THE ROLE OF WOODFUEL SAVING COOKSTOVES IN COPING WITH FUELWOOD SHORTAGES, WITH A FOCUS ON FOOD PREPARATION PATTERNS IN KISII DISTRICT, KENYA.

BY

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DECLARATION

I **OBARA CLEMENSIA NYABONYI** hereby declare that this thesis is my original work and has not been presented for a degree in any other university.

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This thesis has been submitted with our approval as university supervisors.

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DEDICATION

TO MY PARENTS FOR THEIR DEDICATION TO MY EDUCATION.

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DEFINITIONS

Astra and **Chulha:** these are names for Indian fuelwood efficient cookstoves

Bananas: this is boiled green bananas, occasionally mashed and taken with no accompaniment.

Beans: refers to a dry beans relish.

Dependency ratio= $\frac{\text{population <15yrs + population >65yrs}}{\text{population aged between 15-65 years}}$

Food preparation patterns: This is defined as number of dishes cooked per day, frequency of cooking certain foods per week (long/short duration cooking) and cooking time per dish.

Green vegetables: refers to a green vegetable relish

Improved h/holds: these are households using energy saving cookstoves.

Indigenous Kisii household: means a household inhabited by people using Kisii language as their mother tongue.

Jiko: a Swahili name for cookstove.

Kales: refers to a kales relish.

Long cooking dish: this is one that takes at least one hour to cook.

Mai-sauki and **Malgache:** are Niger's fuelwood efficient and traditional cookstoves respectively.

Maendeleo and **Kenya Ceramic Jiko (KCJ):** these are Kenyan fuelwood and charcoal efficient cookstoves.

Nyoyo:a Kisii name for a dish of mixed maize and beans.

3A: this is a name of a stove production centre in Kajiado District.

3PA: a Burkina Faso fuelwood efficient cookstove.

Potatoes: refers to boiled sweet potatoes mostly taken with no accompaniment.

porridge: refers to maize or finger millet porridge

Sae: this is an Indonesian improved cookstove.

Short cooking dish: this is one that takes less than 30 minutes to cook.

Trad/h/holds: these are households using three stone traditional cookstoves.

Ugali: this is a thick maize meal porridge.

ABBREVIATIONS

A.C.T.S	- African Centre for Technology Studies
E.N.D.A.-T.M	- Environnement et D'eveloppement du Tiers-monde, Programme Energie
C.A.R.E	- Corporative American Relief Everywhere
C.B.S	- Central Bureau of Statistics
C.E.M.A.T	- Centro Mesoamericano de Estudios sobre Tecnologia Apropiada
C.C.R.E.R.T.	- Chinese Center of Rural Energy Research and Training
C.O.R.T	- Consortium on Rural Technology
F.A.O	- Food and Agricultural Organisation
F.W.D	- Foundation for Woodstove Dissemination
G.o.K	- Government of Kenya
G.T.Z	- Germany Technical Cooperation.
G.A.T.E	- Germany Appropriate Technology Exchange
I.D.R.C	- International Development Research Centre.
I.L.O	- International Labour Organisation
I.T.D.G	- Intermediate Technology Development Group.
I.T.P	- Intermediate Technology Publication.

K.U.A.T.C	- Kenyatta University Appropriate Technology Centre
K.E.N.G.O	- Kenya Energy and Environmental Organization.
K.W.A.P	- Kenya Woodfuel Agroforestry Programme
K.C.J	- Kenya Ceramic Jiko
K.R.E.D.P	- Kenya Renewable Energy Development Project.
M.O.E	- Ministry of Energy
M.Y.W	- Maendeleo ya Wanawake
N.G.O	- Non-Governmental Organisations
S.I.D.A	- Swedish International Development Agency
S.E.P	- Special Energy Project
U.N.I.C.E.F	- United Nations International Children Emergency Fund.
Z.E.C.N	- Zimbabwe Energy Conservation Network

INCLUSION CRITERIA

The households were categorised according to whether they were using improved cookstoves or three stone traditional cookstoves. The following operational definitions were used for inclusion;

1. Improved cookstove households had been using the cookstoves for at least one year.
2. Improved cookstove households had to be using the improved cookstove as the main meal preparation stove.
3. Traditional cookstove households had to be neighbours of the improved cookstove households.
4. Traditional cookstove households had not owned an improved cookstove in the past.
5. Traditional cookstove households had to be using the three stone cookstove as their main cookstove for meal preparation.
6. The household had to be an indigenous Kisii household.

ABSTRACT

A cross sectional study was carried out in Kisii District to compare fuelwood consumption and food preparation patterns of households using improved cookstoves with those using traditional cookstoves. A sample of 196 households was selected using multistage sampling from four purposively selected sub-locations with the highest utilization of improved cookstoves. A pretested questionnaire was administered and a sub-sample of 120 households was observed.

Results show that improved cookstove households used significantly less fuel than the traditional cookstove households. Fuel saving increased with cooking time, hence, the longer the cooking time, the higher the fuel saving. Fuelwood was the cheapest fuel in the area, and most households gathered the fuelwood from their farms, while six percent exclusively purchased their fuelwood. A few households supplemented fuelwood from the main source with collections from roadside and neighbours' farms. Fuelwood was mainly collected by women and children. It was found that the two groups of households spent similar amounts of time per trip on the collection of fuelwood, but improved cookstove households collected fuelwood less frequently compared to the traditional cookstove households.

There was no significant variations in the food preparation patterns between the two groups, implying that fuelwood problem has not yet had significant impact on food preparation patterns. Food preparation patterns were affected more by availability of food and time for its preparation than by lack of fuelwood. It was also established that longer duration cooking dishes cooked faster on an improved cookstove while shorter duration cooking dishes cooked faster on a traditional cookstove.

In conclusion, use of improved cookstoves reduces the demand for fuelwood, and hence, not only saves time for other activities, for instance, crop production, but also contributes towards environmental conservation. It is recommended that widespread dissemination of information and accessibility to the improved cookstoves should be established in order to plan for their increased use.

CHAPTER I

1. INTRODUCTION

1.1. Statement of the Problem

The rapidly increasing consumption of energy is one of the major concerns of the world today, as known reserves are continuously being depleted. The situation in the third world has been further compounded by the escalating costs of petroleum based products. This has caused a growing concern about the ability of developing countries to meet their energy requirements, especially in the rural households. The majority of people in the developing countries use woodfuel as their major source of energy for cooking, heating and lighting. However, this source of energy is increasingly becoming scarce and poses problems.

In 1980, it was estimated that 2,000 million people depended on woodfuel, and this figure was expected to grow to 3,000 million by the year 2,000, (FAO/SIDA,1983). It was further estimated that by the turn of the century only nine million Africans will have adequate fuelwood supplies. However, the situation in the Sahel region is worse because it is estimated that the remaining trees can only provide fuelwood on a sustainable basis for 2 million people - just half of the region's 1990 population.

Kenya like the other sub-saharan countries is experiencing levels of energy demands in excess of available supplies. This is manifested by the current depletion of woodfuel stocks. GTZ/SEP (1985), estimated that by the turn of the century the country will be experiencing fuelwood supply shortfall of 30 million tons and the smallest farms will be hit the most. This implies that the shortages will get worse in the future unless appropriate intervention measures are taken to help households which are largely dependent on fuelwood cope with the problem.

Review of alternative indigenous fuel supply options for Kenya does not yield an optimistic prognosis for the medium and short term. Given the prohibitive costs of importing petroleum fuel, the only options which are capable of being implemented at the necessary scale are fuelwood expansion programmes and reduction on woodfuel consumption through the use of fuel efficient technologies. The first option does not look promising given the rapid population increase (3.8%) in the country which has led to the competition for available land, (GOK, 1989). However, the second option which focuses on more efficient use of woodfuel through the introduction of improved cookstoves holds some promise, but only if extensively used.

There are many types of fuelwood efficient cookstoves that have been developed and although the designs differ from country to country, they have the common goal of being energy efficient. In 1990 the Foundation for Woodstove Dissemination (FWD) stated that improved cookstoves are the most promising means of assisting millions of people who rely on woodfuel and are suffering from its diminishing availability. Woodfuel consumption studies done in the past few years have also shown that considerable saving (30-50%) can be achieved if the energy efficient cookstoves are widely and regularly used, (GATE/GTZ, 1991).

Although dissemination of these cookstoves has been going on since the late seventies, the level of dissemination is still low. This has been attributed to lack of experience and ideas by the implementors of the dissemination programmes. However, this problem was addressed in 1983 through the formation of the FWD, which was charged with the role of facilitating the exchange of information and experiences worldwide. The FWD has a decentralized structure with seven regional offices worldwide, namely;

1. CEMAT in Guatemala covering Central and South America.
2. CCRERT in China covering China.
3. KENGO in Kenya covering East Africa.

4. CORT in India covering the Indian sub-continent.
5. Dian Desa in Indonesia covering Southeast Asia
6. ZECN in Zimbabwe covering Southern Africa.
7. ENDA-TM in Senegal covering West Africa.

According to GATE/GTZ (1991), Kenya is one among four countries that has achieved a level of dissemination of 11-50%, others are China, India and Sri Lanka. Nevertheless, it should be noted that energy issues in Kenya had in the past occupied a back seat till 1979 when the Ministry of Energy was formed. Intensive woodfuel surveys were then undertaken in the early 1980s, primarily by the Beijer Institute, which showed that woodfuel was the most important fuel in aggregate terms and that there was a major growing gap between sustainable supply and demand. This prompted a number of woodfuel based renewable energy technology projects to be undertaken in the country. The projects hoped to contribute towards the alleviation of the woodfuel crisis through wide scale dissemination of improved household and institutional cookstoves.

1.2. Justification of Research Problem

In the light of the aforesaid, it is evident that a lot has been done on the increasing scarcity of fuelwood and

strategies on how to increase and sustain the supply have been considered. Improved cookstoves have been seen as one major step forward in the looming crisis. These cookstoves were developed as an intervention strategy to reduce the fuelwood consumption through their efficient fuel utilization. Studies done in the laboratories have shown that they cut fuel consumption by half. However not many studies have been done under prevailing field conditions to assess their effectiveness in reducing fuelwood consumption.
In fact IDRC, (1985), reported that some of the stoves which have been shown to be fuel efficient under ideal conditions may actually increase fuelwood consumption. One such study showed that people were using 33% more wood when using an improved cookstove compared to those using a traditional cookstove. Hence, the main goal of this study is to assess the fuel efficiency of the improved cookstoves under prevailing field conditions. This will be done by comparing fuelwood consumption patterns between users of the improved cookstoves and users of the traditional cookstoves. Kisii district was purposively chosen for this study because it was among the first three districts in the country to implement the improved cookstove programme in 1985.

It is hoped that the results of this investigation will provide facts to be considered by the Ministry of Energy and other associated organizations in the development of improved cookstoves and energy programmes in general.

1.3. Study Objectives

1.3.1. To determine the contribution of improved cookstoves to the reduction of household fuelwood demand.

1.3.2. To determine whether there is any difference in food preparation patterns between improved cookstove households and traditional cookstove households.

1.4 Sub Objectives

1.4.1.1. To determine the types and source of cooking fuel.

1.4.1.2. To determine the frequency of fuelwood collection and average time per collection.

1.4.1.3 To identify types of cookstoves used.

1.4.1.4. To determine preferred uses for each type of cookstove.

1.4.1.5. To determine the amount of fuelwood used per day.

1.4.1.6. To determine other fuel saving strategies used.

1.4.2.1. To determine the type and frequency of commonly cooked dishes.

1.4.2.2. To determine the number of dishes cooked per day.

1.4.2.3. To determine the length of cooking time for commonly cooked dishes.

1.4.2.4. To determine whether some dishes are eaten cold and why.

1.5. Hypothesis

Given the above objectives it was hypothesised that,

1.5.1. Households using improved cookstoves spend less time on average in the collection of firewood compared to those using traditional cookstoves.

1.5.2. That there is a difference in the food preparation patterns between households that use the improved cookstoves and those that use the traditional cookstoves.

CHAPTER 2

2. LITERATURE REVIEW.

2.1. Introduction

The world is experiencing an energy crisis as available supplies of non-renewable energy dwindle while alternate sources cannot be rapidly built up. For the majority of people in the developing countries who depend on fuelwood, the demand for the wood is increasingly outstripping the supply. According to the Population Report (1992), three out of every five people in developing countries will be short of fuelwood by the year 2,000. Carr (1985), reported that Niger's forest and woodlands will be exhausted within 23 years, and in Upper Volta the demand for wood already exceeds the regeneration capacity.

Kenya's woodfuel demand in 1980 was 20 million tonnes with only 13 million being drawn from sustainable yield and seven million from depletion of stock (GTZ/SEP, 1987). It was further estimated that by the year 2,000, 30 million tonnes would be met from depletion of stock. According to Obel (1982), Kenya,s fuelwood stock is being depleted at a rate of 40% greater than it is being replenished. This implies that in future, deforestation in Kenya will expand, leading to increased fuelwood shortages and natural resource degradation.

Although potential exists in the exploitation of geothermal and hydro-electric power, the high cost of installation limits their establishment due to the precarious economic situation of the country. Nonetheless, a considerable amount of research and experimentation work has been carried out in the country on new and renewable energy sources over the last decade. These experimentations have focused on hydro, wind, biogas and geothermal energy. However, even if these energies were to be availed throughout the country, it is unlikely that rural households will afford them given their difficult economic conditions. Hence, woodfuel will continue to play a central role in the supply of fuel to the majority of Kenyan households. Therefore, ways must be found to make it readily available to rural households.

FAO (1989), argued that as the fuelwood shortages grow, people have to walk progressively further to collect it, while crop residues which could have been used as livestock feed and dung as soil conditioners have to be diverted to fuel use, and fruit trees of economic value will have to be sacrificed for fuelwood. As the situation gets worse, more cash income will go to buying of fuel at the expense of other essential commodities. Eventually, fuel shortages can become so acute as to force people to alter their food consumption patterns, (Hoskins et al, 1985).

It is in the midst of this scenario that many improved cookstove projects were undertaken especially in the developing countries. The introduction was meant as an intervention strategy to avert the "woodfuel crisis". Nonetheless, the emergence of these cookstoves can be traced back to Mahatma Gandhi in pre-independence India who first drew attention to the cookstoves as a major element in the process of improving the living conditions of the rural women. This inspired a lot of work by the Hyderabad Engineering Body, culminating in the development of the smokeless *chulha* cookstove in 1947, after two years of research, (Raju, 1954). This was soon followed by many other cookstove activities in Indonesia, Egypt and Ghana , (Joseph et al, 1990). This first phase of improved cookstove development was strongly motivated by considerations of smoke removal and hygienic benefits that accrue from it.

The second phase started in the wake of the oil crisis of the 1970s when Eckholm (1975), graphically described the hardships of the poor of the world and the fuel gatherers in his book, "The Other Energy Crisis". He argued that improved cookstoves were not only going to save fuelwood but could use a diversity of locally available fuels. It was at this time that a large number of energy studies were initiated in many developing countries, by both national and international agencies. The main activities of these projects were to encourage tree planting, look for substitute fuel and improve cookstoves.

These activities were based on the assumption that the three stone traditional cookstoves were fuel inefficient and therefore large scale introduction of energy efficient cookstoves would slow down the rate of woodfuel consumption. This will in turn reduce the rate of deforestation and save developing countries from the impending domestic energy crisis. A number of woodfuel consumption studies that had been done had clearly established that considerable saving could be achieved (30-50%) if the technology was adapted to people's needs and therefore regularly used, (GATE/GTZ, 1991).

Mugo (1990), observed that the *Maendeleo* improved cookstove has twice the fuel efficiency of the three stone traditional cookstove. Therefore, she alleged that if households were to use this cookstove constantly they would save up to 50% of the fuel required by the three stone traditional cookstove.

Improved cookstove initiatives in Kenya are reported to have started seriously after the United Nations Conference on New and Renewable Sources of Energy held in Nairobi in August, 1981, (Karekezi et al,1989). After the conference a number of multilateral and local agencies started improved cookstove projects. The most important agencies involved were:

-Ministry of Energy (MOE).
-Kenyatta University Appropriate Technology Centre (KUATC).
-Kenya Energy and Environment Organization (KENGO).
-Intermediate Technology Development Group (ITDG).
-CARE Kenya.
-UNICEF.
-Artisans of Shauri Moyo.
-Maendeleo ya Wanawake.
-Bellerive Foundation

All these agencies have played some vital role in the evolution of improved cookstoves in the country, but the Ministry of Energy has been the most important since it has been engaged in the coordination of cookstove activities by both the NGOs and government ministries. However, it should be noted that Kenyatta University was the first to start improved cookstove research activities even before the 1981 conference on energy.

Cookstove activities started in Kenyatta University in 1976, they involved rural fuel surveys and research on the design of improved cookstoves. By 1980s it had become the leading research centre for the design and testing of the improved cookstoves in the country. The work was being carried out under the auspices of the Department of Physics.

In June, 1981, KENGO was created by over sixty organisations working in renewable energy in Kenya. Its main role was to coordinate the activities of NGOs involved in renewable energy projects in the country. KENGO's cookstove activities were largely confined to household surveys, dissemination of improved cookstove information and training of artisans in the production of the cookstoves.

Unlike many of the other agencies working on improved cookstoves in Kenya, Maendeleo ya Wanawake (a women development NGO), with the assistance of GTZ has concentrated on the dissemination of rural household woodfuel cookstoves rather than urban charcoal burning cookstoves. This organisation spearheaded efforts to encourage adoption of the improved cookstoves in rural Kenya, after they designed the cookstove popularly known as the *maendeleo* cookstove. The *maendeleo* cookstove is a one pot mud stove that is built in situ and is the one that is currently being promoted for use, especially in rural households. It is estimated that by mid 1988, 22,000 maendeleo stoves had been introduced into the rural areas of Kenya, (Karekezi et al, 1989), and between 1989 and 1992 a further 60,000, giving a current national total of 82,000 improved (*maendeleo*) cookstoves, (SEP/GTZ, 1992).

2.2 Causes of Fuelwood Scarcity and its Implication for Rural Households

Three major causes of fuelwood scarcity have been identified, namely: environmental potential, competing demands and accessibility, (Munslow et al 1988). Although environmental potential is determined by climate, topography and soil, human land use practices over the years have affected the environment severely, and tampered with the fuelwood base. The changing land use practices include clearing of forests for agriculture and overgrazing through overstocking of herds of cattle, goats, and sheep. K'Okul (1991), remarked that as more and more land is cleared for cultivation community woodlot are being replaced by grasslands resulting in fuelwood shortages.

It has also been claimed that even if the wood was available, other competing demands for it are given priority over fuelwood. The other uses include timber for construction, fodder for animals, environmental protection, food, cultural and medicinal purposes. Munslow *et al* (1988), further asserted that access to fuelwood can also be restricted by physical constraints. Population density has been viewed as the biggest physical constraint. According to the Population Report (1992), population pressure is a major cause of the increase in fuelwood demand leading to fuelwood scarcity. Carr (1985), narrated that due to population pressure some city dwellers' demand for wood and charcoal has left many cities surrounded by rings of deforested land, stretching for many kilometres. One such city is the Sudanese capital of Khartoum, where rapid population increase between 1973 and 1980 left the city with only isolated woodlot within 90km radius. Yet in 1955 the city was surrounded by a dense woodland. This implies people must now spend more time and travel farther and farther in search of fuelwood. Omosa (1987), reported that when tenants first settled in Bura Irrigation Scheme in 1982, fuelwood was easily gathered from nearby bushes, but by 1984 they were travelling up to 6km to get it, and by 1986 the tenants were travelling over 12km to gather it.

The Population Report (1992), further projected that population increase will account for about 80% of the increase in people experiencing fuelwood shortages between 1980 and the year 2,000. The same sentiments are shared by Omosa (1987) who contended that fuel scarcity in Kenya is a crisis of the carrying capacity and not environmental potential. This means that population growth of both human and animals will account for most of the household shortages, and in areas like Kisii district, this is the factor that is playing a crucial role given the current population density of 687 persons per km^2. Not only is it impossible to find space to plant trees in the small landholdings (1.2 hect.) which characterise the district, but there is increased demand on the little supplyavailable. It has also been alleged that cultural accessibility to trees by women is another cause of fuelwood shortages, especially at the household level. KWAP (1990), found that in Kisii and Kakamega Districts cultural practices and beliefs contribute significantly to the fuelwood shortages. For instance, among the Luhyas, women are not allowed to plant trees and yet they are the heaviest consumers at the household level and they feel the fuelwood scarcity most. Among the Kisii any permanent features on the land which include trees belong to the man as head of the household. This means that even though the trees may be there the women will still be experiencing fuelwood shortage because they have no direct access to the trees except through permission from the men.

ILO (1987), explained that in parts of India the fuelwood shortage for a number of households is a problem of land ownership. In other parts of the world the era of colonisation brought land alienation, which created a level of land privatisation, hence, increased social differentiation leading to decreased access to fuelwood for the disadvantaged. Further commercialization of fuelwood has meant that poor households cannot afford to purchase the fuel given the limited cash at their disposal.

As the fuelwood scarcity increases the households have been forced to adopt strategies to deal with the situation. Some of these strategies have a direct bearing on their food preparation patterns. According to Nyang (1992), Brouwer (1992) and GTZ/GATE (1991), some of the strategies include travelling long distances in search of fuelwood, use of poor quality fuel, purchasing of fuelwood and economising on the available fuelwood. K'Okul (1991), commented that women in Busia (Kenya) have had to travel farther and farther over the years in search of fuelwood. This trend has led to the increase in the amount of time and energy spent by women on fuelwood collection, leading to reduced time for food production, income generating activities and childcare. According to GATE/GTZ (1992), the three main strategies for increasing fuelwood supply are:

1 Increasing energy and time spent on collecting fuelwood.

2 Substituting fuelwood with alternative fuels and

3 Economising on consumption of fuelwood and alternative fuels.

Unfortunately, these strategies affect food supply, income generating activities, food preparation and consumption, all resulting in a deterioration of the nutritional condition especially of women and young children. Some of the above effects occur when, for instance, alternative sources of fuel like agricultural residues and dung are used. It means that waste like dung, instead of being put in the field to increase fertility, is withdrawn leading to decreased fertility. Brouwer (1992), also argued that inferior fuel like maize stocks require constant attention to keep fire going and so it puts a strain on women's time.

Gate/GTZ (1992), have further claimed that economising on fuelwood can contribute to malnutrition as a result of cooking fewer meals, cooking food for less time or omitting some meals. In most instances the trends are likely to increase intestinal infections, impair absorption of protein or cause a decrease in the amount of food consumed. Experiences of Hammer (1983), in Sudan have shown that families have started consuming raw food which should have been cooked. This in his view is leading to an increase in intestinal diseases. FAO (1989), indicated that women in the Sahel region are now switching from millet diet to rice diets because of the cooking time involved. The trend is changing from long duration cooking dishes to short duration cooking dishes. Also, it has been observed that in Senegal lack of fuelwood has led to consumption of cold-left overs or uncooked millet flour mixed with water. In parts of Nevada and India, women have cut the number of cooked meals from three to one per day, (GATE/GTZ, 1992). Ministry of Energy (Gok, 1988), also observed that in order to economise on fuelwood some households in Kisii district have changed their cooking pots from the longer heating clay pots to the shorter heating aluminium pans. However, it should be noted that extensive research has been done on the consequences of fuelwood scarcity on nutrition. Infact most of these referencesare based on limited research or anecdotal evidence. Nevertheless, the most important strategy which thepresent study focuses on is the use of improved cookstoves.

2.3 Efficiency of the Improved Cookstoves

As already cited in section 2.1, improved cookstove activities have been going on since the early 1940s. They have been seen as one of the major intervention strategies that will go along way in alleviating the woodfuel problems facing developing countries through their efficient consumption of fuelwood. This was recognised as an effective strategy during the Earth Summit in Rio de Janeiro Brazil, in 1992. It was then highlighted that improved cookstoves are an important component of Africa's sustainable energy strategies for the future (Kerakeze *et al*, 1992). Improved cookstoves activities have been operating in the third world for over two decades as part of national energy saving strategies, (ILO, 1985). The reasons for which they are adapted are not only limited to fuel saving but include removal of smoke, making kitchen neat, cooking faster and comfort in cooking (Joseph *et al*, 1990). Although the designs of these cookstoves differ from country to country and even within countries, they are all designed to have the common characteristics of being fuel efficient, smokeless and providing more comfort in use than the traditional cookstoves. In Kenya, for instance, there are three main improved cookstoves designs. These are:

a) The Kenya ceramic jiko (KCJ) whose design was aimed at urban household and uses only charcoal.
b) The community woodfuel cookstoves which are designed for institutional use and
c) The *maendeleo* cookstove which uses woodfuel and is designed mainly for use in the rural households.

A number of surveys that have been carried out among users and non-users of the improved cookstoves show a statistically significant (at 5 per cent level) decrease in fuel consumption with use of improved cookstoves. (Joseph *et al*, 1990 and GTZ/SEP, 1987). A survey carried out in India by FWD showed that the per capita fuelwood consumption for the improved cookstove (*ASTRA*) users was 0.86kg/day/person, which was 19% less than the traditional stove. The main reason given for adopting the cookstoves was, however, smoke removal (65% of the repondents).

A similar survey by FWD in Guatemala showed that the major reason for adopting the improved cookstove (*lorena*) was its cleanliness (57%). In addition, fuel consumption measurement established a per capita of 2.5kg/day/person for the *lorena* cookstove and 4.2 kg/day/person for the traditional cookstove.

Surveys in Indonesia reported that the improved *(SAE)* cookstove is regarded as being slow in cooking but most people said they adopt it because it saves fuel (62%). Although 19% of the people interviewed said that the cookstove is not fuel efficient, kitchen performance tests demonstrated that per capita fuelwood consumption was 0.8kg/day/person for the improved *(SAE)* cookstoves compared to 2kg/day/person for the traditional cookstoves. The *SAE* cookstove is also claimed to cook slower than the traditional stove, but it has the advantage of having two cooking holes, so one can cook two dishes at the same time.

Studies done in Niger revealed that the improved (*Mai-sauki*) cookstoves use 68% of the fuel used by the traditional (*Malgache*) cookstove while studies done in Burkina Faso showed per capita fuel consumption of 0.3kg/day/person for the improved (*3PA*) cookstove compared to 0.4kg/day/person for the traditional cookstoves.

Field tests done in Kenya have exhibited a per capita fuel consumption of 1kg/day/person for the improved (*maendeleo*) cookstove compared to 1.9kg/day/person for the traditional three stone cookstove, representing a 50% saving of fuel, (GTZ/SEP, 1992). Longitudinal surveys carried out in Kisii showed a per capita consumption of 1.1kg/day for improved (*Maendeleo*) cookstoves compared to 1.8kg/day for the three stone traditional cookstoves representing a saving of about 38% (Nyang, 1992). Studies done in kisii by GTZ/SEP, (1987), established that the cooking time for the various dishes in the District was not different between the improved (*maendeleo*) stove and the three stone cookstove.

In summary, it is clear from the above studies that improved cookstoves being promoted in the field can be fuel efficient. There is also little doubt that fuelwood crisis exists in the world today, and especially in developing countries. Hence, there is need for urgent intervention measures to be taken to prevent the crisis from escalating. There are several intervention measures being taken, including efficient utilisation of fuel, but the promotion of improved cookstoves look promising in alleviating the problem if effectively encouraged. Although Laboratory and controlled field tests of these stoves have demonstrated a fuel efficiency of up to 50%, it is apparent that not many surveys have been carried out under prevailing field conditions to assess the effectiveness of these improved cookstoves in reducing the household fuelwood demand. A few studies have been carried out in a couple of countries with encouraging results but none has been carried out in Kenya. Therefore, there is need for research in this area to assess the effectiveness of these stoves in alleviating the existing fuelwood problems in the country.

Secondly, although it has been cited that scarcity of fuelwood is likely to have an impact on food preparation patterns, such as reduced number of meals per day and eating of cold foods, no studies have been carried out to appraise the contribution of the improved cookstoves in arresting this problem. Hence, there is need for such a study to be carried out primarily through comparing the food preparation patterns of households with improved cookstoves and those with traditional cookstoves.

CHAPTER 3

3. BACKGROUND INFORMATION

3.1. Study Site

The study site was in Kisii District of Nyanza Province. The district lies between latitude 0° 30′ S to 1° S and longitude 34° 38° to 30° E and is about 400km from Nairobi. The district is situated in the highlands of south western Kenya and covers a total area of 1351 $km^{2,}$ making it the second smallest of the six districts in Nyanza Province. It shares common administrative boundaries with five districts: Kericho and Nyamira to East, Narok to the South and Homabay and Migori to the West. Its district headquarters is Kisii town which is a big centre of commercial activities relative to neighbouring towns because the main highways from Migori to Kericho and from Kisumu to Narok pass through the town.

3.2. Climate

The District's climate is of the highland equatorial zone despite its proximity to the Equator. There are hardly any pronounced climatic variations throughout the year. The period from March to June constitutes the long rain season while October to December constitutes the short rain season with an average annual rainfall of 2,000 millimetres. While January and August record less than 100 millimetres of rainfall, April has the highest precipitation of over 300 millimetres. Due to the high altitude (averaging 1800 metres) the district does not experience excessive temperatures despite its proximity to the equator. The minimum night temperatures average about 10^0C and maximum day temperatures average 28^0C throughout the year. However, sometimes temperatures go as low as 8°C and therefore necessitate house warming especially at night, (GoK, 1989).

3.3. Land Use

The district is characterized by small land holdings averaging 1.2 hectares, but it has the advantage of having both fertile soil and reliable rainfall which allows intensive mixed farming. The main cash crops grown are tea and coffee while food crops include maize, bananas, millet, beans and a variety of horticultural crops. Maize is the major crop and accounted for 40% of total cultivated land in 1987, (Gok 1989).

3.4. Natural Resources

There are no minerals of economic importance in the district except the soapstone, located in South Mogirango. Mining of the stone has not been fully exploited because the local people have failed to form a strong body to do the mining. Secondly, there are no proper marketing channels.

The district lacks public grasslands and forests of economic value. The small landholdings resulting from the increased population have not been favourable to development of forest reserves. Even hilltops which were once covered with trees have been cleared to leave more land for foodcrop cultivation.

A cultural survey carried out in the district (Ong'ayo 1985), indicated that tree planting in the past had been rare, since most of the trees required grew naturally and in plenty. Moreover, land was owned communally, and the trees growing on it were used freely by community members. Hence, nobody felt obliged to plant trees on community land. Before the introduction of exotic trees, indigenous trees were only planted as hedges around homesteads or around animal *boma* and in special cases certain trees were planted for medicinal products or symbolic purposes. It is recorded that as early as 1900, much of the original tree cover in the district had been cleared (Barnes, *et al* 1984). Given the current problems, arising from population pressure, it is unlikely that enough trees will be planted to cope with the ever increasing demand for woodfuel.

3.5. Population

Kisii is one of the districts with the highest population growth rate in the country, which stood at 4% in 1979, when the national average was 3.8%,(GOK, (1989). Currently the population stands at 927,907, giving an average density of 687 persons per square kilometre. The district is exclusively inhabited by one ethnic group, the Abagusii. Basically, they derive their existence from small scale farming. The society is patrilineal, where land and all other permanent assets are owned by the male household head. Trees and any other permanent features of the land are regarded as part of the land and are therefore owned and controlled by the men (Ong'ayo, 1985).

3.6. Housing

Most (65%) of the houses in the district are semi permanent (iron sheet roof and mud wall), while the remaining are grass thatched (22%) and permanent (13%). The households, in most cases, comprise a main house for sleeping in and a kitchen. This kitchen is typically a separate building from the main house and is where cooking stoves are built. The ceiling in the kitchen is normally used as a food and woodfuel store, (Ong'ayo, 1985).

3.7. Household Fuel and Cookstoves

The main source of energy for cooking in this community is fuelwood. Baseline surveys carried out by the Ministry of Energy in the district showed that fuelwood accounts for 82.3% of total energy requirements for cooking, (GoK, 1988). The main types of fuelwood used by the households can be categorised as split wood, branches, twigs, shrubs and agricultural residues (mainly maize stalks, maize cobs and sugar cane stalks).

Generally, shrubs and crop residues are considered low quality fuelwood and their increased usage is seen as an indication of the growing scarcity of fuelwood in the District. Other indicators of the growing scarcity are; expanding markets for fuelwood, high fuelwood prices and decreased tree cover. Splitwood and branches are the most preferred form of woodfuel. The purchased fuelwood is always in the form of split wood. It should be noted that the market for fuelwood in Kisii is not well pronounced. Most purchasing takes place interhousehold, involving the purchasing of whole trees which are consequently felled and split into woodfuel, (Onchere et al, 1992).

The major causes of fuelwood scarcity in the area are; failure to plant trees, increased sub-division of land and failure to use fuel efficient cookstoves. The District's major strategy for fuelwood development according to the 1989/93 plan was to increase use of fuel efficient cookstoves by the households to 20% by 1993. Other strategies were to supply seedlings to farmers for planting and to intensify tree planting education messages to farmers, (GoK, 1989).

The Kisii community has traditionally used the three stone traditional cookstoves and the metal charcoal stoves. However, in 1983 when the Special Energy Programme "Women and Energy" was launched as a joint venture between GTZ/Kanu Maendeleo ya Wanawake, Kisii was one of the three districts (others were Meru and Lamu) used as pilot for testing improved cookstove prototypes. After two years of trials it was established that a conservative woodfuel saving of 25-30% could be realised if the improved cookstove (maendeleo) is used instead of the traditional three stone stove. Hence, since 1985 the project has focused on the dissemination of the improved cookstoves, which are mainly of two designs, one pot and two pot types.

The main goal of disseminating the improved cookstoves is to improve the living and working conditions of the rural population through reduction of fuel requirement, creating job opportunities and improving health conditions through smoke reduction. The district has become one of the few in the country that have achieved the highest number of improved stove dissemination (over 6,000), (GTZ/SEP, 1992). However, dissemination of these stoves has experienced several setbacks which include lack of adequately qualified personnel in installing them, absence of accredited manufacturing centres within the district and above all inadequate extension services to pass on the awareness messages on the existence of the stoves.

Currently, only five percent of the households in the District use improved cookstoves, (GTZ/SEP, 1992). There is also only one centre in the district (Wise Women Group) that produces and markets the improved cookstoves. The fact that these cookstoves are marketed by some local women group members who do not effectively distribute them due to lack of adequate marketing strategies, demand seems to be outstripping the supply in most areas of the district. Fortunately, the Ministry of Agriculture through GTZ/SEP funding, has been ferrying the stoves from other centres outside the district to boost the local supply, at no additional cost to the consumer.

CHAPTER 4

4. METHODOLOGY

4.1. Type of investigation

The investigation was a cross-sectional survey of both descriptive and analytical nature involving a comparison of two groups of households. Households with improved cookstoves were compared with those using traditional three stone cookstoves in terms of amount of fuel, time and food preparation patterns.

4.2 Sample size Determination.

The sample size was calculated using an estimated improved cookstove dissemination of 5% in the district, (GTZ/SEP, 1992). The following formula was then used;

$$n = 2z^2 pq / d^2$$

Where n = sample size if population is more than 10,000

z = desired confidence limit.

p = % factor that is expected to be different between the two groups.

q = % factor not different between the groups.

d = expected allowable difference of no practical importance.

Then P was estimated to be 5%, q was then 100 - 5 = 95% .
Z was 5% and its value is 1.96 and d was 5%. Therefore, by using the above formula the minimum sample size was calculated as follows;

$$n = 2(1.96^2\ (.05*.95)/.05^{2)} = 146.$$

$$n = 146$$

After comprehensive sampling the total number of households with improved cookstoves that met the criteria for inclusion were 98 and they were all included. Then an equal number of traditional cookstove households for comparison were sampled, resulting in a final sample of 196 households.

4.3. Sampling

A multistage sampling was used to select the study households. Purposive sampling was used to select four sub-locations with the highest utilisation of improved cookstoves. The sub-locations chosen were Bokeire, Ikuluma, Taracha and Nyakoe. Selection of study sub-locations was followed by a comprehensive sampling of 98 households with improved cookstoves, based on the cencus of all improved cookstove households which met the inclusion criteria for selection in those sub-locations. This was followed by selection of a comparison group of 98 traditional cookstove households from the neighbours of those sampled with the improved cookstoves. By the toss of a coin, either the neighbour to the right or the left was selected.

Proportionate sampling was employed to pick 60 observation households from each group. During this stage 56% of the households in each sublocation were sub-sampled (see figure 1).

Fig.1 Schematic presentation of the sampling procedure.;

KISII DISTRICT

4 Sub-locations were purposively Sampled [Those with the highest utilisation of improved cookstoves].

These were:- Bokeire
- Taracha
- Ikuruma
- Nyakoe

A comprehensive sampling of all households with improved cookstoves and an equal number of those with traditional cookstoves in the four sub-locations was carried out.

- Bokeira sub-location - 48 households
- Taracha sub-location - 46 households
- Ikuruma sub-location - 38 households
- Nyakoe sub-location - 64 households

(Total = 196 households with improved and traditional cookstoves were sampled)

A proportionate sampling (56% of the households in each sub-location) was used to select 120 households for observation

- Bokeire - 30 households
- Taracha - 28 households
- Ikuruma - 26 households
- Nyakoe - 36 households

4.4 Study Instruments.

The study questionnaire comprised four parts of which the first part dealt with social demographic details, the second contained questions on types of fuels and cookstoves, the third section included information on food preparation patterns, while the fourth part was an observation sheet.

4.5 Preparatory Phase

The preparation for the fieldwork started in October 1992. A preliminary journey was made to the study district after obtaining the research permit from the Office of the President. A courtesy call was made on the area district commissioner to brief him on the intended survey. This was followed by a visit to the relevant ministries dealing with the topic under research. These included, Ministries of Energy, Agriculture, Economic Planning and Development. Finally, it was the Ministry of Agriculture that participated most in orientating the investigator to the study site. In addition, it assisted in identifying the sub-locations with the highest concentration of improved cookstoves and also provided transport.

4.6 Training of Field Assistants.

Four enumerators of form four level of education were recruited to assist during the main field survey. An intensive two weeks field training exercise was carried out. The exercise included instructions on how to administer the questionnaire, use of equipment, weighing techniques and how to time the cooking of each dish. The enumerators also accompanied the investigator during the piloting phase as part of training in order to gain practical experience. All the enumerators were fluent in Kisii which was the local language spoken by all the study households.

4.7 Pilot phase

Pretesting of the questionnaire was carried out in mid October in the study district but a different sub-location from those that were selected as study sites. A total of 18 households were sampled (nine with improved and nine with traditional stoves). The purpose of the exercise was to test the suitability of the study tools; like clarity of the questions to both the field assistants and respondents, validity of the questionnaire, time taken to administer the questionnaire and time taken from one household to the next. After the piloting the investigator returned to college and presented the results to the advisors, other academic staff and fellow students. Relevant and necessary changes were then made based on the findings of the pilot results. Data for the main study was collected between November 1992 and February 1993.

4.8. Data Collection

The purpose of the study was communicated to the households during the sampling. The households were informed that they may be visited at least three times. This was to allow for observations and revisits for questionnaire verification.

The data was collected in two phases. During phase one, the administration of the questionnaire was done. The observation was done during phase two of the survey. It was also during phase two that fuel collection time was observed.

4.9. Phase One of Data Collection.

4.9.1. Social demographic characteristics data

Social demographic data was collected on the first day of data collection. It covered information on; land size, household size and ages of members, sex of head of household, education, monthly expenditure on food and type of houses.

4.9.2. Types of fuel and Cookstoves data

The collected data was on the types of household cookstoves and their preferred uses. In addition, data was also collected on types of fuel used, and if fuelwood, where it was gathered, how often and how many killogrammes of fuelwood the household consumes on an average day. The respodents were asked to bring from their fuelwood stock the approximate amount of fuelwood they use during an ordinary day from morning till evening. This fuelwood was then weighed using a hanging salter scale which had a capacity of 25kg and was calibrated at intervals of 0.1kg. This was then referred to as the recall fuelwood used per day. These scales were regularly checked at the office of weights and measurements for accuracy and precision.

4.9.3. Food preparation patterns data

Under this, data was collected on number of dishes taken the last 24 hours, whether any of the dishes were served cold, the types of dishes commonly cooked by the households, how frequently they are cooked and the reasons for cooking certain dishes less frequently.

4.10. Phase Two of Data Collection - Observation

Two days were spent per household observing a sub-sample of 120 households carrying out dish preparation and fuel gathering activities. These two days were not consecutive since day two depended on the household acquiring the fuelwood required for cooking nyoyo. Day one was devoted to collecting information on the number of dishes cooked, length of cooking time per dish, the amount of fuelwood required for each dish and the number of missed meals in the last 24 hours. Day two was for timing the cooking of dry and soaked *nyoyo*, time taken per trip of fuelwood gathering and the amount of fuel collected. During day one of the observation the enumerators had to arrive at the household at about 6.30 a.m and leave around 7.00 p.m depending on the agreement with the households. This was to allow for observation of all dishes cooked that day, including breakfast and supper dishes.

4.11. Observation Procedure.

During this period of data collection fuelwood to be used was weighed before and after cooking for each dish, the difference was then recorded as the amount of fuel used by the dish. At the end of each observation day the subtotals were added to get the total fuelwood used per day for each household. The scales were regularly checked and adjusted using known weights.

Time observation was done using a casio stop watch. The timing of the dishes was done from the time the pot was put on the cookstove up to the time it was removed. It was then recorded to the nearest minute. The stop watches were regularly checked for accuracy and precision.

In all the above observations the cooking was done in the presence of the trained enumerators. During the *nyoyo* preparation, as was the practice, the maize/beans were soaked overnight.

4.12. Validation of Data.

The principal investigator closely supervised and spot checked on the enumerators from time to time to check their timing and weighing of fuelwood throughout the observation period. The weighing scales were also regularly checked for accuracy and precision with known weights.

4.13. Methods of Data Analysis

Data was computer processed using Dbase III and SPSS\PC programmes. After entering the data, cleaning and editing was done using these programmes. Frequency distributions, cross-tabulations, between dependent and independent variables was done. Associations, differences and relationships were done using chi-squares, t-tests and correlations respectively. While the significance level cut-off was taken to be $P < 0.05$.

CHAPTER 5

5. RESULTS

The major aim of the study was to determine whether improved cookstoves reduce household fuelwood demand and whether there is a difference in food preparation patterns between households using the three stone traditional cookstoves and those using the improved (maendeleo) cookstoves.

The results presented below are based on data collected from a primary sample of 196 households (98 with improved cookstoves and 98 with traditional three stone cookstoves). They further include findings from an observation sub-sample of 120 households (60 improved cookstoves and 60 three stone traditional cookstoves). The results are organized such that each section addresses a research sub-objective.

5.1. Social Demographic Characteristics

Sampled population comprised 51% of the population that was below 15 years of age, 46% that was between age 15 and 65 and 3% above age 65, reflecting a dependency ratio of 1.2. Most of the household heads had attained some level of education with only 12% who had no education at all, while 56% had been to primary and 44% had gone beyond primary. The average household size was 6.7 persons and 6.5 persons for the improved and three stone traditional cookstoves respectively. The mean land holdings were 1.4 hectares for both groups of households. Table 1 is a summary of the social demographic characteristics. There was no significant difference in social demographic characteristics between the two groups.

Table.1 Summary of social demographic characteristics of the sampled population.

Characteristics	Improved h/holds n = 98		Trad/h/holds n = 98		
	mean	sd	mean	sd	p-value
Household size	6.7	2.4	6.5	2.3	0.625
Land size (acres)	3.4	1.5	3.4	1.8	0.973
% female headed households	18	-	15	-	0.703
Monthly food expenditure (ksh)	967	495	842	518	0.683

5.2. Type of Fuel Used and Source

Table 2 shows the types and combinations of fuel used by the households. Many of the households exclusively used fuelwood, followed by 30% that used a combination of fuelwood and agricultural waste. There was no significant difference in the combination of fuels used by the two groups of households. All households claimed that fuelwood is the cheapest fuel in the area.

Table 2 Distribution of households by types of fuel used.

Type of fuel	Improved h/holds n = 98	Trad/h/holds n =98
	%	%
Firewood only	43	49
Firewood and charcoal	12	17
Firewood and agricultural Waste	27	29
F/wood, charcoal and paraffin	18	5

The majority of households (54% and 67% of the improved and traditional respectively) exclusively gathered their fuelwood free. Only 6% and 5% of the households for improved and traditional cookstoves purchased all their fuelwood respectively. While 40% of the improved and 28% of the traditional cookstove households used a combination of gathered and purchased fuelwood. Fuelwood gathering was done mainly from their farms (60%), but 40% of the households gathered it from the roadside and neighbours farms to supplement. As already cited in section 3.4, there are no public lands in the district for free fuelwood gathering.

Most of the study households had planted trees on their farms (93% and 96% for improved and traditional cookstove respectively). Those who had not planted any claimed that it was due to lack of space as land sizes were too small. However, of those that had planted, only 29% and 18% had planted specifically for fuelwood in the improved and traditional cookstove households respectively. This difference was not statistically significant ($p<0.05$).

5.3. Types of Stoves in the Households and Their Uses

There were three types of cookstoves in use by the households; these were the woodfuel cookstoves (100%), the charcoal cookstoves and the paraffin cookstoves. All surveyed households used the fuelwood cookstove as their main cookstove while 30% and 22% of the households used it with a combination of charcoal and paraffin cookstoves in the improved and traditional cookstove households respectively. The improved cookstove households were using more combination of the other stoves compared to the traditional stove households. These results were found to be significant ($p=0.012$).

However all study households reported that apart from the main cookstove (improved/three stone cookstove), all other cookstoves were rarely used except for warming the house or cooking light meals. (see Table.3).

Table 3. Distribution of households by reasons for using other cookstoves.

Reason	Improved h/holds n=30	Trad/h/holds n=22
	%	%
lack of f/wood	23	11
Warming house	49	54
Light dishes	28	35

5.4. Frequency of Fuelwood Collection

Table 4 shows the frequency of fuelwood gathering by the households. These results show a significant association (P=0.004) between cookstove type and frequency of fuelwood collection, whereby households with improved cookstoves collect fuelwood less frequently compared with three stone traditional cookstove households. However, the mean observed time for fuelwood gathering was two hours and seven minutes(sd .52) for improved cookstoves and two hours twenty six minutes (sd .78) for traditional cookstoves while the mean fuel collected in both cases was 12kg (sd 2.88) for the improved cookstove households and 13kg (sd 3.00) for the traditional cookstove households. But these differences in the means for the time taken and amount of fuelwood collected were not significant (at $p<0.05$).

Table 4. Distribution of households by frequency of fuelwood collection.

Frequency of Fuel collection	Improved h/holds n=98	Trad/h/holds n=98
	%	%
Daily	29	45
Weekly	47	43
Monthly	24	12
Total	100	100

The persons most involved in the gathering of the firewood were the women and the children. In 95% of the households fuelwood gathering was done by the women and children, while in the remaining (5%) it was done by hired labour. In the cases where trees had to be cut for fuelwood, hired labour contributed over 65% of the labour while the husbands contributed 25% and children 10%.

Forty one percent and 33% of the improved cookstove households indicated that the cash for hiring the labour mainly came from wages and sale of food crops respectively while 25% and 42% of the traditional cookstove households indicated that the cash came from wages and sale of foodcrops respectively. Other sources of cash included sale of cash crops and businesses.

5.5. Reasons for Purchasing or not Purchasing an Improved Cookstove.

Seventy nine percent of the households said the major reason for adopting the use of the cookstove is because it consumes less fuelwood, 15% said because it cooks faster while 7% said because it makes the kitchen neater. On the other hand the main reason for not owning an improved cookstove by the traditional cookstove households was that the cookstoves are not available in the local markets (57%), followed by lack of money (24%) and absence of a permanent kitchen (19%).

5.6. Mean and per Capita Fuelwood Consumption per Day

According to recall, mean daily fuelwood consumption was 5.4 kg (sd 1.2) with a range of 5.9 and a median that was equal to the mean for the improved cookstove households while it was 8.7 kg (sd 2.0) with a range of 9.0 and a median of 8.5 for traditional households. On the other hand the observation mean for improved cookstoves were 5.5 kg (sd 1.4) with a range and a median that were equal (5.3) while for traditional cookstoves the observation mean was 8.5 kg (sd 1.9) with a range of 8.8 and a median 7.9. It should be noted that both recall and observation yield very close means for both groups. However, these means were significantly different between the two groups (p<0.001).

The per capita woodfuel consumption was 0.9kg/day/person (sd 0.4) for improved cookstoves and 1.4kg/day/person (sd 0.5) for the traditional cookstoves. These results were also significantly different (p<0.001), (see Table 5).

Table 5. Mean and per capita fuelwood consumption per day.

Fuelwood consumption	Improved h/holds				Trad/h/holds			
	n	kg	sd	range	n	kg	sd	range
Mean recall	98	5.4	1.2	5.9	98	8.7	2.0	9.0*
Mean observed	60	5.5	1.4	5.3	60	8.5	1.9	8.8*
Mean per capita	98	0.9	0.4	-	98	1.6	0.5	- *

*All results are statistically significant (p=.000)(t/test).

Household size and fuelwood consumption were positively and significantly correlated (r=.3705, p= 0.001) while household size and per capita consumption were negatively and significantly correlated (r=.8050, p=0.001). From Figure 2, it appears that as household size increases the per capita consumption decreases while the mean consumption increases. However, both consumptions seem to level off as the household size approaches 10. Mean fuelwood consumption was also found to be significantly correlated (r=.2068, p<0.01) with usage of other energy saving devices in the households.

MEAN AND PER CAPITA FUELWOOD USE PER DAY

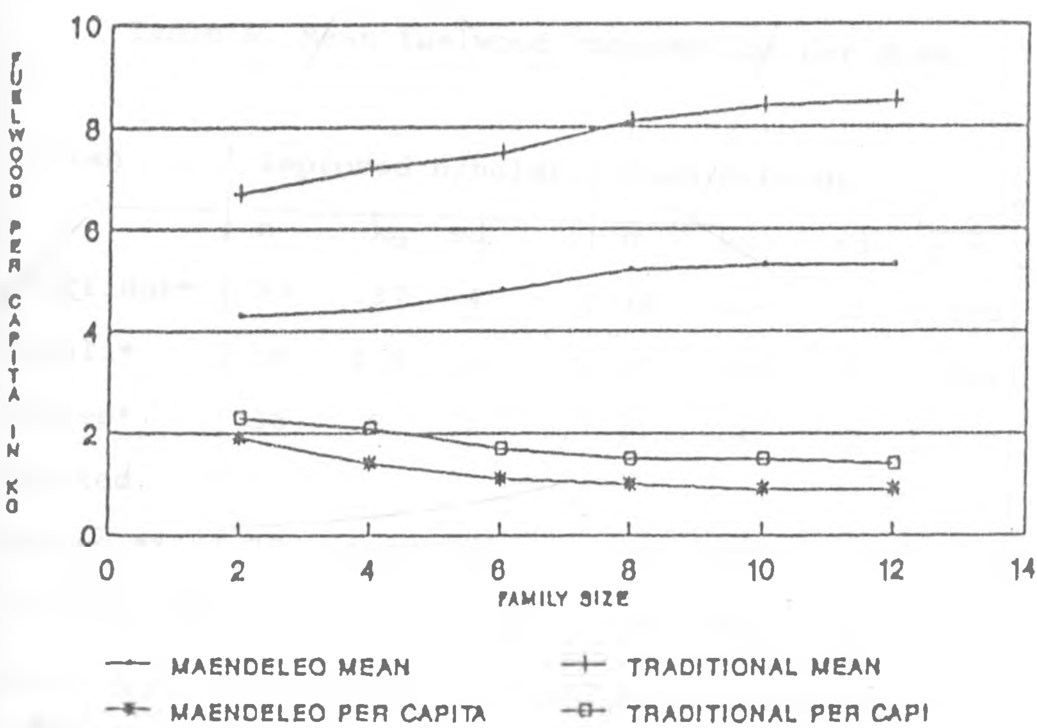


FIG.2

5.7. Mean Fuelwood Consumption per Dish

Improved cookstove households used significantly less ($p<0.001$) fuelwood per dish compared to traditional cookstove households. However, the percentage fuel savings ranged from dish to dish, with long period cooking dishes saving more fuel (46%) than short period cooking dishes (see table 6).

Table 6. Mean fuelwood consumption per dish.

Dish	Improved h/holds			Trad/h/holds				
	n	kg	sd	n	kg	sd	p-v	% saved
Porridge*	37	.37	.4	30	1.4	.5	.000	36
Ugali*	58	1.1	.3	57	1.5	.5	.000	27
Kales*	38	.6	.2	41	.8	.2	.000	25
Soaked								
Nyoyo **	30	4.4	.5	30	8.0	1.0	.000	45
Dry *nyoyo***	30	6.0	.7	30	10.2	1.2	.000	46

Note: * Short period cooking dish.

** Long period cooking dish

5.8. Fuel saving strategies

All the 196 households were using some forms of fuel saving strategy. Table 7 shows the most commonly used fuel saving strategies.

Table 7. Distribution of household by fuel saving strategies.

Strategy	improved h/holds n=98	Trad/h/holds n=98
	%	%
magadi soda *	37	44
cover pan	29	10
put off fire	16	25
soak food	18	21

*Magadi soda is a bicarbonate of soda which is mainly added to nyoyo to shorten the cooking duration through softening the cellulose.

5.9. Food Preparation Patterns:

During the observation period only 7% of the improved cookstove households and 4% of the traditional cookstove households missed breakfast while lunch was missed by 3% and 6% of the households with improved and traditional cookstoves respectively. These results were not significantly different ($p<0.05$). The reasons given for not preparing the missed meals were lack of time (64% and 58%) and lack of ingredients (36% and 42%) for both improved and traditional cookstove households respectively.

Cold dishes were served in 41% of the households with improved cookstove and 63% of those with three stone traditional cookstoves, demonstrating a strong association between cookstove type and service of cold food ($p=0.004$). But the major reason given in each case was either food was preferred cold or there was no time for cooking a fresh meal (see table.8). The problem of fuelwood scarcity only accounted for 9.4% in improved stove households and 12.5% in the traditional stove households. However, these differences were not found to be significant ($p=0.628$).

Table 8. Distribution of households by reasons for serving cold dishes

Reason	Improved h/holds n=98	Trad/h/holds n=98
	%	%
Preferred cold	57	48
Lack of time	33	41
Lack of fuel	9	13

5.10. Cooking Pans

The types of cooking pans that were in use by the households were aluminium pans and clay pots. Aluminium cooking pans were exclusively used in 58% and 61% of improved and traditional three stone cookstove households respectively, while the rest used a combination of aluminium pans and clay pots. There was no household that used only clay pots. Even those who had the clay pots mostly used aluminium pans. The two most important reasons given for preferring aluminium pans were; they are durable and they cook faster. Lack of fuelwood only accounted for 6% and 9% of the cases in the improved cookstoves and three stone traditional cookstove households respectively (see Table.9).

Table 9. Distribution of households by reasons for preferring aluminium pans

Reason	Improved h/holds n=98	Trad/h/holds n=98
	%	%
Durability	41	49
Cooks faster	32	28
Readily available	15	13
Less fuel to cook	10	6
Other	2	4

5.11. Type and Frequency of Commonly Cooked Dishes.

From Table 10 the results show that there was no significant difference between the two groups of households in the number of times selected dishes were cooked per week - between the long cooking and the short cooking duration dishes. However, the reasons given for cooking some dishes less frequently ranged from unavailability of particular foods to lack of time, for the long period cooking dishes. Only less than 20% of the households in both cases gave fuelwood as a reason for not preparing long period cooking dishes more frequently (see Figures, 3, 4 and 5.).

Table 10. Mean number of times common dishes are cooked per week.

Type of dish	Improved h/holds n=98		Trad/h/holds n=98		
	mean	sd	mean	sd	p-v
Ugali*	11.7	2.4	11.6	2.8	.138
Bananas*	2.5	1.2	2.5	1.3	.935
Potatoes**	1.4	0.7	1.5	0.8	.592
Beans**	1.9	0.8	2.0	0.9	.805
Maize and beans**	4.6	2.2	4.1	2.2	.954

Note: * Short duration cooking dish.

** Long duration cooking dish.

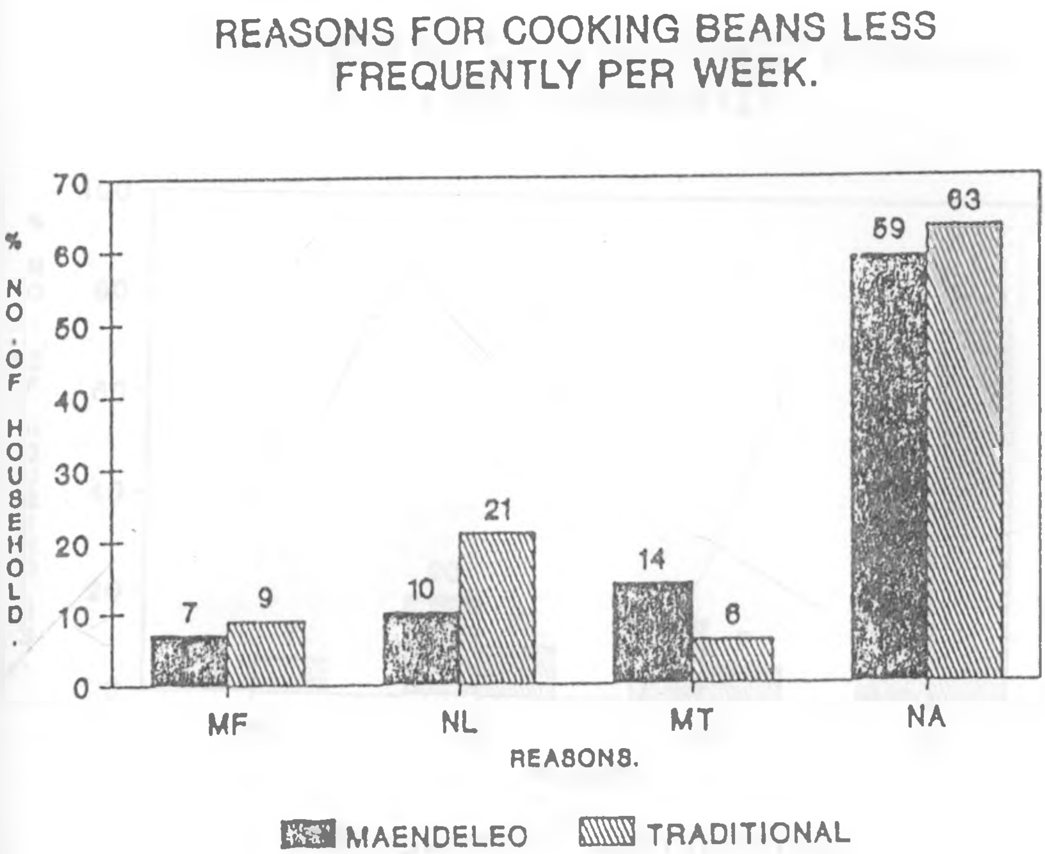


FIG. 3

KEY:

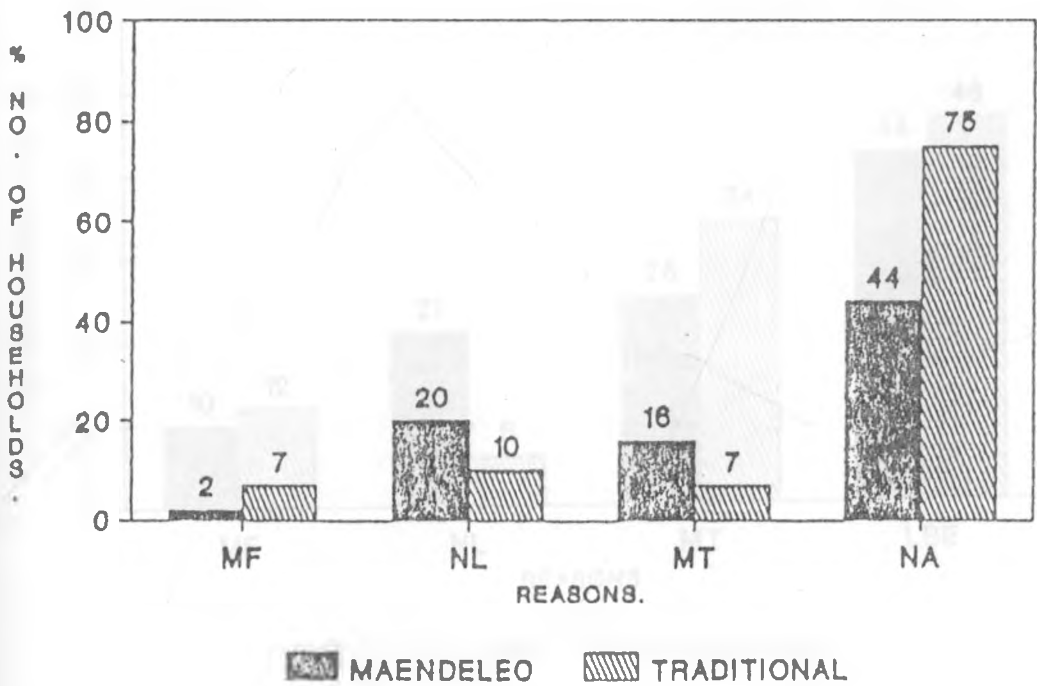
MF - More Fuel

NL - Not liked

MT - More time to cook

NA - Not available

REASONS FOR COOKING SWEET POTATOES LESS FREQUENTLY.



KEY:

MF - More Fuel

NL - Not Liked

MT - More Time to Cook

NA - Not Available

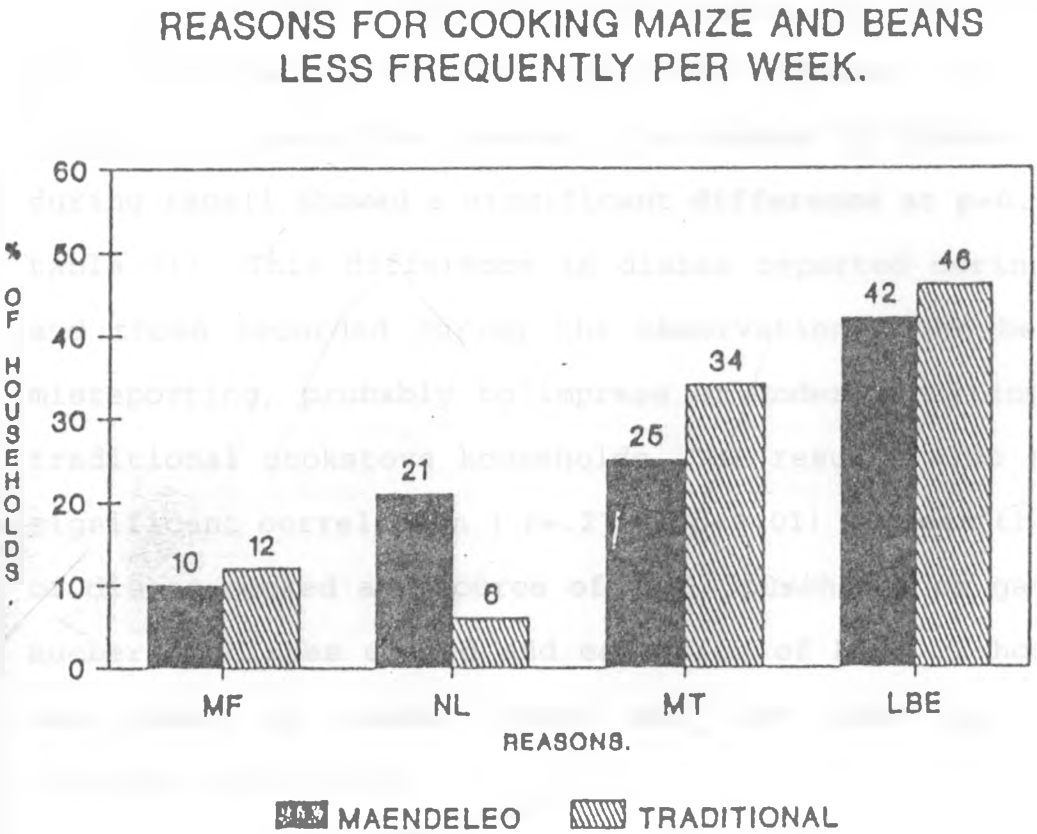


Fig.5

KEY:

MF - More Fuel

NL - Not Liked

MT - More Time to Cook

LBE - Lack of Beans

5.12. Mean Number of Dishes Cooked per Day.

The mean number of dishes cooked during the observation was not significantly different (p=0.442) between the two study groups of households. However, the number of dishes reported during recall showed a significant difference at p=0.024 (see table 11). This difference in dishes reported during recall and those recorded during the observation might be due to misreporting, probably to impress or under reporting by the traditional cookstove households. The results also showed a significant correlation (r=.2724, p<0.01) between the number of dishes cooked and source of fuel (purchased or gathered), number of dishes cooked and education of head of households and number of dishes cooked and time taken per trip of fuelwood collection.

Table 11. Mean dishes cooked per household per day.

Dishes	Improved h/holds			Trad/h/holds			
	n	mean	sd	n	mean	sd	p-v
Recall	98	5.3	.8	98	5.0	.9	.024
Observation	58	4.6	.7	57	4.4	.8	.442

5.13. Mean Cooking Time for Commonly Cooked Dishes

Table 12 shows that the short duration cooking dishes cook faster on a traditional cookstove while the long duration cooking dishes cook faster on an improved cookstove. Soaking *nyoyo* before cooking cut cooking time by 30%.

Table 12. Mean cooking time in minutes for observed dishes.

Dish type	Improve stove households			three stone households			
	mean	n	sd	mean	n	sd	p-v
Porridge*	24.1	39	5.4	25.49	34	4.5	0.002*
Tea*	18.0	42	5.7	19.4	25	7.9	
Ugali*	25.4	57	6.7	21.2	58	6.5	0.001*
Green vegetables*	12.1	38	3.3	12.6	45	4.8	
Potatoes***	60.0	10	11.2	74.0	8	7.1	0.041*
Meat**	50.5	11	10.8	47.5	4	25.3	
Beans***	75.3	5	49.6	95	11	15.7	
Bananas*	32.8	5	5.0	34	11		
Dry *nyoyo****	188	30	21	221	30	25	0.000*
Soaked *nyoyo****	124	30	16	151	30	18	0.000*

Note: * Short duration cooking dish./ ** Medium duration cooking dish./ **** Long duration cooking dish.

CHAPTER 6.

6. DISCUSSIONS

6.0. General Characteristics

Although it had been anticipated that there might be a significant socio-economic difference between the two groups of households, the results demonstrated otherwise (see Table 1). Therefore any differences in both fuelwood consumption and food preparation patterns could be largely attributed to the difference in types of cookstoves in the study group.

6.1. Social Demographic Characteristics

The characteristic young population of the study area is similar to most developing countries. More than 50% of the population was below 15 years of age, giving a dependency ratio of 1:1.2. These results were expected given the high birth rate in the district. However, these figures were slightly lower than those reported in the Kisii Development Plan of 1989-1993, which recorded the under fifteen years population as 54% and dependency ratio as 1:1.3.

The household size was 6.7 and 6.5 persons for the improved and traditional households respectively, reflecting a smaller household size compared to the results of an early survey carried out in the district, which recorded a household size of 8, (GoK, 1988). This may be partly attributed to increased family planning utilisation leading to smaller family sizes. The small landsizes of 3.4 acres for both groups of households was not unanticipated given the rapid population growth in the district and the cultural land inheritance laws, which call for continued sub-division of land. The education level of household heads was similar between the two groups. This similarity is not unexpected given the cohesiveness of the study community.

6.2 Types of Fuel Used and Their Sources

The widespread use of fuelwood in the study area demonstrates that it is the most utilised fuel in rural households. This practice could be due to its accessibility because it is available. The other types of fuel in use were agricultural residue, charcoal and paraffin (see Table 2). However, it was surprising to find that only 27% and 29% of households using improved and traditional cookstoves respectively reported using agricultural residue, despite the fuelwood scarcity in the district. This low reporting my be a reflection of

Ongayo's findings (1985), that, in Kisii most households consider agricultural residue low quality fuel. The same sentiment has been shared by Onchere et al (1992) after a fuelwood market survey in the same district. Brouwer (1992), also reported similar results in Malawi. All the same, the fact that agricultural residue is being used by some households illustrates the scarcity of fuelwood in the district.

The majority of the households did not buy fuelwood, however, the fact that up to 40% of the households were purchasing all or part of their fuel is a manifestation of the fuel problems the district is experiencing. Traditionally, fuelwood in this area used to be given freely, especially during social ceremonies, but the current expansion of fuelwood markets in the District is a clear indication of increasing fuelwood problems.

On the other hand it is interesting to note that more improved cookstove households are purchasing fuelwood compared to traditional cookstove households, this might imply that they are feeling the impact of fuelwood shortages more than the traditional cookstove households. This explains their willingness in installing the improved cookstoves since they assist in cutting the cost incurred in the purchase of fuelwood.

Given the land tenure laws in the country it was not unforeseen to note that most households (60%) did fuelwood gathering from their farms. Only 40% supplemented with collections from the roadside and neighbour's farms. Roadside collection seemed to contribute a good portion (33%), possibly because it is a free collection site for all.

The fact that most households depend on their farms for their fuelwood requirements means that any strategy to increase supply must be household based. However, given the small land sizes which limit the establishment of woodlots, it means that species of trees that will be encouraged must be those that can be intercropped (agroforestry).

Although most households were found to have planted trees, only a few had planted trees specifically for firewood. This fact could be attributed to the low priority given to the fuelwood problem, especially by men. This finding agrees with that of Ong'ayo et al (1985), who found that trees in this area are planted mainly for purposes other than for fuelwood.

6.3 Mean Time and Frequency of Fuelwood Collection

Mean fuelwood collection time per trip was not significantly different (P=0.218) between the two groups. According to the investigator's observation this was not unexpected considering that whoever went fuel gathering always collected a headful before retiring. Hence, the consistence in time taken to collect the fuelwood between the two groups. These results, however, contradict Nyang's (1992), who reported that improved cookstove households always collected less fuel per trip and took less time compared to traditional cookstove households.

The observation that improved cookstove households collected fuelwood less frequently compared to traditional cookstoves households is possible, considering that the two groups took similar time per trip and collected roughly same amount of fuelwood. Yet improved cookstove households were using less fuel on average compared to the traditional cookstove households. Therefore this finding supports the research hypothesis which stated that: "Households using improved cookstoves spend less time on average in the collection of fuelwood compared to traditional cookstove households".

The results showed that women and children are most involved in the gathering of fuelwood compared to hired labour. This agrees with gender based labour division in the study district which stipulates fuelwood gathering as a woman's job.

6.4 Types of Stoves in the Households and Their Uses:

Although there were three types of cookstoves in use, it was not surprising to note that fuelwood cookstoves were the most frequently used. This trend could be attributed to the high cost of the other fuels compared to fuelwood. This is demonstrated by the 100% response that fuelwood is the cheapest fuel in the area.

Despite the demonstrated fuel efficiency of the improved cookstoves it was discouraging to note that only 5% of the study households had managed to acquire one. Although the major reasons given were that they are not available in the local markets and that there was lack of money to purchase one these reasons, in my opinion, are not convincing. Possibly, the low dissemination of information regarding the benefits of an improved cookstove account for this lack of effort in acquiring one. Although there is only one production centre in the district, the Ministry of Agriculture through GTZ sponsorship were willing to supply the cookstoves to interested parties at no transport cost. On the other hand, the prices of the cookstoves are really not beyond the reach of the households since they cost Ksh.40 which is less than the price of one chicken.

6.5 Mean Fuelwood Consumption

The observation that improved cookstoves significantly reduced fuelwood consumption compared to the traditional cookstoves is a clear indication that the core objective of the improved cookstove promotion is being achieved. Similar observation has been reported from India, Guatemala, Indonesia and Niger (Karekezi *et al*, 1990). Although a number of households were in possession of other types of cookstoves, only a weak negative correlation was noticed between fuelwood consumption and presence of other cookstoves in those particular households, implying that despite the presence of charcoal and paraffin, fuelwood is still the preferred fuel and therefore commonly used.

Although fuelwood consumption was found to be significantly correlated with household size, it was realised that the bigger the size the more economical the per capita fuel consumption and vice versa. This finding, however, does not suggest that big families should be encouraged, but implies that the bulkier the food you cook the more fuel you save.

Probably this was why some households were cooking food for more than one meal to be taken later as a cold dish.

Analysis of total fuelwood consumption by the various dishes showed a wide variation in percentage fuelwood savings, from one dish to the other. The observation that short period cooking dishes saved the least fuel (25%), while the long period cooking dishes saved the most fuel (45%) supports the principle behind improved cookstove designs of retaining heat. Hence, the longer cooking dishes benefit from both the generated and retained heat. Whereas the shorter cooking dishes do not experience the double advantage. On the basis of this findings it seems that households stand to benefit more if they can organise to prepare their dishes at the same time rather than at separate times.

The households seemed to assess quite accurately the amount of fuelwood they require per day. This was demonstrated by the closeness of the mean consumption figures between recall and observation. This finding could be an indication of fuelwood stress, whereby, households are constantly assessing the amount of fuelwood required for the various tasks, hence, the accurancy.

6.6 Fuel Saving Strategies

The study revealed that the surveyed households used various forms of fuel savings strategies, the commonest being *magadi soda* and covering of pots when cooking. *Magadi soda* was probably used more because it is added mainly to *nyoyo*, which is considered a long period cooking dish in the area. However, the fact that there existed a strong correlation between usage of fuel saving strategies and fuelwood consumption is a clear indication that households are using these strategies in an effort to save both fuel and cooking time.

Nevertheless, it is surprising that only a small percentage of households reported using covering of pots as a commonly used fuel saving strategy, despite the fact that during observation almost all of them covered their pots while cooking. The possible logical explanation is that probably they do not perceive the strategy as fuel saving. On the other hand, no household used peeling of food as a fuel saving strategy, even though sweet potatoes is a common dish in the area. Perhaps, change of taste resulting from peeling before cooking discourages this practice.

6.7 Food Preparation Patterns

6.7.1 Number of meals and dishes prepared per day.

From the results of this study it is encouraging to note that fuelwood shortage has not affected food preparation patterns. These results disagree with those of GTZ/Gate (1992) who reported that as fuelwood shortages increase households are being forced to relinquish some meals. The findings also differ with those of FAO (1989) who recorded that households are changing from preparation of long duration cooking foods to short duration cooking foods. However, since it has been shown that traditional households use more fuelwood per day, it is clear that they must be sacrificing more time in search of fuelwood at the expense of other important activities like food crop production. This is demonstrated by the strong correlations between the number of dishes cooked and the time taken to gather fuelwood. It is also further illustrated by the strong association between frequency of fuelwood collection and type of cookstove used by the household, whether traditional or improved cookstove.

This trend of no difference in meal preparation patterns could also mean that either the fuelwood crisis is still under control in the district or as already stated, the households are sacrificing other necessities to make sure they have enough fuel for their meals. The results further agree with Brouwer's findings (1992) that in Malawi households never missed a meal despite the fuelwood shortage.

In fact, during this study the main reasons given for missing a meal were lack of ingredients or lack of time for meal preparation. These results also confirm the findings of Omosa (1987) in Bura irrigation scheme, where she reported that meal preparations patterns were not affected by lack of fuel but by other factors like unavailability of food.

Although there was a significant difference recorded in the number of dishes prepared in the two groups of households during recall, this difference was not demonstrated during observation. This could imply that the improved cookstove households had exaggerated the number of dishes cooked the previous day or the traditional cookstove households under reported the number dishes prepared the previous day.

The study showed that a high proportion of households served cold foods, and this practice was significantly associated with cookstove type, but contrary to the expectation that fuelwood problem was the main reason, the major reasons given were either the dish was preferred cold or lack of time to prepare a hot dish. This is an indication that due to the women's numerous activities, they probably serve cold dishes in an effort to save time for other activities. It is, nevertheless, evident that since this trend is strongly associated with traditional cookstoves households, it could be a sign that fuelwood could be contributing, even though they did not stress this factor during the study.

Aluminium pans were the most commonly used cooking pans except for a few households who were using both aluminium pans and clay pots. The reasons given for this trend; that they cook faster and are durable, differ with the Ministry of Energy findings (GoK, 1988) in Kisii, which reported the major reason as lack of fuel, since only less than 10% in both groups of households gave lack of fuel for this practice. This is not unexpected considering that clay pots are very delicate and break easily. Furthermore, the concern for cooking time was reasonable, considering that women work for long hours every day without ever accomplishing their daily tasks.

6.7.2. Types and frequency of commonly cooked dishes

Contrary to what was expected there was no significant difference in the types of dishes commonly cooked by the households (see Table 11). The results show that traditional households seemed to be cooking more of the longer cooking period dishes although not statistically significant. This outcome supports Omosa's findings (1987), which showed that the types of dishes cooked were determined more by availability of the particular food, rather than availability of fuel. During Omosa's study (1987) it was observed that a number of households were cooking more of the long period cooking dishes like *nyoyo* despite the lack of fuelwood. These results were expected since these are rural households who depend mainly on food produced from their farms. Hence, they are likely to cook what is available regardless of how much fuel it consumes. These assumptions are further supported by the reasons given for missing meals, which ranged from availability of food to cook, to time required to prepare it. These lead to the rejection of the research hypothesis which stated that; "There is a difference in meal preparation patterns between those households using improved cookstoves and those that use the traditional cookstoves".

6.7.3 Average cooking time for commonly cooked dishes

The mean cooking time for most of the observed dishes were not significantly different between the two groups. These results agree with those reported by GTZ/SEP (1987) in Kisii during field testing of cookstoves. However, during this study, it was noted that the long period cooking dishes cooked faster on an improved cookstoves while there was no difference in cooking time for the short period cooking dishes between the improved and the traditional cookstove (see Table 12).

This observation can be explained by the fact that for long duration cooking dishes, the heat intensity increases with continued generation, hence, they cook faster. While for short duration cooking dishes there is no sufficient time for the heat to built up. These results disagree with those of Obel (1982), who reported that, generally, improved cookstoves cook faster than traditional cookstoves.

CHAPTER 7.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

This study set out to establish two major objectives. First, whether improved cookstoves contribute towards the reduction of total household fuelwood demand. Secondly, whether there are differences in food preparation patterns between improved cookstove households and traditional cookstove households.

7.1.1 Fuelwood consumption

This study has shown that the improved cookstoves being used in the district save up to 45% of fuelwood requirements of the traditional cookstoves. The presence of other cookstoves in the households does not affect the consumption of fuelwood since they are rarely used. The fuelwood collection time per trip between the groups is similar, but traditional cookstove households collect fuelwood more frequently and, therefore, spend more time on average in collection of fuelwood than improved cookstove households. The percentage fuelwood saved, depends on the type of dish being prepared; long period cooking dishes save more (45%) while short period cooking dishes save less (25%). Household farms are the main source of fuelwood in the study community, but a few rely on collections from roadside and neighbours' farms. About 5% of the households are likely to be dependent on exclusive purchase of their fuelwood requirements.

7.1.2 Food preparation patterns

There is no difference in food preparation patterns between improved cookstove households and traditional cookstove households and the number of meals and dishes cooked per day are similar between the two groups. The choice of dish to be cooked is determined more by availability of the food and time to prepare it rather than by access to fuel, hence, availability of the food and time to cook overrides all other reasons including scarcity of fuelwood. Consequently households utilise strategies like use of improved cookstoves to save on fuelwood to cook more meals and also to save on fuelwood collection time. Other fuel and time saving strategies like *magadi soda* and soaking of food are also used to save fuel and to cut on time required to cook a given dish.

7.2 Recommendations

Based on the findings of this study, it is clear that households stand to gain by adopting the use of the improved cookstoves. Therefore, it is recommended that:

1. Rural households be encouraged to adopt the use of improved cookstoves.
2. That the government and concerned NGOs promote the cookstove manufacturing industry and make them readily available to the rural households.
3. Households be encouraged not only to plant trees but plant fast growing trees, specifically for fuelwood. However, it should be noted that this can only be done through sensitizing men to appreciate fuelwood scarcity as a household problem and not just a woman's problem.
4. Given the concern for time by the women there is need for research into appropriate time saving technologies that can be availed to the women to release more time for other activities.

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Appendix 1. Study Tools

Date of survey_____/_____/__199___ Household code_______
Name of Interviewer______________ (Improved household =1
Division_________________________ Traditional household=2)
Sub-location_____________________
Household no.____________________
Name of household head___________
Sex of household head_________M/F

PART 1

a. Social Demographic Section

Household Profile

Serial no.	*Name*	*Age*	*Sex*	*Education*	*Occupation*

Code:

Sex: *male=1*
sex =2

Education:
None =1
Std 1-4 =2
5-8 =3
Form 1-2 =4
3 and above =5

Date________________ Name of Interviewer______________
Sub-location_________
Household no_________ Household code___________________

b. Socioeconomic Section

1. How many acres of land do you have? ______acres

2. Do you grow cash crops? yes/no (tick).
   If yes, which is the main cashcrop? coffee/tea [tick]

3. Type of main house, permanent/semi-permanent/grass thatched. [tick]

4. How much money do you spend monthly on the purchase of food? ksh._______

5. What is your estimated monthly income? <ksh.1000 =1
   >ksh.1000 -2

PART 11

a. Cookstove Section

1. What types of stoves do you have?

   Traditional stove only = 1
   Traditional/charcoal stove = 2
   Traditional/paraffin stoves = 3
   Traditional/charcoal/paraffin 4
   Improved stove only = 5
   Improved/charcoal = 6
   Improved/paraffin = 7
   Improved/charcoal/paraffin = 8

2. If the household has more than one stove, which is the most commonly used?
   1...............

3. Apart from the most commonly used stove, when are the other stoves used?
   1....................

Date of Survey______________ Name of Interviewer__________
Sub-location________________
Household No________________ Household Code______________

4. What is the most important reason for purchasing an improved cookstove?
1......................

5. Why have you not purchased an improved cookstove? Give one major reason,
1....................

b. ***Fuel Section***

1. List the types of fuel used by the household.
1...................
2...................
3...................
4...................

Of the fuels listed above which is the cheapest?
1...................

2. What is the source of the fuelwood you use?
gather free = 1 [tick]
purchase = 2
gather and purchase= 3

3. If the fuelwood in number three is gathered, list the sources of gathering.
1....................
2....................
3....................

4. How far do you travel to collect fuelwood?.......km

5. How long does it take you to gather a handful (5kg) of fuelwood?.......hrs

6. Who are the persons involved in gathering fuelwood?
1.....................
2.....................
3.....................
4.....................

Date of Survey__________________ Name of Enumerator________
Sub-location____________________
Household No____________________ Household Code__________

5. *When trees are to be split for fuelwood, who normally does the splitting?*
   1................

   If hired labour is used, which is the major source of cash for hiring?
   1..................

7. *How frequently do you collect fuelwood?*
   daily = 1
   weekly = 2
   monthly = 3

8. *How many killogrammes of fuelwood do you use on an average day? ....kg*

9. *Which is the most important fuel saving strategy used in this household?*
   covering pans = 1
   putting off fire= 2
   soaking food = 3
   magadi soda = 4

10. *Have you planted trees? Yes/NO (tick)*

    If no, why not........................

    If yes, have you planted any trees specifically for fuelwood? yes/no (tick)

PART 111

Food Preparation Patterns Section

1. Food Frequency Table

Common Dishes in the household	No. of times dish is cooked per week	Reason for preparing dish less frequently

* Dish is considered less frequently cooked, if it is cooked three times or less per week.

2. Which dishes are considered long cooking in this community?
   List,
   1.................................
   2.................................
   3.................................
   4.................................
   5.................................

3. Which dishes are considered short cooking in this community?
   List 1........................
   2........................
   3........................
   4........................

4. How many dishes did you serve yesterday starting from morning up to evening?

   No..............

Date of Survey________________ Name of Interviewer__________
Sub-location__________________
Household No_________________ Household Code_____________

5. Do you sometimes serve cold dishes? yes/no (tick)

If yes, what is the major reason for serving cold dishes?
1.....................

6. What types of cooking pans do you use?
clay pots = 1 [tick]
aluminium pans = 2
clay pots/aluminium pans= 3

Of the above pans, which is the most frequently used and

why,..
(Give most important reason)

PART IV

Observation Section

1. Dish cooking observation sheet

Type of dish	time taken to cook	total fuelwood used
Breakfast		
Lunch		
Supper		

Note; If a meal is missed, please indicate the reason for missing it in the table.

2. Observed time taken in fuelwood collection.
..................hrs
Total fuelwood collected..............kg