UTILIZATION OF ENERGY SAVING COOKSTOVE TECHNOLOGY:

THE CASE OF IMPROVED INSTITUTIONAL COOKSTOVES IN KISII AND NYAMIRA DISTRICTS OF KENYA

BY

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A THESIS PRESENTED TO THE FACULTY OF SCIENCE
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR A
MASTER OF SCIENCE, (TECHNOLOGY),
AT THE APPROPRIATE TECHNOLOGY CENTRE, KENYATTA UNIVERSITY

1999

DECLARATION

This thesis is my original work and has never been presented for a degree in any University

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DEDICATION

To the most wonderful parents any one could have:

my mom, Mary,
for her love and support
and
my dad, Daniel,
for his encouragement and drive for me to succeed

ACKNOWLEDGEMENT

I wish to thank

my parents for providing the funds and other facilities for my studies. Lots of thanks also go to my wife Sophia and brother Clifford for giving me the encouragement and reason to go through this. James (J.T.) for being my mentor and source of pride in ways he won't understand,

special thanks to Dr. J. K. Laichena, my supervisor to whom I owe deep gratitude for being very patient with me and giving me his time and guidance to make it possible for me to write this thesis. I say thank you very much,

Dr. David M. Hall and Dr Asenath K. Omwega for giving me very valuable direction that enabled me focus on this study,

Eunice, KCB and Fred, Nakuru Computers for letting me use their PCs at any time during my proposal writing. Frederick of Out of Africa, Export House; Bob of Mosmab Investments, Dr Hall of Genesis Technologies and Caren of Riverbank for kindly allowing me to use their PCs in writing up my thesis,

the co-operative spirit of the respondents and especially the help from Madame Mwambua, Christine and their crew of FWD. Thanks to Mr. Ombaye for kindly providing me with his vehicle to use during part of my fieldwork,

Sam D. Angima for all the support we gave each other during our study at ATC, and

the unmentioned ones who contributed to the success of this piece of work.

To all of the above I say may God bless and reward you abundantly.

ABSTRACT

The main objective of this study was to determine the factors that influence the adoption and utilization of improved institutional cookstoves, which have a higher thermal efficiency, are safer to use, and are more user-friendly than the traditional cookstoves. Evaluation of the utilization, operation, and maintenance of the improved cookstoves, by those using them, was another major objective of the study. The study was carried out in institutions that offer catering services in Kisii and Nyamira Districts of Kenya. These included schools, colleges, hospitals and hotels. The study area falls under the highly populated regions of the country, where the shortage of fuelwood is currently acute.

Institutions used in the study were randomly selected and constituted 61% all of the institutions offering catering services in the study area. These included 53 schools, 4 colleges, 10 hospitals, 10 hotels and restaurants. Three manufacturers-cum-disseminators of improved institutional cookstoves were also interviewed, two of which were based in Nairobi and one in the study area. The study was conducted by use of questionnaire and interview method. By use of three different sets of questionnaires, responses from the interviewee and observations by the interviewer were recorded. The first set of questionnaires was for cateresses and/or administrators of the study institutions, the second for kitchen staff, and the third for the cookstove manufacturers-cum-disseminators. Only 57% of the sample institutions were found to have adopted and were using the improved cookstoves. This is rather low considering the acute shortage of fuelwood in the study area, hence the need for use of energy-saving devices.

The study established the main factors causing hindrance to the adoption of institutional improved cookstoves as the lack of awareness, among the non-users, on the existence and advantages of the improved cookstoves and the lack of information on where to acquire

them. A reasonable number of the non-users knew about the improved cookstoves, had interest of acquiring them, but did not know where to buy them from. The initial cost of the improved cookstove was also reported as a limiting factor, though not rated very high.

Reduction in the fuelwood used for a given cooking activity was generally acknowledged as being attainable with usage of the improved cookstoves. Such fuelwood saving translated directly to monetary gain through reduced expenditure on the cost of purchasing fuelwood. The study also found that the most desired characteristics of the improved cookstoves, by the kitchen staff, are that they provide a smoke-free and cool kitchen environment, are safer to work with, cook faster and keep the food hot for a long period after cooking. They however did not like their lack of tilting mechanism.

In spite of the numerous advantages cited, the study showed that there were some users of the same cookstoves who did not realise their advantages. This was due to misuse of the cookstove through improper operation, poor preparation of fuelwood, poor or no maintenance of the cookstove system, and failure to repair or replace broken or damaged parts of the cookstove. This was mainly due to lack of training on the operation, repair, and maintenance of the improved cookstoves.

Manufacturers-cum-disseminators of improved cookstoves by conceded that they had not marketed the cookstoves widely. This was actually the cause of the lack of awareness to potential buyers. There is, therefore, a clear need for better promotion strategies by the disseminators of the improved cookstoves since there is an existing large market.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACTS:	African Center for Technology Studies
FAO:	Food and Agricultural Organisation
ITDG:	Intermediate Technology Development Group
KENGO:	Kenya Energy and Environment Non-Government Organisation
KIFCON:	Kenya Indigenous Forestry Conservation
WHO:	World Health Organisation

APPENDICES

1.0 INTRODUCTION

1.1 BACKGROUND TO THE PROBLEM

Every year, more than 11 million hectares of forest is destroyed in the world (FAO, 1987; Aslanian *et al*, 1992). A United Nations Environmental Program (UNEP) report says that at least 4.5 million hectares of rain forests are lost through large-scale commercial logging. This is a constant reminder that man is a threat to both his survival and that of the environment.

In many developing countries, the disappearing forest base is increasingly unable to supply enough woodfuel for energy needs, leading to even greater pressure on forest which in turn can lead into dessertification (Rowe and Hamilton, nd). Today, more than half the world's population of between 5.5 and 6 billion cook with biomass fuels (SHARE, 1994; Gore, 1994; Alibhai, nd). FAO indicates further that part of this population relies on woodfuel supply that is severely endangered. Another study show that 250 million people are now threatened by dessertification with a further 750 million having their livelihood threatened indirectly (Sino, 1995). Some 100 million people in 22 countries no longer have enough trees to meet their minimum fuel needs (Gruduah, 1995). They are facing a crisis as the land wood resources are being depleted and forests cut down.

Woodfuel accounts for more than two-thirds of the energy consumption in developing countries, with over 70 percent of it being used for domestic cooking alone (Krugmann, 1987). Traditional woodfuel cookstoves convert inefficiently the primary energy available in the wood into useful energy used in cooking. Estimates of energy efficiency in these cookstoves are in the range of between 5 and 10 percent (Krugmann, 1987) thus increasing the volume of woodfuel required to supply energy to the increasing human population.

One of the technologies that has gained commendable advancements and will be the focus of this study is the improving end-use energy conversion systems such as cookstoves. Because of its improved fuelwood saving feature, on the aggregate, its widespread adoption and utilisation will help reduce the amount of fuelwood harvested from any sources available within a given region used to fire them. Work on improving cookstoves has been very progressive with present cookstove designs achieving a thermal efficiency of up to 45% heat transfer as compared to 5% for open fire (KENGO, 1993).

Focusing on the energy conversion technologies, the improved cookstoves advantages, as opposed to the traditional cookstoves, include:

1) Reducing consumption of woodfuel that is already scarce. The improved cookstoves have a thermal efficiency of 45% as compared to 5% for open fire, implying that, for a given cooking activity, the improved cookstoves will consume a lower amount of woodfuel as compared to traditional cookstoves, hence a saving. This will also save the amount of time which would otherwise have been spent collecting and harvesting the fuelwood.
2) Reduce the cost of purchasing the fuelwood. Because of the higher efficiency of the improved cookstove, the quantities of fuelwood needed will be lower hence lower cost of operating the improved cookstove. This will be a saving by the user, that is, the institution.

3) The contribution to environmental conservation through reducing the destruction of trees which acts as a CO_2 sink, deforestation which leads to desertification, and soil erosion.

4) Through reducing the amount of fuelwood burnt for a given kitchen activity, they contribute to cutting down on emission of CO_2 into the atmosphere. Carbon dioxide is the most important greenhouse gas (GHG) contributing about 66% of the global warming (ACTS, 1990), and

5) Enhancing better health for the improved cookstove users. The use of traditional cookstoves exposes the cookstoves users to large amounts of carbon dioxide and carbon monoxide gases and other emissions, high temperatures during cooking and the danger of sustaining burns from open fires. Thus, the improved cookstoves are safer to use, they eliminate the smoke emissions into the kitchen area, are insulated, and the fire chamber is enclosed and covered during cooking.

1.2 STATEMENT OF THE PROBLEM

In developing countries, virtually every rural family relies on woodfuel for all or part of its cooking and space heating. This is because alternative and conventional sources of energy are either unavailable or unaffordable to these families. This has resulted in heavy dependence on woodfuel in area with or without a source of wood. Wood does not only predominate over other household fuels but it also provides between 75 and 90 percent of the total national domestic energy consumption (SHARE, 1994; Khamati, 1987).

Therefore, deforestation to create land for food production and human settlement, supply wood for fuel among others is the most important environmental problem in developing countries. In a speech delivered at a UN Conference on population held at Cairo, Egypt, Vice President Al Gore of United States of America, said that for the environment, rapid population growth often contributes to degradation of natural resources (Gore, 1994). In Kenya, areas which are densely populated such as Nyanza, Western, and Central provinces have been cited as experiencing acute wood shortages (KENGO, 1983). Due to this, any available wood is not allowed enough time to dry up, hence burning wood with high moisture content which emits a lot of smoke that does seriously affect the health of the users.

Scarcity of woodfuel causes widespread human suffering and environmental degradation. Turning to use of agricultural residues deprives the soil of organic nutrients. Severe scarcities will lead to declining quality of life especially in the rural areas. The introduction of improved cookstoves would ease the pressure on existing biomass energy resources. Studies carried out had shown that improved cookstoves in rural areas were yet to be popular (Burnes, 1985; Hankins, 1987; Walubengo and Joseph, 1988).

Since there is scarcity of fuelwood, there is every need to utilise efficiently the little that may be available. This little is either expensive or not easily available hence the need to conserve and save the little that may be available without committing more resources and time to satisfy this need. Improved cookstoves can therefore help alleviate this problem by conserving the available resources.

The thermal efficiency of cookstoves is continually being improved on through newer cookstove designs. There is also need to improve on their functional efficiency by improving on cooking habits so as to save fuel since the cookstove performance is highly dependent on associated user habits. However, targeted institutions, nationally, have not significantly adopted the improved fuelwood cookstoves (Mwaniki Associates, 1987; Walubengo and Joseph, 1988). A national study in 1990 found out that only 720 institutions out of 2000 institutions that would require improved institutional cookstoves had adopted the improved cookstove, that accounting for only 36% of their projections (Oyieke et al, 1991).

There is, therefore, a need to investigate why these cookstoves are not widely used in the rural areas especially those with woodfuel shortages and high population. By so doing, it will become easier to tackle those concerns so as to promote and avail the cookstoves to the users, hence their utilisation.

The study is aimed at determining what influences the acceptance of improved cookstoves so that wide dissemination can be possible. If this is determined, it would go a long way to help remove some bottlenecks that could be deterring the successful transfer of the technology.

1.3 STUDY OBJECTIVES

The objectives of the study were to

i) establish how much woodfuel is actually being saved by use of improved cookstoves,

ii) determine the financial benefits accrued from use of this system to the institution,

iii) find out the acceptability of the system by those using the cookstove,

iv) find out from those not using the improved cookstove why they do not use it, how much they know about them and if they understand the disadvantages associated with the use of "traditional" cookstoves in relation to the improved cookstoves,

v) establish if there are any users who have stopped using the improved cookstoves and reverted to "traditional" cookstoves and why,

vi) determine how well the manufacturers targets are being achieved in the cookstoves dissemination, and

vii) determine the factors contributing to the low adoption of improved cookstoves in Kenya.

1.4 SIGNIFICANCE OF THE STUDY

A lot of work has been put into research and development on the possible solutions to the energy problem with considerable progress being achieved in systems development by improvising and improving on new and existing technologies.

The results from this study will be used to enhance the adoption of improved cookstoves. That wil be through increasing the awareness of improved cookstove users and other potential cookstove users. The results will also inform the disseminators and manufacturers of the real needs and handicaps of the potential users so as to address those issues that had been raised.

By increasing the cookstove awareness and making the improved ccokstove more accessible and affordable, the number of improved cookstove users adopted will very likely increase tremendously. This study would then have contributed towards achieving higher improved cookstove adoption rates.

Appropriate technology emphasizes identifying a need, finding solutions to the problem and then solving it. The solving of the problem can satisfactorily be achieved by monitoring and evaluating the performance of the technology being disseminated. Despite the present interest and usefulness of appropriate technology, there are still other obstacles that undermine the set-up of appropriate technology. One of the factors centres around popularization of devices and dissemination of information where a lot of questions still need to be answered (Mburugu, 1994)

A technology will also cease to be appropriate if it is not accepted and hence adopted by the target group. This study therefore aims at finding out or determining the reason for the low adoption of improved institutional cookstoves despite their high thermal efficiency. The information gathered through the study will be useful to the cookstove designers, manufacturers and disseminators.

1.5 DEFINITION OF TERMS

Improved Cookstoves - As used in this study, this is the third generation cookstove. For the purposes of this study, this excludes the Alpha Laval cookstove that is a second generation cookstove. The main characteristic of the improved cookstove is its cooking pot insulation with a fire box that is enclosed and has a chimney.

Traditional Cookstove - For purposes of this study it encompasses all other fuelwood cookstoves excluding the improved cookstove. These includes the three-stone, two-column and Alpha Laval cookstoves.

Other Cookstoves - As used in this study, this refers to those cookstoves that do not use fuelwood directly as a source of fuel. These are gas cookers, electric cookers, steam boilers and charcoal jikos.

Fuelwood - It is raw wood used for fuel.. This includes trees grown for purposes of energy production.

2.0 LITERATURE REVIEW

2.1 GLOBAL BIOMASS ENERGY SITUATION

Biomass is the fourth most important source of energy in the world (Scurlock and Hall, 1990). It still features prominently in the world energy supply and it has a higher proportion, in the global energy consumption, than nuclear energy and hydropower.

Global patterns of fuel use show that since the early 1970s when the potential constraints imposed by disruptions of energy supply on human welfare were brought into sharp focus, there has been an accelerated effort to understand society's energy needs and the means to supply them. Thus the energy crisis much of the human race has been experiencing is not the crisis caused by changes in the world petroleum supply system but the problems associated with the harvesting and use of traditional biomass fuels (Eckholm, 1975).

Biomass energy is generated, converted and used in many different ways. Biomass energy systems include a wide range of technologies ranging from simple three-stone fire common in many rural areas in the developing world to multi-million dollar ethanol complexes in the developed world. It is estimated that about half the world's households cooks daily with biomass fuels. Much of this is not being harvested from managed stands of trees but is gathered from natural or otherwise unmanaged forest areas.

Fuel gathering and the need for new land to expand food production due to increasing pressure from increasing human and livestock population have subjected many areas to deforestation. Food and Agricultural Organisation (FAO, 1987) estimated that more than 1.2 billion people relies on fuelwood supply that are severely endangered. Fuelwood is the most widely used form of biomass energy for the majority of households in Africa and other developing countries.

The high rate of depletion of Africa's biomass resources is mainly as a result of high levels of population growth, clearing of forested woodland for agricultural use and the other-dependence by households on fuelwood for cooking and excessive numbers of livestock per given area. This has halved the area of forested woodland in Africa since 1970 and the pace of deforestation and land degradation is actually increasing (Anderson and Fishwick, 1984). Generally, it has been a widely held concept that deforestation led to a fuel supply crisis. This and other early findings that the efficiency of the three-stone fires was very low led to many cookstoves and other conservation projects world wide beginning in the mid-70s.

2.1.1 BIOMASS ENERGY SITUATION IN KENYA

Woodfuel is used by 95 percent of rural households and greater that 70 percent of urban households in Kenya (Senelwa and Hall, 1993; Kapiyo, 1982; Mungai, 1991). The current annual supply of woodfuel is estimated at 18.7 million tonnes, yet there are reserves of only 950 million tones with an estimated decline of 1 percent per annum (Mungai, 1991).

World wide studies by the FAO indicate that most regions in developing countries are already facing acute fuelwood scarcity problems (FAO, 1987). Consumption of biomass fuels exceed the rate at which they are replenished (Senelwa and Hall, 1993). In Kenya, the fuels commonly used in most urban households are petroleum derivatives such as liquefied petroleum gas (LPG) and paraffin, electricity and charcoal. Most rural households rely heavily on wood and partly on charcoal.

During the late 1970s and early 1980s there was substantial publicity on problems of deforestation resulting in a growing awareness of the problems associated with fuel shortages and soil erosion in Kenya. A study carried out by Beijer Institute in 1982 concluded that Kenya's gross woodfuel demand was of the order of 20 million tonnes per year with 13 million tonnes of this being from sustainable sources (O'Keefe *et al*, 1984).

Some recent evidences indicate that the tree cover in densely populated area such as western Kenya may actually be increasing, however, this tree cover may be trees for commercial purposes which may not necessarily translate into wood for energy purposes (Anderson and Fishwick, 1984). Other reports indicate that these areas are experiencing severe shortages of woodfuel because of reduction in standing biomass. However, this report ignores the fact that much fuelwood does not come from managed forest areas but from dead branches, twigs, and thinning obtained from trees grown on farmlands, along river banks and roads or from communal or privately owned land. The woodfuel supplied or available from these so called "trees outside the forest" is difficult to quantify because they are scattered and variable (Heidenreich *et al*, 1993).

Tree growing for family uses rely on non-commercial incentives. Basically, trees are grown for building, fencing, and lopping for firewood. It should be noted that the concept of energy cropping which applies the cultivation of both wood and agricultural crops is more comprehensive than that of woodfuel plantations. The ultimate concern of energy cropping is the production or regeneration of the biomass upon which the particular woodfuel supply in question is based (Walubengo, 1986). Other agroforestry approaches appear to have substantial advantages over traditional forestry practices. This including the ability to achieve higher planting rates stimulated by commercial incentives, reduced need for public wood supply expenditure, enhanced soil fertility and fodder production for livestock, reduced demand for land and most effective use of small areas of farmland (Anderson and Fishwick, 1984). By so doing, more users will be hopefully self-sufficient in fuelwood supply hence satisfying their own need and easing pressure on local forest and common lands (Foley *et al*, 1984).

2.1.2 WOOD CRISIS AND ITS IMPACT

Fuelwood remains the major source of energy for African homes and economies. More than 2.5 billion people depend on fuelwood to meet their household basic energy needs in the developing world (Alibhai, nd; NAS, 1983). These people are experiencing a wood crisis since their local firewood resources are being depleted and forests cut down. The large amounts of fuelwood required to satisfy the indigenous energy needs has continued to put pressure on woodlots.

Over 90 percent of the African population uses fuelwood at the equivalent of about three to four metric tones of wood-equivalent per family per year (Anderson and Fishwick, 1984). This converts to enormous amounts of energy needs. For millions of fuelwood energy dependants, the wood crisis is real and immediate. The utilization of energy as well as destruction of wood and other biomass due to agricultural clearing and other factors has led to significant depletion of woody biomass stock (Anderson and

Fishwick, 1984). High levels of population growth, the need for new agricultural clearing, dependence on woodfuel for all household requirements and excessive numbers of livestock and commercial logging cause the rate of depletion of the biomass resources significantly.

Deforestation is caused by such activities. The undue emphasis placed on woodfuel as the cause of deforestation has obscured the role played by other major causes. Wood cutting for energy use only becomes significant in the later stages of the deforestation process. This is after the forest recede, then the demand of the remaining trees grow and over time, only does fuelwood scarcities develop significantly.

There is increased awareness of the adverse ecological effects and social impact of large scale deforestation especially in rural areas. There are numerous reports of women having to walk further and further in order to collect fuelwood for their daily domestic needs. There is increased use of biomass, that might otherwise be used as fertilizer like maize stocks, as fuel, of families having to start purchasing wood or licenses for wood collection in forest reserves, of changing cooking patterns and traditions due to lack of adequate fuelwood supplies.

Some recent evidence indicates that the biomass cover in densely populated areas such as Rwanda and western Kenya, may actually be increasing (Anderson and Fishwick, 1984). Nonetheless, given the growing depletion of biomass supplies in Africa, it is unlikely that stabilizing biomass supplies at current levels is an achievable goal.

The agroforestry approach appears to have substantial advantages over traditional forestry practices. This includes the ability to achieve higher planting rates stimulated by commercial incentives, reduced need for public wood supply expenditure, enhanced soil fertility and fodder production for livestock, reduced demand for land and the most effective use of small areas for farmlands (Anderson and Fishwick, 1984).

Greater woodfuel scarcity in rural areas significantly increases the labor required of women and children for fuel gathering. These scarcities could be eased by adopting the agroforestry practices that include the concept of energy cropping which applies the cultivation of both wood and agricultural crops which is more comprehensive than that of wood plantations. The ultimate concern of energy cropping is the production or regeneration of the biomass upon which the particular woodfuel supply in question is based (Walubengo, 1986).

Although the fuelwood crisis has already reached serious proportions, sound technical and economic means exist both for reforestation and for improving the efficiency with which wood and other fuels are burned (Bansal et al, 1990). The heavy dependence on biomass fuels means that emissions from these fuels are an important source of indoor pollution especially in rural communities in developing countries. These emissions contain important pollutants that adversely affect health which include suspended particulate matter, carcinogens especially benzo-a-pyrene as well as gaseous pollutants, carbon monoxide, formaldehyde (WHO, 1984). The most identified adverse consequences for human health are chronic obstructive pulmonary disease, acute bronchitis and pneumonia because respiratory defenses are impaired (WHO, 1984).

The health hazards have effects that vary in type and severity depending upon the locality and probably the type of fuel and population at risk. The culture, customs and housing conditions of the population are important determinants of the level and nature of the risk. Indoor air pollution occurs in domestic settings and is increasingly becoming a major health concern due to its effects on both children and adults. In developing countries, mainly burning of biomass fuels in medium- and most low-income households causes it. Most of the cookstoves used in unvented kitchens do not direct smoke away from cooking area (Gathoga, 1991).

Exposure to large amounts of wood smoke may imply a risk to health, that is of a similar or worse order magnitude as if smoking 20 packs of cigarettes a day (WHO, 1984; Aggarwal et al, nd). This can lead to respiratory diseases like Acute Respiratory Infections (ARI) in children and Chronic Obstructive Lung Disease (COLD) in adults (Gathonga, 1991). In June 1984, the World Health Organisation (WHO) announced that respiratory diseases had become the chief cause of death in developing countries.

To alleviate this among other problems, the use of fuelwood can be made more efficient through the design and dissemination of improved stoves. Various simple and inexpensive improved cookstoves have been developed but they have not yet been widely disseminated. Benefits of improved cookstoves to convey the importance of fuel conservation is required to be propageted amongst low income families (Bansal et al, 1990).

2.2 COOKSTOVE TECHNOLOGY

Woodfuel is the major source of energy with over 80 percent of the general population dependent on it for most of their cooking and heating activities. About 70 percent of all the energy consumed in Kenya is in the form of firewood and charcoal (Kinyanjui, 1982). With an increasing population and the sustainable demand for new cropland, wood stocks are currently being depleted at a rate of about 40 percent greater than replenishment (Kinyanjui, 1982). Imbalance in woodfuel and supply in Kenya coupled with lack of foreign exchange due to the weakening of the shilling, in the wake of foreign exchange currency (FOREX-C) liberalization for petroleum based fuels necessitated the development of locally available sources of renewable energy. There have been efforts to increase afforestation activities and promoting woodfuel conservation technologies (Kinyanjui. 1982).

A lot of energy researches which were undertaken in Kenya during the 1970s and early 1980s showed that there was a growing gap between sustainable supply and demand (Karekezi and Walubengo, 1989). Increasing costs of oil prices prompted the initiating of wood energy based renewable energy conversion technologies. These efforts included introducing renewable energy conversion technologies such as improved charcoal kilns, briquetting of biomass residues and the wide scale dissemination of improved household and institutional cookstoves (Karekezi and Walubengo, 1989).

In the last 30 years, substantial effort has been made directed towards the modernization of fuelwood production and end-user technologies. One of the most substantial efforts has been the development of an environmentally-sound and efficient improved cookstove for rural and urban households and institutions in developing countries

(Karekezi, 1990). In Africa and other developing countries, the development of improved cookstoves have been produced with considerable vigor. It has been suggested that improved cookstoves are the most promising means of assisting the millions of people who depend mainly on woodfuel and are affected by its declining availability.

Cookstove programs have an estimated higher cost advantage as an immediate energy conservation measure over other activities. They provide direct benefits to participating households without having to wait for long. The task of collecting firewood is almost always the responsibility to the women and children. Therefore, as fuelwood becomes scarce and the user have to travel further and further away each time in search of firewood, more time is spent on this activity and more often than not, it reduces attention to other important involvement such as education, sanitation and nutrition (Khamati, 1987). In the rural areas, the bulk of the fuelwood needs for cooking are met by collection of dead branches, twigs, crop, and animal residue. Cutting of trees in a forest will be to create space for food production, grazing, commercial timber production and supplying fuelwood to institutional users who require bulk supply.

Since time immemorial man has lived his life making a fire after gathering firewood to keep warm, see with and cook his food. Over time with civilization, man's population has grown tremendously. Today, the human population has prompted change in lifestyle and firewood that was abundant has become scarce. They have learnt to care and conserve the little they have. It has been realized that only dead wood is collected where fuelwood is plentiful because it is lighter than green wood, easier to split and burns better. Though branches may be lopped off, whole trees were rarely felled merely to provide fuelwood. Under these circumstances, fuelwood supply and consumption will be in approximate equilibrium. With increasing population, the increasing fuelwood demand was met by extending the collection area. Eventually, people are not able to find fuelwood within walking distance after which collection is concentrated in an area, then further cutting starts to cause deforestation.

Improved cookstoves were developed because it was generally argued that they will save large quantities of fuelwood, thereby reducing deforestation and energy consumption at a national level (Burnes, 1985). For instance, the Delhi-based Centre for Science and Environment tried to justify this by saying in 1982 that just by doubling the energy efficiency of wood stoves, which is a miserable 5-10% at the moment, the country could half its then fuelwood consumption to about 75 million tones (Foley et al, 1984).

Open fires allow smoke to flow freely. In grass-thatched houses, the smoke forms a protective coating on the inner thatch that keeps insect pests away. The three-stone cookstoves classified as traditional cookstoves have been used against a background of low population making low demand on impenetrable forests thought to be an apparent eternal fuelwood resource. With time, natural and manmade changes have taken a heavy toll on this environment. Today's high population have resulted in the encroachment of forest areas for settlement and cultivation. Due to these, the improvement of these traditional cookstoves and the development of a cookstove to replace them is of immediate necessity. There is need to assess the advantages of the traditional cookstoves and adapt them appropriately to today's needs. The ideal cookstove should be more fuel efficient, reduce the gases produced and have most of the benefits of a traditional fire (Khamati, 1987).

2.2.1 PHASES OF COOKSTOVE DEVELOPMENT

Substantial technological development has been undertaken to design and improve the efficiency of traditional cookstoves (Parsad and Verhaat, 1983). These technical efforts have resulted in cookstoves, which use less fuel, produce the same amount of heat and are safer and more convenient to use. Traditional cookstoves are often simple but inefficient in terms of useful thermal output. Often, only 10-15 percent of the energy is utilized by such stoves (Vohra, 1982).

Improved institutional cookstoves are mainly used in hospitals, schools, restaurants and small hotels. The distinctive features of institutional cookstoves include cooking for large numbers of persons. The fuel used in institutional cookstoves is almost always bought often in large consignments which tend to facilitate the collection of the relevant fuel consumption data (Karekezi, 1993).

Improved cookstoves have evolved over the years taking different phase changes. At the different phases, approaches have been changed so as to be appropriate. The first phase started in the 1950s and was concerned with socio-economic aspects (Krugmann, 1987). The main objective of this early program was to uplift the living conditions of the poor majority in the third world countries through self-sufficiency and general emancipation. Therefore, socio-economic and cultural concerns of the end user, who was the woman, were at the centre stage (Karekezi, 1993).

The second phase started in the early 1970s and it brought together two groups, technologists and energy specialists (Karekezi, 1993). Technologists aimed at developing an acceptable and efficient cookstove while energy specialists were concerned with getting a solution to the woodfuel crisis which was then said to be a major contributor to deforestation (Eckholm, 1975). Work in this phase was driven by the rationale that linked cookstoves to dessertification. The rationale was that the dissemination of millions of energy-efficient cookstoves would reduce woodfuel consumption and lead to fewer trees being cut down to provide cooking fuel. This with the Oil Crisis in the early 1970s added vigor to work on improved cookstoves which was by then perceived as one of the most important intervention in the household energy sector (Karekezi, 1993). Therefore, there was extensive research and development and laboratory-based work. The main agenda here was both technical and scientific concerns replacing the socio-economic aspects. These concerns were perceived as more important than the needs and aspirations of the cookstove user.

The third phase that began in the 1980s saw the dissolution of the technical and scientific optimism. By then, substantial progress on how to define, measure and improve the performance of a cookstove had been made (Prasad and Verhaat, 1983). In the three development phases, the efficiencies of the various cookstoves have improved considerably. The first phase cookstoves; the open fires, had a heat transfer efficiency of between 5 and 10% (Krugmann, 1987; KENGO, 1993); the second phase cookstoves which included the Alpha Laval cookstoves had an efficiency of about 23.5% (Walubengo, 1988); and the third phase cookstoves, classified in this study as improved cookstoves, have an efficiency of up to 45% (KENGO, 1993). This significant difference should reflect on their performance when in use.

The improved cookstoves are of superior quality than the traditional cookstoves, which include Alpha Laval, and three-stone cookstoves. The improved cookstove main feature is its insulation case, which reduces the heat loss to the surface and improves the heat transferred to the cooking pot. The cookstove is also designed to be used by inserting the pieces of dry wood into the fire chamber and shutting the fire chamber door. On the door, there is provision for air inlet holes that can be opened or closed depending on the needs of the user. The holes are of a size that allows sufficient amount of air into the chamber for complete combustion of the woodfuel. This ensures that inserting excessive amounts of fuelwood pieces wastes no fuel. This feature ensures that there is minimal wastage of woodfuel by reducing the amount of pieces that can be inserted at any one given time. Complete combustion of the woodfuel reduces the amount of toxic emissions into the atmosphere thus contributing to the reduction of "greenhouse" gases.

The cookstove height is such that an average height person would not need a platform to be able to reach a comfortable towering height so as to cook in the cooking pot. Therefore, it is not too high to make it uncomfortable to cook in like Alpha Laval cookstove or half-drum used on the "two-column" traditional cookstove. Therefore it is easier to use and more comfortable than the traditional cookstoves.

Dissemination of millions of cookstoves, which had been thought to be achievable, had not taken place. It was realized that the link between cookstoves and deforestation was no longer as clear as was originally assumed (Foley, 1991). Clearing of agricultural land seemed to be the most important cause of deforestation and the establishment of a dissemination system, which was cost-effective and viable, was found to be very complex.

Research findings of a study carried out as recorded by Karekezi showed that there were aspects that were more important to the user than originally perceived. It was established that in rural areas the fuel needs for cooking was met by collecting dead branches, twigs, crop and animal residues eliminating the need to cut trees for this purpose (Karekezi, 1993).

The product of a research carried out was to improve the already existing cookstoves (Karekezi, 1993), to develop an improved cookstove, which have different brand names e.g. Bellerive Foundation SMP and Hoteli, KENGO institutional, and UNICOOKER cookstoves. It would be important to note here that the UNICOOKER products are very similar to Bellerive Foundation SMP and Hoteli cookstoves. This is because the UNICOOKER producer was trained at Bellerive Foundation while as an employee who later moved out and started his own business. The main distinctive feature of the improved cookstoves is their heat retention ability due to the insulating casing introduced into the cookstove. This increases the amount of heat transferred into the cooking pot thus the improved thermal efficiency of the cookstove.

The other needs and interests of the user that have gained significance are removal of smoke, cleanliness, convenience and safety besides cookstove efficiency (Joseph et al, 1990; Karekezi, 1993). Enhanced kitchen environment and functional design are increasingly becoming important components of improved cookstove programs. The third phase did incorporate the socio-economic issues with the technical and scientific aspects. Now, the users needs are tackled in a more knowledgeable manner technically and scientifically and an integrated approach to the cookstove issues is gaining greater acceptability.

2.2.2 SUCCESSFUL COOKSTOVE DESIGN

Traditional cookstoves have evolved in many parts of the developing world. In Kenya, light metal charcoal cookstoves called jikos are used almost universally. Metal cookstoves do waste energy due to poor insulating quality of their metal sides. Open fires, particularly lit outside the house in an open shed can be very inefficient in their fuel consumption, but a few simple measures can greatly improve fuel efficiency, for example, through shielding and tending the fire.

Putting an enclosure around a fire does improve it by protecting it from breezes and draught and directing the flow of combustion gases more closely around the pot, increasing the amount of heat it absorbs. Better, still, channelling the hot gases past more than one pothole can mean more efficient use of their heat. When cooking on one pothole, the others can be used to heat water or keep food warm. For an improved cookstove the dimension and relative positions of the fire chamber, gas passages and other stove parts have to be correct for a multiple hole cookstove to work efficiently. The efficiency of a poorly dimensioned cookstove or one that has deteriorated severely, may even be worse than that of a reasonably tended open fire.

By use of a hinged or sliding door to cover the firebox, the draught through the stove can be controlled for the fuelwood to burn properly and hot gases drown past the various potholes. So, the users may leave the door open, due to falling off or being damaged, while efficiency requires otherwise. In order for the firebox door to remain closed, the wood has to be cut to sizes that can allow for complete insertion. The cutting of fuelwood to desired lengths may add substantially to the work of the household and spend the time saved by collecting less wood for use on a more efficient cookstove.

To work well, a cookstove needs a chimney to help create the necessary draught and it carries the smoke away from the kitchen. Thus the ideal cookstoves should be more fuel efficient, reduce the poisonous gases produced and have most if not all of the benefits of a traditional fire (Khamati, 1987; Micuta and Haas, 1987).

2.3 THE ADOPTION OF TECHNOLOGY

Adoption of any technology is influenced greatly by users perception of a need and how it will be satisfied. There is great importance in establishing the need and how much of a priority it is. People using a cookstove are not only influenced by its efficiency but also by traditions and their economic levels and whether they buy or gather the fuel. Therefore, the process of successfully designing and marketing a cookstove is similar to that which successful manufactures of most consumer goods engage in before launching a product. A cookstove will only be bought if it is affordable, desired and perceived to be better. In the absence of concrete data and statistics on experiences with introduction and use of new devices, it is difficult to confirm the real nature and causes of the problems encountered in dissemination and adoption of appropriate technology in different areas (Mburugu, 1994).

There is need to establish good channels of marketing and promotions which will also be used for evaluation and monitoring the performance of the cookstove. Many cookstove programs are operating in virtually total ignorance of whether or not they are meeting their fuel saving objectives. It will be of substantial importance to know how wood is being saved as a result of using these cookstoves. It has been realized that most consumption surveys are usually carried out soon after the cookstoves have been disseminated and installed and the energy efficiency is usually maximum and this point in time, the users are conscious about fuel use and are eager to find out if the cookstoves will meet their anticipated results.

Past household fuel conservation projects have dealt primarily with improving end-use efficiency. The conventional wisdom has been that reduction of up to 50% in fuelwood was achievable. However, experience has shown that such large savings are difficult to achieve. Low public adoption rates of self-sustainability have led to few actually successful conserving cookstove programs.

There are no comprehensive surveys that have been carried out or at least documented to establish the energy savings of cookstoves after many years of use. The only thing that can be assumed with reasonable certainty is that such savings will usually decline with usage (Foley et al, 1984). At least it is hoped that cookstoves make it easier to save fuel or use the available supplies more efficiently and effectively. They eliminate or cut down health hazards of smoke and reduce the dangers of burns from embers, therefore, improved cookstoves mark an advancement in living conditions of the users.

The cookstove has to match the people's perception of their needs and be affordable, durable and have conserving ability. They are acquired for reason of reducing fuel consumption, reducing cooking time, improving the kitchen environment through reducing levels of smoke and reducing risks of burns, and cutting down on time spent on cleaning kitchen walls and utensils.

The most important target group, the poor, the understandably reluctant to adopt technologies that do not meet their perceived needs and are seldom consulted when projects, such as this, are designed. However, renewable energy technologies can successfully be adopted by poor people when they are involved in the planning and management of the projects and when projects can be profitable (Khamati, 1987).

So far, there is no shortage of smokeless cookstoves designs or of dissemination programs, yet there are no substantial evidences of widespread adoption of these cookstoves in the rural areas of developing countries. From the few that have been disseminated, complaints from cookstove users most frequently relate to design features that constrain the cookstove flexibility and in some areas, its supposed inappropriateness. Improved cookstoves are generally less flexible than traditional cookstoves since the latter can be operated on a wide variety of fuels and allows the user a wide choice of cooking options in terms of cooking pots. Improved cookstoves are designed with potholes to hold fitting cooking pots as closely as possible. Though this increases the efficiency of the cookstove during normal use, it limits its capability to accommodate a variety of cooking pots as in the case of three-stone cookstove.

From the study so far, the main obstacles to a successful dissemination program is lack of available cash to purchase the cookstoves and lack of awareness. It should be realized that technology on its own, no matter how good, is not an end in itself and until it is widely disseminated and accepted by users, it might as well not exist (Khamati, 1987).

Improved cookstoves show clearly how difficult it can be to disseminates even a simple technology. Most cookstove experts thought that they would go into a place, point out the advantage of the improved cookstove and that would be it. Experience however has shown that cookstoves can only be introduced where there is need and for need to be recognized, the level of public awareness plays an important role in introducing any technology otherwise the usefulness of any technology would not be realized. In developing countries, the development of improved cookstoves have evolved but which on the dissemination front have not had much success. This in effect has prompted the realization that it is necessary to regard the social point of view rather seriously in respect to new technologies, which would otherwise be viewed as being interference to the already existing technologies, which are usually familiar to the users.

Some of the characteristics of socially acceptable appropriate technologies include enhancement of the quality of life rather than merely to increase in the consumption of goods, blending rather than disrupting traditional technologies and fabrics of social life and reducing the women's work load and mobilizing their creative potential with an aim towards a greater degree of self-realization (Heidenreich et al, 1993).

3.0 METHODOLOGY

3.1 STUDY AREA

The research study area was Kisii and Nyamira Districts of Nyanza Province of Kenya. Nyanza province is among the most densely populated areas in Kenya. It has been reported that western, Nyanza and Central provinces are the most populated areas in Kenya (Figure 1) and are deficient in woodfuel and import it from other provinces (KENGO, 1983).

Kisii and Nyamira Districts are located in highland regions, areas which are of high agricultural potential hence support high populations. These population requires land for settlement, land to farm on and produce adequate food and wood for their energy needs. In a scenario like this, there is likelihood of competition for land between agriculture and woodlands.

Kisii and Nyamira Districts are located on the south western part of Kenya, covering an area of about 2,196 square kilometres (Makhanu, 1983). They are south east of Kisumu, the provincial capital of Nyanza and west of Nairobi, about 400 kilometres away by road. South Nyanza, Narok and Kericho (Figure 2) border Kisii and Nyamira Districts. The latter two districts have been split further ever since and now their neighbours are Trans Mara and Bomet districts respectively.

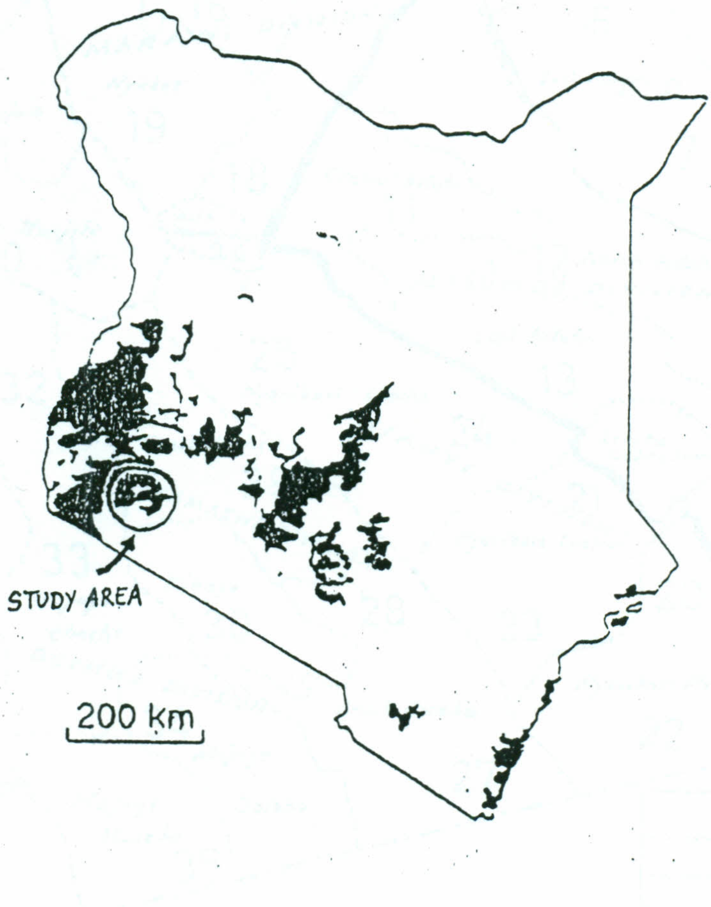

Figure 1: A map of Kenya showing the densely populated areas

Source: KIFCON, 1992

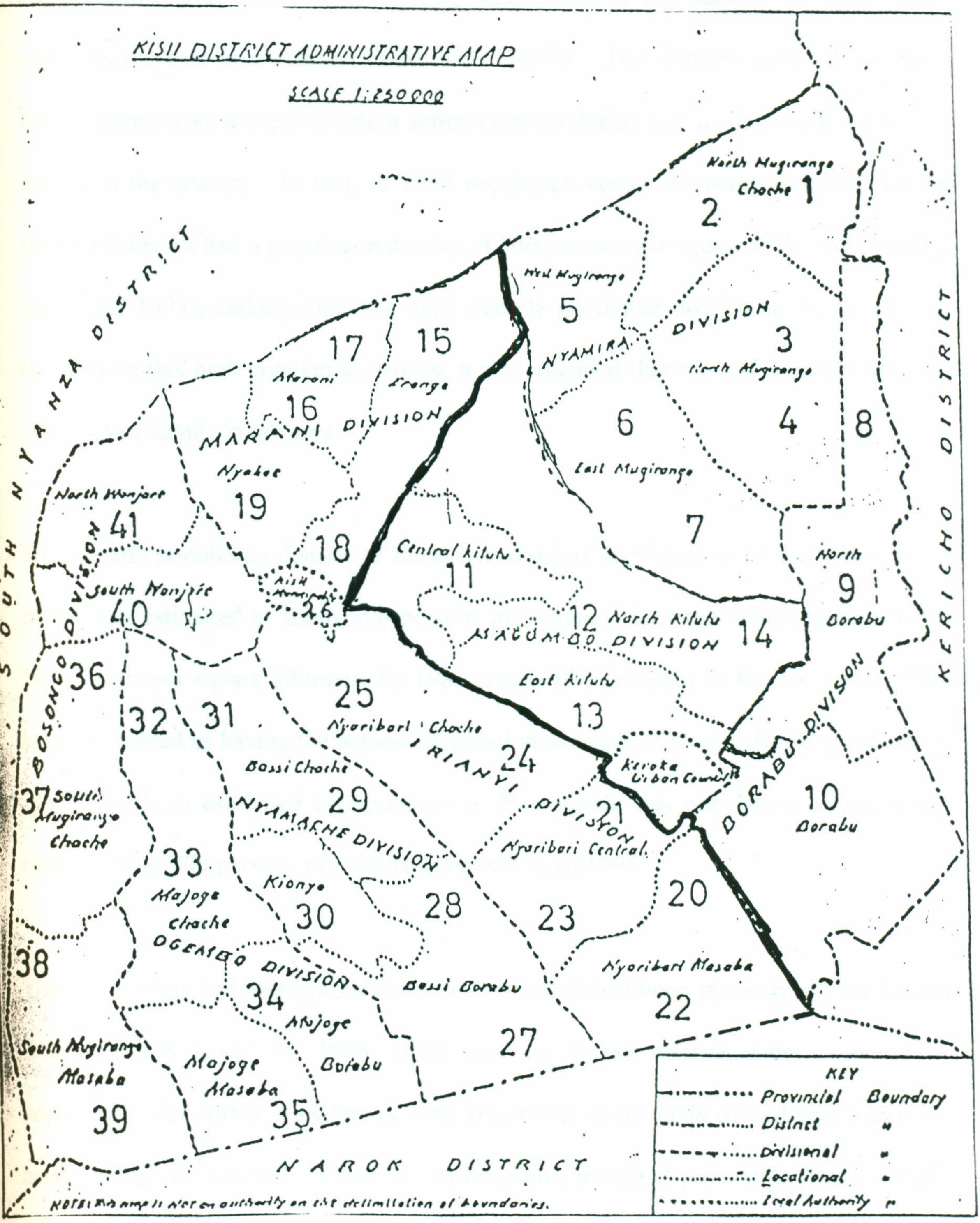

Figure 2: An administrative map of both Kisii and Nyamira Districts

Source: Government of Kenya, 1987

The study involved institutions found in the study area described. The two districts, until recently, were under Kisii District, hence most of the information documented combines the two new districts under Kisii District. The districts were selected as a representative area e experiencing a serious energy deficit due to their high population density in the country. In fact, in 1989 population census estimates indicate that the then Kisii district had a population density of 586 persons per square kilometer (Bradley and Huby, 1993), making them the most densely populated districts in the country so far. Due to this high population density, it was assumed that there is a severe shortage of woodfuel supply in the area.

The average population density of these two districts combined as of 1979 population census was estimated at about 396 persons per square kilometre which had grown to 586 persons per square kilometre by 1989 census (Government of Kenya, 1991). This has been quoted as having the highest population densities in Kenya (Bradley and Huby, 1993). With an estimated extrapolation at 4% growth, this population density could stand at about 700 persons per square kilometre as of 1995.

The two districts had Nyangweta forest reserve which had been seriously encroached on (Kilombo, 1983) and by 1986, there was no forest reserve either gazetted of demarcated. Any other woodlots existing are grown on privately owned land which are hardly enough for commercial use. From the above indicated population density, it can be realised that more pressure is being exerted on the land and the acreage per family is becoming less and less each year. This is because traditionally, the male offspring are entitled to a share of their parents' land where they themselves settle and raise their families. This reflects lack of land to grow communal woodlots that would otherwise supply fuelwood for use.

The area has at least 11 hospitals and nursing homes, 104 schools and colleges, and 12 hotels and restaurants making it a total of 127 institutions, that are offering catering services as illustrated in Table 1. The institutions indicated are those that offer catering food services but exclude kiosks which are made of temporal structures. These institutions are all potential buyers of improved cookstoves.

3.2 SAMPLING

The study targeted at least 50% of the institutions but about 61% of the institutions were studied. The institutions studied included mostly boarding and day schools, hospitals, hotels and restaurants that were well organised and located in permanent premises and not small *Jua Kali kiosks.*

Personal interviews were held with District Education Office personnel in charge of statistics to determine the number of educational institutions and their respective locations (Appendix I). These information classified the institutions as either colleges, secondary, or primary schools within the district. The other institutions such as hotels., restaurants and hospitals were mainly identified by physical count throughout the two districts and without knowing if they were using improved cookstoves or not. All that was required was to determine if the institution used a cookstove or not.

Table 1: The Institutions that are offering catering services in the study area: Kisii and Nyamira Districts

Type of Institution	Hospitals	Hotels & Restaurants	Schools	Others - Colleges	Total
Number of Institutions	11	12	97	7	127

From the list generated, each institution was assigned a number randomly and identical pieces of papers were written the corresponding numbers. The pieces of paper were in turn rolled into identical paper balls. Then out of a total of 127 institutions, 77 of those were randomly picked to represent 60% of the total sample. The minimum number targeted for the study was 50% but since the population sample was not too large, a sample of 60% was used. In Nyamira district, questionnaires were administered to 33 out of 50 institutions, which offer catering services, whereas in Kisii district, questionnaires were administered to 44 out of 74 institutions, making it a total of 77 institutions in all.

Table 2 shows target institutions in the two districts by category and those involved in the study. It further gives the number of institutions used in the survey and those surveyed without the improved cookstoves. Those without the improved cookstoves did not have even a single unit. These institutions studied included mostly boarding schools, day schools, hospitals, hotels and restaurants that are well organized and located in permanent premises and not small Jua Kali Kiosks.

Once a sample list had been generated,. the interview process began. The questionnaires were administered personally so as to improve the response time and also be able to observe the cookstoves, their condition, the kitchen environment and the sizing and storage of the fuelwood. The sample selected had institutions that had users and non-users of improved cookstoves. Even though the study area covered two districts, for purposes of this study, they were treated as one because the two had just been split (by the time of carrying out the survey) and any information available had

Table 2: Target institutions and those used in the survey by category in Kisii and Nyamira and districts

Type of Institution	Total Number	Institutions used for the Survey	Percentage of Total	No. With Improved Cookstoves	% With Improved Cookstoves in the Survey	No. Without Improved Cookstoves	% Without Improved Cookstoves in the Survey
Hospitals	11	10	90%	6	60%	4	40%
Schools	97	53	54%	35	66%	18	34%
Hotels & Restaurants	12	10	83%	1	10%	9	90%
Others - Colleges	7	4	57%	2	50%	2	50%
TOTAL	**127**	**77**	**61%**	**44**	**57%**	**33**	**43%**

them combined. Those institutions that were using the improved cookstoves were 44 whereas those not using them were 33 institutions.

3.3 DATA COLLECTION

3.3.1 RESEARCH INSTRUMENTS

Introduction letters where drawn to heads of institutions and department heads (Appendix I, II). This letters detailed the need to be permitted to carry out research in their institutions; briefly outlining the purpose of the study, hence the need for their contribution towards the study.

Three sets of research questionnaires were prepared for the targeted study groups. These were used as the research instruments. The first set of questionnaires was for cateresses and administrators of the study institutions (Appendix III) which gathered data on costs of cookstoves systems in use, purchasing procedures, benefits, if any, accrued from use of the cookstove, source of their information on the cookstoves, and fuelwood supply situation as viewed by the administration.

The second set of questionnaires was for kitchen staff, mainly cooks, (Appendix IV) which gathered information on how user friendly the system was, establish the advantages and disadvantages of using improved cookstoves as compared to traditional cookstoves and if it is easily adaptable to existing kitchen set-ups.

The third set of questionnaires was for the cookstove manufacturers and disseminators. Questionnaires for manufactures-cum-disseminators (Appendix V) were used to gather data on design parameters, marketing strategies employed by them to disseminate their products, back-up support they offer their clients-after sales service, terms of selling agreements, market areas targeted and achievements so far.

In addition to the questionnaires, observations were made by the interviewer and recorded as the interviews were going on. This covered the areas of general layout of the improve cookstove in the kitchen, the use of the cookstoves, condition of the cookstove, fuelwood preparation and utilization, food preparation and general kitchen environment

3.3.2 FIELD DATA COLLECTION

Each sample institution was visited once or twice depending on if an authoritative person was available on the first visit to sanction the interview. Failure to meet such persons meant booking an appointment later and requesting for permission to carry out the survey in advance, after which the questionnaires were administered to the respondents. An introduction letter was given to the heads of institution which detailed the purpose of the visit and seeking permission to carry out the research in their institution (Appendix II). Once the institution administrators had granted permission to carry out the interview, the interview session then began with the kitchen staff, mainly the head cook.

Before administering the questionnaires, the interviewer would explain the purpose of the study to the respondents, assuring them the information sought was purely for academic purposes and not some investigation from the Ministry of Health, Inspection Unit, and that the name of the institution would not be indicated in the report. Once they realized that it was a friendly assignment, they were able to freely respond to every question asked and express their feelings on the condition of their cookstoves and what they generally thought about them.

The interviewer then gave a copy of the questionnaire to the respondent to read and answer verbally while responses were recorded. If the respondents were not able to read and/or preferred that the questionnaire be read to them, then the interviewer would read out the questions and record their responses. This was usually done in a language best understood by the respondent, which was either Kiswahili, the local language, i.e., Ekegusii, or occasionally English. Most of the cooks were more comfortable with Kiswahili and/or Ekegusii languages. This was possible because the researcher was fluent in the three languages. The respondents preferred that the questions be read to them and their responses recorded.

The first set of questionnaires to be administered was for kitchen staff (Appendix IV). It became appropriate to carry out personal interviews because most of the kitchen staff were not able to communicate in English hence the need to use a local dialect that the interviewer was conversant with. Observations were recorded on the status of the kitchen, the cookstoves and the ventilation of the cooking area. Still pictures were taken of some of the cookstoves while in use.

The next set of questionnaires was for the administrators and cateresses (Appendix III) who were able to read through the questions themselves as the researcher recorded their responses. Most administrators did not have accurate information on the cookstoves and their operation, preferring to refer some questions to the cateresses or head cook. They also did not seem to have kept any proper records on their kitchen expenditure to quantify how much they spent on purchasing their fuelwood. They were doing it in a random manner and at different pricing, making it impossible to determine the costs. It was not clear whether that was a deliberate attempt not to be accountable or not but it seemed a common practice in all institutions.

Besides the responses to the questionnaire, physical observation of the cookstove condition, its operations, woodfuel preparation, the woody biomass surrounding the institution, and other unique relevant observation were recorded. While in the kitchen, some photographs were taken of the different cookstoves in use and the woodfuel available for use, and others showing some of the users while using the cookstove.

In relation to the amount of wood used, the quantities given were expressed in terms of truck loads which were variable but assumed to be of some weight. None had any record in kilograms or tonnes. Those using wood from their own woodlots were not able to quantify their usage. However, for those who had changed to using improved cookstoves did acknowledge reduction in amount of wood used which was of a small fraction as compared to the former cookstoves.

The third set of questionnaires was for the cookstove manufacturers and disseminators (Appendix V). It was administered to 3 manufactures; The Bellerive Foundation, Nairobi, Kenya Energy and Environment Non-Governmental Organisation (KENGO), Nairobi and UNICOOKER Ltd, Kisii. These manufacturers are independent producers and distributors who were the primary source for cookstove construction and installation. These disseminators got involved in the cookstove technology to improve on the existing cookstoves; to come up with new cookstove designs which would reduce the amount of fuelwood needed for a given activity, through domestic and institutional use.

Persons interviewed were the technical and marketing personnel who are involved in the direct production and selling of these cookstoves. Those interviewed were given a copy of the questionnaire but chose to respond verbally as the researcher recorded their responses. They were more accurate on their responses especially on the costing because they were keen on the costing and were continually working towards reducing their costs of productions. This is because cost of purchasing the cookstove unit was of critical importance for them to be able to sell their products. However, they did not have standardized pricing, choosing to deal with each client as they came.

4.0 RESULTS AND DISCUSSION

4.1 GENERAL DATA & OBSERVATIONS

The study aimed at evaluating the utilization of energy saving cookstoves, in particular the improved institutional cookstoves, as an end-user technology. Different institutions were visited and by use of two sets of questionnaires (Appendices III and IV), background information was obtained on location, population sizes, types of fuel, and type of cookstove used. This information has been used to classify and group the data received for analysis and to make any responses to the study. They were classified under schools, hotels and restaurants, and others (colleges and technical institutes).

Table 2 shows low application of improved cookstoves by hotels and restaurants as well as colleges. This is because the cooking needs of restaurants and hotels vary from those in other institutions. In these institutions, meals are prepared as ordered, implying that the amounts of food required are in small quantities requiring a lot of flexibility in respect to the kind of cookstove to be used. This means hotels and restaurants are still maintaining use of either charcoal, three-stone, two-column, gas, and electric cookstoves depending on their financial abilities, location and clientele and hence low adoption of the improved cookstoves.

Table 3 shows the average population distribution of institutions sampled for the study. The figures indicate that the mean population for the sampled institutions was 201-300. Others were of the ranges 101-200 and 501-600. Therefore the populations were large

Table 3: Average number of persons catered for in the institutions involved in the study

Range of Population	Number of Institutions	Percentage
0-100	9	11.7%
101-200	14	18%
201-300	15	19.5%
301-400	9	11.7%
401-500	6	7.8%
501-600	11	14.3%
601-700	3	3.9%
701-800	6	7.8%
Over 800	4	5.2%
TOTAL	77	100%

enough to justify the usage of large capacity cookstove. 17% of the institutions had populations of over 600 persons with another 12% catering for a population of less than 100 persons. 38% had a population of between 100 and 300 persons, these accounting for the majority institutions.

Table 4 shows the types of cookstoves used with their corresponding usage period by 1994. The improved cookstoves were of two distinctive types. One type was large capacity cookstoves namely the Bellerive SMP, UNICOOKER institutional, and KENGO institutional cookstoves. They had cooking pots with capacities varying between 80, 100, 120, 150, 180, 200, 250 liters. The other smaller capacity cookstove was the Bellerive Hoteli with a capacity orange of 10, 15 20 liters. This were all multi-pot, that is, they had 2 pots each. They had a common fuel feeding door and chimney but two separate pot holes.

Most institution had more than one type of cookstove, that means that the percentages given will not necessarily add up to 100%. For instance all the Bellerive foundation *Hoteli* cookstoves units, except one, were owned by those institutions which had Bellerive foundations SMP cookstoves implying that the net percentage for improved cookstoves is marginally less than 73%. Other users had all the types of the cookstoves hence distorting the exact picture of the percentages of each type of cookstove in use. However, they were not necessarily using all the cookstoves at the same time. Population variation made the shift between traditional cookstoves and improved cookstoves since the latter which are of large capacity are economical to operate only when their application is 75% or more. Overall, the data collected shows that a very

Table 4: Cookstoves that are in use in various institutions of Kisii and Nyamira Districts

Type of Cookstove Group	Type of Cookstove	Number of Institution	Percentage of Users
Improved	Bellerive SMP, UNICOOKER, and KENGO	56	73%
	Bellerive Hoteli	10	13%
Traditional	Alpha Laval	21	27%
	Three-Stone and Two Column-Stone	21	27%
Others	Gas Cooker	13	17%
	Charcoal Jiko	10	13%
	Electric Cooker	6	8%
	Steam Boiler	3	4%

NB: More than one response per cookstove group was allowed.

good number of survey institutions had at least purchased one unit of the improved cookstove as shown by user percentage.

Many institutions are changing their cooking systems from electricity or fossil fuels to woodfuel with an effort to save money and improve the reliability of supplies. Fuelwood is readily available hence its supply is more predictable and cheaper as compared to other types of fuels. Government hospitals recently received a directive advising them to abandon gas cookers in favour of wood (KIFCON, 1992). Many institutions which have been using gas are also known to be experiencing difficulties guaranteeing fuel supplies for their cookstoves hence the conversion to wood burning systems is wide spreading. However, population growth in institutions and change from other cooking systems to woodfuel cookstoves will both lead to an increase in demand in wood products. Many institutions already burning fuelwood are installing more efficient cookstoves which will reduce consumption to some extent to counter the increasing demand..

Traditional cookstoves are still in use but in small numbers, with both Alpha Laval and the stone cookstoves accounting for 27% a piece. This could be attributed to the durability of these kinds of cookstoves which had survived up to the time of this survey. Since they were still useful, the institutions could have found them worth retaining even though they may not be used as the main cookstove systems.

Three-stone and two-column cookstoves did constitute an ownership percentage of 27%, but it was observed that it was a stand-by system for most institutions since there were already other cookstove systems in place like gas cookers, electric cookers improved cookstoves and charcoal *jikos*. The three-stone and two column-stone were the oldest of all the cookstoves in use. It is important to note that these cookstoves were not in constant usage. Some of them were housed in temporal structures implying that they may be in use occasionally and thus were used as a standby cookstove.

Most of these users cited inconsistency in fuel supply such as cooking gas and paraffin as the reason why they still maintained traditional cookstove on stand-by. Those who were using the three-stone and/or two column-stone cookstoves as their only cookstove system accounted for 4% of the total institutions sample and it was noted that these institutions were serving only one meal e.g. lunch only.

Table 5 shows different types of cookstoves used by the institutions involved in the survey with their corresponding usage period. The usage period corresponds with the time the cookstove unit was purchase in reference to 1994, which was the time the survey was carried out. It is important to note that an institution could be using one or more types of cookstoves at any given time depending on their supply of fuel and population catered for. Most of the cookstoves were well kept with their general condition being good or very good indicating that were likely to be operational for long before they could be rendered useless.

Seventy three percent of the institutions in survey had purchased at least one improved cookstoves unit. Their cooking requirements are similar especially in terms of capacity.

Table 5: The type of cookstoves used by the different institutions sampled with their corresponding usage period

Period of Usage (Years)	No. of Users of Improved Cookstoves	No. of Users of Traditional Cookstoves	No. of Users of Other Cookstoves
0-2	18	8	3
2-4	23	10	1
4-6	13	13	3
6-8	3	5	0
Over 8	4	3	0
TOTAL	**61**	**39**	**7**

NB: There were users of both improved and traditional cookstoves who had purchased more units of the same cookstoves at different times, hence higher number of totals than the number of institutions used in the study.

They both prepared large quantities for their clients hence using the improved cookstove gives them the advantage serving the population better.

There are differences in percentages between ownership and usage because there are those institutions who owned several cookstoves systems but not necessarily use all of them depending on the fuel supply and its availability.

The low figures of improved cookstoves which had been used for more than 6 years signifies the period when they were being launched into the market. The increased number of improved cookstove in the last 6 years implies an improvement in dissemination and adoption. The overall condition of these cookstoves was good or very good for all the cookstoves involved in the study. Only one improved cookstove which had been used for over 8 years had been rendered useless due to damages on the outer metal sheet while the cooking pot was in good order.

The traditional cookstoves are the oldest types and are classified under the first phase of the cookstove development. Alpha Laval cookstoves were manufactured during the second phase of cookstoves development for use in institutions, whereas the improved institutional cookstoves are as a result of further improvements on the second phase cookstoves and are classified as the third phase of cookstove development.

The pictorial representation of the various types of cookstoves in use in different institutions are shown in the Figures 3-8. The first phase generation cookstoves are the

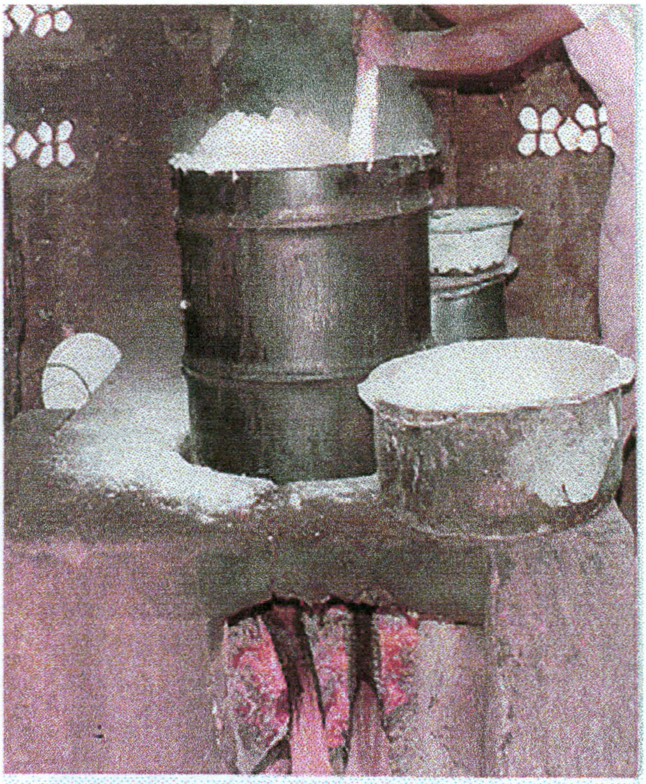

Figure 3: Photograph of a traditional “two-column” cookstove

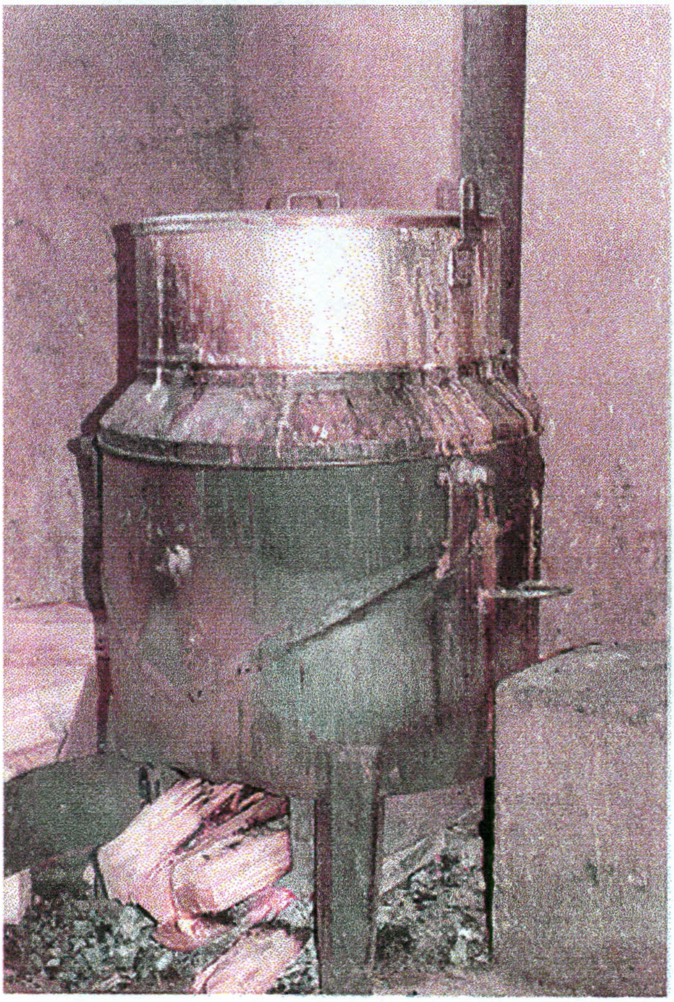

Figure 4: Photograph of an Alpha Laval Cookstove

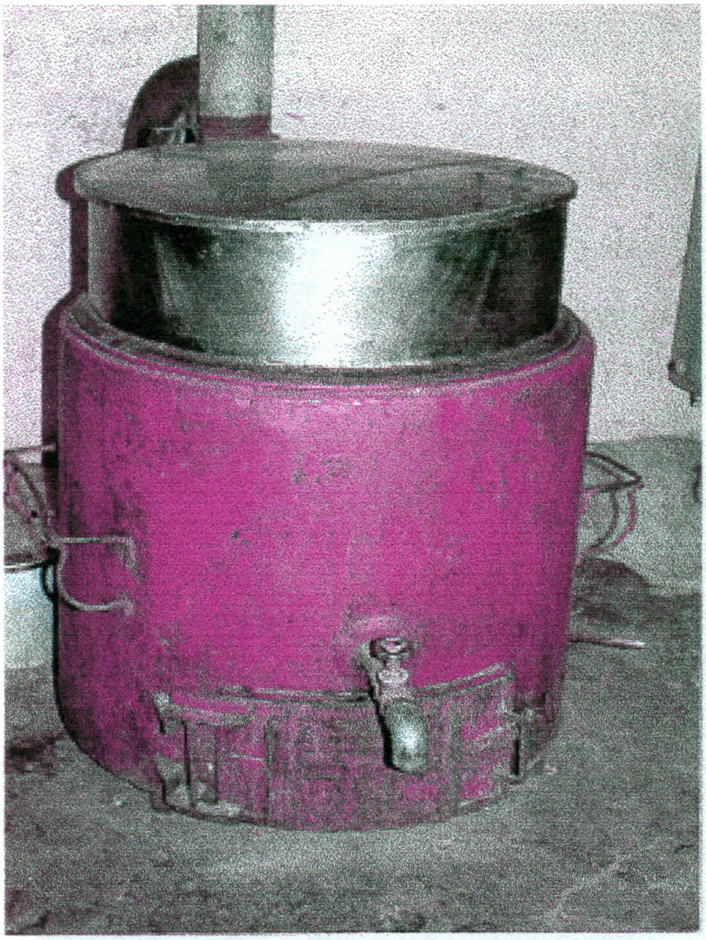

Figure 5: Photograph of an Improved Institutional Cookstove; UNICOOKER Tap-type

Figure 6: Photograph on an Improved Institutional Cookstove; UNICOOKER

Figure 7: Photograph of an Improved Institutional Cookstove; Bellerive Foundation - SMP

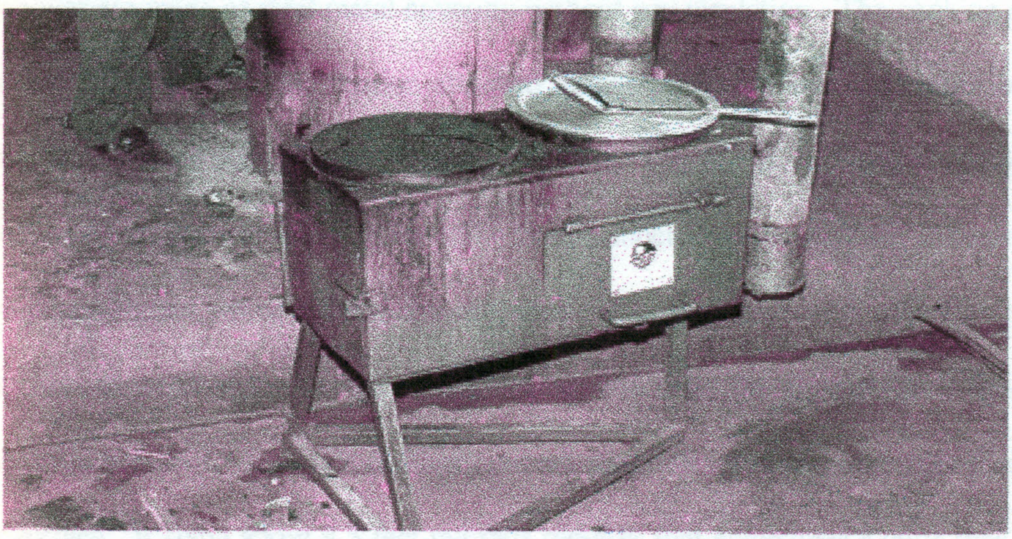

Figure 8: Photograph of an Improved Institutional Cookstove; Bellerive Foundation - *Hoteli*

oldest used and are referred to as two-column and three-stone cookstoves. The two-column is an improved typed of the three stone cookstove, shown in Figure 3.

The fire in the cookstove shown in Figure 3 has an open fuel feeding compartment. Its fuel feeding compartment is generally wide open allowing usage of large logs or pieces of wood. This way, the amount of fuel used is unlimited. The open fire emits smoke into the kitchen area because the exhaust gases are not channeled out completely. The support base for the cooking pot is made of cement and fixed to the ground. The cooking pot is placed on the support base hence not very stable because it can tilt off balance. This poses a danger of the hot food burning the cook. The fitting of the cooking pot into the support base is not very accurate, therefore the smoke finds its way round the cooking pot and does become irritating during usage.

The cookstove in Figure 4, Alpha Laval, is a product of the second phase of cookstove development which were commonly used in the 70s and early 80s. The Alpha Laval cookstoves are made of steel metal covering without any insulation. The cooking pot is in-built and tilt at its middle section attached hinges. This allows for pouring out of beverages easily and even scooping out cooked food. The fuel is feed at the bottom into an enclosed fire chamber with a door. The fire chamber is suspended and it contains a lower compartment which collects the ash which is emptied regularly. The cookstove has a chimney attached at the back to channel out and away the exhaust gases from the combustion chamber. It stands on four support stand on its own hence raised off the floor surface. It stand about 4.5 feet tall thus requires that sometimes a cook may need to stand on a raised level to cook. The lack of any insulation implies that lot of heat is emitted off the surface of the cookstove during usage.

The cookstoves shown in Figures 5, 6, 7 and 8 are classified as improved institutional cookstoves. These are the UNICOOKER tap-type, UNICOOKER non tap-type, Bellerive SMP and Bellerive *hoteli* cookstoves. They are products of the third phase of cookstove development. It will be important to note that the difference between the UNICOOKER tap- and non-tap types is that the tap type is used to prepare beverage whereas the non tap type is used to prepare other more solid foods that can not be poured necessarily.

Figure 5 shows a UNICOOKER tap-type of the improved institutional generation. The cookstove has an insulation covering the maroon painted part (covering the lower part of the cookstove) with the non painted part (top part) being a section of the fixed cooking pot. The tap at the front is used for pouring out or tapping the fluids. This is usually the beverages or water. Just below the rap is the fire feeding compartment whose hinged fire door is shown closed. On careful examination, there are two covers mounted on the door with holes perforated on them, used for air flow control. Attached at the rear is the chimney which is usually connected to the outside of the kitchen area. That ensures that no smoke is emitted into the kitchen area.

Figure 6 shows another type of the UNICOOKER type cookstove. This cookstove also has an insulation. It is made of the unpainted stainless steel sheet metal cover. It has a removable cooking pot with attached handles on either side. Its fire feeding compartment and door are the same as Figure 5. In addition, the chimney has an extra feature. It has a larger lower base that the upper part. The lower base is large because it is an enclosure round the chimney base which has both an inlet and outlet for water piped through it. The water utilises the heat from the hot exhaust gases as they are expelled out. The lower left part of the chimney shows some plugs without a tap attached. Note that by the time of taking the photograph, the water piping was not complete yet.

Figure 7 shows a Bellerive Foundation - SMP. Very similar to the UNICOOKER on Figure 6. The fire door is shown open and the air inlets are visible. In the cooking pot, the water level is visible indicating how full it can be filled. The insulation covering is also made of stainless steel. Other features are same as a UNICOOKER institutional cookstove.

Figure 8 shows a Bellerive Foundation *Hoteli*. This is one of the smaller capacity improved cookstoves. On the left side of the cookstove, we can see an empty pot slot. On the right is the chimney channel. The fire door is shown with a Bellerive Foundation label on its closed position. During usage, both the pot slots are supposed to contain pots otherwise smoke will be emitted through any unoccupied slot. Because of its size and feeding orientation, fuelwood pieces used must be small and of fitting size so that the fire door remains closed like all other improved cookstoves.

4.2 USE AND MISUSE OF COOKSTOVES.

During the survey process, observations were made during the actual operation of the cookstoves and a few photographs taken of the same. This presented an opportunity to record the cooking procedure as carried out by the users in relation to what the manufacturers advised. Figure 9 shows a cookstove being used appropriately. It has the cookstove fire chamber door in place and closed while the cookstove is in use. On the lower part of the chimney, it can be noticed that the chimney appears wider. That part is a water heater chamber which uses the hot exhaust gases to heat the water which can be used for cleaning of utensils, cooking and drinking. The wider part of the chimney is a cylindrical enclosure which holds water piped into it from the top and releases it from the bottom placed side tap. Once the cooking is done the food remains covered and the fuelwood that is not yet consumed is removed leaving the hot charcoal to keep the food warm.

Closing of the fire chamber door ensures that the air flow unto the combustion chamber is regulated. This allows for total combustion of the fuelwood and minimising heat losses by convection. Otherwise draught will cause carrying the heat away from the pot by blowing it towards the chimney and eliminate the heat circulation round the cooking pot which also causes fuelwood wastage. With control on air flow, the heat is able to circulate round the cooking pot, fuelwood burns slower thus reducing wastage. Covering the cooking pot helps retain the food heat and increase pressure in the pot which allows for faster cooking reducing the time taken to prepare a meal, hence less fuel consumption.

Figure 9: Photograph of an Improved Institutional Cookstove - UNICOOKER - being used appropriately

The cookstove usage shown in Figure 10 is an example of inappropriate usage of the cookstove because the cooking pot is the wrong size and is placed in the wrong position. Notice that the users have removed the right size cooking pot and inserted a smaller size pot and put in pieces of wood to act like supports. From the picture it is evident that one person is supporting the cooking pot by use of pieces of fuelwood whereas the second person is cooking. These pieces of wood are placed on the cookstove insulating lining. This kind of usage is very likely to cause damage on the lining through foods or fluids spilling onto hot lining surface. This will either cause super cooling effects on that surface or create hot spots which could cause cracking thus reducing the useful life of the cookstove.

The users are exposing themselves to dangers of getting burns from unprotected embers which the cookstove designers are actually trying to eliminate by having an insulating lining between the cooking pot and the outer casing to reduce the surface temperature on the cookstove casing. This kind of application introduces smoke into the kitchen, a thing that had already been eliminated by the improved cookstove design by use of a chimney. The use of logs of wood, as shown in the picture on Figure 10, also double as fuelwood for cooking which in effect means more fuelwood is burnt than necessary hence being wasteful. This negates the otherwise fuel saving by use of an improved cookstove.

The users of the cookstove displayed on Figure 10 were among the respondents who were not able to identify positively the advantages of using an improved cookstove because of inappropriate use of the cookstove. In the displayed application, the users

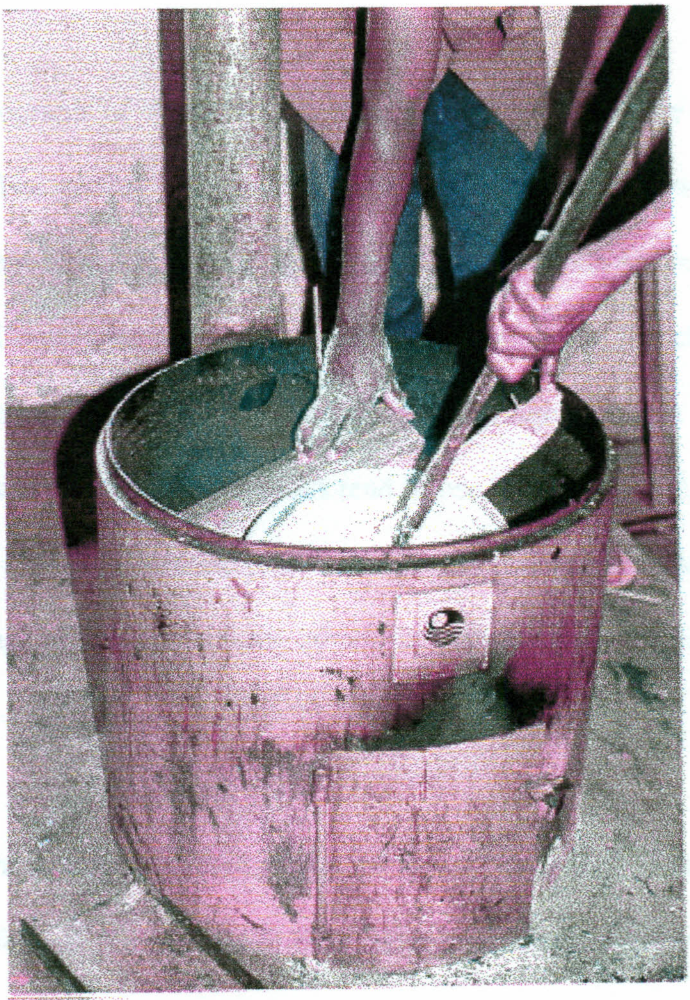

Figure 10: Photograph of an Improved Institutional Cookstove - SMP - being misused by placing a wrong size cooking pot on the lining with log pieces as supports for the pot.

expose themselves to the danger of sustaining burns from the unprotected embers, there is the danger of damaging the lining if it cracked, there is too much heat loss through use of a small pot hence side losses, misuse of fuelwood.

The photograph of Alpha Laval, Figure 11, shows the fire grate and fire chamber missing. The missing parts had been worn out but no repairs were undertaken since the cookstove was still functional hence the parts were lying around or had been misplaced already. Consequently, the space right below where the fire chamber was supposed to be, is being used as an area to feed the fuel through. Without a confined fire chamber, the users who are usually the cooks tend to use big chunks of fuelwood and hence being wasteful. There is also excessive heat losses and uncontrolled burning of woodfuel. Any savings which could have otherwise been realized by use of the cookstove are negated.

The shown fuelwood feeding allows for flow of smoke into the kitchen area, makes the outer surface of the cookstove dirty as seen on the cookstove with soot, and causes burning the outer covering sheet metal. Warping seen on top of the lower end of the cookstove evidences the effects of burning the sheet metal.

Smoke that is emitted is not directed into the chimney but gets its way into the kitchen area. The smoke makes the kitchen look dirty and the cookstove looks aged and poorly maintained. Cookstoves are designed to operate with chimneys and can not function properly without good chimneys. A chimney allows exhaust gases to exit through and promotes an adequate and steady draught. A draught is the differential between the

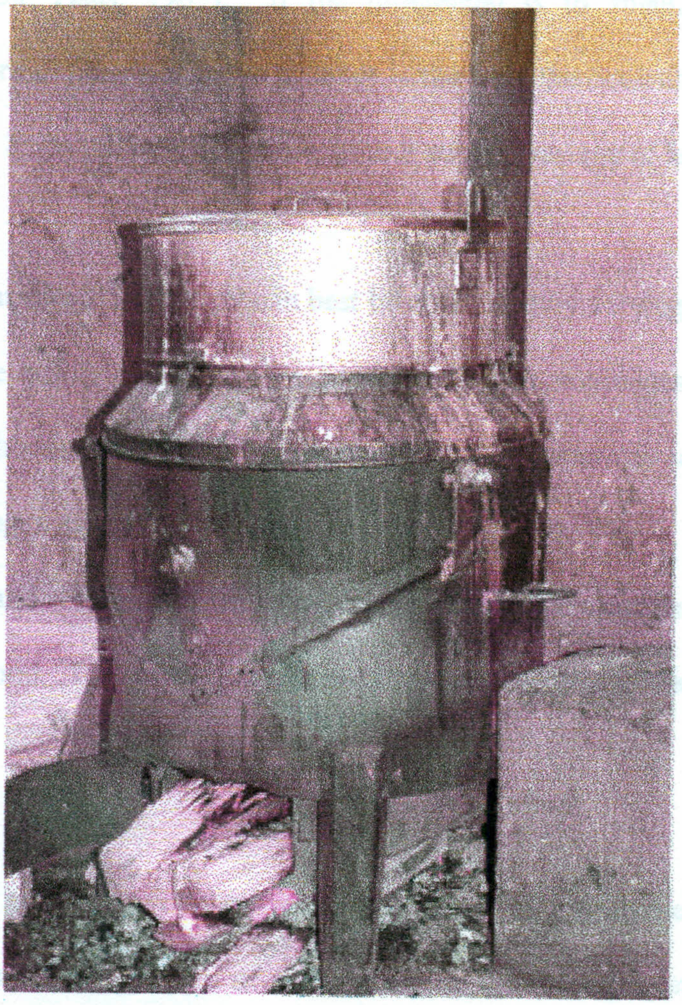

Figure 11: Photograph of an Alpha Laval cookstove without a fire chamber door and grate because they have been worn out or broken.

density of hot gases in the combustion chamber and the ambient air above the chimney (Micuta and Haas, 1987). If the differential is to small, which means that the temperature of the gases in the chimney is too low, the cookstove will cease to function correctly. If the differential are too large it causes wastage of heat and thus fuel.

The regulation of the draught can best be controlled by varying the volume of fuelwood and by the inflow of air into the cookstove. This underlines the importance of well designed fire chamber doors and the ability of the operator to use them correctly. In all cases, using a cookstove without controlled draught causes wasteful combustion of fuelwood and very little of the heat generated is actually transferred into useful energy to cook the food. This way, a lot of smoke that is generated is discharged into the kitchen area.

Therefore, poor usage of the fire chamber door has negative effects on the cookstove performance. The absence of a fire chamber door creates an air inlet with a larger surface area than the chimney's column cross-sectional area. Once the fire has been lit, the air in the chimney column gets hot and since it becomes lighter than cold air, it moves up the column and out. Since the chimney has a smaller cross-sectional surface area than the fire chamber door coupled with less densely air in the chimney column, it cause a suction effect within the system. That kind of effect prevents the hot air from circulate round the cooking pot enabling even transfer of heat. It further causes the woodfuel to burn faster and wastefully than necessary and generally cause a "blow-by" effect as shown in Figure 12.

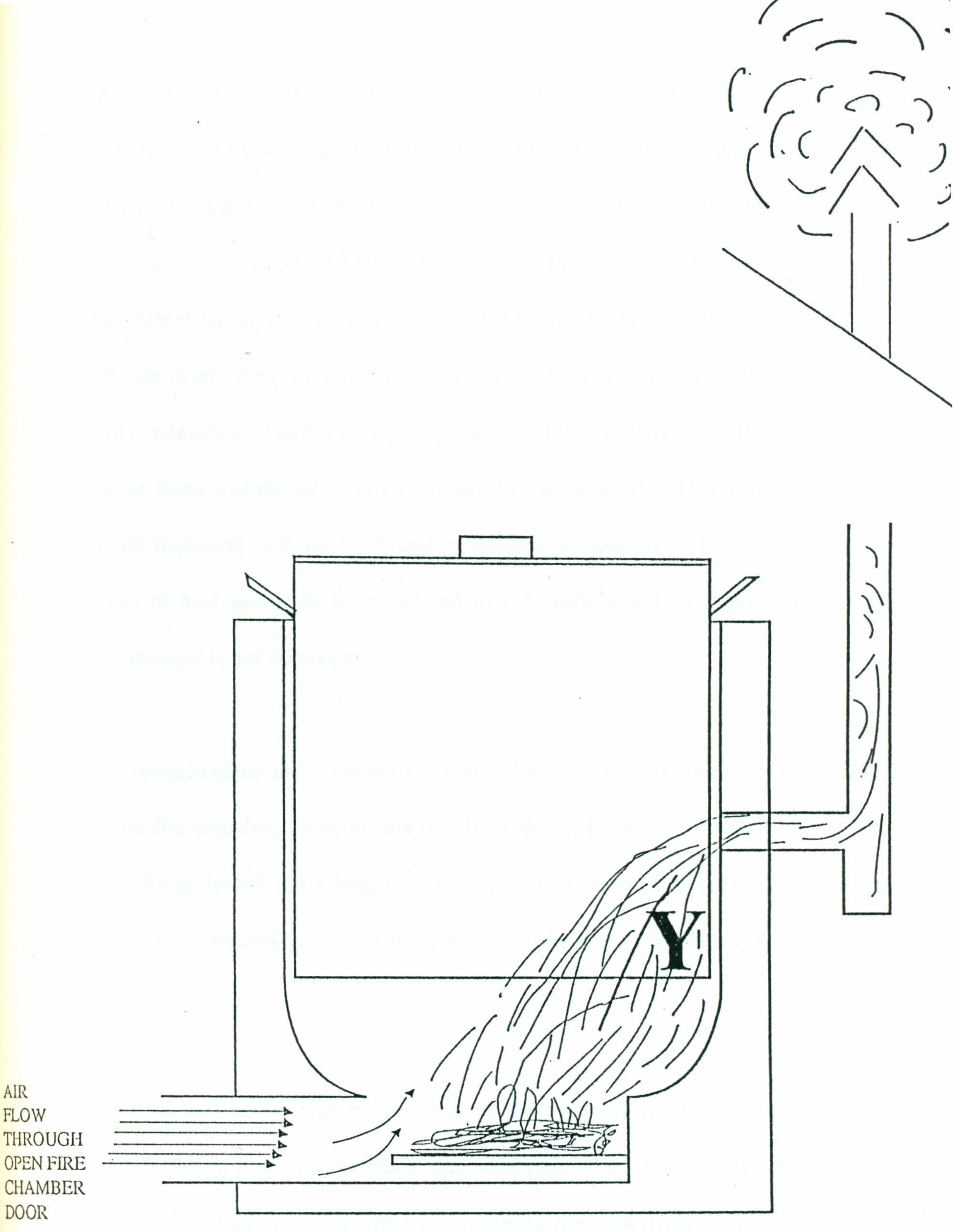

Figure 12: Sketch diagram of an improved institutional cookstove being used with the fire chamber door open showing a "blow-by" burning effect.

This causes excessive and uneven burning around the part marked **Y** which could cause food to burn around that area. This is against all intentions of the manufacturer when designing the cookstove for use. The cookstove is designed in such a way that the fire chamber door should be closed but with the small air inlet holes on it open, fully or partially, during usage as shown in Figure 13. When the door is closed with the air inlets on the door open, only the necessary amount of air is sucked in, enough for complete combustion. The hot air goes up and round the cooking pot transferring lot of heat before being channelled through to the chimney column. This way a minimum amount of fuelwood will be used and consumed completely. This way a higher percentage of heat generated is transferred to the cooking pot as opposed to a case when the draught is not controlled.

The door being in place also regulates the size and weight of wood pieces that should be used in the fire chamber. This means that if small, light, and dry pieces of wood are used then the grate will last a long time as opposed to when large pieces of wood are used which exert excessive amount of pressure on the grate especially when it is very hot.

In conclusion, fuel saving was proportional to the usage of the improved cookstove. For example, taking two extreme cases, one institution which did not acknowledge any significant fuel savings was observed to be misusing the cookstove. This was done by the cooks who did not follow the instructions given by the disseminator and did not have a cateress to oversee the operations of the kitchen besides a head cook who was no

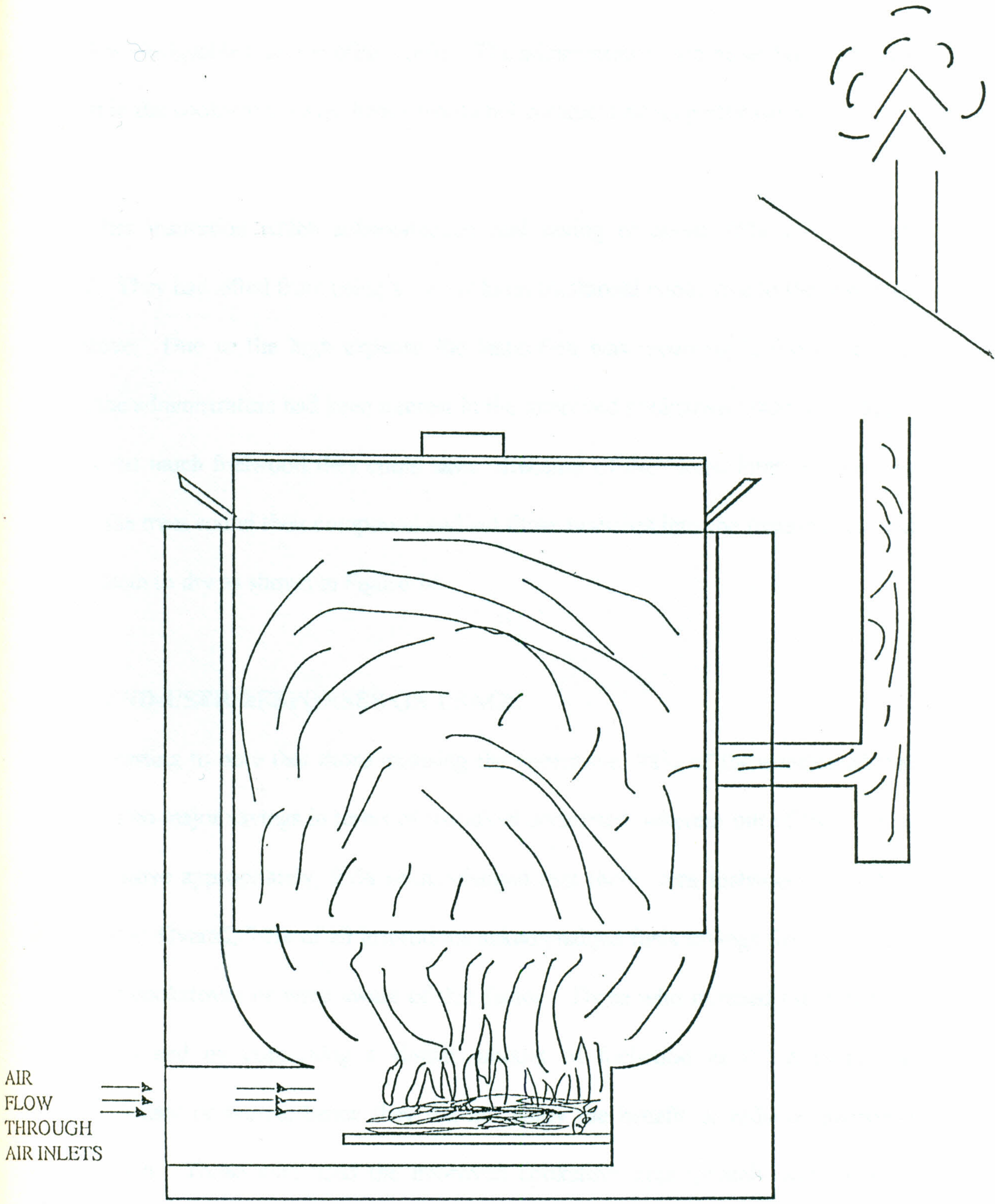

Figure 13: Sketch of an improved institutional cookstove being used with the fire chamber door closed but with the air inlet holes open.

more knowledgeable than the other cooks. The administrators had never taken personal interest in the cookstove usage, hence would not comment on its performance.

The other institution which acknowledged fuel saving of about 75% was privately owned. They had sifted from using a two-column traditional cookstove to the improved cookstove. Due to the high expense the institution was incurring in fuelwood cost alone, the administrators had keen interest in the improved cookstove usage and wanted to find out much fuelwood they could save. Because of their keen interest they even pruned the trees round their compound and cut those branches into the required size and stored them to dry as shown in Figure 14.

4.3 END-USER RESPONSES ON USAGE

It is interesting to note that those misusing the cookstove, 88% of them indicated that there was no major savings in terms of woodfuel consumed, whereas out of those using the cookstove appropriately, 96% acknowledged that there were fuelwood savings of about 50%. Overall, 74% of all institutions acknowledged fuels savings from using the improved cookstoves or were aware of that factor. Those who misused the improved cookstoves end up consuming a similar amount of fuelwood as for a traditional cookstove user or worse, hence they did not enjoy the benefit of reduced fuelwood consumption. Those who used the improved cookstove appropriately were able to realise that there was savings from reduced fuelwood consumption. Because the improved cookstoves users were more than non users, the study managed to record fuel saving in the overall.

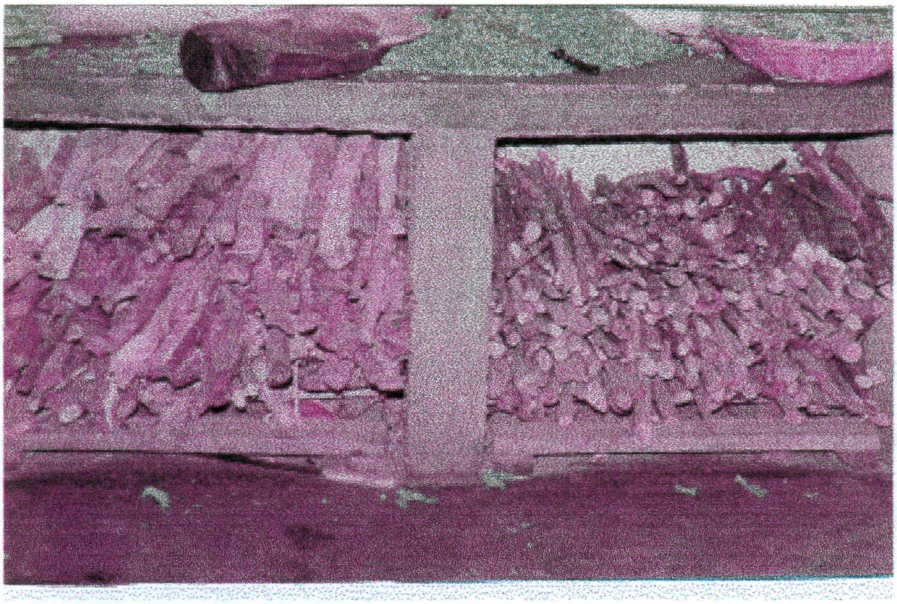

Figure 14: Photograph of branches of trees cut to small pieces, that can be inserted in the improved cookstove fire chamber, and are stored to dry before use.

It is therefore evident that the adoption of the improved cookstoves alone does not guarantee saving but a combination of adoption of the improved cookstove and following of proper operation procedures that will show fuelwood savings and other benefits accrued from use of an improved cookstove.

Study into the period of usage of the improved cookstove revealed that a majority of them with at least one unit of cookstove were 6 years old or newer. Table 5 shows the numbers of those users and the corresponding period of use of their improved cookstoves. The cookstoves were bought at different times and had therefore been in use for mostly between one and eight years. This shows that the improves cookstove technology is not very old in the area of study. This period of usage is long enough for those who had at least one improved cookstove to recognise the advantages of its use.

There has been an increase in the number of new improved cookstoves users as shown on Table 5 over the past 6 years. However, the study also revealed that as much as there were new users purchasing the improved cookstoves, the old user had not significantly increased the number of units they had. This was because there was either no one to sell the extra required units to institutions or users did not care enough to invest more in these fuel efficient cookstoves to boost the number of cookstoves they already had.

There was obvious trend in increased improved cookstoves purchased over a period of time. New users purchased improved cookstove on trial because it was noted that users had maintained the units they first acquired without any additional units. No monitoring was carried out to show saving from use of improved cookstoves, thus there was lack of accurate information. If this information were available, they could have used it to justify replacing existing traditional and other cookstoves. These users clearly failed to observe the advantages of using improved cookstoves. They did not closely monitor the kitchen budget to recognize change in the fuel cost. There is therefore need to educate old and new users about the advantages of adopting the improved cookstoves, the essence of following the proper operation procedures and the need to monitor their operation.

To establish how these user purchased their cookstoves, the respondents were asked to give their source of information about cookstoves. As illustrated in Table 6, most of them obtained their information directly from sellers and some through their neighbouring institutions who had acquired the cookstoves while others got their information through exhibitions. These shows that disseminators were using direct marketing and promotional approaches to reach out to potential clients.

When studying the responses on how they obtained their information about the improved cookstoves, the number of those who responded were comparatively fewer than any other question. This is because most of the institution heads left because of transfers or change of jobs and there is lack of proper information by the incumbent administrators which could otherwise be used by their successors in this respect.

Most institutions used woodfuel as their basic source of energy as illustrated in Figure 15. It just gives the count of users of whatever type of fuel without any indication of

Table 6: Source of information about improved cookstoves for the institutions

Source of Information	Number of Institution	Percentage
Radio	0	0%
Newspaper	5	6.5%
Trade Fair	0	0%
Television	0	0%
Seller	47	61%
Neighboring Institution	16	20.8%
Exhibitions	9	11.7%
Total	**77**	**100%**

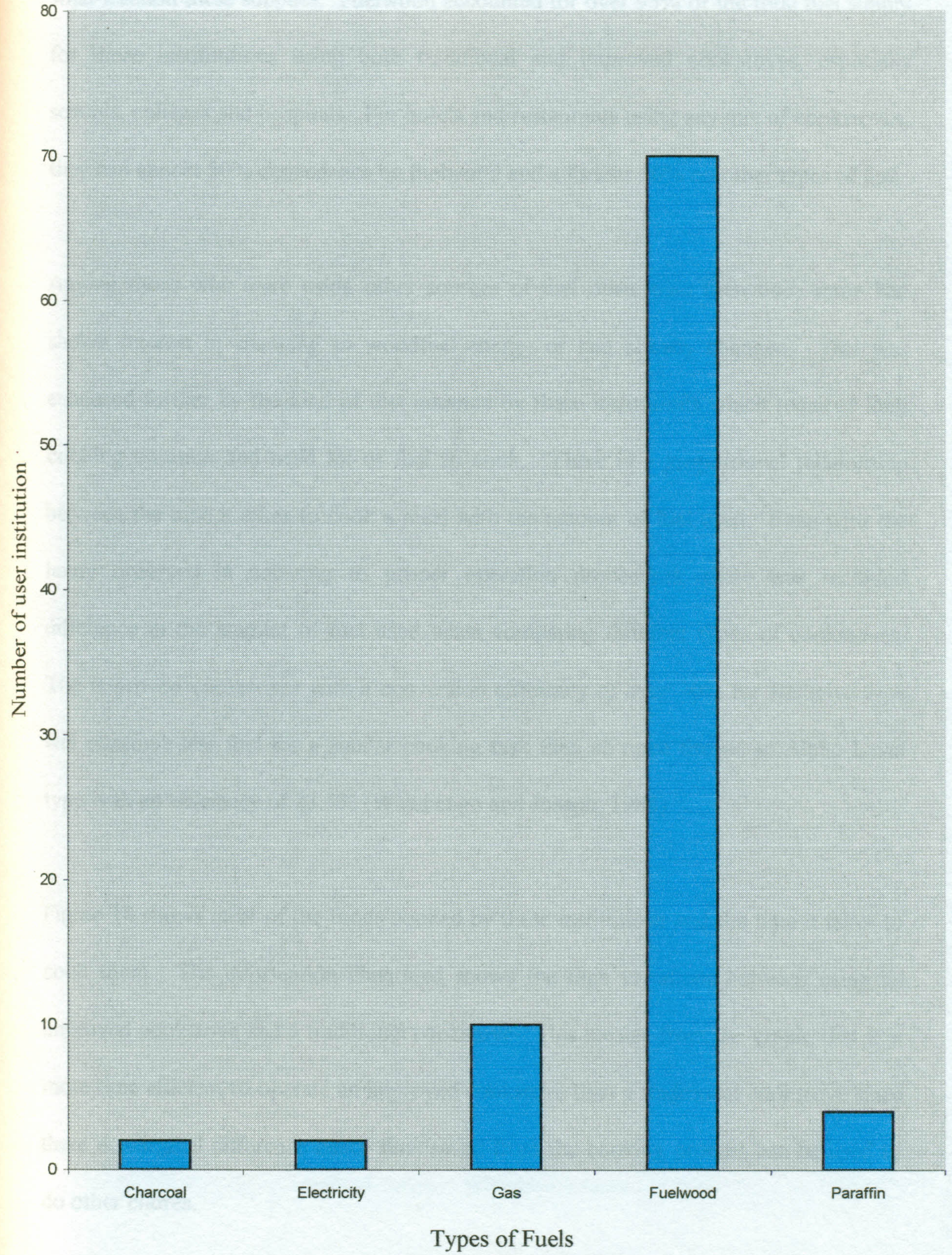

Figure 15: Various types of fuels used in the sampled institutions

what fraction these supplies. Fuelwood accounted for over 95% of the total fuel supply for those institutitions using both traditional and improved cookstoves, especially schools, colleges and hospitals. For hotels and restaurants using any mix of cookstoves, they had almost 50% dependence on fuelwood and a further 50% on other types of fuel.

Among those who were using other sources of fuel other than fuelwood, some had shown interest in changing to woodfuel energy or had already changed. This was enhanced further by the kind of diet adopted by these institutions which required long cooking duration and need lot of fuel to cook. There is a proportional relationship between the time it takes to cook a meal with the amount of fuel used. Even with the laxity observed in adhering to proper operation procedures, there was recorded difference in the amount of fuel used when comparing different types of cookstoves. The improved cookstoves with a conversion efficiency of over 30% for Bellerive type will consume less fuel for a similar cooking task than an open fire or an Alpha Laval type with an efficiency of 23.5% (Walubengo and Joseph, 1988).

Figure 16 shows most of the foods cooked by these institutions and the time it takes to cook them. The information illustrated shows the time variations between using an improved cookstove and a traditional cookstove. This means, from the graph, that it is more time efficient to operate an improved cookstove than a traditional cookstove since there is marginal difference hence time saved from the cooking process can be used to do other chores.

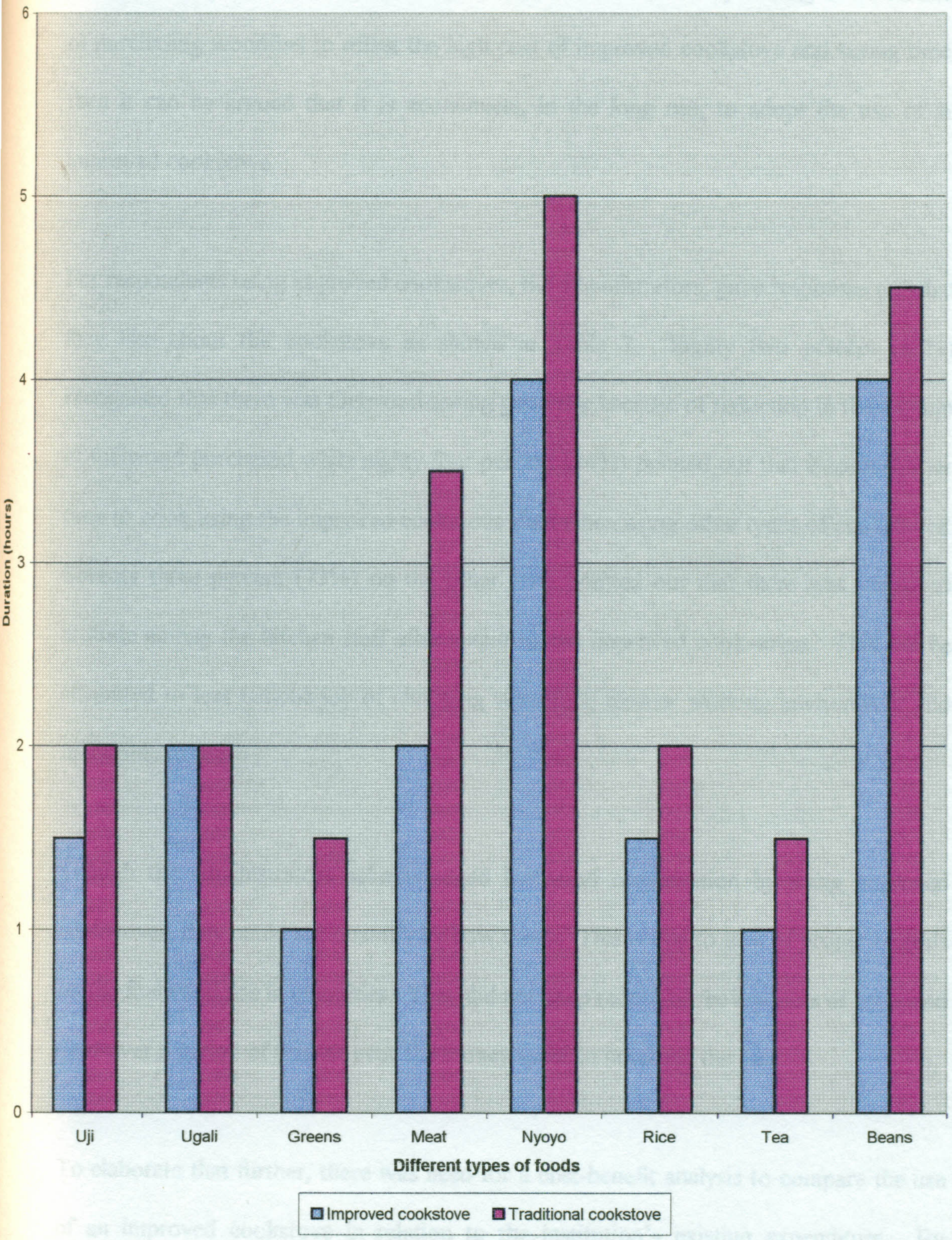

Figure 16: Average cooking time for various foods using improved and traditional cookstoves

Therefore, if enough is saved by using an improved cookstove by cutting down on cost of purchasing woodfuel to offset the high cost of improved cookstove and saving time, then it can be argued that it is economical, in the long run, to adopt the use of an improved cookstove.

For respondents using improved cookstoves, the administrators, gave responses on what they like about the cookstove as shown in Table 7. Eighty two percent (82%) recognised that there was fuelwood saving generally because of reduction in the amount of fuelwood purchased while eighty four percent (84%) pointed out that it took shorter time to cook using the improved cookstove than when using other types of cookstoves. Seventy three percent (73%) on the other hand pointed out that there was improved attitude among the kitchen staff after acquiring the improved cookstoves. This can be attributed to less tedious job of chopping woodfuel, cleaner working environment and more time to relax.

Though the administrators acknowledged fuelwood conservation by using improved cookstoves, they could not quantify by how much. This is due to lack of proper records on the fuelwood use in quantities. They did not keep record of the amounts of fuelwood used over a period of time or even the money spent to purchase the fuel.

To elaborate that further, there was need for a cost-benefit analysis to compare the use of an improved cookstove in relation to the institution's existing expenditure. By availing information on the quantity of fuelwood used, and cost of purchase per year, it

Table 7: Administrators response on what they liked about the improved cookstoves

Administrators responses	Respondents	Percentage
Fuelwood conservation	36	82%
Shorter cooking duration	37	84%
Improved staff attitude	32	73%
Others	3	7%

would then be possible to calculate how much it would cost to operate improved cookstove units versus existing types of traditional cookstoves.

The cost of purchasing fuelwood for use by the new improved cookstove plus the cost of purchasing an improved cookstove unit would then be compared to the cost of operating the existing or old cookstove system to determine how long it would take to break even. After that, it would be easier for the administrator to conceptualize the projected savings. It is important to state at this point that those heads of institutions lacked this important quantifiable information. Even non-users of improved cookstoves also did not keep such record, hence cannot do a cost-benefit analysis to determine the economic viability or advantages of improved cookstoves. Therefore, there is need to educate the administrator to have some control and record information on their energy consumption. That way, they would be more committed to ensure that there is proper management on energy utilization since fuel supply is costly.

Table 8 shows responses on what the end-users did not like about the improved cookstoves. The lack of a tilting mechanism topped the list with a response of 20% of the respondents. These respondents were pegging their response on the Alpha Laval cookstove design which has a tilting pot. Eleven percent (11%) pointed out that the cooking pot lid warped after a few months of use. This allowed for loss of pressure and heat during covered cooking period. This was attributed to possible weakness in the lid material strength. Nine percent (9%) reported quick breaking of the fire grate as a problem. These users recognised that a fire grate was an important part of the cookstove and hence its absence was a factor in the efficient operation of the improved

Table 8: Kitchen staff responses on what they did not like about the improved cookstoves

Responses	No. of respondents	Percentage
Lacked tilting mechanism	9	20%
Fixed pot on the cookstove; tap type	1	2%
Fuel feeding compartment small	1	2%
Cleaning the chimney	2	5%
Inappropriate cooking pot size	2	5%
Fire grate strength	4	9%
Maintenance requirements	3	7%
Warping lids due to weak material	5	11%

cookstoves. The grate serves the purpose of holding the fuelwood in place that it can burn well and allow the ash to fall off inside the fire chamber compartment. Therefore they were concerned about the material strength of the grate and its ability to withstand high temperatures during the long hours of exposure to the direct heating.

Other responses like maintenance requirements, cooking pot size, cleaning the chimney, fuel feeding compartment size, and mounting of cookstove pot had responses of seven percent (7%) or less. Though the respondents are few, these could be important factors for cookstoves designers to consider for further improvement of the cookstoves.

The quick breaking of the fire grate reported by few respondents could be as a result of misuse of the cookstove. This is by inserting large and heavy logs of fuelwood into the fire chamber as observed in a few cases. Such heavy weighing logs would continually exert undue pressure on the fire grate. The users failed to follow the instructions of splitting such heavy logs into small lighter pieces and inserting the right amount. Hence, such misuse may be the main cause for such breakages as opposed to the strength of the construction material.

Table 9 shows some aspects of the cookstove the users considered desirable for improvement. During installation of the improved cookstoves, the disseminators gave the users some training on operational procedures to get the best out of the cookstove. About twenty three percent (23%) of improved cookstove users recommended that the pot lid material be improved to last longer by using a type of metal cover that can withstand the high temperatures involved during cooking. Fourteen percent (14%) of

Table 9: Aspects of improved cookstove users considered desirable for improvement

Improvement area	Respondents	Percentages
Fuel feeding door size	1	2%
Fire grate strength	6	14%
Cooking pot size	2	5%
Cookstove height	2	5%
Cooking pot lid strength	10	23%
Tilting mechanism	9	20%

the users further recommended that the fire grate material strength and durability be improved. This is because there were those who reported broken or damaged fire grates. This further shows the need for the cookstove manufacturers to pay attention to this problem. Though overloading of the grate by the users could contribute to the breakage, there is need to evaluate the strength of the currently used construction materials and the use of stronger materials.

The other area pointed for improvement by twenty percent (20%) of the respondents was incorporating some form of tilting mechanism into the cookstove. Most of the improved cookstove users recommend that the cookstove be designed so as to incorporate some tilting mechanism to make it easier for them to remove the cooked food from the cooking pot. Such a design would then continue to enhance the user-friendliness of the improved cookstoves.

Table 10 shows the instructions given to the users, by the disseminators, during installation as per the respondents. However, some respondents acknowledged that there was some kind of instructions given during installation, but did not know them clearly mainly because those who were given the training had long left and had not transferred the skills/knowledge to others. This lack of continuity or transfer of trained skills reduces the appropriate usage of the cookstove hence reduces the functional efficiency of the cookstove. This is as a result of poor user habits by the untrained new staff.

Table 10: User instructions given during installation by the disseminators

Instructions	Respondents	Percentages
Fuelwood preparation	22	50%
Food preparation; dicing and slicing	7	16%
Soaking long to cook foods	9	21%
Chimney cleaning	20	45%
Cooking pot cleaning	19	43%
Cookstove maintenance	8	18%
Fuel feeding door use	16	36%
Tilting Mechanism	9	20%

Fifty percent (50%) respondents were instructed that fuelwood needed to be dried and cut into sizes that would fit the fuel feeding compartment. Forty five percent (45%) respondents were aware that the chimney required occasional cleaning to remove the soot build-up which would otherwise clog the chimney and affect the burning of the fire. Clogging of the chimney blocks the smooth flow of exhaust gases from the fire chamber. Hence the smoke will flow back and be exhausted through the fire-chamber door and in effect introduce smoke into the kitchen area. Such clogging of the chimney will also reduce the rate at which it draws the air into the cookstove and hence reduce the oxygen supply into the combustion chamber. Hence the fire will burn slowly and cooler and may die altogether. What this means is the cooking will take longer.

Forty three percent (43%) of the respondents continued to clean the outer surface of the cooking pot as instructed. This is essential because it improved the heat transfer from the fire to the food. Otherwise soot build-up on the outer surface of the pot forms a hard layer which acts as an insulator. Thirty six percent (36%) were still making proper use of the fuel feeding door. This was by ensuring that the fuelwood was cut into small pieces that would fit the fire chamber compartment and inserting appropriate amount of the fuelwood pieces into the fire chamber completely. Such complete insertion would enable the users close the fire chamber door and appropriately adjusting the air inlet. Twenty percent (20%) pointed out the proper utilization of the air inlet shutter on the fire chamber door as another instruction given and followed. The air shutter is used to regulate the amount of air intake during cooking. This is critical in controlling the combustion of fuelwood.

Eighteen percent (18%) had some basic knowledge on the cookstove maintenance whereas thirty seven percent (37%) acknowledged that pre-cooking processing of foodstuff, such as dicing, slicing and soaking of dry beans, maize, etc., increased the rate at which the food was cooked and hence consume less fuel. By adhering to all the instructions as given, on the aggregate, the savings would then be substantial. That would be summed up to; reduced time taken to cook any given meal; reduced amount of fuelwood used; efficient conversion of energy by the improved cookstove and maintaining a longer life span of the improved cookstoves.

Improved cookstove users gave responses to certain advantages and disadvantages they associated with using the cookstoves, Table 11. Most users acknowledged the complete elimination of smoke from the kitchen area (100%) and the reduction of heat emission from the surface of the improved cookstove, due to good insulation, into the kitchen environment (80%) as the most desirable. The improved cookstove users further reported fuelwood saving because the amounts used per given meal were less as compared to other cookstove performing similar tasks. Only fifty percent (50%) of the respondents mentioned this as an advantage. This is rather low because due to their high efficiency, one would have expected many, if not all, to highlight the fuel saving as an advantage. However, this could be because most of the respondents where probably more concerned with benefits that they viewed as directly affecting them. As much as this was an advantage, the kitchen staff may not be keen on its careful utilization. It would therefore be of importance if the administrators themselves would take responsibility to control fuelwood usage so as to enjoy higher savings.

Table 11: Response by improved cookstoves users (kitchen staff) on the advantages and disadvantages of using an improved cookstove

Classification	Responses	Respondents	Percentages
Advantages	No smoke in the kitchen	44	100%
	Little heat generated into the kitchen environment	35	80%
	Kitchen environment cool and clean	25	57%
	Stable cooking pot	7	16%
	Cooks faster	30	68%
	Variable amounts of food	6	14%
	Fuelwood conservation	22	50%
	Preserves heat in food	31	70%
	Others	24	55%
Disadvantages	Lacking tilting mechanism	17	39%
	Cooks slower	2	5%
	Takes long to light	5	11%
	Burns the food	3	7%
	Expensive to maintain	6	14%
	Others	19	43%

Sixteen percent (16%) respondents pointed out that they liked the cookstove stability, the availability of various sized cookstoves that would be able to cook varied amounts of foods. This was especially desirable to those users with smaller sized improved cookstove with more than one cooking pot. Other advantages enjoyed were maintaining the food hot after cooking (70%), taking shorter time to prepare a meal (68%) because of good heat transfer from the flame and glowing char to the cooking pot, and hence using less fuelwood.

Respondents pointed out some disadvantages they associated with the use of the improved cookstoves. Among them, thirty nine percent (39%) gave the lack of a tilting mechanism to enable pouring of beverages from the cooking pot as the major drawback of the cookstove. This implies that the fixed cooking pot design limits the various foods that can be prepared. However, there already exists other improved cookstove tap-type designs (UNICOOKER) which are in use in some institutions. Such kind of improved cookstoves as shown in Figure 5, make pouring of beverages very easy. The positioning of the tap at the bottom part of the cookstove enables easy tapping of liquid foods and even draining of water when cleaning the improved cookstove.

Other users complained that improved cookstove took longer to light, cooked slower and burns food. From the overall observations of the various cookstoves, it is only possible to take longer to cook a given meal using the improved cookstove when it is inappropriately used. Burning of food was possible in cases where the fire chamber door was not shut. That would then allow draught to cause a blow-by effect as shown in Figure 12. Otherwise, with proper regulation of the amount of air through the air shutter on the fire chamber door as illustrated in Figure 13, and using well dried and sized pieces of fuelwood such problems would not be experienced.

With proper use and operation of the improved cookstove, the maintenance required would only be to clean the surface of the cookstove casing, the cooking pot and the chimney. These are jobs that would be easily undertaken by the kitchen staff themselves. It need not cost anything extra to do that. The fire chamber door and fire grate would last a long time if they were handled with care and as per instructions by the disseminators.

From Table 11, those who responded to other disadvantages were forty three percent (43%). The majority of those respondents cited the cost of purchasing an improved cookstove unit as being beyond their means, especially if they were to make a single payment. That would have serious implication on their cashflow. However, if there was credit facility available, then they would consider purchasing them. Others pointed out that the cooking pot lid was made of poor quality sheet metal making it warp after short period of use. Once the lid warps, it is not able to retain the steam in the cooking pot to cause rise in pressure which would in turn facilitate faster cooking. The users proposed strengthening the cooking pot lid.

Institutions which did not have improved cookstoves gave various reasons as to why they did not have them. These are shown in Table 12. The lack of awareness of improved cookstoves by most institutional heads who were decision makers comes out as the major hindrance to the adoption and utilization of the improved cookstove in the

Table 12: Improved cookstoves non-users responses on their hindrances towards its adoption

Responses	Number of Institutions	Percentages of respondents
Lack of awareness	25	76%
Don't know seller	15	45%
Low institution population	12	36%
Financial difficulties	5	15%

study area. 76% of the respondents pointed out that they did not have information about the advantages and costs of purchasing improved cookstoves. It was actually noted that even those whose institution already had improved cookstoves, still were not aware of their advantages and proper utilization. Their lack of knowledge made them poor managers to administer any controls or supervision of the improved cookstoves.

This high percentage indicates that lack of awareness has contributed greatly to the non-adoption of improved cookstove systems. Since they lacked the in-depth knowledge of, say the advantages of the improved cookstoves, that would influence them to purchase the cookstove, they were not likely to purchase them even on trial basis. Most of those who lacked the knowledge about improved cookstoves did not know even where to purchase either. About forty five percent (45%) of the non-users did not know where to obtain these cookstoves from if they were to purchase them even though they knew about their existence. They had seen them elsewhere and had a good idea about some of their advantages. This means there was no aggressive marketing by the disseminators who should sell their products to potential clients. The two factors indicate clearly that manufacturers and disseminators have not been able to meet their targets by aggressively disseminating the improved cookstoves across the country.

About fifteen percent (15%) of the respondents said they knew about the improved cookstoves, would have wanted to purchase them but they were not financially able to and no credit facilities were available. This is because they were already running high kitchen budgets. However, they failed to realize that by adopting the improved cookstoves they would be able to cut down their overall operating kitchen expenses and finally the cookstove pay back within a short period. Finally, thirty six percent (36%)

cited low institution population as a reason why they were not using the improved institutional cookstove. This is because it would not be economically viable to purchase and operate it while catering for a small number of customers. Purchasing a new improved cookstove would be too expensive for them considering that any venture they engaged in had to be viable and be supported with informative details. That is to say that they would require some working to show a cost-benefit analysis. Various scenarios could be used to show what it would cost to purchase a unit and what it would cost to operate it, total it up and compare with what it costs to operate and maintain the existing cookstove. That way they would consider and make an informed decision. Because of lack of factual information, they did not know that there were small capacity improved cookstoves like the *Hoteli* which would serve their small population appropriately and would be affordable. All the same, the non-users of the improved institutional cookstoves acknowledged some positive factors they were aware of about the improved cookstoves.

Cooks who had used both traditional and improved cookstove systems acknowledged that improved cookstoves consumed less fuel than traditional cookstoves for any given application. There was a general feeling that even without quantifying the amounts of fuelwood saved, there was a reduced consumption of fuelwood when using improved cookstove. For those who had converted from open fire or two-column kind of cookstove directly to improved cookstove enjoyed very significant reduction of fuelwood quantities used. Their savings were higher than those who converted from Alpha Laval type to improved cookstove. Such differences were possible if the improved cookstove were utilized properly, especially using small and well dried pieces of wood which can be obtained from branches from pruned trees or split logs of wood and stored to dry as shown in Figure 15. Those institutions changing from open fire to improved cookstoves were more likely to achieve savings of about seventy five percent (75%) whereas those changing from Alpha Laval traditional type to improved cookstoves were able to achieve reduction of about twenty five percent (25%).

Most cookstoves operators, the cooks, were more conscious of other factors such as reduced smoke emissions, as evidenced by their one hundred percent (100%) response on advantages of improved cookstoves, little heat generated from the surface of the cookstove, keeping food warm over a long period after cooking, and cooking faster than other cookstoves as opposed to fuel saving since fuel purchasing was not their main concern. These factors were more relevant to them since they affected them directly rather than the economics of saving fuel.

Fuel conservation was a major concern to the administrators, which eighty two percent (82%) respondents highlighted, because they were committed to cutting down on their kitchen operating costs to work within their budget allocations. It was observed that those institutions which had a cateress or someone directly in charge of the catering service apart from the head of institution made better use of the cookstoves better than those who did not. They tended to feel more responsible and were concerned about the welfare and health of the cooks. They also seemed knowledgeable enough on the effects of smoke emissions, heat generation and hygiene at their work place. Kitchen management was taken more seriously and performed properly in those institutions which were privately owned, like the private hospitals and private schools than in public institutions, where the cookstoves were well maintained and used appropriately. Any training instructions given by the manufacturers or disseminators were followed more strictly.

Both users of traditional and improved cookstoves identified some of the advantages and disadvantages of traditional cookstoves as illustrated in Table 13. Most of the traditional cookstoves users, who had not used the improved cookstoves, did not state some of the obvious disadvantages like high smoke emissions and high heat emissions because they had not had any better cookstove to compare with. Those who had used both cookstoves were able to state much more clearly such disadvantages of using either of the cookstoves. Note that the table gives figures for both traditional and improved cookstove users since both had most likely used traditional cookstoves.

The responses in Tables 11 and 12 are very critical to the entire study mainly because these are major influences to the decision making by the users . The understanding of these advantages and disadvantages to the user enables them to make a comparative analysis with their existing cookstove.

Table 13 shows high responses on aspects such as emission of lots of smoke, heat generation from the outer surface of the cookstove to the kitchen environment, and high fuelwood consumption as the most serious disadvantages of traditional cookstoves. These disadvantages have a direct and serious impact on the health of the users. The users are affected by high smoke emission because it causes, among others, eye

Table 13: Responses by both traditional and improved cookstoves users on advantages and disadvantages of using traditional cookstoves

Classification	Responses	Respondents	Percentages
Advantages	Cooks fast	13	17%
	Variable amount of food	25	32%
	Other	21	27%
Disadvantages	Emits lot of smoke	52	68%
	Lot of heat generated	52	68%
	Dangers of burns from embers	17	22%
	Unhygienic kitchen environment	9	12%
	Pot unstable	8	10%
	High fuelwood consumption	64	83%
	Others	21	27%

irritation, headaches and chest problems. Such effects are experienced only a short time after starting to work in the kitchen especially by the new comers in the cooking assignment.

The main other disadvantages which was cited by twenty seven percent (27%) respondents included short life span of the traditional cookstoves. Most of these cookstoves except for the Alpha Laval cookstoves had a very short life expectancy which lasted between one and three years. The cooking pots which were improvised from the 200-liter drums were replacable almost annually depending on their usage.

These disadvantages have been eliminated or improved on in improved cookstoves thus making it a more superior type of cookstove. It therefore contributes positively towards the adoption of improved cookstoves by the users.

4.4 MANUFACTURERS AND DISSEMINATORS

Manufacturers who usually double up as disseminators perform various functions. This starts with carrying out their own research on the cookstove needs and design requirements so as to be able to design and produce a cookstove that is appropriate for particular users. For instance, the Bellerive Foundation contracted Mwaniki Associates to carry out a market survey for Kenya institutional stove which was concluded by 1987 (Mwaniki Associates, 1987). Bellerive Foundation and KENGO were among the pioneering institutions to get involved in the cookstove technology. Other upcoming manufacturers and Jua Kali artisans have been either trained or worked for these organizations, for instance, the proprietor of UNICOOKER Ltd. was trained in Bellerive Foundation.

These disseminators have been trying to market their products as far wide as possible with a target of reaching institutions all over the country. When the improved cookstoves were being launched, there were funds from donor agencies to help promote the cookstoves and even train artisan to enlarge the network of distribution. However, when the funds ran out, the existing disseminators had to operate on their own on a commercial basis. This meant that they had to market and sell the cookstoves at a profit. Therefore, the new prices had to be higher than the subsidized one since the grants had been withdrawn by the donors.

These disseminators were involved in the technology because it was economically viable to run the enterprise and more so to develop a cookstove that could utilize woodfuel energy efficiently. This was because there was need to cut down on the heavy dependence and use of biomass resources for energy supply . Besides, the cookstoves were meant to be environmentally friendly by cutting down on the emissions into the atmosphere. The disseminators projected that a large number of cookstoves were to be adopted by institutions whose aggregate savings would have an impact at regional and national levels on the net emission of carbon dioxide into the atmosphere.

From the response given, the disseminators did most of their marketing from their offices. This involved mailing a letter of introduction and making a phone call to those in charge of publishing and talking about the cookstoves, making appointments to make personal visits and sometimes arrange for demonstrations. Those institutions who showed interest by inquiring about the cookstoves were then given further follow up by the disseminator by sending a representative to discuss further on the institutions requirements and give the details about the cookstove types and sizes available to chose from. The representative would advice on the appropriate cookstoves capacity suitable for their requirements.

If the visit is fruitful, then the institution would place an order and make a down payment of 50% of the total cost price with the balance payable on delivery. When placing an order, the buyer has an option on what kind of material they want for the cookstove construction. Once the cookstove is ready and the final payment have been made, the buyer pays for the transportation and the manufacturer does the installation and gives instructions on the operation and maintenance of the cookstove. Then the manufacturer would make a follow up after two to four months. After this period, any other repairs or services are paid for separately. Therefore, the cookstoves are manufactured on order and the disseminators do not have any financial arrangements to make it easier for willing buyers, with insufficient funds, to make a purchase. According to some of the manufacturers, they used to sell the cookstoves on loan but apparently most clients defaulted on their payments and hence they were forced to withdraw the loan system.

So far dissemination has not been as extensive as targeted. It has been more localized at the points of manufacturing. For instance, both Bellerive Foundation and KENGO have been able to market to institutions around Nairobi area, Kiambu, Thika, Machakos and Murang'a regions whereas UNICOOKER has been marketing around Kisii, Nyamira and South Nyanza regions. Thus the disseminators have not managed to penetrate the whole country as targeted due to financial constraints.

The pioneer manufacturers of the improved cookstoves namely KENGO and Bellerive Foundation also have established research departments that have regional collaboration with other similar organizations within East Africa, Africa and other developing countries. This kind of network in conjunction with their own research enables them look into ways of improving the present cookstove systems continuously. Information sharing between different organisations provides new insight into findings from various interest groups that are used to improve on existing systems. New breakthroughs in research in a different area can be modified to suit the needs of another area. By sharing findings with each other, it enable researchers avoid duplication of efforts. Therefore any information received on the needs of the users is easily shared to allow for improvement.

The cookstove prices are very viable depending on the cost of materials used for construction, type and design of cookstove and capacity of the cooking pot. For example, a 100 liter cookstove, Bellerive type, cost Kshs 42,180.00 whereas a 200 litre cookstove would cost Kshs 57,800.00 (1994) prices. Ordinarily, mild steel is used for the cookstove construction but if a more durable type of steel metal such as stainless steel is used, the price of the cookstove increases because stainless steel is more durable and marginally expensive.

The institutions buying the improved cookstoves arrange for their own financing in full. Financing schemes that existed before by the disseminators were abused and debt collection was poor, forcing the disseminators to withdraw them. This has reduced the number of institutions which could have purchased the cookstove but for those who finance themselves have a serious and planned commitment and will use the cookstoves appropriately so as to enjoy the benefits and make the savings.

During installation, the users are trained how to use the improved cookstoves. Some of the areas of training include cutting fuelwood into small pieces of specific length to fit into the fire chamber; drying of the fuelwood; feeding of fuelwood into the fuel chamber; use of fire chamber door and its air inlets; the cleaning of the cookstove chimney periodically to remove soot build up; cleaning of the cooking pot; use of pot lid during cooking; and preparing raw foods by slicing, chopping and/or soaking them to allow for faster cooking. Strict adhering to these instructions translates directly into both time and fuel savings to the user.

The cookstove structure is such that they would easily fit in any type of kitchen. No major modification or reconstruction is required in the kitchen to accommodate the improved cookstove. The minor modification usually done during installation is to build a small platform where the cookstove is mounted and the chimney channelled to the outside of the kitchen room through the roof or through the side wall. The disseminators during installation carry out this modification. The proper setting of the chimney ensures that the smoke produced is expelled into the atmosphere. Once the installation is completed, the disseminator makes one or two trips to check on the cookstove performance and any subsequent visits thereafter are on request by the users.

When asked what they thought was affecting the cookstove dissemination, the manufacturers acknowledged low levels of awareness on the improved cookstoves to potential users and high cost of raw materials for cookstove construction. High cost of cookstove construction material translated to high cookstove cost, making it expensive for most of the prospective users to afford. Levels of awareness, as reflected by seventy six percent (76%) of non-users as well, (Table 12), have been low because the manufacturers-cum-disseminators no longer sponsor improved cookstove promotion programmes because it is an expense they have tried to avoid. Their available resources, especially without donor funds, are no longer able to sustain a promotional program as previous. This is different from when the improved cookstove programme was being launched with donor funds. This is also reflected in Table 5 which shows the decline of the rate of adoption of improved cookstoves in the area as from 1992.

The materials used for construction are durable as evidenced by the condition of improved cookstove after a given period of use. Out of all the improved cookstoves evaluated, there was only one unit that had physically deteriorated so badly that even the smoke was oozing out of the outside casing which was tattered. However, the cost of the improved cookstoves make them unaffordable to a vast majority of potential buyers because they lack the funds to readily purchase them.

Out of the three disseminators interviewed, two of them -Bellerive & KENGO- are Non-Governmental Organisations working on energy systems. They were continually researching on ways of improving their existing systems so as to increase the thermal efficiency, durability and acceptability of their system by users. There was therefore work going on improving the existing improved cookstoves. UNICOOKER were not carry out any research because it was business enterprise entirely, hence was concerned with selling cookstoves for purposes of making money only.

The disseminators did not have fixed pricing for their products. They used rough figures, fluctuated their pricing depending on cost of purchasing their material. The pricing ranged from about Kshs 20,000/= up to 75,000/= depending on the size. The small capacity cookstoves, for instance *Hoteli* costs from Ksh 20,000/= upwards depending on the pot sizes. Those with cooking pot capacity of 100 litres cost from Kshs 48,000/= upwards to Kshs 75,000/= for a 250 litre cookstove. These cost included the cookstove, cooking pot with lid and chimney, training and one other site visit after installation. The cost of installing and transportation of the cookstove to the kitchen and modification of the kitchen area were borne by user as extra charge.

During introduction of the improved cookstoves, KENGO & Bellerive where among the NGOs that benefited from donor funds that enabled them sell the improved cookstoves even on credit. The users needed to show interest in trying the improved cookstoves and made a commitment by paying a small deposit of, say 10,000/=. The rest of the money was payable in installments as would be agreed. However repayment by those who acquired the improved cookstoves was very inconsistent whereas some even defaulted. With the termination of funding for that project, the manufacturers have continued to make the improved cookstoves but are no longer selling the units on credit. Buyers make a 50% down payment with order, then they pay the balance in full when the improved cookstoves units are ready for collection. The improved cookstoves are almost always manufactured on order. This ensures that the need of the users are addressed accurately.

With this kind of financial arrangement, most institution find it difficult to raise the required amount in a span of 15 days, which is the time it would take to construct a unit of improved cookstoves. Most of the schools would only afford to spend such amounts of money only at the beginning of the year since that is when a bulk of the fees is paid by the students. This is a serious hindrance towards adopting the improved cookstoves. Most of the heads could afford payments spread over the year with a bulk of the payment possible during the start of academic year and smaller installments due on dates to match beginning of subsequent school terms.

During installation, the manufacturers sets the improved cookstoves at the kitchen and fits the chimney in place. They then demonstrate how to light the cookstove; prepare the fuelwood in proper size and quantity; cleaning the pot, inside and outside the cookstove; and the chimney. Cleaning the cookstove casing ensures that the metal cover lasts a long time. Scrapping off the soot build-up in the chimney column to avoid clogging that would otherwise reduce the effectiveness of the cookstoves is emphasized. They also demonstrate how to soak dry foods like beans and maize so that they could cook faster. They demonstrate proper use of pot lid and how to feed fuelwood and operate the fire door.

There was not much modification required when introducing improved cookstoves into kitchen areas. Basic floor preparation carried out were to make a concrete platform where the improved cookstoves were placed and chimney passed through the roof.. In cases where the roof was concrete and didn't have provision to channel it through, the chimney was then modified through the window to the outside, otherwise most improved cookstoves fitted well with the existing kitchen setup. The disseminator would then make another visit usually a short time after installation to ensure everything is okay. Any other subsequent visit are upon request and is chargeable.

After setup, there was remarkable difference in operating improved cookstoves if users were using traditional cookstoves. This is because of stricter fuelwood preparation that required use of small and well split or cut pieces. The pieces need to fit in the fire chamber and they would require six to eight pieces as opposed to using long logs of fuelwood sticking out into the kitchen area in front of the cookstove. The new cookstoves eliminated any emission of smoke into kitchen area and were cool to touch.

The users found the system much clearer and friendlier, the height of the cookstove is average at standing position, comfortable enough for average height persons for large capacity stoves the small capacity. The small capacity cookstoves are smaller and can be mounted at comfortable heights as users may desire, to meet their needs.

The users were always excited at the introduction of the improved cookstoves. They were able to have more time to rest which they would have otherwise taken to keep feeding the fuelwood into the cookstove. They were less exposed to dangers of open fires and cookstove was smoke fire. The kitchen area was much cooler than before making it comfortable to cook in without excessively sweating. They found the design of cookstove nice and acceptable and the height comfortable on standing position.

The manufacturers did not have information on the condition of the cookstove since they did not follow up on cookstove usage to evaluate their performance. However, from the observations recorded, those improved cookstoves which had been purchased within two years were looking as good as new. Most of those up to 6 years old were in good shape. Few cookstoves had the fire gate broken and missing. Those over eight years were in fair shape with most missing the gate and fire door. The casings were starting to look dull due to dirt but otherwise strong.

The newer cookstove had better looking casing material and was much easier to clean. The cooking pots were generally in good order. About two cooking pots had been repaired because they had developed holes or cracks. These were in the usage bracket of over eight years.

4.5 SUMMARY

The improved cookstoves were generally an acceptable system as evidenced by the trend of purchase in the last 6 years and the responses by users on the advantages of using an improved cookstove. They are highly favored by keen users as superior to traditional cookstoves, durable, clean even during use and easy to work with.

Most of the non-users of improved institutional cookstoves lacked the awareness about the existence of the cookstove. They were also limited by their financial capabilities to afford purchase of improved cookstove. No improved cookstove users in the study had been reported to have abandoned the use of the cookstove in favor of the traditional cookstoves.

The lampsum amount of money required to purchase the cookstoves, lack of information to the potential users on existing and new improved cookstoves were among the factors that they reported hampered widespread adoption of the improved cookstoves. Further to that, the users' lack of quantifiable information on the costs of kitchen operation made it difficult for potential users to visualise the possible savings by switching to the improved cookstoves or purchasing more units of the improved cookstoves.

Manufacturers had not yet met their targets. Their sales were way below their projected targets as of 1994 evaluation carried out by one manufacturer (Mwaniki Associates, 1987). There was need to expand their network and even encourage some of the people they have trained to start their own establishments and help disseminate the improved cookstove technology as was with the case of UNICOOKER that was started by a former employee of KENGO.

5.0 CONCLUSIONS & RECOMMENDATIONS

5.1 CONCLUSIONS

The study was carried out mainly to determine what influences the adoption and utilization of improved institutional cookstoves. This was to find out that what enhanced or deterred adoption of improved cookstoves, which have a higher thermal efficiency, safer to use and are user-friendly. Evaluation of the utilization of the improved cookstoves, by those using them, was another major objective of the study.

The study was carried out in institutions that offer catering services in Kisii and Nyamira Districts of Kenya. These included schools, colleges, hospitals and hotels. By use of three sets of questionnaires, responses and observations by the interviewer were recorded during the study. The first set of questionnaires was for cateresses and administrators, the second for kitchen staff and the third for the cookstove manufacturers and disseminators. Institutions used in the study were randomly selected and constituted 61% of all institutions offering catering services in the study area.

The following conclusions were drawn from the study:

1. The following factors were established by the study as causing hindrance to the adoption of improved institutional cookstoves.

a) Lack of awareness among the heads of institutions and head of the kitchen units, mainly cateresses, on the existence of the improved cookstoves. Some were aware of their existence but did not know of their advantages, hence the need to adopt them. Such institutions will therefore continue to use the traditional woodfuel cookstoves. This shows the need for aggressive advertisement to enlighten both potential and current users of the existence of improved cookstoves and their advantages over traditional cookstoves.

b) Potential users of improved cookstoves did not know the contacts of the disseminators, hence found the cookstoves unavailable for purchase. This indicated that marketing by the manufacturers and disseminators has not been aggressive and widespread. Marketing strategies should be improved and tailored to the target heads and/or kitchen unit heads who in turn would be instrumental to the purchase of the improved cookstove.

c) High initial costs of purchasing the improved cookstoves as compared to traditional cookstoves were an hindrance to their purchase for those institutions that were aware and knowledgeable about the improved cookstove technology. As much as the institution used in the study indicated high kitchen operating costs, they were not able to set aside the required full amount for a new purchase. Lack of credit facilities to ease the financial pressure the new purchase could exert on the kitchen budget is a major constraint.

d) Low institutional population contributed to non utilization of the improved institutional cookstove by some institutions because of the current designs of the available cookstoves to the users were of large capacities targeting large population. Even though there are smaller capacities cookstoves like *Hoteli* now available, they were not yet a popular model which could have otherwise been used by such institutions. That and possibly another medium range design ought to be introduced to cater for institutions with small populations.

2. The improved cookstove is a user-friendly system. The ease with which it is operated and its superiority over the traditional cookstove made it easily accepted by users, i.e., cooks and cateresses. Further more, it is fuel efficient, thus requiring less fuelwood to prepare a given meal. Hence less time is taken to prepare the fuelwood to use in the improved cookstove; it does not emit smoke and excessive heat into the kitchen environment, thus making it hygienic and comfortable to work in.

3. Reduction in the fuelwood used was generally acknowledged as being attainable with usage of improved cookstove. Such a fuelwood saving translated directly to monetary gain through reduced expenditure on the cost of purchasing fuelwood. The magnitude of fuelwood savings was variable depending on how well and strictly the operation and maintenance training instructions given by the manufacturers were adhered to. The more strictly the instructions were adhered to, the higher the fuelwood savings were achieved whereas the carelessly operated cookstove users did not enjoy any significant fuelwood saving.

4. The improved cookstove are durable because of their general condition after use for a varied period of up to 8 years. Most cookstoves were in very good condition with all parts such as a fire grate, fire chamber door in place and the outside casing strong clean. A few cookstoves did not have the fire grates because they had been broken after some usage. This could be a consequence of poor operation of the cookstove by the users, but still the designers need to look at this part of the cookstove for possible improvement.

5. No improved cookstove users had abandoned their use after starting except for those who would occasionally use an alternative cookstove when their wood was not dry and not split to small pieces or when their population were low to operate the large capacity cookstoves, especially schools when beginning the terms. Otherwise they were in constant use.

6. It is evident that the purchasing of the improved cookstoves alone does not guarantee saving but a combination of adoption of the improved cookstove and following proper operation procedures would show fuelwood savings and other benefits accrued from its utilization.

7. In spite of the numerous advantages of improved cookstoves cited, the study showed that there were some users of the same cookstoves who did not realise their advantages due to

a) misuse of the improved cookstove through poor operation. This was as a result of not using the fire chamber as intended or recommended so as to save fuelwood. Others were not using the lid to cover the cooking pot during operation. These are some of the habits that do improve the efficiency of the cookstove.

b) misuse of fuelwood. This was as a result of not drying the fuelwood to reduce the moisture content. Otherwise wet fuelwood produces lot of smoke negating the intended smoke reduction and part of the energy is used in drying the fuelwood. Also, some users were using large pieces of fuelwood that could not be fully inserted in the fire chamber. That way, the air intake is not controlled hence wasteful combustion of the fuelwood. Also the rate of burning large pieces of wood is low and consequently cooking a given meal takes longer than expected.

c) Poor or no maintenance of the cookstoves system. This included simple tasks such as cleaning the cookstove outer casing and the chimney. Once the cooking pot is clean, heat transfer is better and more efficient. The chimney requires occasional cleaning so that it does not get clogged which would otherwise force smoke back into the kitchen through the fire chamber door. This will then be like an open fire.

d) Failure to repair broken or damaged parts of the cookstove, e.g., broken fire-grates. Once the fire-grate was not in place, then the amount of fuelwood feed into the fire chamber would be more than necessary hence causing wastage of fuelwood. There would also be no place for the ash to collect after combustion.

8. Manufacturers-cum-disseminators conceded that they had not marketed the cookstoves widely. They agree there is a need to aggressively market their product and offer attractive terms of purchase that would be attractive and affordable to potential users and encourage acquiring the improved cookstove units to replace the traditional types.

9. The study found that the most appreciated advantages of improved cookstove are the provision of smoke-free and cool kitchen environment (hence ensuring safe working environment for the cookstove users); fast cooking and maintaining the food hot for a long period; and fuelwood saving. These are important factors which cookstove disseminators should emphasize when marketing the improved cookstove.

10. The features of improved cookstoves not liked by users were lack of tilting mechanism, high cost of purchasing the improved cookstove units, the warping of the cooking pot-lid, and breaking of the fire grate. These are factors which the cookstove designers should consider for improvement in order to make the cookstove more acceptable. The manufacturers-cum-disseminators should also, seriously, do an assessment and see how to reduce the cost of the cookstove in order to attract more buyers.

5.2 RECOMMENDATIONS

Based on the findings of the study, I recommend that:

a) Information on the improved cookstoves should be widely availed to the users and potential users so that the may plan on acquisition of the same. By highlighting the advantages of utilizing the improved cookstoves and their availability, it may prompt those who had not thought of it before to think about it and encourage them to adopt them.

b) Disseminators and manufacturers should establish ways in which can make it affordable and convenient for institutions to purchase new cookstoves. It may be that because of the nature of their revenue receipting, disseminators could arrange to offer credit terms to institutions to match the periods they receive the bulk of their revenue without disrupting their cash flow.

c) Disseminators should work out a plan where by they work together with the institutions with improved cookstoves so that they realize the fuel saving ad consequently see the benefit once they pay out lumpsum money for purchase of the improved cookstove. There should also be follow up to ensure proper usage of the equipment.

d) There is need to educate users on the importance of maintaining proper records of fuel consumption, quantities and cost; that way they would be able quantify their savings and monitor usage of the various cookstoves in use. With such records then, it will be possible to do a cost-benefit analysis and be able to justify the need to purchase improved cookstoves (for non users) and additional units (for users).

5.3 RECOMMENDATION FOR FURTHER WORK

1) A study be carried out to determine how to enhance information awareness on cookstove technologies. Such will enhance the level of awareness of the users hence create the need to purchase the cookstoves.
2) Study be carried out on use of durable material of cookstove construction yet be cheaper than what is currently in use. Use of cheaper cookstove construction material will translate to more affordable improved cookstoves. Material used for making the fire grate should also be able to withstand high temperatures and be as durable as the other parts of the cookstove.
3) A study be carried out on designing variable cooking pot holder to cater for the various cooking pots sizes. Such a cookstove should be able to accommodate or use various sized cooking pots hence meet the needs of a wider scale of users with different needs.

4) A similar study as this be carried out in other areas of the country to determine the factors influencing the adoption of improved institutional cookstove in those areas. Results from such studies in addition to this one would then cumulatively produce conclusive factors that could be said to influence adoption of improved cookstoves in the country.

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7.0 APPENDICES

APPENDIX I: INTRODUCTION LETTER TO EDUCATION OFFICER

RESEARCH PROJECT
P. O. BOX 318,
KEROKA.

DISTRICT EDUCATION OFFICER,
___________ DISTRICT,
P. O. BOX __________,
________________.

Dear Sir/Madam,

RE: ACCESS TO INFORMATION

I am a Research Student at the Appropriate Technology Center, Kenyatta University carrying out research on Energy Saving Improved Cookstoves in Institutions in Kisii and Nyamira District of Nyanza province.

I am hereby writing to request you to let me obtain information which will facilitate my research both from your office and from institutions within your jurisdiction.

The information I need will be to know:
1) How many boarding institutions i.e. Colleges, Boarding and Day Schools, and Institutes, there are in the District,
2) Geographical location of each institution, if possible, shown, on a district map, and
3) Non-boarding institutions that offer catering services.

I will highly appreciate having this information from your office. Thank you for the anticipated assistance.

Your faithfully,

Mosomi, Evans Nyamweya,
Research Student,
Appropriate Technology,
Kenyatta University.

APPENDIX II: INTRODUCTION LETTER TO INSTITUTIONAL HEADS

RESEARCH PROJECT
P. O. BOX 318,
KEROKA.

HEAD OF INSTITUTION,
_________________,
P. O. BOX _________,
_________________.

Dear Sir/Madam,

RE: RESEARCH STUDY AT YOUR INSTITUTION

I am a Research Student at the Appropriate Technology Center, Kenyatta University carrying out research on Energy Saving Improved Cookstoves in Institutions in Kisii and Nyamira Districts of Nyanza Province.

I have chosen your institution as one of the institutions that I will research on and will need your permission so as to interview your kitchen staff and get access to the kitchen to analyze your cookstove system. Your acceptance to my request will be of uttermost importance to my study and I will keep whatever information received confidential and use it for academic purposes only.

I look forward to working with you. Thank you for your assistance.
Yours faithfully,

Mosomi, Evans Nyamweya
Research Student,
Appropriate Technology,
Kenyatta University.

APPENDIX III: QUESTIONNAIRE FOR INSTITUTION HEADS

QUESTIONNAIRE FOR SURVEY TO EVALUATE UTILIZATION OF ENERGY SAVING COOKSTOVES TECHNOLOGY
The Case of Improved Institutional Cookstoves in Kisii and Nyamira Districts of Kenya

POSITION: ________________.
INSTITUTION: COLLEGE; SCHOOL; HOSPITAL; HOTEL; RESTAURANT
LOCATION: RURAL; URBAN
DISTRICT: KISII; NYAMIRA

1. What is the population catered for by the institution's kitchen services?

(1) 001-100 (2) 101-200 (3) 201-300 (4) 301-400

(5) 401-500 (6) 501-600 (7) 601-700 (8) 701-800

(9) Over 801

2. What type of fuel do you use?

(1) Charcoal (2) Electricity (3) Gas

(4) Wood (5) Others

3. What type of cookstove do you use?

(1) Traditional Cookstove (2) Improved Traditional Cookstove

(3) Alpha Laval Cookstove (4) Improved Cookstove

(5) Gas Cooker (6) Steam Boiler

(7) Other

4. When did you buy the cookstove(s) and how much did you pay for it (them)?

(a) Years ago

(1) 0-2 (2) 2-4 (3) 4-6 (4) 6-8 (5) Over 8

(b) Cost Kshs ____________

5. How many meals are prepared, and the approximate time taken to cook them?

FREQUENCY DURATION

a) Uji

b) Ugali

c) Vegetables

d) Meat

e) Nyoyo

f) Rice

g) Chapati

h) Tea

i) Other

6. How often do you replace your cookstove? ____________

7. What is the condition of your cookstove?

(1) Yes (2) Fair (3) Poor

8. Do you use an institutional improved cookstove?

(1) Yes (2) No

(a) If YES, why do you use it?

(b) If NO, why don't you use it?

9. How long have you been heading this institution? _________

If you answered NO to Que. 8 go to Que. 20. If you answered YES, proceed to Que.

10

10. How did you learn about the improved institutional cookstoves?

(1) Radio (2) Newspaper (3) Trade Fairs (4) TV

(2) Seller (6) Neighboring Institution (7) Exhibition and demonstration

11. a) How much woodfuel do you buy? (tones)

(1) 0-4 (2) 5-9 (3) 10-14 (4) 15-19 (5) 20-24

(6) 25-29 (7) 30-34 (8) 35-40 (9) 40-44 (10) Over 45

b) How much do you pay for it? __________

c) How much did you have to buy while using the former cookstove? _______ tones

12. What are the costs of running the present cookstove as compared to the former?

(1) 1 (2) ¾ (3) 2/3 (4) ½ (5) 1/3 (6) ¼

13. What do you like about the cookstove?

(1) wood consumption reduction

(2) cooking duration shortened

(3) improved kitchen staff attitude

14. What don't you like about the cookstove?

(1) lack of tilting mechanism

(2) fixed pot

(3) fuel feeding compartment

(4) cleaning of chimney

(5) height of cookstove

(6) size of pot

15. What aspect(s) of the cookstove would you consider desirable for improvement?

(1) door size

(2) grate size

(3) pot size

(4) cookstove height

(5) other

16. Did you encounter any difficulties acquiring the improved cookstove system?

(1) Yes (2) No

a) If YES, please elaborate ______________________________________

____

______________________________________.

17. Do other institutions inquire about your improved cookstove? ________________

18. After installation of the improved cookstove, where your kitchen staff trained on how to use the cookstove? ____

19. What was the reaction of the kitchen staff to the introduction of the improved cookstove? ____

20. a) Do you know about the existence of improved cooksotve? _______________

b) Do you know of any benefits of using an improved cookstove? _____________

c) If not, would you be interested to know more about it?

If NO, Why not? ____

____.

d) Would you be interested to use them again?

(1) yes (2) no

21. a) Do you know about the existence of improved cookstoves?

(1) yes (2) no

b) Do you know of any benefits of using an improved cookstove?

If YES, which one(s)?

(1). reduction in fuel consumption

(2) shorter cooking duration

(3) lower operation cost

(4) reduced smoke emissions

(5) other

c) If NO, would you interested to know more about them?

(1) yes (2) no

22. What are some of the hindrances towards acquiring the cookstoves?

(1) lack of capital

(2) do you know whom to buy from

(3) low population

(4) small kitchen

23. Have you sought any help from outside?

(1) yes (2) no

24. If the cookstove were to be bought, how would it be budgeted for?

____.

____.

25. Who makes the decision on what kind of cookstove is to be used in the kitchen?

(1) head of institution (2) Board of Governors (3) Others

26. Are the decision makers aware of the existing alternatives like the improved cookstove as a way of reducing kitchen operating costs?

(1) yes (2) no

27. Do you feel that woodfuel is scarce and expensive and hence need to be conservatively used?

(1) yes (2) no

28. Do you know how woodfuel production and its use affects the local region especially the climate?

(1) fairly well (2) slightly (3) no at all

29. Do you have enough land to develop your own wood lot?

(1) yes (2) no

30. Would you want to have your own wood lot?

(1) yes (2) no

31. Do you know of any benefits accrued from energy conservation?

(1) yes (2) no

32. Do you know any fast growing trees species that can regenerate fast enough woodfuel?

(1) yes (2) no

33. Do you understand the effects of smoke emission?

(1) yes (2) no

34. Do you understand the dangers of deforestation?

(1) yes (2) no

35. If you were to know the effects of wood crisis, will it influence;

a) your cookstove system choice?

(1) yes (2) no

b) your woodfuel production and use?

(1) yes (2) no

36. Do your kitchen staff know the importance of closing the fire chamber door when using it?

(1) yes (2) no

37. Do you understand the implications of controlled air flow?

(1) yes (2) no

38. How much importance do you attach to following the advised operation procedures strictly?

(1) a lot (2) a bit (3) not much

39. How much importance do you attach to following the advised procedures strictly?

(1) a lot (2) a bit (3) not much

APPENDIX IV: QUESTIONNAIRE FOR KITCHEN STAFF

QUESTIONNAIRE FOR KITCHEN STAFF ON THE USE OF IMPROVED COOKSTOVES IN THEIR INSTITUTIONS
The case of Improved Institutional Cookstoves in Kisii and Nyamira Districts of Kenya

POSITION: ___________________.
INSTITUTION: COLLEGE; SCHOOL; HOSPITAL; HOTEL; RESTAURANT
LOCATION: RURAL; URBAN
DISTRICT: KISII; NYAMIRA

1. How long have you been working as a cook in an institutional kitchen? (years)

   (1) 0-2 (2) 2-4 (3) 4-6 (4) 6-8 (5) 8-10 (6) over 10

2. a) What kind of cookstove are used in the institution?

   (1) traditional cookstove

   (2) Alpha Laval cookstove

   (3) improved cookstove

   (4) others

   b) If you have used an improved cookstove, which one?

3. a) What are the advantages of using a traditional cookstove?

   (1) cooks faster

   (2) variable amounts of food can be cooked

   (3) others

   b) What are the disadvantages of using a traditional cookstove?

   (1) emits a lot of smoke

   (2) lot of heat generated from the cookstove surface

   (3) danger of burning from unprotected embers

   (4) unhygienic

   (5) pots are unstable

(6) others

4. a) What are the advantages of using an improved cookstoves?

(1) no smoke emitted into the kitchen area

(2) little heat generated from the cookstove surface

(3) kitchen environment clean

(4) stable pot

(5) cooks faster

(6) variable amounts of foods cooked

(7) others

b) What are the disadvantages of using an improved cookstove?

(1) fixed cooking pot

(2) cooks slowly

(3) takes long to light

(4) burns the food

(5) hard to maintain

(6) others

5. Are you consulted in cases of buying kitchen utensils?

(1) yes (2) no

6. If you are using an improved cookstove, were you consulted before they introduced the cookstove?

(1) yes (2) no

7. a) How do you prepare the woodfuel before using the cookstove?

(1) splitting

(2) cutting to specific lengths

(3) using fuelwood when wet

(4) drying the wood before use

b) Is it different, now, as compared to the former cookstove?

(1) yes (2) no

8. Are there any different preparations that you have to carry out now that you did not need to carry out then?

(1) yes (2) no

If YES, which one(s)?

(1) cleaning the utensils exterior surface

(2) wood preparation

(3) others

9. Do you understand how the wood problem affects your local region?

(1) yes (2) no

10. Do your understand the effects of smoke emissions?

(1) yes (2) no

11. Do you understand the implication of controlled air flow?

(1) yes (2) no

12. Do you understand the importance using the cookstove appropriately?

(1) yes (2) no

13. Do you attach serious importance to the advised operation procedures?

(1) yes (2) sometimes (3) not sure

APPENDIX V: QUESTIONNAIRE FOR MANUFACTURERS AND DISSEMINATORS

QUESTIONNAIRE FOR MANUFACTURERS AND DISSEMINATORS ON THE USE OF IMPROVED COOKSTOVES IN THEIR INSTITUTIONS
The case of Improved Institutional Cookstoves in Kisii and Nyamira Districts of Kenya

POSITION: ___________________.
LOCATION: __________________.
COOKSTOVE INVOLVEMENT: MANUFACTURER; DISSEMINATOR; BOTH

1. a) For how long have you been involved in Cookstoves Technology?

b) How long have you dealt with institutional cookstoves?

2. a) What were your targets when establishing yourself?

i) National Level

ii) Local Level

b) How far have you gone in achieving these targets?

3. a) What area or regions of this country, in particular, have you been actively involved in?

b) What is the general population distribution in these areas?

4. How many institutions have you sold your cookstoves to?

5. a) What are your dissemination strategies in these and other areas?

b) How well are these cookstoves being adopted?

6. Does any of the above areas you have mentioned fall in a high population density area?

If YES, how well have you disseminated the cookstoves?

7. What size of institutions do you target in terms of population or any other factors?

8. a) How do you market your cookstoves to these institutions?

b) What problems do you encounter in your marketing efforts?

9. What is the type of institution cookstove do you produce or disseminate?

10. a) What is the design of this/these cookstove(s) like?

b) What are the design features that make it desirable, say better than other existing cookstoves, - improved or traditional.

Could I please have a sketch drawings of the cookstove?

11. Is there are any research on dissemination or design improvement o the cookstove going on?

If YES, what kind?

12. a) What is the general range of cost of this institutional cookstoves?

b) How is the purchasing of the cookstoves financed?

13. How well do institutions meet their financial obligations in purchasing the cookstoves?

14. What kind of prior training, if any, do you offer the users in terms of usage and basic maintenance?

15. What kind of follow-up do you make after installation?

16. What is the general condition of the cookstoves after use for a period of

a) less than 1 yr.

b) up to 5 yrs

c) up to 10 yrs

d) over 10 yrs

17. How well does the cookstove fit into the kitchen that is already existing?

18. Does the cookstove fixing require that the kitchen be modified to accommodate it?

19. How much does the use of the cookstove change the operations and behavior of kitchen staff?

20. What is the general feeling, of the user, about the cookstove in terms of design?

21. What factors do you think affect the dissemination and eventual adoption of the cookstove?