal optimal depleting resource extraction paths include an opportunity cost, Environmental damages from energy use include climate change from greenhouse gases, primarily carbon dioxide. Environmental costs not incorporated into energy price (externalities) lead to overuse of energy and motivate policy interventions.

2.1.3. Energy Sources for Household Consumption.

Cooking fuels are given due consideration among all people in rural and urban areas of Ethiopia. Many types of fuel sources for cooking are being used now a day's .but the dominant proportion lies on fuel wood in both

rural and urban areas. In rural areas the seasonal availability of the fuels is a very great problem; crop residue, and tree twigs are harvested in the cropping season while, cow dung and fuel wood become the dominant in the long non-cropping season. In urban areas where fuel sources are highly commercial, price variation and supply reduction are key problems.

2.2. Theoretical Review

2.2.1. The Status of Energy Economy in Tropical Countries

Energy economic studies energy resources and energy commodities and includes: forces motivating firms and consumers to supply, convert, transport, use energy resources, and to dispose of residuals; market structures and regulatory structures; distributional and environmental consequences; economically efficient use. It recognizes:

1) Energy is neither created nor destroyed but can be converted among forms;
2) Energy comes from the physical environment and ultimately returns there. Humans harness energy conversion processes to provide energy services.

Energy demand is derived from preferences for energy services and depends on properties of conversion technologies and costs. Energy commodities are economic substitutes. Energy resources are depleting or renewable and storable or non-storable.

Human energy use is dominantly depleting resources; particularly fossil fuels. Market forces may guide a transition back to renewable resources.

Inter- temporal optimal depleting resource extraction paths include an opportunity cost, or rent world oil prices remain above pre- 1973 levels and remain volatile as a result of OPEC market power. Oil supply disruptions of the 1970s led to economic harms.

Environmental damages from energy use include climate change from greenhouse gases, primarily carbon dioxide. Environmental costs not incorporated into energy price (externalities) lead to overuse of energy and motivate policy interventions.

Developing countries have 80% of the world's population but consume only 30%of global commercial energy. As energy consumption rises with increases in population and living standards, awareness is growing about the environmental costs of energy and the need to expand access to energy in new ways. Increased recognition of the contribution renewable energy makes to rural development, lower health costs (linked to air pollution), energy independence, and climate change mitigation is sifting renewable energy from the fringe to the mainstream of sustainable development. Support for renewable energy has been building among those in government, multilateral organizations, industry, and non governmental organization (NGOs) pursuing energy, environment, and development agendas at local, national, and global levels. At the same time, commercial markets for renewable energy are expanding, shifting investment patterns away from traditional government and international donor sources to greater reliance on private firms and banks. Changing investment patterns make it more important to think about markets for renewable energy, rather than simply about the technologies themselves and their economic characteristics.

Changing investment patterns also elicit increased decision-making and participation from a wider variety of stakeholders- not just traditional donor agencies and governments, but also manufacturers, rural entrepreneurs, individual households, local technicians, NGOs, community groups, utility companies, and commercial banks. (Tesfaye Kassie, 2007).

2.1.2. Household Energy Consumption in *Ethiopia*

The household sector is the major consumer of energy in Ethiopia and it covers a share of more than 88% of the total energy consumption of the country used for cooking and lighting (Trudy, Hiwote etal, 1995). They also indicated that, for rural households, biomass fuels are affordably used. The most important sources of energy that are used traditionally are, fuel wood, agricultural residues and cow dung, that account for around 94% of the country's total energy consumption. When we see kerosene, LPG and electricity coverage, according to Trudy, accounts for 4% of the country's total fuel consumption and they are only restricted in urban areas. This shows the extent to which the rural and even urban people are totally dependent on biomass energy consumption. The prospect of substituting biomass fuel with modern energy system is unthinkable due to development status, economic situation of the country.

2.1.3. Major Types of Energy Sources for Household Consumption.

Cooking fuels are given due consideration among all people in rural and urban areas of Ethiopia. Many types of fuel sources for cooking are being used now a days (Tadelech, 2001), but the dominant proportion lies on fuel wood in both rural and urban areas. She also noted that, in rural areas the

seasonal availability of the fuels is a very great problem; crop residue, and tree twigs are harvested in the cropping season while, cow dung and fuel wood become the dominant in the long non-cropping season. In urban areas where fuel sources are highly commercial, price variation and supply reduction are key problems.

In Ethiopia biomass fuels provide the majority of the total energy supply of the country with 79% being derived from woody biomass, 8.7% from crop residue and 7.7% from dung (GTZ/ MOA, Project Brief 2000). Therefore, from the biomass fuels larger amount of energy is derived from woody biomass, the consequence of which is a decrease at an alarming rate of forestland cover in the country.

2.3. Empirical Review

2.3.1. The State of Renewable Alternative Energy Sources in Tropical Countries.

Renewable energy commonly refers to both traditional biomass (i.e., fuel wood animal wastes, and crop residues burned in stoves) and modern technologies based on solar, wind, biomass, geothermal and small hydropower. Our definition here, also called new renewable by many others, excludes large hydropower because it is already a mature technology and treated well elsewhere. While traditional biomass provides about 7%-11% of global primary energy supply, the modern forms of renewable energy provide about 2 %. For developing countries approach 90%. Besides traditional biomass, small hydro powers in china and transport ethanol in Brazil are among the largest single contributors to renewable energy

supplies in developing countries. In fact, modern biomass represents 20% of Brazil's primary energy supply, aided by significant increases in the past 20 years in the use of ethanol fuels for vehicles and sugarcane waste for power generation.

The largest developing country china gets about 2% of its primary energy supply from renewable energy, mostly from small hydropower generation. Globally, Contributions from wind power and solar photovoltaic (PV) are still small, but applications of these technologies are growing fast at annual rates of 10%- 30% in recent years.

Most treatments of renewable in the literature are organized by supply technology (e.g. solar, wind, biomass). A large literature looks at technology options, comparative costs, resource potentials, environmental and social benefits, research and development, commercialization, and technical performance. The literature that approaches renewable energy from a market or end- use perspective is much smaller but has grown rapidly in recent years. This literature is by no means well- defined because market- oriented elements appear in a variety of sources. But a market orientation focuses on market-social conditions, consumer knowledge, demand for products or services (driven by the benefits they confer and affected by social structures and culture), product characteristics, and sales volume, financing and credit manufacturing, suppliers and distributors technical skills, service networks, business models, regulatory frameworks, and public policies.(Tesfaye Kassie. 2007).

2.2.2. Household Level on Biomass Fuel Consumption

Estimating wood fuel demand equation that contains key explanatory variables is the primary goal for empirical economic work. Off course, the empirical literature to date is sparse but growing. We focus estimates of rural household demand, but it covers a wide variety of experiences. To accommodate differences of these ranges of experiences, economists usually look relative rather than absolute effects. Most often elasticities (the percentage change in the dependent variable divided by the percent change in the explanatory variable) are taken as a good measurement. An elasticity of less than 1.0 in absolute value is called inelastic, indicating that the dependent (woody mass fuel demand) is not very responsive to changes in the explanatory variable. Elastic results (>1) depict greater potential successful policy impacts than inelastic results.

The main factors that influences demand for fuel wood that empirical studies exhausted are own price, cross price, income, household characteristics and demographic factors.

2.4. Working framework

Energy commonly refers to both traditional biomass (i.e., fuel wood animal wastes, and crop residues burned in stoves) and modern technologies based on solar, wind, biomass, geothermal and small hydropower. The definition here, also called new renewable by many others, excludes large hydropower because it is already a mature technology and treated well elsewhere.

Most treatments of renewable in the literature are organized by supply technology (e.g. solar, wind, biomass). A large literature looks at technology options, comparative costs, resource potentials, environmental and social benefits, research and development, commercialization, and technical performance. The literature that approaches renewable energy from a market or end- use perspective is much smaller but has grown rapidly in recent years. This literature is by no means well- defined because market- oriented elements appear in a variety of sources. But a market orientation focuses on 1) market-social conditions, 2)consumer knowledge, demand for products or services (driven by the benefits they confer and affected by social structures and culture), 3) product characteristics, and sales volume, financing and credit manufacturing, suppliers and distributors technical skills, service networks, business models, regulatory frameworks, and public policies.(Tesfaye Kassie. 2007). In this study the impact of fuel wood saving Mirt stove assessed in house hold fuel consumption in both Urban and Rural area. And we will see improved 'Mirt' stove with respect to their efficiency, fuel wood consumption and being economical.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of the study area

Ethiopia is part of the East African region commonly referred to as the Horn of Africa situated between $3^0$30' and 15^0 North latitude and 33^0 and 48^0 East longitude, it covers an area of approximately 1.13 million km^2. Bordered by Somalia and Djibouti to the east, the Sudan on the west, Eritrea to the north and Kenya to the south, Ethiopia id a land locked country. Ethiopia having 13 months of sunshine country with population about 82 Million (UN, 2012) which makes the country second-most population in Sub-Saharan Africa. It is a country where there is a federal state with nine regional states and two city administration.

In Ethiopia biomass fuels provide the majority of the total energy supply of the country with 79% being derived from woody biomass, 8.7% from crop residue and 7.7% from dung (GTZ/ MOA, Project Brief 2000). Therefore, from the biomass fuels larger amount of energy is derived from woody biomass, the consequence of which is a decrease at an alarming rate of forestland cover in the country. The study is expected to cover areas with high, medium and little market accessed Kebeles of the district in Addis Ababa that is capital city of Ethiopia. The study mainly focus on the alternative fuel wood saving Mirt stove, because of the various cooking requirements, households tend to own different types of stoves.

The study has mostly concentrated on the basic factors, which determine the household cooking in every aspect. Among the various cooking the study

took the most frequented types of cooking in urban areas which are Injera making, 'Wot' or stew making and coffee making. This doesn't mean that there are no other kinds of cooking. But due to time and financial limitation specially peoples with less income, for it has taken the most common and frequented ones, which every household utilizes, for every day cooking.

3.2 Sampling Design and Sample Size

The **general objective** of this study is to examine the improved stove (Mirt Stove) in Addis Ababa Ethiopia Kebeles of the district with primary data Gathered secondary data from GIZ and Rural Energy Improvement Office. Collecting information through informal interviews with persons who are working at different levels in Governmental and Non-Governmental organizations.

The primary data obtained from the customers and total customers of 37 and 40 from 2012 and 2013 respectively take from Addis Ababa city of different Kebles of the district. Out of the total population of each year, 8 from 2012 and 7 from 20013, a total of 15 sample respondents will select and interview using personal recorder depending on the semi- structure interview formats prepared by manually.

3.3 Type and Method of Data Collection and Source of Data

The study is based on both primary and secondary data, the secondary data obtained from different organizations engaged in improving the household energy consumption pattern throughout the country.

- Secondary data collected from GIZ and Rural Energy Improvement Office.

- Collected information through informal interviews with persons who are working at different levels in Governmental and Non-Governmental organizations.
- The primary data obtained from the customers and total customers of 37 and 40 from 2012 and 2013 respectively taken from Addis Ababa city of different Kebles of the district. The method of data collected was simple random sampling which is categorized under the probability data sampling method.

3.4 Data Analysis Method

3.4.1 Descriptive analysis

Descriptive statistics are used throughout data analysis in a number of different ways. Simply stated, they refer to means, ranges, and numbers of valid cases of one variable. The study was applied quantitative method of data analysis using time series and other related relevant data .The improved stove description and the results of the analysis are presented in tabular and graphic forms with due discussions.

3.4.2 Major Types of Stoves Used in Ethiopia

Ethiopia is a country where people practice different cooking habits, requirements and preferences. Because of the various cooking requirements, households tend to own different types of stoves. The different types of stoves in the household sub sector are categorized as Traditional, Modern and improved stoves, according to Hailawe, reviewed as follows:

3.4.3. Traditional Stove

Traditional stoves are those that are developed and produced locally by the users themselves or local artisans. The stoves are assembled in such a way as to fit with the cooking device, the type of fuels used on it and the cooking places regardless of the performance and different technical parameters of the stoves. These stoves are mostly made of the local cheap materials available in the surrounding areas and are subject to modification at different times by the users themselves, as different conditions appeared with regard to their uses. For example, there are open-fire stove, enclosed stoves and traditional charcoal stoves. The open-fire 'Injera'-baking stove is the most Popular in our country due to its flexibility in construction and space utilization. The 'mitad' rests on three supports, stones or preferably bricks.

As the name indicates, three stones are used to raise the 'mitad' to a height of about 12 cms from the ground (Hilawe Lakew, 1999). It is cheap, rugged, and adaptable to every 'Mitad' Size and it takes up little space in a crowded kitchen. It can also be put in at any place, whenever the need arises and can be dismantled into pieces after wards.

Figure 1 Traditional three stone stove

According to (Hilawe, 1999), the efficiency of a three-stone open-fire injera stove varies from 8 to 10 % depending on various factors. First of all, the height of the 'mitad' from the ground plays a significant role in affecting the performance of the stove. If the 'mitad' is raised too high the heat transferred to the cooking pot will be reduced. Moreover, air blowing underneath the 'mitad' cools the temperature of the flame and hence reduces the efficiency. On the other hand, when the 'mitad' height is reduced below a certain level, the bottom surface of the 'mitad' quenches the flame resulting in poor combustion. Secondly, the variable that affects the efficiency of the stove is the type of fuel used. Different fuels have different burning characteristic and it is always difficult to optimize a stove for all types of fuels. The third factor is the fuel management skill of the cook. The fourth factor is the weight of the 'mitad'. For a given size of 'mitad', up

to 2 kg of weight differences can be observed and this greatly affects how the stove performs.

3.4.4. Heat loss from the stove

The three-stone stove is the most heat wasting. Due to the heating up of the stones from 300 ^{0}c to 500 ^{0} c and the openness of the area where the fuel is combusted, heat will be lost to the surrounding by radiation and convection. In addition, the flame that is totally exposed to the surrounding air will change the flammable gases in to smoke instead of flame. Even if they burn and produce flame the surrounding air will push them away and will not reach the cooking pot.

3.4.5. Modern Stoves

Modern stoves are those developed for the utilization of modern fuels (Kerosene, Liquefied Petroleum gas and Electricity). And are produced according to the different technical and thermal performances of the stoves (efficiency, fuel saving, durability, transportability, etc are taken in to account). Most of the modern stoves in use in Ethiopian households are imported though locally made ones that meet the unique cooking requirements of the households are available. Some of the types include kerosene stove, Electric hot plates, Electric 'Mitad' (its essential parts).

3.4.6. Improved Stoves

Improved stoves are those that are developed through an Improved Stove Programs taking the energy scarcity of the country into account that comes from unsustainable use of resources by the household sub sector. These are efficient stoves as compared to the existing ones, suitable for basic cooking requirements of households, and they offer various user conveniences such as cooking fast, clean, easy and safe, mobility for the advantage of space utilization and reduce health hazard

3.4.7. Description of 'Mirt' Stove

'Mirt' is an enclosed 'Injera' stove designed by the Ethiopian Energy Studies and Research Center of the Ministry of Mines and Energy under the cooking efficiency improvement and new fuels marketing project (CEINFMP). The name 'Mirt' means the best. The basic design of Mirt is adopted from the Ambo and Burayu enclosed 'Injera' stoves and further optimized so that it can handle different types of fuels (Hailawe, 1999)

3.4.8. Raw Materials and Production

It is also stated on Hailawe's report that, the raw materials for the production of 'Mirt' are cement and pumice (sometimes known as volcanic ash). Pumice binds well with cement and is a good insulator. Since it is formed at high temperature, it resists heat quite comfortably. In areas where pumice is not available scoria (red ash) or pure river sand can be used alternatively.

Pumice is pounded and sifted to remove large particles and then mixed together with cement. The pumice to be mixed is of two particle sizes. The fine grain size is 3mm and the course grain in 5mm. These two-grain sizes

will be mixed in 3 parts fine and one-part course grains. Four part of this pumice will again be mixed with one part of cement and water. When the mixture is dump wet, it will be molded to different stove parts using metal moulds. The mixture will be compacted inside the mould by hand tamping or using a vibrator. Then the molded stove part will be immediately removed from the mould and will be left for about 7 days for curing. It needs watering at least twice a day until the seventh day.

The stove has six parts; four arcs fit together to form the circular combustion chamber. Producing this section of the stove in four parts avoids formation of cracks due to thermal stresses. It also eases the problems of handling, transportation and storage of stoves.

The U-shaped part and the circular pot rest placed on top of it will form the chimney part. The total weight of the stove is about 45 kg.

Figure 2 Improved Mirt Injera Stove

3.4.9. Performance of the Stove

The performance of the 'Mirt' 'Injera' stove was tested both in laboratory and in the field. The rationale for the field test was to see how the stove performs in actual cooking conditions. In the laboratory controlled cooking test the stove was tested using two different 'mitad's and two cooks. The results are compared with a three-stone open-fire 'Injera' stove similarly tested. With a lighter 'mitad' the efficiency of 'Mirt' ranges between 19 to 21%. With a heavier 'mitad', the efficiency was dropped to a range of 16-17%. In both these testes the fuel was wood. A similarly tested open-fire stove shows an efficiency of 10.6% and 8% with the lighter and heavier mitad respectively. The comparative fuel saving ability of the stove to the open-fire stove is between 45-50% (Hailawe, 1999).

3.4. 10.Data Presentation

3.4.10.1 Analysis of secondary data

3.4.10.1.1 Analysis of economic benefits of Mirte Injera stove with respect to biomass consumption reduction

Table 1 shows how traditional stove is highly devastating forestland. Further studies indicated that in order to bake one piece of 'Injera' traditional stoves consumes 6.97MJ of energy from wood (398 gm) and takes 3.5 minutes. Because of the long time exposure of 'Injera' to fire on the cooking stoves, the amount of fuel wood consumed is very large, and this shows how enormous is the hectare of forestland cleared per annum.

Table 1 Fuel wood consumption of the tradition Injera Stove.

Cooking Period	Wood energy requirement		Baking Budget requirement (0.23 ETB/kg)	Forest land requirement to meet demand (ha)
	Kg	MJ		
Week	199	3482.5	45.77	0.03
Month	796	13,930	183.08	0.11
Three months	2,388	41,790	549.24	0.33

Source: (GIZ –HE, 1999)

Note: MJ= Mega Joule

3.4.10.1.2. Promotional strategy and distribution rate of improved stoves by GTZ-HEPNR PROJECT at rural and urban areas in different regional states of the country.

Of the different organizations involved in distribution of improved stoves, the GTZ –HEPNR project the Ethio-German bilateral project is the only project currently active in the promotion of improved stoves. This project is jointly implemented by Ministry of Agriculture (MOA) and GTZ since 1998 (Hiwote Teshome, 2000).

In Oromiya, Amhara, Tigray and SNNPR several people in many towns are involved in the production and dissemination activities, and many households are purchasing and using it preferably to their traditional old designed stove.

The following tables' shows number of zones, woredas, towns and number of mirt stove producers in all regions.

Table 2 Total number of woredas, Towns and number of Mirt stove producers in four regions.

	Region	Nº of zones	Nº of woreda	Nº of towns	Nº of stove producer
1	Oromiya	16	83	92	166
2	Amhara	11	65	74	113
3	Tigray	5	34	40	55
4	SNNPR	7	16	17	35
Total		**39**	**198**	**223**	**369**

Source GIZ-ECO

The table illustrates that the number of zones, woredas, towns and producers is the largest in Oromiya and the least in SNNPR. Oromiya stands first in all because many NGOs and developmental agencies mostly participate in introduction and promotion of the 'Mirt' in the region especially in the western Oromiya (Ambo, Guder, Welliso). In Amhara there is a great progress next to Oromiya. SNNPR is the region where attention is given lately.

Table 3 Number of Mirt production and sales figure by region.

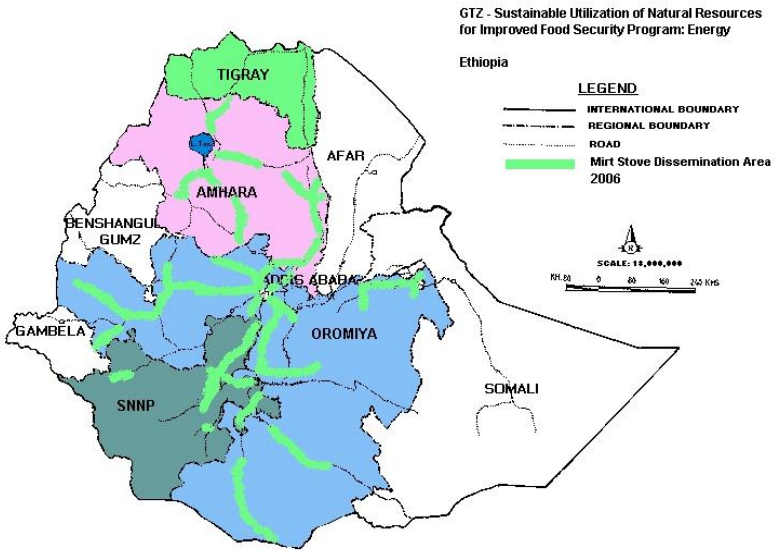
	Region	Nº Production	Nº of sale
1	Amhara	24,270	19,725
2	Oromiya	57,161	44,287
3	Tigray	37,059	32,160
4	SNNPR	17,356	15,454
Total		**135,846**	**111,626**

Source GIZ-ECO

From the table we see that the most product and sell is in Oromiya region and the least is in SNNPR. Oromiya holds the majority of all, because as we have explained, the GIZ and NGOs developmental agencies are working with a great attention here.

The major 'Mirt' production towns regionally

Figure 3 Distribution Stove in Ethiopia



Source: GIZ-ECO

Amhara region (12)

- Bahirdar, Gonder, Debark, Dessie, Kombalcha, Weldiya Debot, Gedober, Wanzaye, Hara, Debre Birhan, Shoarobit

Oromiya region (19)

- Ambo, Guda, Welliso, Bako, Holeta, Fiche, Gebre Guracha, Nekemte, Nazareth, Debrezeit, Mojo, Zeway, Shashemene, Akaki, Jima, Agaro, Asandabo, Daneba, Sokoru

SNNPR (15)

- Awassaa, Aleta wondo, Sodo, Humbo, Bodity, Mizan Teferri, Alaba Kulitu

  Butajira, Walaita, Worabe, Dalocha, Hossana, Durame

Tigray (4)

- Adigdat, Mekele, Alamata, Maychew

Source: GIZ, keeping biomass renew able, Addis Ababa.

The above distribution is not fairly equal.

The GIZ project has many intervention areas, assisting the private sector in every possible way to produce and supply the market with affordable technologies like 'Mirt' stove. This is why the dissemination of 'Mirt' stove is made possible. Therefore GIZ-HEPNR followed the following sequential steps to disseminate the stove through private sectors in all its pilot areas (according to Hiwote.)

3.4.10.1.3. Fuel wood consumption of improved 'Mirt' stoves and traditional biomass fuel stoves.

The rate adoption of 'Mirt' stove in both rural and urban areas has been increasing from time to time since its discovery. The estimated rate is about 10 % of households in rural areas, 35 % in urban medium sized towns and 50 % in large towns. (Rural Energy Development project, 2004). The comparison can be illustrated in two ways:

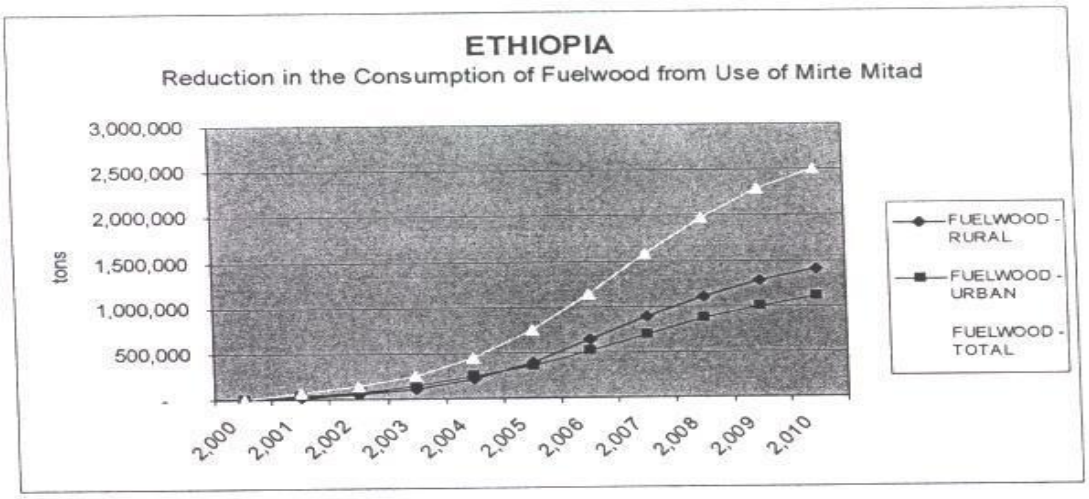


Figure 4 Reduction in the amount of fuel wood consumed following the adoption of the Mirt mitad at the national level.

Source: (EREDPC/BTG, 2004), Rural energy development project

The above graph indicates that from the use of 'mirt' stove; the urban household reduced the consumption of fuel wood by 1,200,000 tones and the rural household by 1,300,000 tones, which gives a total reduction of 2,500,000 tones of forest biomass annually.

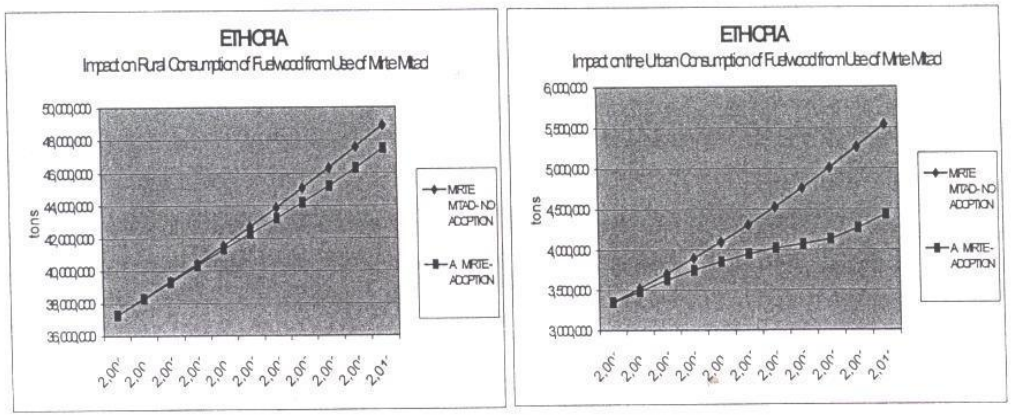


Figure 5 Comparison of fuel wood consumption of Mirt Stove and traditional stove in rural and urban households at the national level.

Source: - HEPNR, 2005.

The above graph shows how significantly using 'Mirt' stove can reduce the amount of biomass consumed. In rural areas between the years 2000-2020

the consumption will falls from 49,000,000 to 47,000,000 tones and in urban areas from 5,500,000 tones to 4,475,000 tones (estimated figures). This implies that 'Mirt' stove has a paramount importance in serving as a means to conserve and sustainable use biomass resource.

In addition to that explained in the above graph, 'Mirt' has more advantages over traditional stove and this is summarized as follows.

3.4.10.1.4 Marketing of improved Mirt stove

3.4.10.1.5 Method of payment for the Mirt Stove

For the financing of the Mirt, Households (HHs) mostly have the opportunity to acquire the stove on credit term with a payback period of two to three months. Since the Ethiopian millennium in September, 2007, so-called Coupons have been available for HHs for ETB 20 less than the actual price of the stove and can be exchanged for Mirts at the producers' workshops.

In Debre Zeit, 29% acquired the Mirt stove on credit term, while only 6% in Fiche and 7% in Bahir Dar chose this way of financing the stove. As it turned out, stove producers in Fiche and Bahir Dar did not provide this opportunity for the majority of users 'because of lacking reliability and creditworthiness'.

Table 4 Payment for the Mirt Stove

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
Cash	25	32	28	85	84%
credit	10	2	2	14	14%
for free	1	1	0	2	2%
Total	36	35	30	101	100%

Source GIZ-ECO,

3.4.10.1.6. Information on the Coupon System

It turned out, that overall two thirds did not yet know about the coupon system, with the highest number of uninformed HHs in Debre Zeit (77%). Still, more than half of the interviewed HHs had not yet been informed about the coupon system in Fiche (66%) and Bahir Dar (53%). After informing them about the system, most HHs considered this as a sufficient way of financing the Mirt Stove.

Table 5 financing method/coupon system.

Financing method / coupons	Debre Zeit	Fiche	Bahir Dar	Total	Percent
just been informed about coupons	27	23	16	66	66%
coupons are the best option	8	7	5	20	20%
going to use coupon for new Mirt	0	2	2	4	4%
do not need it	0	0	5	5	5%
never used	0	3	2	5	5%
Total	35	35	30	100	100%

Source GIZ-ECO,

3.4.10.1.7. Information about 'Revolving Fund

It is also of interest, whether people knew about the 'Revolving funds'. 20% in Debre Zeit and Bahir Dar had actually used revolving funds before, mostly for cattle and selling food. In Bahir Dar 10% even used it for the construction of extra living space to give for rent, while only 9% in Fiche had at all used it before. The major and very common complaint about this system is the dependence on the reliability and creditworthy of other group members. 13% reported having failed and/or having had to compensate for

unreliable group members. One proposal was to give revolving funds to individuals instead of giving it to groups only.

Table 6HHs having used a Revolving Fund'

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
not used	15	28	22	65	65%
do not now yet	3	3	1	7	7%
do not want to use it	6	1	0	7	7%
planning to	4	0	1	5	5%
Yes	5	3	4	12	12%
Failed	2	0	2	4	4%
Total	35	35	30	100	100%

Source GIZ-ECO

3.4.10.1.8 Condition of the Plastering of the Mirt Stove

The plastering holds together the four different stove parts, the clay pan, and the chimney and prevents the expulsion of flames and smoke at undesirable places of the stove. Usually, this plastering consists of mud, sometimes mixed with hay or ash, but can also be made of cement, if further transportation is not to be expected. If the plastering is not firm – similar to enlarged fuel inlets – too much heat and smoke escape, but also the clay pan and the lid are damaged and the Injera often burns towards the edges. Three HHs had even modified the Mirt by installing it on a stand, plastering it with cement, extending it to the sides for additional pot rests and attaching brick and cement chimneys.

An alarming 52% of the examined stoves in Bahir Dar were not properly maintained and plastered. Some stoves even were in extremely bad

conditions and extruding flames on all ends, burning the lid, the clay pan and the baked Injera. Fiche showed a slightly lower number of 38% stoves with decayed plastering, while Debre Zeit showed only 18%. More often, families with a higher income did not maintain their stoves properly, while most of the families of lower income seemed to keep the stoves in a good condition.

Table 7 Plastering of the examined stoves still firm.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
yes	26	21	13	60	66%
no	6	13	14	33	34%
Total	32	34	27	93	100%

Source GIZ-ECO

3.4.10.1.9 Positioning of the Mirt Stove

According to standard, the stove is supposed to be placed in an enclosed kitchen near to a window and not in line with the door in order to not allow incoming wind to burn the fuel at a faster rate – which results in fuel consumption inefficiency – and causes additional smoke.

Overall, 69% of the examined stoves were positioned according to standard, but the results varied across the three towns covered. The highest number of inaccurately positioned stoves was recorded in Bahir Dar with nearly 41%. Nearly 31% of the stoves in Debre Zeit and only 18% in Fiche were not positioned according to standard. Out of 30 assessed HHs in Bahir Dar 26% of the stoves were not even installed inside a kitchen, but outside in the yard.

One HH in Debre Zeit reported having been advised to install the stove in line with the door for extra oxygen.

Table 8 Accuracy of the position of Mirt Stoves.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
according to standard	24	28	16	68	70%
not according to standard	12	6	11	29	30%
Total	36	34	27	97	100%

Source GIZ-ECO

3.4.10.1.10 Consumers' perception of the features of the Mirt Stoves

The major purposes of developing the Mirt stove are, most of all, the saving of biomass fuel as well as significantly reducing the massive smoke production of the traditional open fire.

Biomass fuels provide more than 90% of the total energy supply of the country which accounts for the reduction of the forest cover of Ethiopia to only 3% of the total land cover within a few decades. Due to a large and fast growing population, the rate of depletion of the natural forests has been estimated at between 150,000 and 200,000 ha per annum, even though the per capita energy consumption is among the lowest in the world.

Women baking Injera in Ethiopia very often suffer from eye diseases and respiratory infections such as Asthma, as well as burns and fire hazards from escaping flames. Small children are usually on the mothers' backs while baking Injera and cooking on open fire or charcoal, which exposes them to the numerous hazardous fumes at a very tender age.

Besides reducing the forest cover depletion as well as the level of emissions from smoke and other pollutants, a reduction in fuel consumption can also reduce the high workload of women and children to transport fuels. Furthermore, fuel prices are rising and many HHs cannot afford fuel wood any more, but have to switch to other types of biomass fuel such as animal dung, BLT, saw dust and whatever they can usually find on their property. Money and time savings can be spent for other activities (i.e. education) and may significantly change the quality of life.

HHs were being interviewed about the comparison of fuel consumption with the traditional open fire and the fuel saving Mirt stove, about the present smoke situation compared to before using the Mirt, and about possible suggestions for improvements on the Mirt stove.

3.4.10.1.11. Consumers' perception of Mirt Stoves on smoke emissions reduction

A vast majority of HHs (92%) reported the massive smoke reduction since using the Mirt stove (97% in Debre Zeit, 88% in Fiche and 90% in Bahir Dar). In Fiche, 6% could not compare the situations, because of using only the electric stove before, and two HHs reported slightly less to no change of smoke amount (most probably due to cracked plastering and wrong positioning). Out of the three HHs in Bahir Dar not considering the smoke reduction to be immense, one HH had constructed a chimney and the other two were inaccurately positioned.

Table 9 Smoke amount compared to previously used stove.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
no change (but wrong position, outside)	1	1	0	2	2%
slightly less smoke	0	1	2	3	3%
a lot less smoke	34	31	27	92	92%
Chimney	0	0	1	1	1%
electric before / no comparison	0	2	0	2	2%
Total	35	35	30	100	100%

Source GIZ-ECO

3.4.10.1.12. Consumers' perception of Mirt Stoves on Fuel Consumption

The responses on fuel consumption were slightly surprising. While 86% in Debre Zeit and 91% in Fiche declared saving a lot of fuel and 9% in both towns could not estimate the amount of fuel saved due to different types of fuel being used before the Mirt, only 67% in Bahir Dar recorded much saving in fuel consumption. Due to observations made, the 23% HHs stating little or no saving mostly had their stoves positioned outside and/or in a very bad condition due to decayed plastering and cracks in the cement walls (13% had even removed the chimney, which allowed heat to escape freely in the back of the stove). On the contrary, 9% in Debre Zeit and 7% in Bahir Dar declared, that not much refueling is necessary once the stove is heated up. Another interesting statement in Debre Zeit was the belief that (due to

personal experiences) the fuel consumption also depends on the thickness of the clay pan.

Table 10 Fuel consumption compared to stove prior to Mirt.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
much saving	30	32	20	82	82%
little saving	2	0	6	8	8%
no saving	0	0	1	1	1%
cannot compare (due to different types of fuel)	3	3	2	8	8%
fuel consumption varies	0	0	1	1	1%
Total	35	35	30	100	100%

Source GIZ-ECO

Based on calculations on estimated fuel consumption per baking session with the three stone (open) fire and the Mirt stove, 31% of the interviewed HHs (26% in Debre Zeit, 34% in Fiche and 33% in Bahir Dar) only need 50% of the fuel consumed with the open fire, and 17% (17% in Debre Zeit, 14% in Fiche and 20% in Bahir Dar) even save more than 50% of fuel. In Debre Zeit, 17% of the HHs save between one third and half of the previous fuel consumption, and 31% in Debre Zeit and 37% in Fiche as well as Bahir Dar could not measure the exact amount of fuel used for one baking session (HHs often collect biomass fuel instead of buying it and HHs of higher income sometimes buy fuel supply for an entire year).

Table 11 Fuel saving compared to stove used prior to Mirt.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
half+	6	5	6	17	17%
Half	9	12	10	31	31%
one third	6	2	0	8	8%
less than one fourth	0	0	1	1	1%
do not know how much	11	13	11	35	35%
not applicable	3	3	2	8	8%
Total	35	35	30	100	100%

Source GIZ-ECO

3.4.10.1.13 Consumers' general perception of Mirt stoves and possible enhancements

Suggestions for possible enhancements of the stove were collected, but also 57% in Debre Zeit, 31% in Fiche and 43% in Bahir Dar did not see the necessity of a change of the stove. Only one HH in Debre Zeit complained about too much weight. 20% in Fiche and 10% in Bahir Dar would appreciate a stronger material and respectively more cement in the mixture. 26% in Debre Zeit, 11% in Fiche and 13% in Bahir Dar suggested a chimney; because the smoke is damaging the roof and spoiling the kitchen environment.

3.4.10.1.14 Consumers' perception of the necessity of a chimney to the roof

If it was not already suggested by the HHs, they were introduced to the idea of attaching a chimney to the outside of the roof. Overall, 72% of the HHs liked the idea with the highest positive reaction in Fiche with 77%. 51% would definitely be willing to pay extra (only 26% in Debre Zeit, 63% in

Fiche and 67% in Bahir Dar), and 10% would rather acquire it on credit term or by coupon.

Table 12 Chimney to the kitchen roof.

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
definitely a good idea	24	27	21	44	72%
not acceptable	1	3	0	11	4%
maybe give it a try	2	0	1	17	3%
no need	8	4	8	4	20%
"very important for kitchen environment and to reduce the heat"	3	0	1	0	4%

Source GIZ-ECO

Further comments:

- 'a chimney is very important for the kitchen environment and to reduce the heat'
- without a chimney the smoke is affecting the neighbors
- sauces being cooked on the Mirt have a disturbing smoky taste which could be reduced by a chimney
- a chimney would be beneficial, but not at the expense of the pot rest
- the chimney should be made of cement, not of metal
- not acceptable, because heat would escape and increase the fuel consumption
- farmers often have roofs made out of hay that would catch on fire with a chimney.

3.4.2 Econometric analysis

This study adopts econometric method of analysis in determining the impact of Mirt stove (best stove) in the case of GIZ-ECO project in Ethiopia. The main method of analysis to show the impact of Mirt stove in GIZ -ECO project is simple regression model.

3.4.2.1 Model Specification:

$$\hat{y}i = \hat{\alpha} + \beta Xi$$

$$r^2 = \hat{\beta} \frac{\sum xy}{\sum y^2}$$

Xi =Fuel wood consumption by Traditional three stone Stove

=Independent variable

y_i =Fuel wood consumption by Mirt stove

= Dependent variable

$\mathbf{r^2}$ = Coefficient of determination

$\hat{\mathbf{y}}$ = Estimate of the expected or mean value of y

$\hat{\boldsymbol{\alpha}}$ = Intercept of the equation

$\hat{\boldsymbol{\beta}}$ = Slope of the regression equation

3.4.2.2. Variable definition and hypothesis.

Table 13 Fuel consumption compared to stove prior to Mirt. From page 39

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
much saving	30	32	20	82	82%
little saving	2	0	6	8	8%
no saving	0	0	1	1	1%
cannot compare (due to different types of fuel)	3	3	2	8	8%
fuel consumption varies	0	0	1	1	1%
Total	35	35	30	100	100%

Source GIZ-ECO

For the above table we can assume that:

Based on calculations on estimated fuel consumption per baking session with the three stone (open) fire and the Mirt stove, 31% of the interviewed HHs (26% in Debre Zeit, 34% in Fiche and 33% in Bahir Dar) only need 50% of the fuel consumed with the open fire, and 17% (17% in Debre Zeit, 14% in Fiche and 20% in Bahir Dar) even save more than 50% of fuel. In Debre Zeit, 17% of the HHs save between one third and half of the previous fuel consumption, and 31% in Debre Zeit and 37% in Fiche as well as Bahir Dar could not measure the exact amount of fuel used for one baking session (HHs often collect biomass fuel instead of buying it and HHs of higher income sometimes buy fuel supply for an entire year).

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= Dependent variable

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4. RESULTS AND DISCUSSION

4.1. Results and Analysis of primary data

4.1.1. The major promotional tools that advertised the sample respondents

As the below table displays the major promotional tools by which customers heard of to purchase the Mirte stove in the study area were friends /neighbors (53.3%) and TV (46.7%) respectively. But through radio only (6.7%) of the customers in the study are advertised to purchase the Mirte stove .Here, in Addis Ababa due to a high population pressure and a strong opportunity to communicate peoples of varies sub-city residents and the presence of TV in majority of the house holds the dissemination of information through these tools plays the leading role. Radio to act as a promotional to advertise the selling and production of Mirte Injera stove in Addis Ababa has a minor place since every individual is always in a busy condition to fulfill its daily requirements that made the to have no rest to considerate of Radio opening.

No	Promotional tools	Number of respondents	%
1	Friends/neighbors	8	53.3%
2	Radio	1	6.7%
3	TV	7	46.7%
4	Demonstration	-	0%
5	Producers	-	%

Source from interview of the customers

Table 14 the promotional tools that helped respondents heard of Mirt production.

4.1.2. Stove installation

According to the response obtained from the sample respondents in the case study area, 93.3% and 6.7% installed the stove by themselves and assistance of producers respectively. The customer peoples living in Addis Ababa exceeded those who live in rural part of Ethiopia .The condensed neighboring nature here escalate the day to day contact of peoples to exchange information and experience throughout their life, by this informal learning is well undertaken and it is the reason why almost all of the customers install the stove themselves without the involvement of trained experts .installation here not at all required installation experts due the settlement nature that created wide scope media of learning for individuals from its neighborhood.

4.1.3. Stove utilization prior to Mirte Injera stove in case study area

Table 15 Types of stoves used by respondents prior to Mirt.

No	Type of stove used prior	Number of respondents	%
1	Open fire	6	40
2	Electric Injera stove	7	46.7
3	Traditional closed Injera stove	2	13.3

Source: own computation by interviewing the users of the stoves.

The majority of customers of residents of Addis Ababa previously used open fire (40%) and Electric Injera stove (46.7%) respectively, the traditional three stone Injera stoves (13.3%) was not as such used dominantly in the

study area. Those who are well to do in their financial capacity and live in a better way together with some in a medium standard of living were used electric stove as cooking equipment; the rest medium economic back ground holders and those in hand to mouth living situation were used open fire stoves .Almost nil of the populations used traditional closed Injera stoves. The cost of electric power and fuel wood challenged and made their living miserable and this is condition by which a widely penned room for Mirt stove market is highly intensified in Addis Ababa city.

4.1.4. Types of fuels used by customers in the study area

Table 16 Types of fuels used by customers.

No,	Kinds of fuels used for baking	Number of respondents	%
1	Fuel wood	5	33.3
2	Cow dung	0	0
3	Crop residue	6	40
4	Sow dust	4	26.7

Source: own computation/got the information from costumers

The peoples of Addis Ababa profoundly used crop residue (40%) as a major fuel for baking and followed by fuel wood (33.3%), in a moderate way they also consume sawdust (26.7%).The rate of fuel wood consumption as depicted in the table is low compared to the other sources of fuels that used for baking Injera ,the reason is due to the high cost of fuel wood in Addis Ababa city and the sow dust here is not easily accessible for all consumers because of the specificity of the places where the wood work enterprises are

established and in addition, the in proportionality of the saw dust consumers to that of wood work enterprises forces the majority of Mirte customers to twist into the very cheaper fuel source which is the crop residue .Those who are categorized under the economic minority level obliged to go far in village to fetch these crop residues without any charge of fee. Thus, it is the reason why crop residue is the dominant fuel wood for Mirte Injera stove users.

4.1.5. The way of fuel wood consumption for Mirte stove users in the study area

About 60% of the respondents responded as the majority of Mirte users use the wood without splitting since its longevity and durability is acceptable for a reason of baking more Injera using a single pieces of wood. Its flame formation is uniform to be stayed long heating the stove without depletion and production of large quantity of smokes .The rest 40% of the respondents responded as the used to split during baking. From this it is possible to conclude as utilization of Mirte Injera stove for house hold consumption save not only money for fuel wood purchasing, but also time and labour to split the wood in to pieces for the feasibility of baking by use of traditional stoves .

4.1.6. The fuel saving characteristics of Mirte Injera stove

According to 100% of response from sample respondents of the study area, Mirte Injera stove has much fuel saving capacity as compared to that of traditional stoves .This response approves the invaluable quality of the apparatus to be included in the major strategies of sustainable development through the reduction of huge tones of native forest clearance. In the same

manner, it improves the living standard of the residents of the study area via investing the money that would be used for fuel wood purchase in to other forms of income generating enterprises.

4.1.7. The interval of fuel wood inclusion during baking by Mirte stove

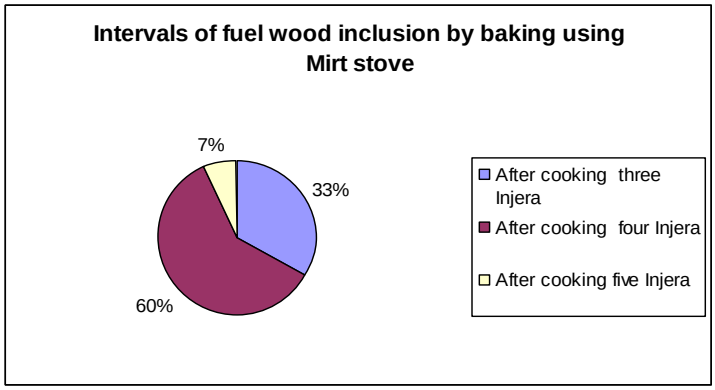

Figure 6 the interval of fuel wood inclusion during baking using Mirt Injera Stove.

As it is illustrated in the figure -1 above the majority of Mirte stove users in Addis Ababa city include splited or crude fuel wood after baking of four Injera (60%) followed by three Injera (33.3%) and five Injera (6.6%) respectively. This implies that the proportion of fuels saved in relation to the amount of Injera baked much lower and users of Mirte could save pursuable amount of fuel wood for the remaining several consecutive intervals of baking periods.

4.1.8. Amount of money saved to purchase fuel wood by the Mirte stove users as compared to the previous stove types

The highest populations of Mirte users save on average 25-30 ETB/month (80%) as the above figure shows depending on the response of sample

respondents .this means it is possible to 300-360 ETB on average annually and it provides some additional economic value to the country in general and specifically to individual house hold consumers.

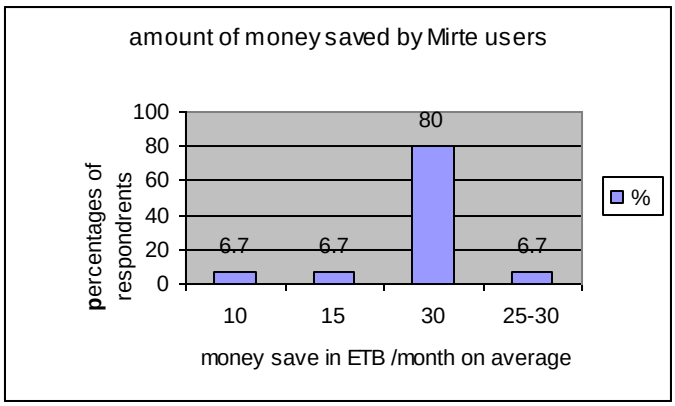

Figure 7 Amount of money saved to purchase fuel wood by the Mirte stove users.

4.1.9. The perceptions of Mirte users in the study area about the presence and absence of chimney to the outside of the house

According to the information obtained from sample respondents (80%) of the study area, the presences of chimney is acknowledged by all users and explain its usefulness as a means of reducing indoor air pollution in advance. Since the smoke produced is released out through the chimney, it fantastically prevents the prevalence of different kinds of polluted air related diseases. On the other hand, the economical burden towards medication that imposed on individual family due to air polluted health effect is well harnessed in a positive way.

Some 20% of the respondents opposed the presence of the chimney in the outside .Their reasoning is with regard to the heat lost through the chimney

along with the smoke which is very significant to heat water for cooking` wot ` and tea .As the heat together with the smoke is released out, such simple but time taking works can't be done during baking Injera in charge of using Mirte stove. Thus, the time which is useful to other economical duties is lost in doing such simple works.

4.1.10. The perceptions of Mirte customers` about its introduction in the study area (Addis Ababa)

All of the respondents (100%) in the study area explained that they all are very happy about the introduction of Mirte Injera stove .The sample respondents discussed the reasons of their happiness in account of its simplicity to accommodate during baking, acceptable reduction in the effect of its smoke, its ability to save fuel wood with respect to the amount included per one baking time and the related cost of the fuel wood when calculated as reference of one month consumption, time saving for doing other works .

This implies that the Mirte Injera stove introduction for customers of GIZ who live in Addis Ababa is highly significance to compensate the ongoing costly of living condition with regard to the high cost of fuel wood.

According to the response and discussion of the sample respondents we can conclude that the role of women in other socioeconomic activities would be tangibly magnified due the diminishing rate of the burdensome work load of fetching firewood from distant villages away of Addis Ababa. In addition, the amount of money saved by virtue of Mirt introduction in the study area

would be valuable to create educational opportunities that helped them to improve the conditions of their living conveniences.

CHAPTER FIVE

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS/IMPLICATIONS

5.1. Conclusions

The GIZ -ECO adoption of Mirt Injera stove improved technology in all of the four major regional states has been appreciably accepted by the majority of the users and in each it became a means of employment for many jobless men and women .This means alongside the reduction of tremendous tones of forest resource and health impact in the country, the goals of sustainable development which has been designed by the federal government of Ethiopia would be addressed through the development of alternative energy source by participating several jobless people.

In the paper it's tried to address the ongoing situation and importance of Mirte stove for rural and urban areas of the country by collecting information from secondary data and primary data through the development of interview questions and interviewing them using the telephone dialing. Compared to the short time gap together with tedious work load in my office, the contents covered in the paper are significant to highlight about the use of Mirte Injera stove to the readers of this paper in relation to the case study area.

5.2. Recommendations/Policy Implication

The users and producers of Mirt Injera stove in the case study area is very liking to purchase the stove because of the cost effective nature of the stove, the quality of the Injera baked, its need of simple management skill ,one means of job opportunity to the poor jobless citizens , its critical role player characteristics in time saving for other economical works and greatly reducing the severe burden of health impact. But, to distribute and full fill the requirement of both the producers and users, the expensiveness of the cost of the cement and the cost of some inputs which are used to produce Mirt stove became a great obstacle because when the price of the row materials increase the price of Mirt stove also increase. The incensement of the input materials of Mirt stove brings a big problem for the producers and users. During the cost of Mirt stove increase the demand of Mirt stove become decrease. At the present time it is difficult to fulfill the costumer interest. Even many producers are now ceased to produce at all. Therefore, the federal government of Ethiopia has to provide a due attention for the matter to settle down the serious fluctuations of producer –user relationship with respect to Mirte stove production and distribution by availing means of easily accessibility of cement products and other important inputs to all producers of the various regions.

The GIZ -ECO has been used several promotional tools to advertise about the Mirte stove utilization and still it works its level best, but through looking at the current situation of increasing number of people for the stove, updating the means of promotional tools and increasing the frequency of

advertisement through the different medias of the country is highly advisable.

In addition to this GIZ-ECO has been working day to day to improve the quality of Mirt stove in scientific way to make easy and to minimize the cost of fuel wood for users and the cost of input materials for producers.

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APPENDICES

Appendix-1.

Table 17 Intervals of fuel wood inclusion during baking by Mirt stove

No.	Types of intervals	Number of respondents	%
1	After coking three Injera	5	33.3
2	After cooking four Injera	9	60
3	After cooking five Injera	1	6.7

Appendix-2.

Table 18 Amount of money saved to purchase fuel wood by the Mirt stove users as compared to the previous stove types.

No.	Amount of money saved ETB/month on average	Number of respondents	%
1	10	1	6.7
2	15	1	6.7
3	25-30	12	80
4	30	1	6.7

Appendix 3:

Table 19 Suggestions for modifications and improvements on the Mirt Stove

	Debre Zeit	Fiche	Bahir Dar	Total	Percent
no change necessary	20	11	13	44	39%
Weight	1			1	1%
size (smaller size of pan enough for smaller families)		1	1	2	2%
Material (stronger!)	1	7	3	11	10%
chimney	9	4	4	17	15%
a stand	1		1	2	2%
plastering between chimney &stove should be firmer (no mud)	2			2	2%
a lid, that doesn't burn on the sides	1		1	2	2%
producers should give a better explanation of differences of different fuel types	1			1	1%
fuel inlet higher (for the use of dung as fuel)	1			1	1%
3 stones on chimney		12	1	13	12%
plastering should be stronger (cement) to have it firm		1	1	2	2%
edges of stove higer so lid doesn't burn on the sides		1	1	2	2%
3 stones on chimney further in the middle than at the edges		1		1	1%
Easier transportable		1	1	2	2%
coupons should constantly be available			1	1	1%
suggest small holes on the sides & minimize fuel inlet			1	1	1%
edges do not heat up easily (because of missing oxygen)			1	1	1%
edges of Injera burn, need higher edge			4	4	4%
prefers Slim: heats up faster and is cheaper			1	1	1%
Should use white instead of red sand, too little cement		1		1	1%
Total	37	40	35	112	100%

Appendix-4:

Equation 1 Interview question

1. How did you find out about the stove?
   - friends/ family/neighbour/colleagues
   - radio
   - TV
   - demonstration
   - producer

2. Who installed the stove?
   - producer
   - trained experts
   - ourselves

3. What kind of stove did you use prior to Mirt?
   - 3 stone fire (open fire)
   - electric Injera stove
   - traditional closed Injera stove
   - self-construction similar to Mirt

4. What kind of fuel do you use for baking Injera?
   - fuel wood
   - dung
   - crop residual
   - saw dust
   - paper/carton

5. Do you use dry or wet fuel wood?

   a. dry fuel wood
   b. wet fuel wood

6. Do you split the fuel wood or not?

- yes, we split it
- no , we don't split it

7. How do you compare your fuel consumption using open fire & Mirt stove?
   - much saving
   - little saving
   - cannot compare (due to different types of fuel)

8. For how many baking sessions does one unit of fuel wood last when cooking on the Mirt stove?
   - After cooking three Injera
   - After cooking four Injera
   - After cooking five Injera
   - Other_____

9. How much money do you save per month to purchase fuel wood?
   - 10 ETB on average
   - 15 ETB on average
   - 20 ETB on average
   - 25-30 ETB on average

10. What would you think about a chimney (to outside of the house) to further reduce the IAP?
   - definitely a good idea
   - not acceptable
   - not needed

11. What do you suggest about Mirte Injera stove introduction?
   - I am very happy
   - A little better than traditional stoves
   - Not happy at all

12. How do you accommodate the process of baking using Mirte Injera Stove?
   - It is so simple
   - It is too difficult
   - moderate