Dissertation

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Adoption of energy saving technology in Khartoum state: the case of improved charcoal-cooking stove.

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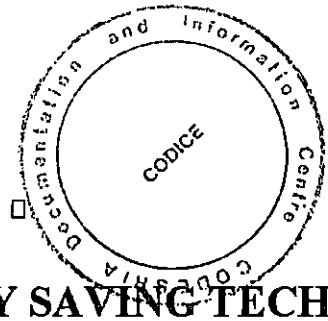

ADOPTION OF ENERGY SAVING TECHNOLOGY IN KHARTOUM STATE: THE CASE OF IMPROVED CHARCOAL-COOKING STOVE

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DEDICATION,

To My Family

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ABSTRACT

Environmental conservation is becoming an increasingly important issue, stressed allover the world. Factors that minimize the eradication of the natural green cover are currently considered by many countries world-wide. In the last decade, Sudan took practical steps for testing and disseminating energy saving technologies. Some Governmental and non-governmental organizations exerted efforts to disseminate the improved charcoal-cooking stoves after they are proved to be effective and efficient in reducing the total amount of charcoal consumed by the household sector, which is considered as the main charcoal consuming sector in Sudan.

This study is primarily accentuated to examine the adoption of improved stoves as energy saving technology in Khartoum State; factors affecting rate of adoption and respondent innovativeness.

Primary data was collected through face-to-face interviews with stratified random sample of respondents in Khartoum State.

Simple descriptive statistics and path analysis which use multiple regression method were used to analyze the data.

The study revealed the limited knowledge of the population about the importance of conserving the environment.

The statistical results showed that, the adoption rate of the improved stoves in Khartoum State is very low, and the possible factors beyond this low rate were examined in the course of this study.

The regression results showed that, people accept new ideas when they feel their tangible relative advantages. Those who

adopted improved stoves are mainly convinced by the technology relative advantages i.e saving of charcoal and cooking time.

Other factors that influence the household innovativeness are housewife education and education of family female members.

Housewife exposure to messages about improved stoves through different communication channels leads her to adopt the considered technology more earlier. This variable i.e exposure to message about improved stoves was found to be positively and significantly affected by housewife education and family income.

It was found that while education is negatively affected by age, it was positively influenced by family income.

High income families tend to use more advanced or modern cooking devices other than improved charcoal-cooking devices.

The study recommends the use of appropriate communication channels to educate people about the importance of conserving the environment. It also recommends the necessity of making clear the relative advantages of the improved cooking stoves to the potential adopters, and calls for making the technology available and at the reach of the people to purchase.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Praise be to Alla Almightily who stated in his holy revelation "He, who abled you to set fire from the green trees". He, who made from the water every living thing. Bless be upon his holy prophet (Mohamed) who explicitly and implicitly explained the benefits of the tree for human and its importance in the aspects of human life to the extent that he expressed "If the hereafter is setup and a seedling in one's hand of you, he has to plant it".

In one of his holy statements, the prophet (Mohamed) warned from the severe consequence which will inflict a person who cuts a tree growing in a bared land (desert) saying: " Alla will throw one in the hell fire, his head downwards, who cuts a tree growing in a desert, a traveller or animals exploiting it as a shade".

It is uncontroversial that the environmental conservation process is one of the most important and a cornerstone aspect in keeping the balance between the exponentially growing, increasingly demanding population and scarce and limited natural resources.

Individuals' relations and reactions with their environments (including the soil, water, air, plants and animals) may result in so many changes in these components. These changes could have positive or negative effects or impacts on the people themselves. So many environmental problems may encompass those resulting from exploitation of natural resources, traditional farming and livestock raising, pollution and overexploitation, but the most

projecting and formidable problem confronting most of the developing countries is the overexploitation or the misuse of natural resources leading to their exhaustion and degradation.

The Ecological Importance of Forests:

Forests or trees play an important role in protecting the top of the soil against water and wind erosion, in addition to that trees can bring up the leached nutrients to the top soil by their deep roots. They can also mild the flash floods; it is claimed that the trees existence may even change the climate by influencing the amount of the annual rainfall or lessing the evapotranspiration of the rain water.

> "It has even been postulated that the felling of trees in equatorial Africa was the cause of lower rainfall in the Sudan" (Jong-Boon, 1990)

Trees also function as windbreaks, stopping sand encroachment and stabilize dunes, therefore act as a protector for villages, roads and canals.

In the last decade the causes of environmental problems are highly stressed in Sudan. A considerable one of these causes is the devastation of natural vegetation. Forests cover more than half a million miles, which represents 23 percent of the total land of the country. The distribution of such forests is highly uneven, due to differences in the climate and population density in different regions. However, at present this natural vegetation is witnessing a quick high depletion rate in East, West, North, and Central Sudan.

Early in the dawn, and when the sun sets its beams at the morning, millions of stoves and fires are lit and cups of tea are made, during the day and till people go to beds, fires are flaming for cooking purposes. About 79 percent of Sudan energy needs is from biomass resources, mainly wood and charcoal. This heavy dependence on such resources of energy has led to deforestation and its negative impacts (Jong-Boon, 1990).

> "Deforestation means the loss of trees and their numerous functions. In Sudan this causes soil deterioration (ultimately leading to desertification), the disappearance of an important source of fodder for livestock, and lack of fuelwood for cooking which may lower the frequency and quality of meals eaten and thus affect health." (Baxter,1981)
> "Depletion of forests is overwhelming Sudan, for every 100 feddans of timber cut only 70 are replaced naturally." (Whitney, 1981)

There is a deficiency of knowledge and lack of commitment towards environmental conservation as appeared from the crisis the country facing. The rural awareness on the matters of energy crisis (fuelwood and charcoal), desertification, environmental degradation, and energy conservation is low. This necessitate an urgent need for formal and informal environmental awareness programs to ease the understanding of environmental laws objectives and hence they will be respected and willingly implemented.

Environment conservation is essential for sound and sustainable socioeconomic development. The sustainable use of resources should be stressed and integrated into development plans

at different levels; national, regional, and local levels. However the success or the achievement of rational use of natural resources depends on individuals and community actions, this could be enhanced through genuine participation of local individuals and communities.

It has been suggested that social and economic changes should be brought in societies or communities that are heavily dependent on trees and the laws prohibiting illegal cutting should be passed and implemented.

Jong-Boon (1990), stated that 98 percent of wood felled is used as fuel for domestic purposes.

Firewood and charcoal consumption for the year 1982/83 were estimated to be 6,511,628 tonnes and 2,262,500 tonnes respectively, with the assumption that a sack of charcoal is 30 kg of usable output, this implies that 75.5 million sacks of charcoal are consumed, which equal to 9,302,326 cubic meter solid firewood and 10,773,809 cubic meter consumed as charcoal, (Abd ella, 1985).

According to surveys carried out by the National Energy Administration, the total amount of fuelwood to meet the country needs is about two millions solid cubic meters assuming a population of 21.5 millions, (Abd ella, 1985).

Laws and legislations in the third world are usually framed and enacted to instruct and direct people in certain respects, eventhough many of these acts remain as phantom, particularly legislations concerned with environmental conservation. The degree of awareness of importance to conserve the environment is

essentially inadequate, but even with availability of such awareness most rural people in Sudan have no access to any source of energy except wood, therefore inspite of their awareness, or banning laws they sometimes fell down trees.

Among the most important factors in determining the amount of wood needed is the efficiency with which it is used. This includes the type of stoves used for cooking and their efficiency, the availability of alternative energy sources etc.

Peasants in rural areas, like Gezira, Rahad and other agricultural schemes in addition to firewood, accustomed to use crop residues, mainly cotton stalks, as a source of energy.

Research institute, especially the Energy Research Council (ERC) / Sudan took practical steps to make use of agricultural residues as a source of energy like briquetting cotton stalks. However, the problems with these products from crop residues whether briquettes or carbonized stalks is that they are loose or light and quickly ignite and run-off and require more suitable efficient stoves that could save the thermal energy more efficiently.

1.2 Problem Statement

The firewood crisis that affects many countries, particularly the sub-saharan Africa resulted in a drastic loss of the natural vegetation cover. For Sudan in general and rural communities in particular trees are the main source of energy, it represent the main source of cooking fuel, being used either directly as

firewood or as charcoal. The increasing demand on firewood make the people, especially in rural areas, to become forest devastator.

Despite the wide range of Sudan natural resources, the country is facing several environmental problems, the main projecting ones are deforestation and desertification. Cutting the trees off the land will result in removing away the fertile soil by the wind and water erosion, leading to deterioration of soil fertility.

Desert is reported to be creeping at a rate of 10 - 20 km per year. The depletion of forests exceeds their renewal growth rate, and in 13 years forests in Sudan will be eliminated if current practices continue (Ahmed and Ahmed, 1984). The main causes of these problems are development process, population growth and the irrational use of natural resources.

A lot of energy is being wasted through using traditional methods of cooking and conventional inefficient techniques and cooking devices. People awareness and education about the importance of preserving trees, and introduction and adoption of more efficient cooking stoves may be more effective in halting trees cutting than imposing prohibiting laws.

Because of the pressure caused by the population growth, fuel-wood is becoming increasingly scarce, and since reforestation programs fail to keep pace with depletion rate and population growth, many African countries depicted on research to develop more efficient stoves to replace the traditional ones, to improve the efficiency with which fuelwood is used and consequently reduce the amount consumed. In Sudan ERC, CARE International / Sudan and

other public and private research and aid organizations started experiments on the efficiency of different types of improved cooking stoves designed to suit the local usage. The improved cooking stoves proved to be efficient and convenient. A labrotary result of tests carried out in 1984 showed that while the traditional stove is 17.8 percent efficient, the average efficiency of improved cooking stoves is about 24.8 percent. This would save a large proportion of family income being allocated for purchasing charcoal, reducing the total country demand for fuel-wood and less trees will be cut.

However, despite such efficiency and income saving, the diffusion of improved cooking stoves and their adoption rate by the household is not quite high or at the level required to reduce the huge demand on charcoal. Therefore this study is intended to investigate the factors and reasons of the slow diffusion and low adoption rate of this energy saving innovation in Khartoum State.

1.3 Objectives of the Study

Because of the significant impact that is expected from using improved cooking stoves, this study aims at examining its adoption by household in Khartoum state so that policies and programs that will enhance its adoption can be designed. However the study will specifically investigate the following aspects:

First; the extent to which the technology of improved charcoal-cooking stoves has been adopted and diffused in the target area; the rate of adoption of the innovation.

Secondly; to determine the factors that influence the adoption of the improved cooking stoves.

Third to develop some recommendations that will enhance the adoption of improved cooking stoves in Khartoum state and possibly elsewhere.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter is divided into four sections. In the first section, the country population, the total energy demand and its impact on the environment is discussed. Section two deals with the history of the improved stoves, their development and their superiority over the existing traditional devices. The third section tackles some sociological concepts to show how societies and communities change over time based on individuals needs, social values and cultural setting and the individual perceptions of life. The last section discusses the innovation adoption theory, and the expectations about the adoption of improved stoves.

2.1 Population, energy demand and environmental consequences

The majority of Sub-Saharan African population (four-fifth of the population) depend wholly or partly on woodfuel (fuelwood, charcoal and agricultural residues), which accounts for two-thirds of energy consumption. In 1989, it was reported that fifty million Africans face acute fuel scarcity (World Bank, 1989). The same report revealed that, based on present trends, the demand for woodfuel will at least triple by the year 2020. The report showed that if the urban household consumption of woodfuel continues at the current rate, the urban demand will amount to 50-75 percent of total woodfuel used in most Sub-Saharan countries by 2000.

In many African countries the rate of fuelwood consumption exceeds the rate of natural growth, hence chronic shortages are almost inevitable. Little or no care is given to control the

overexploitation of the forest cover, and no incentives for its sound management nor for optimization of its yields. Keeping a balance between supply and demand involves; replacing the removed trees, planting of forests, improving forest management, pricing of woodfuel economically, encouraging the use of more efficient energy devices .. etc.

Although there is no reliable data on the state of environmental degradation available for most of African countries, however, surveys carried out in 1980's showed that the 703 hectares of Africa forests were being cleared at the rate of 3.7 million hectares (i.e 0.6 percent) a year. This depletion rate exceeded the rate of forestry replacement by 29 percent; this caused 55 million African to face fuelwood scarcity (World Bank, 1989).

2.1.1 Wood Energy Crisis

Despite the wide range of natural resources in Sudan, the country is facing several environmental problems. The main projecting ones are deforestation and desertification. Firewood crisis is facing all Sub-Saharan countries, and Sudan is no exception. The country is witnessing a drastic loss of its natural vegetation. A joint UNDP / WB report in 1987, on energy assessment highlighted the urgent need to address the wood energy crisis that is emerging from the overwhelming deforestation of natural vegetation in Sudan, due to heavy dependance on wood and charcoal as the main energy sources for domestic purposes.

Sudan Energy Handbook (1991), reflected that as a result of the heavy dependance on biomass as a main energy source, the forest

area is estimated to be depleted by 4 percent annually.

It was reported that while in 1985, the allowable cut covered 70 percent of the total fuelwood demand, it covered only 51 percent in 1990; this means that illegal cutting had been practiced to bridge the gap, which is increasing annually, (National Energy Administration, 1991).

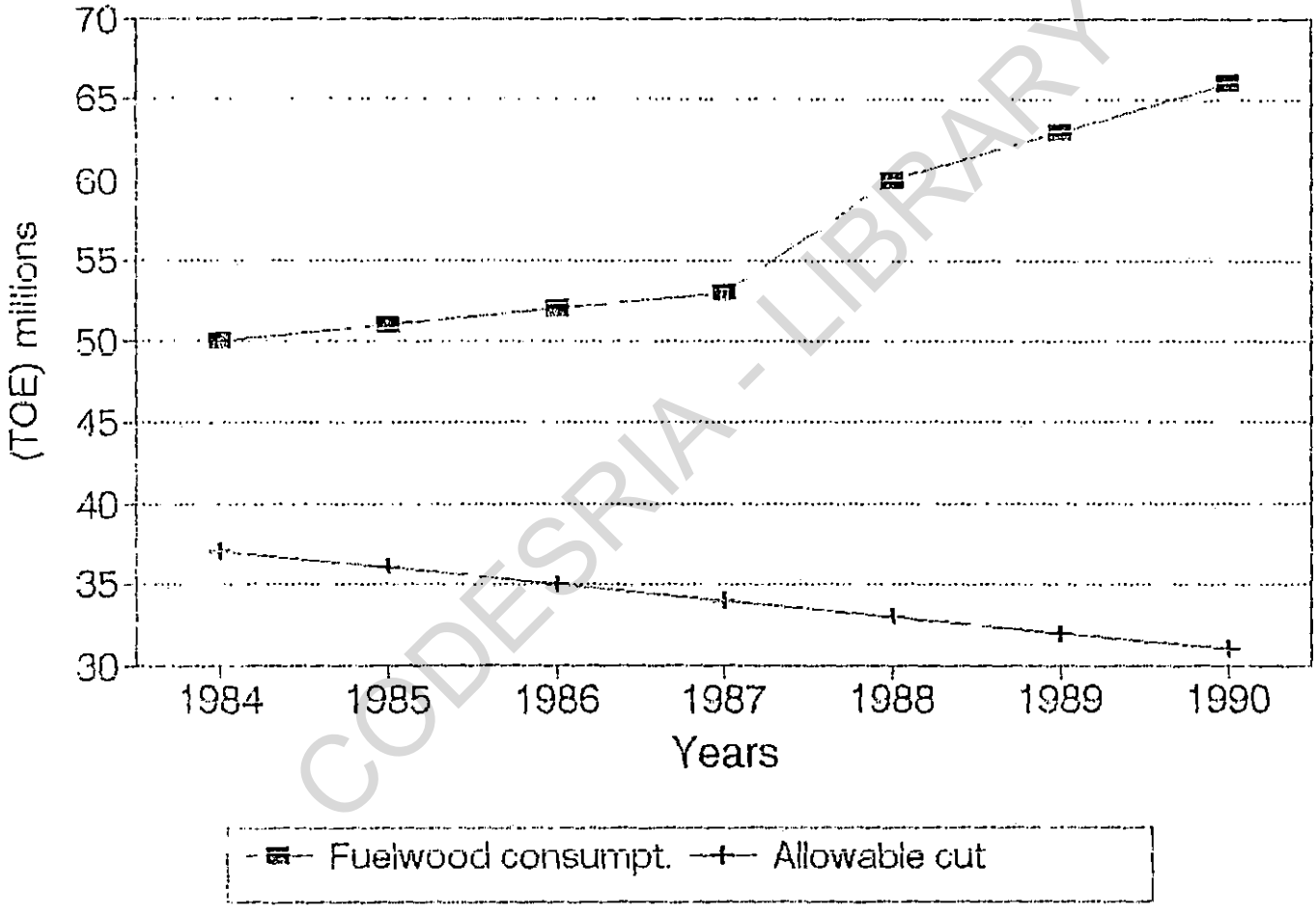
It was estimated that over 30 million tonnes of wood is cut annually for household consumption. This huge demand for fuelwood exacerbate the formidable continuous and widespread deforestation and desertification. Figure 1. below shows the allowable cut versus fuelwood consumption in the period 1984 / 89.

2.1.2 Energy Outlook

The future energy situation will be configerated by todays and future events. Though some events are uncontrollable, but many choices and decisions taken will affect the future image of energy, therefore the challenge will be to take the right decision to protect our future energy source.

The expectation is that charcoal and fuelwood demand will continue to grow with population growth, and since the oil substitute as energy source is not expected to be abundant and available for rural and urban dwellers in the near future, and since urban population is expected to increase in the future, and based on their preference to use charcoal rather than wood, charcoal demand is expected to grow more faster. Table 2.1, shows estimates of charcoal and fuelwood demand in the period 1982-2000.

Figure (1)
Allowable Cut Vs Fuelwood Consumption



Source: Sudan Energy Handbook, 1991

Table 2.1 Sudan Fuelwood and Charcoal Demand during the period 1982 - 2000 in (000 TOE)

Energy Source		Year	
Demand	1982	1990	2000
Wood	2,810	3,930	4,920
Charcoal	1,630	2,220	3,230

Source: Report of National Energy plan Committee Jan. 1985

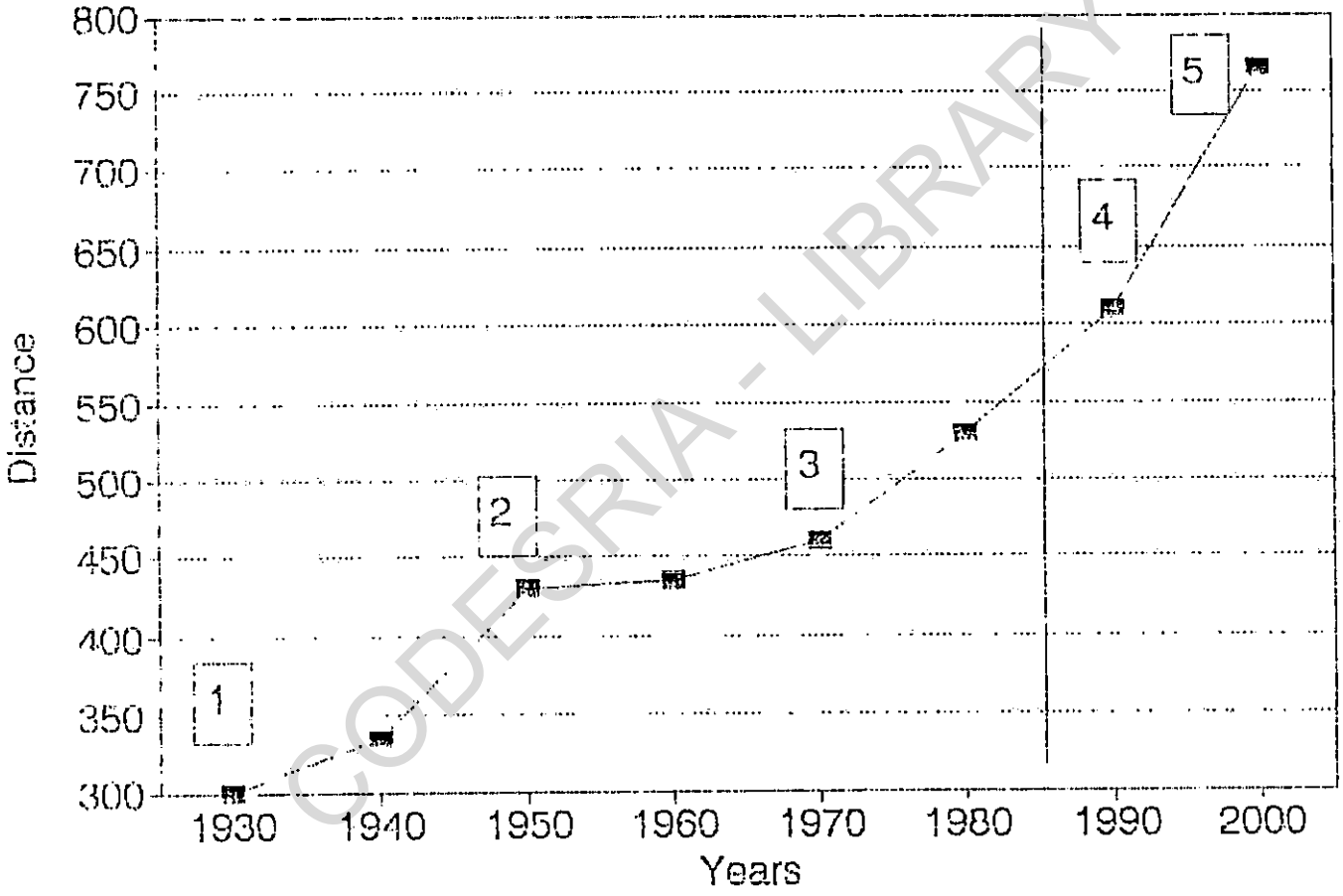
2.1.3 The Increasing Distance of Forest Product From Consuming Centres

Over the last fifty years vast areas had been cleared of natural vegetation. Many forests had been chopped to provide fuelwood and more forests were cut for mechanized agricultural production. The escalation in oil product prices forced many people to divert to wood and charcoal as sources of energy to prepare their food. The result is that forests were cleared from areas near to the urban centres. Charcoal is now brought to Khartoum from southern Damazine, i.e 600 Km away, (see fig.2).

Distance have almost doubled over the past 30 years, and followed that the prices of charcoal increased more and more. All these give a clear indication for complete removal of forests that might exist in all parts of Sudan except in the extreme south. The serious consequences of this will be reflected in terms of human hardship, bad effect on climate, environment and economy.

Figure (2): Distance of Charcoal

Producing Centers From Khartoum



1. Nothern Senga 2.Southern Senga 3. Nothern Damazine
4. Southern Damazine 5. Southern Darfur.
Source: Sudan Energy Handbook, 1991

In response to the increasing demand of fuelwood, the rate of trees cutting exceeds forests replacement, and if the current practices continue, half of the available trees will be cleared in 10 years, (National Energy Plan Committee, 1985).

As energy supplies become more scarce in northern Sudan, prices paid for fuelwood and charcoal will increase significantly eroding household purchasing power and reducing their overall standard of living. With the increasing distance of sources of fuelwood (more than 600 km) from urban centres, the prices of charcoal and fuelwood will be increasing at higher rates in the urban centres, and the urban poors will be forced to spend ever increasing proportion of their income for charcoal (Majoub, 1989). Majoub stated that according to FAO Reports, up to 30 percent of a family's income can be spent on wood and charcoal. Unfortunately up to now there is no viable and locally available alternative energy source that has been identified, to be utilized on a widespread scale. Thus more than eighty percent of Sudan energy requirement is obtained from fuelwood, accordingly, large areas of forests in the central and eastern states were cut to provide fuelwood and charcoal to the major urban centres. Fifty million sacks of charcoal are estimated to be transported to these centres each year from area that is six hundred kilometres away, (Paddon and Ali, 1992).

2.1.4 Population Growth as an Index of Energy Demand

Sudan total population is continuously increasing. Saghayroun (1987), stated that, Sudan total population was 14.8 million in

1973 with annual growth rate estimated to be 2.1 at that time. He added that 10 years later, the 1983 census indicated that the total population of Sudan was 21.6 million with 2.8 annual growth rate, and it is expected to reach 30 millions or more by the year 2000. However, the distribution of the population is highly uneven, with more concentration in Khartoum and areas adjacent to irrigated agricultural schemes.

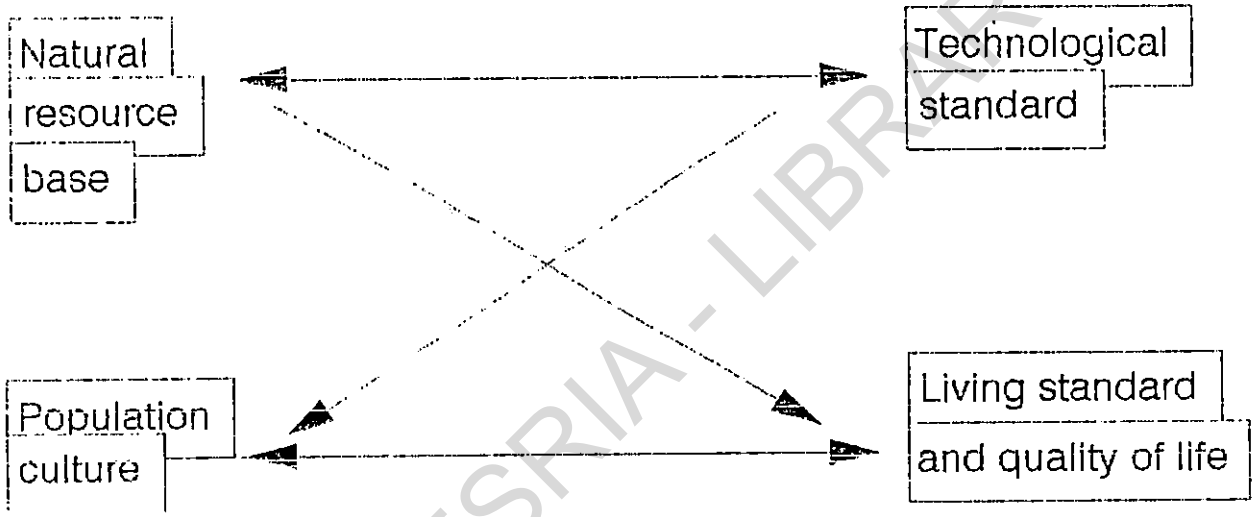
Regarding this continuous increase in population, policies and strategies should be formulated in such away to maintain a reasonable balance between the needs of the growing population and the limited available resources, bearing in mind the impact of these policies on the environment and the interest of the future generations. Saghayroun (1987), stated the relationship between population and environment in figure 3.

According to the 1993 census, Sudan total population is 23,438,515 individuals, and about 3,413 034 of this population resides in Khartoum state (Department of statistics, 1993). With average per capita consumption of woodfuel in Khartoum (0.37 tonne), (National Energy Administration, 1991), the total consumption of woodfuel by the state will amount to 1,262,810 tonne per year.

2.1.5 Sudan Energy Supply And Consumption

Biomass, oil and hydropower represent the three major sources of energy supply in Sudan. In 1987 energy supply in Sudan amounted to more than 10 million ton of oil equivalent (TOE). Out of this total only 60 percent reached the end users; great losses, amounted

Figure (3): Proposed Relationship Between Population and Environment



Source: Saghayroun (1987)

to 4 million (TOE), occurred during conversion, transition and distribution. Particularly in the case of biomass, about 44 percent of the wood supply was lost in the process of converting wood into charcoal (National Energy Administration, 1990).

Biomass energy remains the dominant source constituting 84 percent of the total energy supply mainly in the form of firewood and charcoal. Hydropower share in the total energy supply is only 3 percent, mainly in the form of electricity. Oil energy supply constitutes about 13 percent of Sudan total energy supply, (National Energy Administration, 1990).

In 1990 Sudan energy supply exceeded 10 millions (TOE), and more wood was consumed compared to 1987 (see table 2.2). Although oil and hydropower energy supplies increased by almost 7 percent but still biomass energy supply remains the major contributor to the total energy supply, amounting to more than 87 percent; out of this, 89 percent is from wood. This reflects the large areas of forests need to be cut annually, (National Energy Administration, 1991).

Though the total consumption of different types of energy in the decade 1980/90, reflected an increase in consumption of all the three main source of energy in Sudan, biomass remains the main energy source. In 1990 the total share of energy consumption by type was 79.1 percent, 19.2 percent and 1.6 percent for biomass, oil and electricity respectively (National Energy Administration, 1991).

2.1.6 Energy Consumption by sector

It was reported that energy consumption in Sudan amounted to 6.1 million TOE in 1987. The household was, by large, the largest energy consuming sector accounting for more than 72 percent of the total end users energy consumption, with biomass being the main energy consumed by the household sector, (National Energy Administration, 1991).

It was also reported that, as in table 2.3, 50 percent of the total electric energy consumption is consumed by the household sector, and 3 percent of the total oil consumption in the country is consumed by this sector, (National Energy Administration, 1991).

In 1989/90 about 93 percent of the biomass and 60 percent of the electricity is consumed by this sector (National Energy Administration, 1991). The agricultural sector consumed only 3 percent of the total country energy consumption, industry consumed 10% of the country total energy consumption, and 50 percent of this is oil products. The commercial and service sector consumption is less than 3 percent of the total consumption; 80 percent of it is from biomass resources.

2.1.7 Biomass as a main source of energy in Sudan

Biomass is the most consumed type of energy in Sudan. As table 2.4 indicates during the last decade biomass energy accounted for an average of about 93 percent of the total household energy consumption and 3 percent of the industrial sector consumption (National Energy Administration, 1991).

Table 2.3 The Sectoral Energy Consumption from Petroleum and Electricity in 1989

Sector	Petroleum % of total consumption	electricity % of total consumption
transport	55	0.00
Industry	14	21.5
Agriculture	15	7.5
Household	3	51.5
Others	14	19.5

Source: Sudan Energy Handbook, 1991.

Table 2.4 The sectoral Biomass consumption in 1990

Sector	Biomass % of total sector energy consumption
Industry	3
Households	93
Services	14

Source: Sudan Energy Hanbook, 1991

Estimates of biomass consumption based on per capita consumption obtained through, earlier surveys in different regions during the period 1983-90 reflects the total biomass consumption in the country (Table 2.5).

It is clear that biomass consumption is increasing annually, this is mainly due to the increase in demand for fuelwood.

2.1.7.A Biomass demand by regions

It is estimated that biomass consumption by different regions of the country increased annually; calculations of NEA for the period 1984-1990 reflects the increase in consumption as shown in Table (2.6).

It is clear that khartoum region has the highest increase in biomass energy demand in the same period as the percentage calculation for the different regions shown below, (Table 2.7).

2.1.7.B Charcoal Demand By the Household Sector

Several attempts have been made to estimate woodfuel consumption trends and projections. NEA and UNDP/WB in 1983 estimated charcoal/fuelwood consumption for Sudan at about 2.5 million metric ton (MT) of charcoal and, with fuelwood conversion factor 18 M_3 / MT, this gives about 44.5 million m_3 solid fuelwood. This estimate reflects that the household consumption of charcoal ranges from 6-30 m_3 solid wood equivalent per household per years.

The per capita consumption of biomass from surveys by NEA indicated that the share of charcoal of the total national biomass consumption amounted to 35 percent in the year 1990. Although the consumption rate or demand differs from region to another,

Table 2.5 National Biomass consumption by type (1980-1990 TOE)

Years	Wood	%	Charcoal	%	Other biomass	%	Total
1980	1 969 514	54	1 272 917	35	376 577	01	3 619 009
1981	2 024 094	54	1 308 193	35	387 013	01	3 719 301
1982	2 080 187	55	1 344 447	34	397 738	01	3 822 372
1983	2 137 835	54	1 381 705	35	408 761	01	3 928 300
1984	2 197 001	54	1 419 944	35	420 074	01	4 037 019
1985	2 255 621	54	1 457 831	35	431 282	01	4 144 734
1986	2 315 933	54	1 496 812	35	442 814	01	4 255 558
1987	2 377 989	54	1 536 919	35	454 679	01	4 369 588
1988	2 623 925	54	1 695 870	35	501 703	01	4 821 499
1989	2 689 635	54	1 738 339	35	514 267	01	4 942 241
1990	2 765 240	54	1 787 203	35	528 723	01	5 081 166

Source: Sudan Energy Handbook, 1991.

Table 2.6 Total Household biomass consumption by region during 1984-1990 (TOE)

Regions	1984	%	1985	%	1986	%	1987	%	1988	%	1989	%	1990	%
Northern	114 177	03	115 091	03	116 011	03	116 940	03	127 080	03	128 023	03	129 379	03
Eastern	244 228	06	252 043	06	260 109	06	268 423	06	316 277	07	325 142	07	336 011	07
Centern	699 616	18	717 106	18	735 034	18	753 410	18	831 908	18	851 215	18	873 619	18
Kordofan	633 360	17	646 660	17	660 240	17	674 005	16	655 535	15	669 988	14	683 311	14
Darfur	726 125	19	749 361	19	773 341	19	798 087	19	819 122	18	845 478	18	872 450	18
Khartoum	178 514	05	187 082	05	196 062	05	205 473	05	252 705	06	263 042	06	275 512	06
Southern	1 159 885	31	1 188 775	31	1 218 429	31	1 248 868	32	1 483 130	33	1 515 206	33	1 557 034	33
Total	3 755 905	100	3 856 119	100	3 959 226	100	4 065 316	100	4 485 758	100	4 598 093	100	4 727 344	100

Source: SE Handbook, 1991.

Table 2.7 Percentage increase in biomass consumption by region during the period 1984-1990

Region	North.	East.	Cent.	Kord.	Dar.	Kh.	South.
% increase in consumption	13%	37%	25%	0.08%	20%	54%	34%

Source: Calculated by the author.

regarding the household consumption, Khartoum region showed a notable increase in consumption of charcoal in the period 1984-89 compared to all other regions (Table 2.8).

This higher increase in charcoal consumption by the household for cooking purposes reflects the preference of households to use charcoal as cooking energy source. This trend may be attributed to the cost and lack of other energy substitutes, where the prices of these substitutes increased by a faster rate than those of biomass energy. Figure 4. reflects the unit price, of the different energy types.

Khartoum as an urban center showed the highest percentage increase in charcoal consumption as compared to other regions as far as household sector energy demand is concerned, (Table 2.9).

2.1.7.C Allowable cut and Charcoal consumption

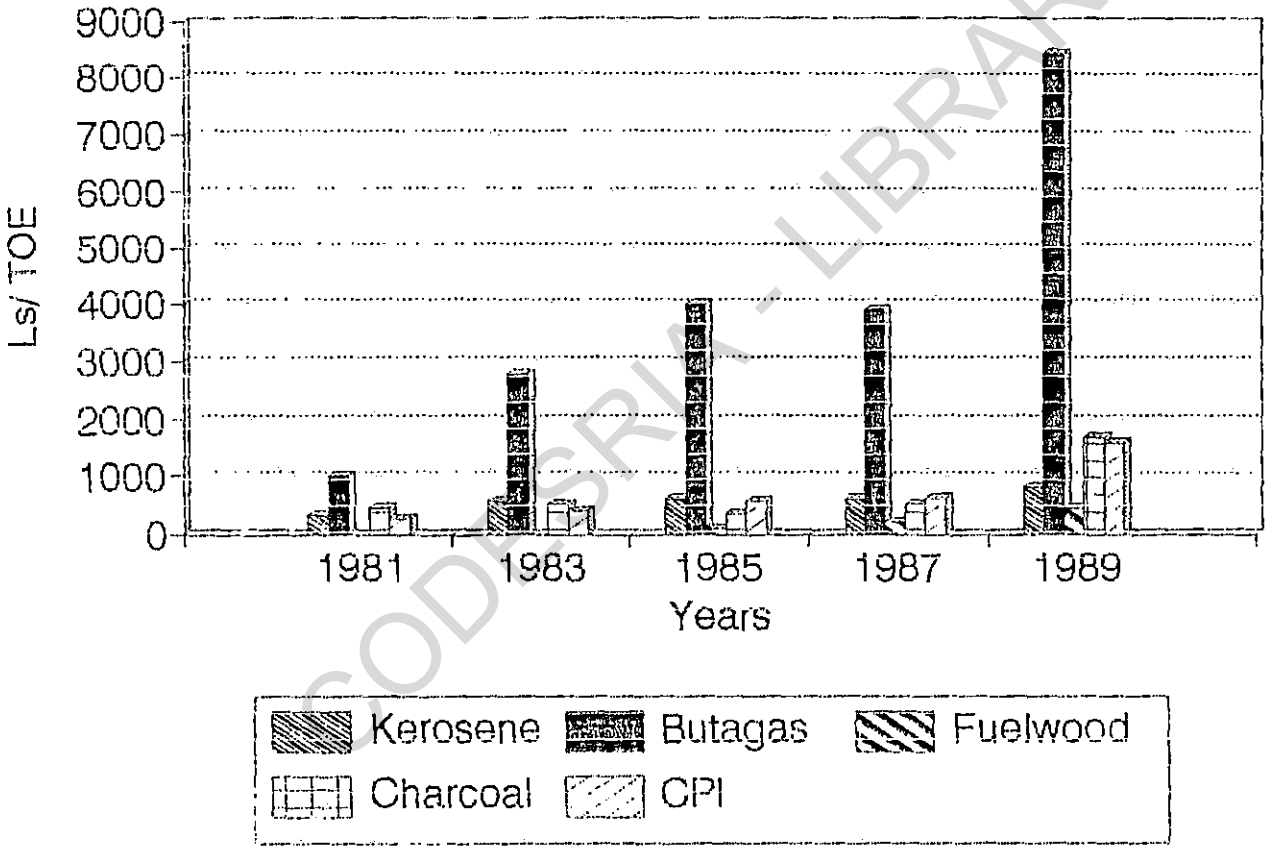
Whereas the wood allowed to be cut each year is determined by responsible authorities, the demand for charcoal increases year by year. As Table (2.10) indicates the demand exceeds the allowable amount of wood to be cut down.

Table 2.8 Household charcoal consumption by region (TOE)

regions	1984	%	1985	%	1986	%	1987	%	1988	%	1989	%
North.	42 650	03.6	42 991	03.5	43 335	03.4	43 682	03.4	47 342	03.4	47 694	03
East.	143 463	01.2	148 054	12.1	152 792	12.1	157 681	12.2	184 576	13.2	189 783	13
Central	323 492	27.1	331 579	02.7	339 869	26.9	348 365	26.9	382 213	27.4	391 139	27
Kordof.	264 562	22.2	227 117	02.2	275 790	21.9	281 581	21.8	276 259	19.8	282 292	19
Darfur	288 043	24.1	297 261	24.2	306 773	24.3	316 590	24.5	325 174	23.3	335 629	23
Khart.	67 157	05.6	70 381	05.7	73 759	05.8	77 300	05.9	99 778	07.2	103 666	07
South.	63 495	05.3	65 068	05.3	66 684	05.3	68 342	05.3	79 019	05.6	80 766	05
Total	1192862	100	1225451	100	1259002	100	1293541	100	1394361	100	1430969	100

Source: SE handbook, 1991

Figure (4): Unit Price of Energy
Vs Consumer Price Index (1981 - 1989)



Source: Sudan Energy Handbook, 1991

Table 2.9 Percentage increase in charcoal consumption in different regions during the period 1984-89

Regions	North.	East	Centr.	Kord.	Darf.	Kh.	South.
% increase	12	32	21	7	16	54	27

Source: Calculated from data in SE Handbook, 1991.

Table 2.10 Wood Allowable Cut in Cubic Meters

Region	Plantation	Natural	Total
Northern	6 846	-	6 846
Eastern	19 240	200 772	220 0122
Central	86 378	758 457	844 835
Kordufan	5 697	2 555 412	2 561 109
Darfur	10 264	8 204 620	8 214 884
Khartoum	6 002	25 674	31 676
Equatoria	29 492	9 654 676	9 684 168
Bahrelgazal	8 436	7 134 419	7 142 854
Upper Nile	169	3 999 174	3 999 342
Total	156 677	3 253 204	32 698 881

Source: SE Handbook, 1991.

It is assumed that, under conditions prevailing in most of Sudan, one MT of dry fuelwood is equivalent to 3 M^3 of growing stock and that it requires 6 MT of wood to yield 1 MT of charcoal. To get 1 MT of charcoal 18 m^3 of growing stock is needed. With conversion factor of 0.72 TOE/MT (National Energy Administration, 1991), the total wood allowable cut in 1990 for Khartoum region will give a total amount of 1267 TOE of charcoal, while the total consumption of charcoal by the region in 1989 is 103666 MT which indicates that large amounts of charcoal should be brought from long distance to the region to cover the deficit.

2.1.7.D Rural-Urban Demand on Charcoal

Records showed that the prices of charcoal are continuously increasing. A sack of charcoal weighing 30 kg on the average, was sold for 12 Ls in 1980, 22 Ls in 1986, and a rapid increase was noticed since 1988 where the same sack was sold for 120 Ls in 1989 (National Energy Administration, 1991). In 1992, the price of sack of charcoal was 1000 Ls. The causes of this increase price of charcoal may be attributed to the long distances of charcoal production area from consumption centers, cost of transport and increase in the demand for charcoal by both rural and urban dwellers, and the high cost and unavailability of other substitutes.

National Energy Administration carried out survey in the household sector in the years 1983/86/88 and 1990 and concluded that the annual per capita consumption of charcoal and wood in Khartoum capital is 0.48 and 0.26 tonne of wood and 0.93 and 0.94

of charcoal for urban and rural areas respectively. It is found that charcoal is the cooking fuel for most households, even the wealthy households use it when bottled gas refills are unavailable. The total consumption of charcoal in Khartoum is estimated to be in the range of 16-22 thousand tonnes monthly, and about 90 % of the families in Khartoum possess charcoal stoves (National Energy Administration, 1991).

Data on per capita consumption reflects that an urban dweller in Khartoum state consumes the same amount of charcoal that a rural dweller consumes. Urban dwellers consumption of charcoal is more than double that of his wood consumption. The consumption of charcoal by a rural dweller is four folds his consumption of wood. Table 11 below shows per capita consumption for household in different regions.

Surveys of NEA in the period 1983-1990, showed that per capita consumption of charcoal in Khartoum state is 0.93 MT and 0.94 MT per annum for rural and urban dwellers respectively. With Khartoum population of 3,413,000 (Department of statistics, 1993), total Khartoum need of charcoal, on the average would be 3,191,187 tonne per year.

2.1.8 Forests Value and Short Term Crisis Management

Conventional national accounting methodology underestimates the contribution that natural resources, such as forests, make towards the national economy, this is because a large proportion of forestry related activities is not part of the monetary economy. It is a short vision methodology to evaluate forests on solely

Table 2.11 Per capita charcoal consumption for household in MT

Region	Urban	Rural
Northern	0.83	1.08
Eastern	2.21	2.04
Central	2.25	2.05
Kordofan	5.29	2.30
Darfur	5.29	2.30
Khartoum	0.93	0.94
Equatoria	0.88	0.27
Bahrelgazal	1.00	0.27
Upper Nile	0.76	0.18

Source: SE Handbook, 1991

income base disregarding its role in environment protection.

Baxter (1981), stated that ninety-eight percent of the cut trees is used as fuel for domestic purposes. A lot of energy being wasted while converting wood into charcoal. Extra losses take place by using primitive end-use devices.

The economic implication of this, is the fact that the production and consumption of biomass are inherently wasteful and it is detrimental to the environment since more growing stock need to be cut to meet the need, therefore there is a clear need to change the pattern of household sector biomass consumption through stiff policies and measures. The findings of research considering improvement of energy use technology, especially in the field of biomass, as well as commercialization of energy conservation measures should be charged.

2.2 Sudanese Traditional and Improved Stoves Cooking Devices

This section is aimed to discuss the Sudanese cooking devices, including both traditional charcoal stoves, and improved charcoal cooking stoves. The characteristics, advantages and drawbacks of the traditional charcoal cooking stoves are discussed. Historical development of the improved charcoal-cooking stoves in Sudan and some neighbouring countries is reviewed, with emphasis on the effectiveness and efficiency of the improved charcoal-cooking stove in comparison to the traditional one is also discussed.

2.2.1 Traditional Cooking Devices

In rural areas of Sudan people depend on firedwood more than charcoal in preparing or cooking their food. Even those who use

charcoal as a source of energy, see that ready made stoves are too expensive to buy and they tend to make their own stoves locally in the house from scrap metals, like tins and buckets. In major urban areas, such as Khartoum the low income group use charcoal much more than the middle and high income group, even these latter groups use charcoal when there is no gas available to them, or when they are waiting for their butagas cylinders to be refilled, (Paddon and Ali, 1992).

Traditional cookstoves are known and used in Sudan centuries ago and still in use in almost all over the country. One of the most popular of these stove is the square metal stove, it is of different sizes, most popular among middle groups in urban areas, and can be obtained from any urban market. A heavier metal gauge called the Ethiopian metal stove is also used by some people in Sudan. The scrap 'bucket' and 'bowl' stove is one which more common in rural areas and the lowest income group in urban areas and usually it is home made, (Paddon and Ali, 1992).

Paddon and Ali (1992), reported that, traditional stoves are found to be effective in cooking purposes, cheap, easy to use but they are inefficient and a lot of heat is lost due to the fact that all of the stove constructure is made of metal.

Majoub (1989), reported that most urban Sudanese households burn charcoal in traditional square "canun" stove that has very low fuel-to-heat convertion efficiencies. The stove, being made of a thin metal, provides minimal isolation, with its so many air holes in the square grates, allows heat to scape as round pots

being on. He stated that these characteristics of the traditional stove revealed that stove has "more heat on the outside than inside". Eventhough the stove is widely used because it is very easy to make device, and it can be made by the family itself using available metals and tools, and can light very quickly.

2.2.2 Improved Charcoal Stoves

2.2.2.A Historical Background

It was reported that the history of improved charcoal stoves go back to 1979, when a research project on "traditional energy utilization" as a joint effort between Faculty of Engineering, U. of K. and Ahfad University College for Women, to find new stoves capable of reducing charcoal consumption while performing the goal of cooking effectively. Experiments were carried on three different types of traditional stoves, which were found to be most popular cooking technologies, (Ali and Huff, 1984).

The research programme conducted by Ahfad College for Women, in 1979 on "traditinal energy utilization" asserted the low efficiency of traditional stoves (15 %). In 1980 work on the design of improved charcoal stoves started in the Faculty of Engineering, U. of K.. The experiment aimed mainly at improving the traditional charcoal stoves efficiency and to enable the households to make use of the small charcoal pieces which constitute a considerable portion of charcoal sack (20 %). Based on the results of the experiment a new stove (Canun Elduga) was designed to enable households to make use of the charcoal fines (Hood and Aba saeed, 1988). They reported that this stove

(Elduga), has an efficiency of about 25 percent and can safe up to 39 percent over the traditional stove as far as charcoal consumption is concerned.

Energy Research Council work on improved stoves, started its programme with the dissemination and adoption of 'Canun Elduga' through Sudan Renewable Energy Project (SREP). dissemination and marketing of the stove was firstly concentrated in Khartoum State and then in the other regions, (Hood and Aba saeed, 1988).

In 1980-82 a project financed by World Health Organization (WHO) was conducted with emphasis on the design of new improved stoves. Both labrotary and field tests reflected that improved charcoal stoves gave high efficiency than traditional ones (Ali and Huff, 1984). In May, 1983 Energy Research Council (ERC) continued on experiments based on previous research of Faculty of Engineering and the project sponsored by WHO, the aim was to publicize the improved stoves country-wide. To fulfill such goal extra tests were carried out, both on labrotary and field levels to assure the feasibility of the stove design before its dissemination, (Ali and Huff, 1984).

Sudan benefited from the neighbouring countries experiences in imroved stoves design. As in most of Sub-Saharan countries, wood is the main source of energy in Niger, about 98 % of the households in the urban areas use it for food preparation. The Nigerien government saw it deleterious to environment as consumption is increasing, and fuelwood being consumed in an inefficient way, so the government addressed the issue to improve the efficiency of

fuelwood consumption by urban households. The government launched a programme to replace the inefficient woodstove with new more efficient one known as the "Mai Sauki" stove, it was designed to suit local conditions and it is found successful, and by its adoption, household expenditure on fuelwood fell by 30 percent (World Bank, 1990). Paddon and Ali (1992), reported that this "Mai Sauki" is later developed in Sudan.

National Cook-stoves Network (NCN), which includes as members; ERC, CARE, FAO, NEA, Islamic African Relief Agency (IARA) and Finnish Donnar Agency (FINNIDA), is the body that manage the improved stove activities in Sudan. In late 1989, this coordinating body carried out scientific testing and evaluation of energy-efficient charcoal stoves, at ERC's field at Soba, (ERC, 1990).

NCN which was created in 1986 recognized the Energy Research Council (ERC) and Renewable Energy Research Institute (RERI) stove centres as the national focus for searching and advising on technical matters related to stoves development and dissemination. Personnel from different agencies were trained and participated in stoves design and dissemination, (Hood and Aba saeed, 1988).

ERC promoted two models of energy efficient charcoal stoves in Khartoum and other major towns, in collaboration with CARE / Sudan and FAO fuelwood development for energy project. The design of the first model "Canun Elsurur" is based on the Kenyan experience (what is known as Jiko in Kenya), while the other one, "The Canun Azza" is a modified model of Thailand bucket stove. Both kinds use a

ceramic grate inserted in a metal cladding for the purpose of diminishing thermal losses and reducing charcoal consumption, (ERC, 1990).

2.2.2.B Improved Charcoal Stoves Design and Performance

The very low efficiency of traditional charcoal cooking stove, coupled with scalating increase in charcoal prices each year and the devastation of forestry necessitate the search for other fuelwood alternatives to increase the efficiency of domestic energy use, this lead people to seriously consider the development of improved stoves.

The efficiency of improved stoves over the traditional ones come from the fact that, while the traditional stove is completely made of metal, the improved stove with interchangable metal grate internally lined with clay liner which isolate the fuel from the metal gauge and decrease thermal losses (National Energy Plan Committee, 1985).

Most important is the quality of clay used to make the stove liner. A mixture of river clay and an organic binder in volume proportion of about 5:1 should be used. If a binder or extender is not used in the manufacture then the stove is more likely to crack with thermal shock when used, (Paddon and Sati, 1986).

In tests carried out at the wood technology section of Forest Research Centre at Soba to compare the performance of different types of traditional and improved cookstoves, under labrotary conditions square-metal traditional stove proved to be effective in cooking purposes, when the charcoal is controlled and confined only

underneath the cooking pot, but at the normal cooking conditions in the kitchen, a lot of charcoal is consumed, the amount of fuel consumed in cooking is likely to be more than doubled. The efficiency is low due to excessive radiated and convected heat and exhibition of charcoal to cross-draughts, (Paddon and Ali, 1992) .

Paddon and Ali (1992), reported that improved stoves (Azza and Elsurur) which are most commonly known to people, proved to be efficient and effective, they minimize charcoal consumption using both small and large cooking pots.

Scientific testing and evaluation at ERC's field, for identifying the efficiency of charcoal stoves revealed the fact that while the traditional stoves are of 10 - 20 percent efficiency, improved stoves are 30 - 40 percent efficient. Well designed improved charcoal-stove when properly used can achieve energy efficiency double that of the traditional stove (ERC, 1990).

It was reported that, a result of field work showed that the average daily family consumption of charcoal for all cooking purposes in traditional stove was (3.3 Malwas)

Malwa = 700 gram

3.3 Malwas = 3.3 X 700 = 2.31 Kg, (Shadia, 1989).

Therefore, family consumption of charcoal per month, for all cooking purposes using traditional stove could be estimated to equal;

2.31 Kg time 30 days = 69.3 Kg of charcoal.

For the same family using the new improved stove, daily consumption is 1.33 Kg of charcoal, (Mohamed, 1989)

charcoal consumption per month;

1.33 Kg X 30 days = 39.9 Kg.

Saving in charcoal used for all cooking purposes per month will be 69.3 Kg - 39.9 Kg = 29.4 Kg of charcoal. This 29.4 Kg saving of charcoal is approximately equal to one sack of charcoal on the average, (National Energy Administration, 1991), which mean 1200 Sudanese pounds saving for family per month (Price per sack of charcoal in May 1992).

Khartoum total population is 3,413,034 (Department of statistics, 1993). With assumption of six individuals per family on the average, total families number will equal to 568,839. With one sack saving of charcoal per family per month, this mean that 568,839 sacks of charcoal could be saved monthly for large Khartoum State which gives 6,826,068 sack saving of charcoal per year for Khartoum State alone.

2.3 Theories of Social Change

This section is aimed to give ideas about some sociological concepts to explain their importance in the social change process, and to help in developing a theoretical framework for the adoption of improved stoves.

2.3.1 Modernization

It is one of the most widely used theories to explain how social change and development can be intiated. Because of its high level of abstraction and wide scope, it is used by different people in different settings. Though economic indices like per capita income or the gross national product are widely used as indicators

of modernization, Ro (1971) argued that these measures ignore a lot of political and social aspects like annual rate of population increase,literacy, educational level, child mortality, the degree of people participation in social organization, level of technology in use etc. Ro (1971) emphasized that, no any single or simple index could be used solely to measure modernity accurately.

modernization is defined and used to involve adoption of ever modern mode of transportation, increase in economic productivity, the use of modern technology and increase exposure of the community residents to mass media (radio, T.V. , newspapers and others), (Edward et al, 1976).

Transition from traditional to modern, or from less modern to more modern status could take place in tribal groups, caste societies, and from societies with different degrees and types of prior urbanization. The extent to which these groups or societies have resources and abilities necessary for modernization and the degree of interrelationships between different parts of the society may greatly affect the degree and the speed at which they will transfer from traditional to modern social entities, (Long, 1977). He added that societies get modernized and changed by transfer from using symbol traditional techniques to the application of scientific knowledge.

Long (1977), stated that, the nature of initial impetus to modernization can vary enormously. In some cases it has been provided by internal groups like the Protestant entrepreneurs of Western Europe, but usually in the third world it has been a result

of impact of various external forces such as colonial expansion, spread of technical innovations or cultural movements.

Dalton (1971), reported that transformation which is conceived as modernization is not only an economic and socio-cultural activities and relationships interaction, but also old economic activities, social relationships and cultural practices that change in reaction to new ones, becoming instituted. He took as an example that the structure of traditional village society undermined when its traditional functions displaced by superior economic and technological alternatives. The aspect of modernization and the process of social change is influenced by the characteristics of the structure under consideration.

2.3.2 Social Structure

It was stated that, social structure of a community consists of three units; individuals, informal groups (set up as a result of friendship and other similar relations), and formal groups such as schools,labour unions .. etc, (Edward and Jones, 1976). He reported that, these types of structure interact and carry on the essential elements or functions that necessary for the community continuity. He also stressed that, it is through the existence of the social structures and their media of progressing, new comers or newly born members learn how to proceed in conformity with the local norms and traditions, and learn to contribute to their community stability, development and welfare. The interaction between individuals and/or groups may be direct or indirect, deliberate or unintended, face-to-face, or through indirect

communication vehicles (Radio, Press, T.V.), it might be cooperative or competitive.

2.3.3 Social System

Rogers, (1983) defined social system as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The subsystems in a community whether are family, governmental, educational, economical .. etc are interlinked in one way or another to complement each other to enable the community members to satisfy their own daily needs and the needs of the community as a whole, and one subsystem can interlink or corporate and share in the activity of another subsystem in the process of change (Edward and Jones, 1976).

2.3.4 Society

To understand the social change process better, it is important to discuss the concept of society and community and how they change over time. The term society has been defined differently by a number of thinkers and sociologists. Spencers who is consider one of the profound sociologists use the term to mean a definite form of reality that he referred to as "superorganic", with process and structural similarities to the biological organisms. He argued that both society and biological organisms are small in size at their earliest stage of constitution and through slow insensible process increase in size. They are also similar in the context of simple structure at the beginning and when increase in size become more and more complex. Both society and biological organisms as viewed by Spencers have loosely

organized parts with low degree of interdependence between these parts at the beginning, and as they grow and develop, they increase in their complexity and the integration between the different parts and the mutual dependence between the parts becomes a must. However, Spencer see that, while biological entities have specific and fixed external form, societies do not have specified such a fixed shape or form. Also, for Spencer, society differs from biological organisms in that whereas, a biological entity is physically connected to each other with the consciousness located in only one part, members of a society are physically free and can spread in large distances, and each member has his own independent consciousness (Ashley and Ashley, 1985). Karl Marx, who is also a prominent sociologist accepted that social life is the process whereby mediative categories emerge,that enable historical subjects to comprehend themselves (Ashley and Ashley, 1985). For Marx the comprehension of the term society could not be set a part from every day life or just an abstraction of some totality of the human daily practices. He viewed that the meaning of a society is an expression of human subjectivity reflected by his role in the life.

Ashley and Ashley (1985), stated that a famous sociologist, Max Weber, conceives the term society as a network of social relationship formed by a group of individuals oriented themselves in a meaningful process. Emile Durkheim, who is considered as one of the outstanding thinkers in the field of sociological theory, used the term society in a number of different ways; close to Weber conception of society, Durkhiem at a time conceive society as a

group or collective life of individuals, regarding how the group or the society members interaction or relation will affect or influence the life of the individuals. Another way of Durkheim's conception of society is his referring of society to the norms,values or properties of cultures developed by a certain group. In his scanning of relations developed among objects, Durkheim states that different forms of interactions among different objects lead to the occurance of certain forms of realities in the world. In analogy to the chemical reactions between certain components, physical interaction between different objects that give rise to a new form or constructure, Durkheim conceives that it is from interactions and relationships between minded beings, (individuals) that social reality or a society emerges (Ashley and Ashley, 1985). This last conception appears to be a good definition of what meant by the term society.

From the above discussion, it is clear that every society is characterized by certain set of values and beliefs that shared by most if not all of its members, Durkheim labelled this shared values and beliefs as "collective representation", as a distinction from non or less shared conceptions that he referred to as "individual representation". The particular set of collective representation can reflect the way in which a particular society understands the world.

2.2.4 Community

Edward and Jones, (1976), referred the term community to forms of varying settlement such as plantation, village, the town, the

city .. etc. What is essential or the essence of the definition that is common to all of these is a grouping of people resides in specific locality and excersize their social life in a such away that they can satisfy their daily needs and to a large extent being in concord with the culture of the larger society of which they are apart. The people of a community have shared concerns and interests, they collaborate in one way or another to provide means for their community to continue with the process of the desirable change. Different subsystems interlink and operate in the community, people in each specialization mutually depends on others, with common sense of belonging to a particular community. Also their cooperation with each other to provide the overall community needs does not preclude the presence of competition and antagonism while each running after his own goal achievement.

MacIver (1959), defined the community as any circle of people that live and belong together, so that they share, not this or that particular interest, but a whole set of interests, that encompass their lives. On such base it could be described as a community ; a tribe, a village, a settlement, a city or a nation. The essence of such definition is that all one's social relations and interactions could be found within the community. It is the locality that gives the base of coeherents of community.

Warren referred to community as ;

> "Organization of social activity to afford people daily local access to those broad areas of activity which are necessary in day-to-day living" (Long, 1977).

This definition narrowly circumscribed the territory functional requirement, though MacIver definition is a broad, even where the local bond is loose as in modern society, but still he regards that the social values is transferred to the larger community, this illustrate that locality is a necessary condition, though it is not enough to create a community.

2.2.5. Norms And Values

Norms and values are conceived as the system's cultural context on which the interaction of the parts or units of a particular community in a given situation is based. The standard of expected behaviour the people hold up to one another is largely determined by these concepts. They are the standard of 'right' and 'wrong'on which rewards and penalties for those who do conform and those who deviate from what is expected, are judged and passed on (Edward and Jones, 1976). Values are portrayed as concepts of the desirable. They are what one believes is right; good, or best, by which individuals of community or society determine what they "ought to" do, and how they "should" behave. They influence goals to be selected and means for their fulfillment, (Beatrice, *et al* 1976).

Beatrice, *et al* (1976), classified values into personal values, moral and social values. The former is the character, or the manner in which the person cope with everyday living, expressed through punctuality, achievements, goal orientation; the interest of one for obtaining a certain belonging based on his theoretical value about it .. etc. Moral values deal with right and wrong.

Social values; in relationship with others, an individual shows such values as support, cooperation, independence, interdependence, respect law .. etc. The acceptance or rejection of a certain society to a new idea or practice brought into the society is affected by the norms and values of the society. Any sort of change is determined, and viewed as desirable or undesirable, by the set of culture prevailing in that society.

2.2.7 Community and Change

Communities are of dynamic nature, with change as an ever-present aspect of life; old generations go and replaced by new ones, people movement, innovations borrowed or devised locally, natural change occurs in environment gradually or drastically. The community either willingly or being compelled as to face the alteration and to be adaptive to the new change, which might be unexpected, or unanticipated unplanned change or change that had been anticipated and being planned for.

Change is inevitable in communities but what differ is the speed with which it occurs. In the process of modernization and urbanization, the speed of change varies from one community to another, from one period of time to another even in the same community, and among different facets of community life (Edward and Jones, 1976).

> Edward and Jones(1976), stated that; "As a rule, the more isolated the community from exposure to outside lifeways, the slower its tempo of change tends to be".

Some of the nineteenth-century evolutionists believed that, to

view a society as static functioning entity is to abstract an image from an actual process of continuous growth and development. They regard society as developing by slow, step-by-step, cumulative, directional, natural progressive advance process-an advance that encompass all of society's institutional areas (Ashley and Ashley, 1985).

It is clear that societies and communities are continuously witnessing natural planned or unplanned change, but it may be a result of minute cumulative, slowly occurring change on the process of life therefore it could not be felt abruptly. This change is an ever present process governed by the set of culture prevailing in each society or community.

2.2.8 The Role Of Family Decision In Change

Family decisions are crucial in creating favorable family environment, it is essential to shape value system, determine the family and individual goals. Appropriate decision making process aids in using resources judgiously to improve the quality of life and preserve our natural resources.The development of knowledge and the impact of technology has opened new opportunities and alternatives for the family, (Beatrice *et al*, 1976).

Contributions of each individual or role activities or actions he performs in the community are governed to a large extend by culture, norms and values of the group of which he is apart, this group may be his family, (Edward and Jones, 1976).

As time goes on, dynamic family find itself, through its central decision-making-implementing activities, within the context

of a rapidly changing environment performs two functions; a) It stabilizes and maintains the family's normative structure and b) It brings about non-disruptive change, (Beatrice, *et al*, 1976).

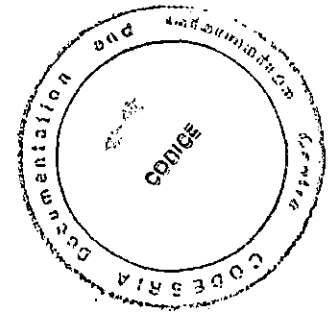
Beatrice, *et al*, (1976), supposed that scientific and technological innovations and advances in mass communication have reduced differences among people, and that family always takes necessary decisions to accommodate the continuous changes whether being internal or mandatory imposed changes. What differs between families is the uniqueness of the family in the way and the speed to handle the change.

He, also, stated that, if the family is to implement decision, motivation for change must be present, but sometimes even this alone is not enough if the change requires some economic ability. Also the view-points of the family members should be alike or somewhat nearer to each other and there is no great discrepancies between them, otherwise no decision for the benefit of the family could be reached easily.

2.2.9 Perceptions, Needs And Change

Individuals react to situations in the way they perceive those situations, the differences in their perceptions to agiven situation may be attributed to natural, physiological differences, the level of learning, opportunities available to them. Many factors may affect perceptions, among which are "mind set" and social pressure, these in turn affect alternatives for change, (Beatrice, et al, 1976).

All people at any level, have some needs which they seek to



satisfy. Human as social beings interact and depend on one another directly or indirectly to give means to their lives and to achieve their 50 and to satisfy their needs. Maslow, held a hierarchial structure of man needs that intiate goal-directed behavior. He ordered these needs (putting as a top priority the first one, followed by the second important for man) as physiological (basic) needs, safety needs, belonging and love needs, and self actualization needs. He postulated that these needs affect one's perceptions of environment and influence family goal formation, (Beatrice, *et al*, 1976).

When a certain need or needs are recognized a certain change may be affected, these needs may make or prevent a certain change in the community. Among the factors that affect or urge the community to take an action is the felt needs of the community, (Edward and Jones, 1976).

It could be stated that whenever an individual feels dissonance, or his situation requires a certain action to change this or that in a more desirable or favorable way on the process of life, then social change might be affected by the individual in the society.

2.4 Adoption of Innovation and Social Change

This section is aimed to discuss the concept of innovation and its adoption and diffusion among the members of a social system. The importance of communication and its role in dissemination of the new ideas. The attributes that lead to the innovation adoption or rejection, especially the characteristics of the improved stoves

are also discussed in this section. The marketing and dissemination of improved stoves and the potential adopters innovativeness are also tackled in this part.

2.4.1 Innovation Diffusion

An innovation is an idea, practice, or object that is perceived as new by individual or other unit of adoption, (Rogers, 1983). Close to this prehension, Brown (1981), defined an innovation as an idea, practice or object perceived as new by an individual. He mentioned that, it is the perception of the idea by the individual that determine his reaction to it.

Rogers (1983), argued that, the newness in an innovation need not only to involve new knowledge, but a favorable or unfavorable attitude should be developed by the individual towards the innovation, hence he may adopt or reject such innovation. He stated that the term diffusion is used to mean the process by which an innovation is communicated through certain channels over time among individuals or members of a social system. To him adoption of innovation is the process by which an individual or any adoption unit implements or puts an innovation or a new idea into practice.

2.4.2 The Importance of Communication and Knowledge in the Process of Adoption

Communication is simplified by Rogers (1983), as a process in which participants create and share informations with one another, so mutual understanding could be reached regarding a certain message.

Despite the controversary, which comes first; need or knowledge, i.e is a felt need create knowledge about the

innovation, or the awareness about the innovation create a need for it, either case of both is possible. The essence of know-how about the innovation, is its importance in reducing the uncertainity associated with the newness of the innovation, the individual is interested in information of how-to use the innovation i.e how-to-knowledge information or software information. Unless adequate level of knowledge is obtained prior to trial of an innovation, rejection or discontinuous is likely to result, (Rogers, 1983).

An individual may acquire knowledge about innovation through different channels, being a mass media channel, like T.V., Radio, newspapers .. etc or direct interpersonal communication channels.

Rogers (1983), stated that communication at knowledge stage could be achieved through commercial or any other agent. Through mass media the information about an innovation could be disseminated to a large number of people over shorter period of time, but people could not have details of how-to-knowledge through mass media channels. This more specific information which help the potential adopters to evaluate the innovation, could be obtained through interpersonal communication and it is more important at the persuasion and decision stage in the process of innovation adoption. He stated that, at persuasion stage, the innovation attributes are important in convincing the individual to adopt. The potential adopter try to seek innovation-evaluation information, which reduces uncertainity about the consequences of innovation use. The individual usually asks what are the advantages of the innovation over the existing practices.

Both the sources of message and the channel that convey it are of importance. The sources of the message could be an individual or an institution that originates the message. A cosmopolite communication channel (those from outside the social system considered) are relatively more important at the knowledge stage, while localite channels (those emanate from inside the social system considered) are relatively more effective at the persuasion stage.

Considering the awareness and use of the improved cookstoves, Ahmed and Ahmed (1988), reported that, in a marketing survey it was reflected that most of the users get their knowledge about the device from their near peers, while some people have never heard of it.

Rogers (1983), stated that individual perception and interpretation of message he received is one of the important determinants of individual behavior in the adoption process, he added that, the attributes of the innovation i.e its relative advantage, compatibility .. etc are significant for individual persuasion to adopt an innovation.

2.4.3 Attributes of Innovation and Adopter Response

Trying to convince people that energy saving technologies have a national benefit or will result in a mild impact on the environment is a rather difficult task and might be very far from the lay man scope to comprehend. Usually in adoption of innovation process the first questions that come to the mind of individual are; What is innovation ? How does it work ?, and What are the

consequences and benefits he will gain from using such innovation. In answering these questions it is found that the innovation adoption rate (the number of members of society who have adopted a new idea over certain period of time (Rogers, 1983), depends on the characteristics of that innovation.

Rogers (1983), stated that among the most important characteristics that lead to the adoption of innovation are; the innovation relative advantages, i.e the degree to which an innovation is perceived as better than the idea it supersedes; it is more obvious and clear when measured in an economic term. Another characteristic is the compatibility of the innovation with experience and needs of potential adopters.

Chambers (1986), said that the problem of the rural people is that, their needs are not felt by the researchers or the innovators, this is why they lag to adopt innovations, because the introduced innovation doesn't meet their felt needs.

Rogers (1983), also added that, the ease of understanding the innovation, its triability and the degree to which the result could be visible and clearly seen and tangible, are attributes that could enhance the adoption rate of innovation.

Regarding these attributes and the adoption of the improved charcoal-cooking stoves as a beneficial and an energy saving technology, Ali and Huff (1984), stated that the ERC work on improved charcoal stoves proved that the stoves are more efficient than the traditional stoves, their saving of charcoal is obvious to the users, they could save half of the total amount of charcoal

consumed when using a traditional stove over the same period of time, which mean that a considerable portion of expenditure on charcoal by the household could be saved. Improved stoves could easily be tried and used, since they are portable and of suitable size, also they are compatible with existing cooking practice.

Considering the adoption of any innovation the population of the potential adopters will not adopt at the same time, some may not adopt even at all, this may be attributed to the differences in economic, social, and geographical aspects of the potential adopters.

Rogers (1983), stated that people differ in their response to adopt certain innovation, based on their level of literacy, education, social status (income, level of living, possession of wealth), social participation, cosmopoliteness, exposure to mass media, exposure to interpersonal communication, knowledge about the innovation. In this statement Rogers takes the matter of adoption as an individual responsibility, disregarding that other factors may interfere in the process of adoption.

Brown (1981), stated that in the past the diffusion approach studies concentrate on diffusion aspects as a problem of individuals to adopt or reject, they had considered the demand aspect of diffusion. This approach postulates that all the potential adopters have an equal chance or opportunity to adopt, therefore focuses on the personal characteristics of the individual as a determining factor in the adoption process. On the otherhand the market adoption perspective takes the issue as a matter of

supply aspect of diffusion, and the opportunity to adopt is not equal for all people and availability of innovation and the conditions prevail are equally important factors. Thus several interacting factors may affect the adoption process. These may include; the establishment of diffusing agency which may make the potential adopters aware of the innovation (the promotional communication process), the infrastructure which may ease the availability of the innovation to the individual, the price of the innovation, the individual's social, economic, locational and demographic characteristics, all these may affect the spatial patterning of diffusion.

The diffusion agency which distributes the innovation or makes it available to the potential adopters, can play a major role in the process. Though, CARE, Sudan held seminars and demonstrations of the improved stoves in different localities of the national capital, but no distributions centures were established to make the innovation at the reach of the individuals to obtain.

Brown (1981), stated that other factors, in addition to the innovation market potential and market penetration may affect its diffusion, he breived his statement by a functional formula as follows:

$$q_{ik} = f\,[\, g_{ik}, p_{ik}, a_{ik}, h_{ik}, e_{ik}\,]$$

where:

q_{ik} is the estimated unit sales of the innovation in place i at time k.

g_{ik} is the general economic conditions in place i at time k, indicated by a surrogate such as unemployment.

p_{ik} is the price of the innovation in place i at time k.

a_{ik} is the advertizing expenditure for the innovation in place i at time k.

h_{ik} is the diffusion agency capacity in place i at time k.

e_{ik} is the diffusion agency effectiveness in place i at time k.

Brown mentioned that general economic conditions would be taken account of in the planning of the propagator, but he can not be able to get control on them, therefore, it is most likely that decisions are based on the price, advertizing expenditure, and diffusion agency characteristics, that affect agency capacity of effectiveness.

Brown (1981), stated that, particular elements are of importance in the strategy that the diffusion agency follows to distribute the innovation. According to him these elements are the development of infrastructure and organizational capabilities, the price charged for the innovation, which is likely to vary with place and time, a third factor is the promotional communication which provides the individual with the information and persuades

him to adopt.

Some innovations could be classified as infrastructure constrained innovations, in the sense that they could be used only in the availability of special infrastructure, other innovations (like improved stoves) could be used everywhere, absence of infrastructures will not handicap their adoption. However some infrasructures may facilitate their distribution and maintenance.

Regarding promotional communication, the source of information to the individual and his confidence in such source is of vital importance. These information could be obtained from the diffusion agency which tend to expose the individual to the innovation, or from the individual's social system, and it is more general that the social system has more impact upon the individual's attitudes.

2.4.4 Improved Stoves Dissemination and Acceptability

The aim of disseminating improved charcoal-cooking stoves is to fulfill a couple of needs; a national need (reducing deforestation), and individual need (reducing cooking time and income spent on purchasing charcoal). The acceptability of individuals is the core of the device dissemination success. Field tests and surveys information and feed back from users are carried for further technology modification, (Ahmed and Ahmed, 1988)

In a dissemination experiment carried out by ERC in 1984 to study the attitudes of individuals towards the stoves, improved stoves were distributed for 300 household in six localities in Khartoum Capital, these include; Hilat-hamad, Shambat, El thawra, Abbassya, Nasir-extension and Third class extension, three months

after providing the same families with traditional stoves. The stoves were provided at special rate and questionnaires were coupled with the stoves. Most of the respondents reported that the stoves were more efficient and convenient to use, (Hood et al, 1986).

In Sudan improved stoves could be manufactured from locally available materials (scrap metals). Currently three private factories producing improved stoves with a total capacity estimated to be 150,000 stoves per year. In the ' Comprehensive National Strategy for the Sudan ', it is recommended that three producing units should be established to provide households with a total of nine million improved stoves per annum, this could save about 1.25 million tonnes of wood annually (National Energy Administration, 1991).

In the national stove programme sponsored by the government, 600,000 stoves were planned to be produced for utilization in khartoum state, and it is suggested that collaboration of NGO's and other development agencies should continue under the umbrella of the NCN for the best design achievement and the dissemination of improved stoves, (Paddon and Ali, 1992).

ERC carried out kitchen performance test on traditional, 'Elsurur' and 'Thai bucket' stoves to see and compare overall charcoal saving, the stove durability and the housewives preference and observations. Hood and Ahmed (1988), stated that preliminary results of such test indicated that most of the housewives prefer Elsurur stoves and they expressed their readiness to buy two stoves

of such type at the current prices.

In early 1990 approximately 2000 improved stoves were being sold in khartoum per month, (ERC, 1990). Fred Swart who is ARD's Advisor leading ERC team, conducted a market survey of the stoves, and stated that, there is a significant demand for 'Elsurur' and 'Azza' stoves, (ERC, 1990).

Contrary to the above mentioned statement, studies carried out by ERC revealed that some people had never heard of the stoves, and a larger proportion of the users mentioned that they get acknowledged of the stoves from their neighbors in the residential area, (Hamed *et al*, 1986).

Brown (1981), stated that the pattern of diffusion rate over time may be explained on different perspective. The adoption perspective may attribute it to innovativeness or resistance to adoption. The market and infrastructure perspective may relate it to diffusion agency strategies. The economic historians would argue that, the slow initial rate of adoption may be interpreted in term of individuals wait for the improvement of the innovation. The level of development is also an aspect to be considered in the innovation diffusion process. It can affect the diffusion through infrastructure and other available goods e.g. transportation is in effect a subsidy for the potential adopters to obtain the innovation i.e it could be seen at their reach. Also the level of development affect the innovation diffusion through societal norms, which to some extent determine the individual's response to innovation prevails.

> Brown (1981), quoted from Yaba (1976): "Differences in adoption time may be the result of the marketing strategies of public or private propagators of the innovation, rather than the result of the innovativeness characteristic of potential adopters"

Eventhough a fact to be mentioned is that, a given innovation will not be adopted in isolation of one's economic, social, locational and institutional context i.e for any innovation there is the associated niche within which it could be diffused or not.

Based on the previous literature of the improved stoves technology, the theories of social change and the adoption process it could be hypothized that improved stoves were being adopted depending on some reliable factors, most expected among these are; age of head of household, housewife age, head of household education, housewife education, housewife exposure to messages about improved stoves, family income, availability of improved stoves alternatives, male education, female education and improved stoves relative advantages. These relationships are depicted in the following model (Figure 5).

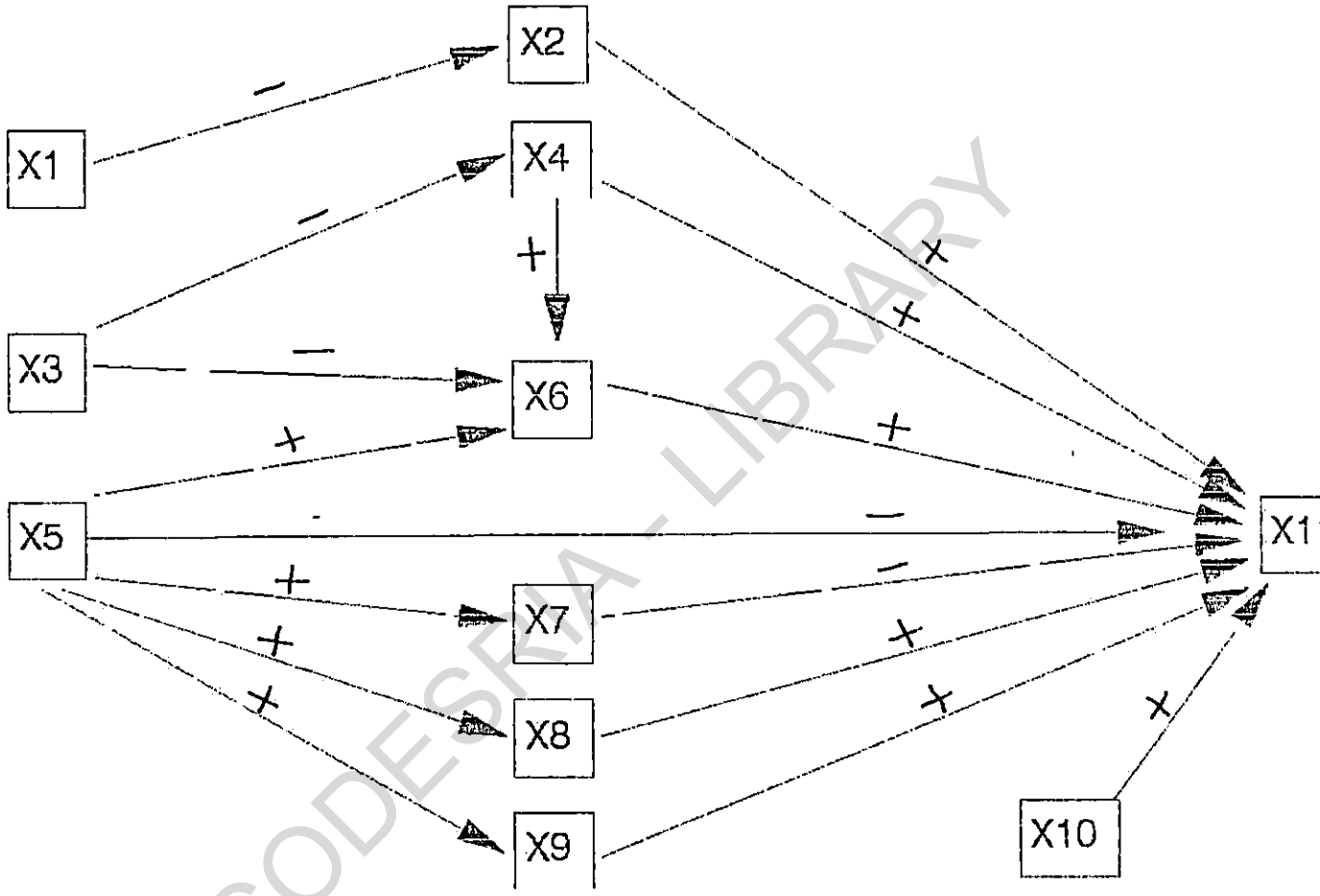


Figure 5 Hypothesized causal relationships between innovativeness and some selected variables

See key on the next leaf

Where:

X1 is the age of the head of household.

X2 is head of household education.

X3 is the age of housewife.

X4 is housewife education.

X5 is family income.

X6 is housewife exposure to messages about improved stoves.

X7 is the availability of improved stoves alternatives.

X8 is male education.

X9 is female education.

X10 is improved stove relative advantages.

X11 is innovativeness.

CHAPTER THREE

THE RESEARCH METHODOLOGY

At the beginning of this section, the area of the study, sample selection and method of data collection are discussed. Then, the chapter tackles the problems and obstacles of the study and measurement of some variables. Operationalized hypotheses of the study and method of data analysis are discussed in the last section.

3.1 Area of the Study

Khartoum is considered as the major area of charcoal consumption, the large proportion of this charcoal is consumed by the household sector mainly for cooking purposes. Following the technical and scientific experiments on improved stoves designs, some research centers and non-governmental organizations exerted efforts on dissemination of information about these devices, and tried to shift the technology to the commercial scale. CARE / Sudan had done a lot of work on the dissemination of the improved stoves in different urban localities, especially Khartoum state.

Staff of CARE held seminars in different districts of the capital mainly in Um durman province (these include 10 districts in which seminars were held). However, CARE demonstration of such technology to the household in Khartoum province was only reported in El sahafa district.

Although Khartoum state is now (1993) divided administratively into four provinces; Khartoum, Um durman, Khartoum North and East

of the nile province. In Khartoum North trial of disseminating the technology was only reported in Shambat district, and no effort of dissemination or demonstration is reported in East of the nile province by CARE or ERC. Therefore Um durman province was selected as the area of the study since the greatest effort by CARE, Sudan is exerted to disseminate the improved stoves in such area. Also there is the Gabani factory for the production of the improved stoves in the industerial district, Um durman. This will make it possible that, at least part of the respondents who will be interviewed have used or have information about the technology under consideration.

3.2 Sample Selection

Um durman which is one of the four provinces of Khartoum state lies on the western bank of the river nile. CARE international staff members have demonstrated the use of improved stoves for the household in ten districts of the province. These include; Bait-elmal, Wad nubawi, El mahadia, El thawra, El abbassia, Um badda, Abu a'anga, Abu seid, El sarourab and El salamania. Four of these ten (Um badda, Abu seid, El sarourab and El salamania) were considered as rural localities compared to the other six localities (El thawra, Bait elmal, Wad nubawi, El mahadia, Abu a'anga and El abbassia), these latter six are taken as urban localities. Three of six urban localities and three of four rural localities were chosen randomly to constitute the districts in which the study will be carried out.

The three urban districts selected were El thawra, Bait elmal and El abbasia, while the rural districts were Um badda, Abu seid and El sarourab. If we take Um durman council office as a center, the site of these districts can be described on approximation as follows:

- El thawra is 7 kiometer North.
- Bait elmal is 2.5 km North east.
- El abbasia is 3.5 km south west.
- Abu seid is 13 km south.
- Um badda is 11 km West.
- El sarourab is 25 km North.

Multistage stratified random sampling is followed to carry out this study. At first the ten districts, where CARE have held demonstration seminars, were divided into rural-urban groups. Then 3 districts of each group were selected randomly to have 6 districts which constitute the area of the study. The place of demonstration in each district is obtained from the records of CARE, Sudan. The sampling frame is established from the population around the centers of demonstration in the six districts to ensure that at least part of the respondents have the criteria of interest. The list of the population in each district is obtained from the people committee for supervision and services, where a complete list of all the families in each block or locality is prepared for the purposes of some commodities distribution through rationing.

The number of families in each block or district, and the

number of families selected to be interviewed is presented in table 3.1.

A sampling frame is obtained from the list of the population in each block in the six areas, then 50 family were selected randomly from each districts, to have a total of 300 families to be interviewed, i.e 150 families in the rural areas and 150 families in the urban areas.

3.3 Method of Data Collection

The primary data for the study was collected through face-to-face interviewing.

A comprehensive questionnaire (appendix 1) was constructed covering questions about the respondents personal characteristics, socio-economic status and communication behavior. The field survey was carried in the period from July, 14th to 31 of August, 1993.

The researcher has met each of the respondent individually, and gave him/her a brief explanation about the purpose of the study to make him aware of the nature of the study and to gain his trust and his confidence. This is of special importance for the fact that the sample includes respondents of the other sex; the housewives. The respondents gave direct replies for the questions red by the interviewer.

3.4 Problems and Obstacles

Out of 300 respondents who were selected to give replies for the questionnaire prepared, only 213 have been interviewed. Table 3.2 shows the number of respondents and the response rate in each district.

Table 3.1 Number of families in blocks and number of families selected

Locality	No. of families in the block	No. of families selected
El thawra block 10	176	50
Um badda-17	201	50
El abbassia Wasat	173	50
Abu seid	180	50
Bait elmal north	182	50
El sarourab	175	50
Total	1087	300

Source: Sample Survey.

Table 3.2 Number of respondents and response rate in the selected districts

District	No. of respondents selected	Respondents gave replies	response rate
El thawra	50	39	78%
Bait elmal	50	34	68%
El abbassia	50	36	72%
Um badda	50	29	58%
Abu seid	50	36	72%
El sarourab	50	39	78%
Total	300	213	71%

Source: Sample Survey.

The overall response rate is 71 percent, this is due to the fact that, 20 percent of the respondents were not available at the time of data collection; some of them were absent, others have left their places to other districts. 2 percent of the respondents refused or asked the researcher's apology for their no cooperation, saying that they never cooperate in such aspects. This might be mainly due to their distrust in the researcher's purposes.

Although interviewing method of data collection has a lot of advantages, by discussing, observing and standing on the respondent reality and the reliability of his answers, yet the method is time consuming. Some of the major problems faced the researcher during data collection are:

- Although each house in the urban areas has a definite serial number, but some of the houses have no labels on the outdoor to show the house number, this coupled with the fact that urban dwellers do not know except their very nearer neighbors, all these compelled the researcher to spend a lot of time looking after the selected respondents addresses.
- The researcher found that in many cases, one family being reported as two families in the commodity rationing list, to get benefits of such rationing, while they are actually one family; this represent about 6 percent of the sample, which is another factor that decreased the number of the respondents, and hence the response rate.
- The researcher found it necessary to go to some families more than two times, because they were not available at the time of

the first visit but they were somewhere around.

- Some of the husbands insist to reply or answers the questions, intended for the housewives, and refused to allow their wives to attend to be interviewed, therefore they are excluded from the sample, and this is another factor that decreased the response rate.
- A lot of time being lost in clarifying and explaining the purpose of the study for the illiterate respondents.
- The researcher faced a great difficulty, trying to gain the respondents trust to give reliable answers, especially in questions covering their incomes and possessions. Many disbelieve the researcher, expecting him to be a tax officer.
- In addition to travelling problems a lot of time was spent in accepting rural people hospitality and trying to conform with their habits and traditions.

3.4 Measurement of Some Variables

1. Education of head of household

This variable is measured by the total number of years of formal schooling completed by the head of household; mean = 7.92 and S.D = 5.6.

2. Education of housewife

It is measured by the total number of years of formal schooling completed by the housewife. It has a mean of 4.822 years and S.D of 5.015

3. Age of head of household.

It refers to age of the head of household in years; mean =

46.197 and S.D = 13.86

4. Age of housewife

This variable is measured in years; mean = 39.49 and S.D. = 11.72

5. Family Income

This variable is measured in terms of the total sum of money in Sudanese pounds gained by all the family members. It shows a great variability among families interviewed in the study; mean = 21104.22 Ls and S.D. = 37002.43.

6. Housewife exposure to messages about improved stoves from different communication channels

This concept is measured in terms of the exposure of housewife to messages about improved stoves through the different mass media channels (T.V., Radio, Conference, exhibition, lectures, posters) and through interpersonal communication. It is quantified in terms of a score of one being given for hearing about improved stove through each communication channel. The total number of scores obtained by each housewife reflects her exposure to messages about improved stoves; mean = 2.06 and S.D. = 1.21

7. Availability of stove alternatives

This concept is used to mean the family ownership of cooking devices other than improved cooking stoves, specifically, butagas and electric cooking devices. A family that has one device is given a score of one, that has two devices is given two scores, and zero score is assigned to a family that has none; mean = 0.73 and S.D. = 0.707.

8. Male education: The use of this variable in the study referred to the total number of years of formal education completed by all the male family members aged 7 years and above excluding the head of household; mean = 17.5 and S.D. = 16.5

9. Average male education: This variables measured by dividing the total number of years of schooling completed by all male family members aged 7 years and above excluding the head of household, by their number; mean = 8.15 years and S.D. = 4.86

10. Female Education

This term is measured by the total number of years of formal education completed by all female family members excluding the housewife; mean = 16.5 and S.D. = 16.5

11. Average female education: It is measured by calculating the total years of schooling completed by the female family members aged 7 years and above excluding the housewife divided by their number; mean = 7.314 and S.D. = 5.27

12. Perceived relative advantage of the improved stove

Here this concept is used to mean the relative advantage of improved charcoal cooking stoves, it portraits the desirable characteristics of the stove, as thought by the respondents. It is measured in terms of the stove saving of charcoal, saving of cooking time, its easiness to use. Each character mentioned by a respondent is given a score of one, the concept of relative advantage for each respondent is obtained by summing up the total number of scores for the characters he mentioned.

13. Innovativeness.

In the study, this variable is used to mean the time that a household had taken to adopt the improved stove. It is measured in term of scores assigned for each household according to the time he had taken to adopt. Since the dissemination of improved stoves started in (1984); then 8 score is assigned for a respondent who had adopted the technology in the first year (i.e 1984) from the starting time of the stove dissemination, and zero score is assigned for the respondent who did not adopt till 1993. The scores assigned for the rest of the respondents depend on the year they adopted in (1985-1992) ranging from 7-1. Thus the variable is measured by scale of (0-8).

14. Adoption rate

It is used here to mean the total number of respondents who used or adopted the improved charcoal stoves in the previous eight years as percentage of the total sample (213). To measure such concept or variable, an adopter or user of the device has been given a score of one, while zero score is signed to the non-adopter respondent. Out of 213 cases, it is found that, only 37 respondents had used the considered technology.

15. Environmental awareness

The study is also attempting to measure the respondent awareness about the environment and the problems that may result from cutting trees or natural vegetation, the concept is measured by assigning a score of one for each environmental problem caused by cutting down trees mentioned by the respondent.

The total sum of scores obtained by each respondent, reflects his awareness about environment. Zero score is given for a respondent who mentioned no problem.

3.5 Operationalized Hypothesis

A theoretical causal model which shows the hypothetical relationships is developed reflecting the causal relationships between exogenous and endogenous variables (Figure 3.1)

The model is an attempt to reflect the total causal relationships (direct and indirect) among variables.

The proposed model includes eleven variables, 4 exogenous variables and 7 endogenous variables.

The four exogenous variables are; head of household age, housewife age, family income and the relative advantage of the improved stove.

The other six intervening variables are; education of head of household, education of housewife, housewife exposure to messages about improved stoves, availability of the stove alternatives, male education and female education. The only ultimate endogenous variable is innovativeness.

The attempt here is to measure the effect of all other variables on innovativeness which is the principal dependent variable. It is hypothized that;

- Innovativeness is positively affected by the technology relative advantage, education of head of household, education of housewife, exposure to messages about improved stoves, male education and female education. On the other hand it is

negatively affected by age of head of household, age of housewife, family income and availability of stove alternatives.

- Education of head of household is negatively affected by head of household age.
- Education of housewife is also negatively affected by her age.
- Family income will impose positive influence on the availability of stove alternatives.
- Both male and female education are positively affected by family income.
- Exposure to messages about improved stoves is affected by housewife education and family income while it is negatively related to housewife age.

3.6 Data Analysis

Simple descriptive statistics (frequency distribution and analysis of variance) are used to have inferences about some variables of the study

The process of data analysis is based on the path analysis technique which use the linear regression model to test the hypothized causal relationship among the set of variables in the analytical model (Fig. 5).

Agresti, *et al* (1979), define path analysis in statistical realm as a series of multiple regression analysis.

They added that, the technique of the path analysis forces the researcher to specify the presumed causal relationship among variables. An advantage of such technique as he encountered is that, it can help ones to work more efficiently in data analysis,

and contributing to logically clear explanations of variables relationships, i.e path analysis involves looking not only for relationships among variables, but also for the sequence of mechanism of causal relationships.

Saeed (1989), said that while the regression technique only shows the direct relationships between variables, path analysis technique can show the direct and indirect effect of the independent variables on dependent ones. A step wise multiple regression model is used to predict the relationships between the dependent and independent variables of the hypothized path analytical model.

CHAPTER FOUR

FINDINGS AND DISCUSSION

This chapter is divided into two sections, in the first one, the findings or results of the data analysis are presented. The second section is devoted to discussion of the results of the study.

4.1 Findings of the Study

4.1.1 Frequency Distribution Results

4.1.1.1 Adoption Rate

Simple descriptive statistics is applied to have inferences about some variables of the study, with 106 rural and 107 urban respondents, frequency distribution results (Table 4.1) reflected that only 17.4 percent had put the technology into use, while the others didn't use it; adoption rate is only 17.4 percent.

Table 4.1 Frequency Distribution of Respondents According to Their Aodption of improved charcoal stoves.

Value	Frequency	Percent
Adopted	176	17.4
Did not adopt	37	84.6
Total	213	100

Valid cases are 213.

4.1.1.2 Awareness About Environmental Problems

Regarding environmental awareness of respondents, frequency distribution (Table 4.2) showed that 52.6 percent of respondents have no knowledge about environmental problems, 16 percent know very little, 26 percent have moderate knowledge and only 5.2 percent of the sample have good knowledge about environmental problems, (Valid cases were 213).

4.1.1.3 Awareness about the Existence of Improved Cooking Stoves

Considering the degree of awareness or hearing about the technology, frequency distribution (Table 4.3) indicated that, with sample size of 213, 86.9 percent of respondents have an idea or heard about the technology, while 13.1 had never heard of it.

4.1.2 Analysis of Variance (ANOVA) Results

4.1.2.1 Effect of Residence on Innovativeness

To assess the impact of the respondent's residence area on adoption of the technology, analysis of variance technique is used. It is found that residency of individuals affects the use of the device significantly at (0.05) level of significance. Table (4.4) showed the proportion of variation in innovativeness explained by the respondent residence area.

4.1.3 Results of the Regression Analysis

To assess the effect of some variables hypothized to have influence on the adoption of improved stoves, step-wise linear multiple regression technique is used. To examine the influence of age on education, first, education of head of household, and education of housewife were regressed on age of head of household

Table 4.2 Frequency Distribution of Respondents According to Their Level of Awareness About Environmental Problems.

Value	Frequency	Percent
Have no knowledge	112	52.6
Limited knowledge	34	16.0
Moderate knowledge	53	26.3
Good knowledge	11	5.2
Total	213	100

valid cases 213

Table 4.3 Frequency Distribution of Respondents According to Their Awareness About The Existence of Improved Cooking Stove technology.

Value	Frequency	Percent
Didn't heard about the technology	28	13.1
Heard about it	185	86.9
Total	213	100

Valid cases 213

Table 4.4 Effect of Residency Area on Innovativeness; Analysis of Variance Results.

Source of variation	sum of squares	D.F	Mean square	F	Significant of F
Main effects (residence area)	7.444	1	7.444	3.68	0.057
Residual	423.142	209	2.025		
Total	430.586	210	2.050		

and age of housewife respectively. Regression results (Table 4.5) showed that, as expected, the age of both husband and wife has a negative influence on their education. The regression coefficient of head of household is significant at 0.01 level of significance, and the coefficient of determination (R^2) is 0.18, and the regression coefficient of the wife age is also significant at 0.01, and the coefficient of determination (R^2) is 0.14

By examining the effect of family income on Availability of alternative cooking devices for improved stoves, male education and female education the results of regression analysis technique (Table 4.6) are consistent with a priori expectation; family income is found to affect all of the three variables positively and significantly at (0.01) level of significance, with explanatory power (R^2) 0.06 for the availability of stoves alternatives, 0.022 for male education, and 0.03 for female education.

When male education and female education were replaced in the model by average male education and average female education, and regressed on family income, the regression results (Table 4.6) showed that, family income remains to influence the two variables significantly at (0.01) and the relationship is positive as expected.

To examine the effect of some variables that are expected to affect housewife exposure to communication means, housewife age, housewife education and family income were used as independent variables. In conformity with a priori expectation, both housewife education and family income showed a positive significant

Table 4.5 Effect of Age on Education

Dependent variable	Independent Variable	regression coefficient	R^2
education of head of household (F=46; P=0.01)	age of head of household	- 0.4225**	0.18
education of housewife (F= 34; p=0.01)	age of housewife	- 0.3766**	0.14

** Significant at 0.01 level of significance

Table 4.6 Effect of Family Income on Some Variables

Dependent variable	Independent variable	Standardized Regression Coefficien	R^2
Availability of other alternatives (F = 13; P = 0.01)	Family income	0.249	0.06^{**}
Male education (F = 4.9; P = 0.1)	Family income	0.15	0.022^{**}
Female education (F = 7.3; P = 0.01)	Family income	0.184	0.034^{**}
Average male education (F = 0.55; P = 0.01)	Family income	0.0566	0.003^{**}
Average female education (F = 0.86; P = 0.01)	Family income	0.07	0.005^{**}

** Significant at 0.01

relationship with housewife exposure to communication means. Housewife age is found to affect the exposure to communication means negatively and significantly at 0.05 level of significance, (Table 4.7). The coefficient of determination (R^2) which means the explanatory power of the model, was found to be 0.022.

In assessing the degree of influence of some selected variables expected to affect the ultimate dependent variable (innovativeness), with a sample of 213, innovativeness was regressed on age of head of household, head of household education, housewife age, housewfe education, family income, availability of other alternatives for improved stoves, housewife exposure to communication means, male education, female education and relative advantage of the improved stoves.

Regression results (Table 4.8) indicated that, in concord with a priori expectation, relative advantage, education of head of household, housewife education, housewife exposure to communication means and female education are positively related to innovativeness. However, at 0.01 level of significance only of these, relative advantage proved to be of significant effect, while housewife education and housewife exposure to communication means reach significance at 0.05 level of significance (figure 6). Unexpectedly, male education is found to be negatively and significantly related to innovativeness at 0.05 level of significance.

Being consistent with a priori expectation head of household age, house wife age and family income were found to influence

Table 4.7 The Effect of Some Variables on Housewife Exposure to Communication Means.

Dependent variable	Independent variable	Standardized regression Coefficient
Housewife exposure to communication means (F = 4.56; P = 0.05)	housewife age	- 0.007*
	housewife education	0.143*
	family income	0.069*

R^2 = 0.022
* Significant at 0.05 level of significance

Table 4.8 Effect of Some Selected Variables on Innovativeness

Dependent Variable	Independent Variable	Direct Effect	Indirect Effect	Total Effect
Innovat-iveness	Relative advantage of improved stoves	+ 0.684 **	-------	+0.684 **
	Head of household age	--------	- 0.011	- 0.011
	Head of household education	+ 0.0259	--------	+ 0.0259
	Housewife age	---------	- 0.0316	- 0.0316
	Housewife educat-ion	+ 0.0834 *	+ 0.0043	+0.0877 *
	Family income	- 0.05668 *	+ 0.0085	- 0.048 *
	Availability of other alternatives for improved stoves	+ 0.0229	-------	+ 0.0229
	Housewife exposure to messages about improved stoves	+ 0.02935 *	--------	+0.02935*
	Male education	- 0.03 *	--------	- 0.03 *
	Female education	+ 0.028	--------	+ 0.028

R^2 = 0.468
** significant at 0.01 level of significance.
* significant at 0.05 level of significance

innovativeness with a negative effect. The effect of family income was significant at 0.05 level of significance. On the other hand and contrary to expectation availability of other alternatives was found to have a positive influence on innovativeness, this influence was insignificant at (0.05) level of significance. The explanatory power of the model (R^2) was found to be 0.47.

Replacing female and male education variables by using the average education of respondents in the model, still average female education, concording a priori expectation, found to have a positive effect on innovativeness, with Beta coefficient (0.032). However, this effect was insignificant at 0.05 level of significance. The average male education also remains to have a negative significant influence on innovativeness at the same level of significance (0.05).

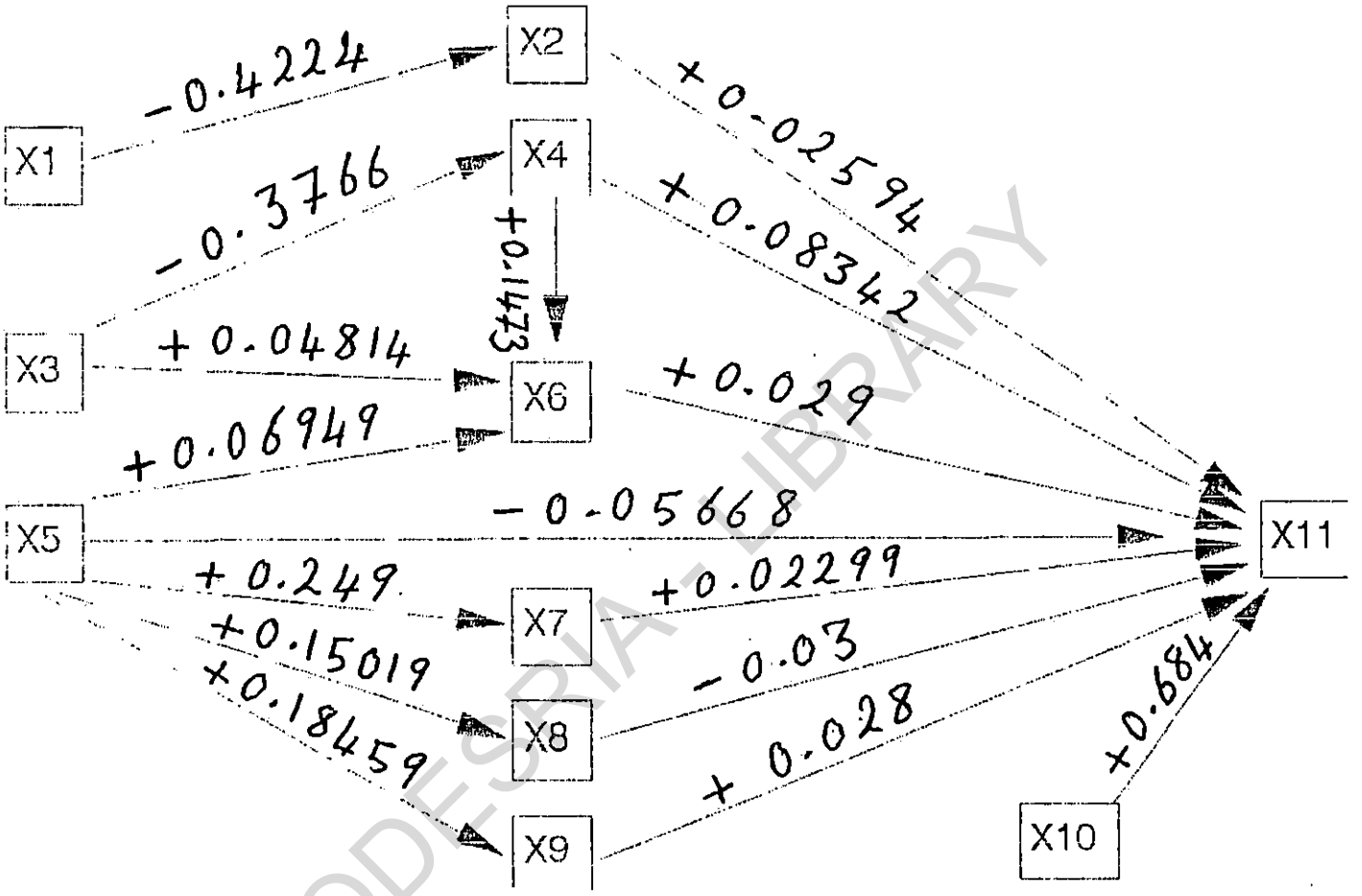


Figure 6 Variables found to have effect on innovativeness

Sea key on the next leaf

key:

X1 is the age of the head of household.

X2 is head of household education.

X3 is the age of housewife.

X4 is housewife education.

X5 is family income.

X6 is housewife exposure to messages about improved stoves.

X7 is the availability of improved stoves alternatives.

X8 is male education.

X9 is female education.

X10 is improved stove relative advantages.

X11 is innovativeness.

4.2 Discussion of Results of the study

4.2.1 Awareness about environmental conservation

Environmental conservation is the theme of this study, to assess people awareness in this respect, frequency distribution results revealed that, of 213 cases investigated, approximately half the population (52.6 percent) completely ignores the environmental problems that might rise by felling down natural vegetation. 16 percent of the total respondents acquired very limited apprehension of the matter, 26 percent reflected a moderate knowledge of importance of environmental conservation, and only small proportion (5.2 percent) of the population were found to be well acquainted with environmental problems that might result from devastating the natural vegetation. This result is consistent with the literature of the study and concord with the argument that, Sudanese knowledge about environment problems is very limited and not at the adequate or required level, (Jong-Boon, 1990).

4.2.2 Rate of adoption

One of the main objectives of the study is to measure the rate of adoption of improved stove technology in Khartoum state. With 213 cases, frequency distribution results reflected that, only 17.4 percent adopted the technology, while 82.6 percent did not use the device, confirming the proposition of the study that, adoption rate of improved stoves in the state is still rather low.

To investigate the reasons behind this low rate of adoption. First respondents awareness about improved stoves is examined, frequency distribution results indicated that some people (13.1

percent of the sample) had never heard about the technology, this is found somewhat consistent with the literature of the study that some people may not be aware or haven't heard about the technology, (Ahmed and Ahmed, 1988). This is one factor that reduced the rate of adoption of the technology, but definitly it is not the only reason for this low rate of adoption.

Effect of residence area on rate of adoption.

The previous result of people awareness about the importance of environmental conservation revealed that Sudanese are far away from the comprehension of adoption of improved charcoal stoves for preserving the natural resources. To go further; investigating the reasons behind the low adoption rate of the technology, analysis of variance results reflected a significant impact of residential area on the adoption of the technology. It has been found that, urban respondents used the device more than the rurals by far. In one of the rural areas (Um badda-17), no one of the contacted respondents has adopted the technology.

Interviewing of respondents by the author, why didn't they use such technology, revealed that, the majority of the non-adopters have the willingness to use the innovation but it is not available to them, or they didn't know from where they can purchase it, this confirm the argument that adoption of new technology is not solely a matter of potential adopter (or demand aspect) problem, but the supply side i.e the availability of the innovation and the conditions prevail are important as equal (Brown, 1981). This also may confirm the attestation that, professional and innovation

disseminating units generally tend to settle and work in urban areas, and rural areas always are given little attention or very brief visits; the problem of urban-bias (Chambers, 1986).

A third factor behind this low adoption rate is that, some of the non-adopters showed that they haven't enough information and they were not sure of the benefits and superiority of improved stoves over the traditional ones, this run in the line of Rogers (1983), argument that adequate level of knowledge about innovation is necessary to reduce innovation risk accompanying consequences and to alleviate the dissonance of the individual towards the innovation.

4.2.3 Interpretations of regression findings

The negative significant relationship between housewife age and her education, and the head of household age and his education, obtained from the data analysis results, revealed that individual's age negatively affects his education, this may be due to the rare chance of formal education in the past, and less attention of the families to educate their members, and to let the youth continue their education for higher levels; thus older members in the family most likely did not receive any education, or attended only few years of formal education, compared to the younger members who find a better chance to be educated due to expansion in formal education, and the increasing emphasis and importance people give to education.

Family income is found to affect the availability of other alternatives for stoves (butagas and electric cooking devices) in

the family home positively, this result is expected for the intuition that, advance technologies are commonly more expensive than traditional ones, a family in a better economical status will be able to purchase such devices that are more convenient to use.

The statistical positive relationships of family income with male education and female education are concord with the expectation that well-off families are in a better position to cover education financial expenses for the family members, poorer families might fall short to continue educating their members because of money or financial handicaps. This finding might be confirmed again by the significant positive result obtained when average male education and average female education were regressed on family income.

Housewife level of education proved to have a positive significant effect on her exposure to messages about improved stove, this could be explained by the general argument that educated women have the ability to read or review the written subjects, and they can receive written message about the stove more easily, this may give them the credit to be more informed about the existence of the device, especially the dissemination of information about the improved stoves, at the earlier stages was mainly through posters and written subjects. Moreover, educated women find no difficulty when they sit infront of visual communication channels (e.g T.V.), or when listening to radio, to grasp complex message more easily and better than less educated women. They are more able to communicate with others, and have the

chance for more contact with colleagues in working places. Untimidly more educated women can attend exhibition and lectures and participate in discussion and interpretation of the subject matter.

The significant positive influence of family income on exposure of housewife to communication means may be explained in the context that, better financial status, could enable the family to procure visual (T.V.), audience (Radio), and written (newspapers magazines etc) communication means, so housewife could find these communication tools at her reach. In addition, financial ability may help the housewife to travel to see exhibitions, participate in lectures or engage in women societies that may be somewhat expensive for the poorer ones.

Consistent with expectation, the data analysis result showed that, the housewife age is negatively related to her exposure to communication means, this may be referred to the argument that older housewives are expected to be less educated (this was proved by the previous negative regression relationship between housewife age and her education), this in turn expected to lower their ability to deal with messages broadcasted through mass media channels (T.V., Radio, written tools, Lectures etc), and their abilities to communicate with their broad surrounding world.

Results of data analysis revealed that, among the selected variables expected to affect adoption of improved charcoal stoves, relative advantages have the greatest positive significant effect on innovativeness. Investigation through the survey of the study

showed that, the main factors that urge the respondents to use the improved stoves are; its advantages of charcoal saving, many users mentioned that. Improved stove reduces family charcoal consumption for cooking purposes to the half; this confirms the labrotary test carried out by ERC (Ali and Huff, 1984). Rogers (1983), argued that one of the major factors affect innovativeness, when a new idea or technology is introduced, is the innovation relative advantage. He also, added that, the relative advantage will be more tangible when it is measured in economic term. Also, some of the users of the device mentioned that, the stove has the advantage of time saving i.e food cooking would take shorter time on improved stoves compared to traditional ones. Another factor that leads the adopters to put the technology into use is its compatibility with their past experience. The improved stove is rather similar and easy to use as the traditional one and there is no complexity in dealing with the device. These are the major factors encountered by respondents as advantages that enhance the device adoption.

Regression results indicated that adoption of improved cooking stoves is positively and significantly affected by housewife education, this result proved to be consistent with the general assumption of the adoption theory that educated people tend to adopt new technology more earlier than non-educated ones (Rogers, 1983). It might be attributed to the probability that educated women generally have more exposure to communication means, (this is consistent with the previous regression positive significant relation between housewife education and her exposure to

communication means), so they can get information about the device more earlier than their non-educated peers and they may grasp the benefits of such technology before others.

The results of the analysis showed that education of head of household has a positive but not significant effect on the innovativeness, this is consistent with the theory of adoption of innovation, again confirming that educated individuals are more innovative. However, the insignificant statistical measure of the result compared to statistically significant relation of housewife education to adoption of the device, might be explained in the realm that, the housewife is the person who deals with the kitchen, so she might be in direct contact with difficulties of cooking problems, therefore she is expected to reflect more response to any advantageous solution that directly touch her felt need, while the educated man of household may be more innovative than non-educated men, but did not feel the need as equal as the housewife.

In line with literature and hypothesis of the study, housewife exposure to communication means showed a positive significant relation with putting the device of improved charcoal stove into use. This might be due to the explanation that, receiving of message about the device through more different communication channels may give the respondent more information about the device benefits, hence be in a better position to decide about the technology attainment. Rogers (1983)generalized that early adopter are of more exposure to communication channels.

The regression results also indicated that family female members' education has a positive impact on adoption of improved stoves. This may be attributed to an increase in total knowledge of the family about the technology, came from the increase in exposure to various communication means by more educated female members, or it could be justified by the interpretation that more educated female members could assess well what benefits the family will gain from adopting such technology. Again this is consistent wilt the literature of adoption theory that educated people are more innovative.

Contrary to the expectation, the result obtained from the data analysis showed that, male education was negatively and significantly influencing the adoption of the improved stoves by the family. This may be explained by the expectation that more educated male in the family will contribute to family higher economic status (more income gained by a number of educated individuals). High income families are expected to use more advance alternative cooking devices other than improved stoves (butagas and electric cooking devices).

To control the effect of family size, average years of family members, education is used. Both family male members' education and family female members' education in the model of analysis were replaced by the average education of family members of each sex. Again regression results using average family members education, confirm that average female education remained to have a positive but statistically insignificant effect on the adoption of improved

stoves. On the other hand, average male education ifluenced the adoption of the device negatively, this effect reach significance at (0.05) level of significance.

These results could be explained in the realm that, in the past, families viewed that women education is not necessary or not desirable even, hence old female family members were not, or less, educated, now young females receive formal education as well, therefore when total years of education of female family members divided by their total number, lowered the average years of education for family female members, hence the positive effect tends to be insignificant. On the other hand, since earlier, male members education, comparatively, received more care, when the average male education effect on the use of the device obtained through regression analysis, it reflects a significant negative relation, indicating that, the actual years of education of mature productive male members add more to this effect, because these mature productive members are expected to add significantly to family income, leading the family to possess advance modern alternative cooking devices, and negatively affect the adoption of improved stoves.

The negative impact of head of household age on implementation of improved stoves by the family, may be attributed to the expectation that old people tend to be more dogmatic and not expected to easily change their held set of beliefs, more tide with the previously existed practices and more conservative towards new ideas.

This negative relationship was again emphasized by the similar result obtained when innovativeness was regressed on housewife age.

The regression results reflected that family income significantly affects the adoption of improved stoves with a negative impact, this is consistent with the expectation that families with high economic status tend to use more advanced comfortable, prestigious, modern, cooking devices like butagas and electric cooking devices and they may have no need, or little interest to purchase or attain such charcoal cooking devices. This is mainly true because, families of very high income, even at times of gas shortages, they can in one way or another find access to refill their gas-cylinders or convert to use electric cooking devices.

Surprising and unexpected result is the positive impact of family ownership of other alternatives (butagas and electric cooking devices), on adoption of improved stoves, however, this relationship do not reach statistical significance. This may mainly be due to the expectation that, since this variable (family income) had showed agreat variability among respondents interviewed, some people who possess modern cooking devices are economically in a better position and expected to be more enlighted and have more access to different communication channels, but they might not be able enough to continue maintaining their gas-cylinders filled at so ever price at time of gas shortage, or afford to pay for prolonged electric cooking, and probably at a period of gas shortage they use charcoal as energy source and with

their above mentioned characteristics (education, exposure to communication means), also because they are consistently innovative (they are enclined to use innovative ideas) theytend to adopt the improved stoves.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter is divided into two sections. In the first section, summary of the major findings and conclusions of the study are presented, in the second section recommendations, based on these findings, are developed and presented.

5.1 Summary of the Major Findings and Conclusions

The study showed that the level of knowledge and awareness of the Sudanese population about the vital importance of environmental conservation is rather low, and saving the natural vegetation is given very little care or no attention by most of the citizens. This reflects the inadequate level of knowledge of the population of the importance and necessity of saving the natural cover, (Jong-Boon, 1990).

The study reflected that the rate of adoption of the improved charcoal cooking stoves in the national capital is very low. The study revealed that the larger part of the non-adopters have the desire, and they are willing to put the device into use but, they didn't know from where to obtain such technology, especially those who reside in the rural localities who showed a very positive attitude towards the device use but, the device is not available to them. This is one of the major factors that lowered the rate of the technology adoption i.e. the unavailability of the device for most potential adopters, especially in the rural districts (In one of the rural districts surveyed no one had adopted the technology)

which mean that very little attention or effort was devoted to the rural localities; the problem of the urban bias, (Chambers, 1986).

Some other non-adopters declared that they haven't enough information about the technology and they were not sure of its benefits and superiority over the traditional ones; this is another factor that caused the low rate of adoption of the technology. Little proportion of the non-adopters revealed that they haven't heard of it, which also lowered the rate of adoption of the technology in Khartoum State.

Education was found to be negatively affected by age, this may reflect the few opportunities available for formal education, and the little attention and care of the families to educate their members in the past.

Both male and female education were positively affected by family income, this may mean that well-off families are financially in a better position to cover education expenses for their members to go further steps in receiving formal education.

Housewife education was found to add positively to her exposure to communication means, this may reflect that more educated women are more able than their uneducated peers, in dealing with written communication messages, they can sit in front of the visual and audience communication tools and find no difficulties to grasp the broadcasted message so easily. Also their level of education would give them the courage to participate in seminars, lectures, and discussions of issues covering the housewife daily life.

Housewife exposure to message about improved charcoal cooking stoves, also found to be positively related to family income, this intuitively means that families in better economic or financial positions might make available at home; the audiovisual and written communication tools, so members of such families found themselves in more contact with their surrounding world, and more exposed to message about new innovations.

The negative effect of housewife age on her exposure to message about improved stoves mean that older people are in less contact with their surrounding. This may also support the previously mentioned conclusion that age affect education negatively, this is because education was found to have a positive relation with exposure to communication means, and age in return is reversely related to education, hence we may conclude that older housewives are less educated, less educated housewives are expected to be of less exposure to communication means.

The obvious significant positive relationship between innovativeness and the improved stoves relative advantages, means that people accept new ideas or technologies, when they know or feel their tangible benefits and superiority compared to the previously existing alike practices.

The positive and significant relationship between housewife education and innovativeness may mean that educated women are more likely to be aware about new technology more earlier and get information that will enable them to evaluate the messages they receive, and thus put new beneficial new ideas into practice.

Housewife exposure to communication means is positively related to her innovativeness. This may reflect that, women of more exposure to communication channels are likely to get more knowledge about new ideas and consequently they are more likely to use it earlier.

The positive impact of family female members education on innovativeness again may confirm that, the more educated females in the family, the family will be in a better position to get information about new technology and assess whether it is appropriate for its needs and conditions.

The housewife age showed a negative relationship with innovativeness, this may mean that older people are more sympathetic with their older norms and values, and they tend to be more dogmatic towards new changes.

The negative effect of family income on innovativeness may indicate the ability of the well-off families and their affordity to use more advance expensive, comfortable and prestigous cooking devices.

5.2. Recommendations of the Study

Regarding the dissemination and adoption of the improved charcoal cooking stove technology, and in the light of the previously mentioned findings and conclusions, the following recommendations are derived and presented to be considered.

- Since the study, being consistent with the previous literature, revealed the low level of people awareness about the importance of environmental conservation, concerned authorities; formal and

non-governmental organizations should stress the significance of saving the environment by informing people about the crucial importance of the matter, and the deleterious impact of devastating the natural cover,and the methods that could be followed to avoid or alleviate such devastation. This could be achieved through well designed and planned program using the appropriate communication channels and suitable time for different target groups.

- To improve the rate of adoption and to boost the dissemination of the improved stove technology, more information about the device should be conveyed to household, especially through visual communication tools and at appropriate convenient time to inform those who haven't heard about the technology and to expel away any reluctance of the others who have heard about its existence but, they were not sure of its superiority. Demonstration, seminars and lectures by well-trained extension workers would be more effective for the rural people. Here relative advantages of the technology, in particular, should be stressed and focussed on to convince people to put the device into use.
- The study revealed that most of the non-adopters have the desire to use the technology but, they didn't know from where to procure it, thus marketing centers for the technology, or coordination between the manufacturers and distributing agencies (like groceries) in different localities should be established to make the device available and at the reach of residents to buy.
- In disseminating information about the device and demonstration

of how it works and its superiority over traditional ones for the rural poor, the disseminating agents should make use of the youth organizations and committees since the youth are more sympathetic with change and acceptance of the new ideas more than the old dogmatic people.

- Since young more educated females are more innovative, to distribute the device, concerned authorities should focus on enlightened youngs in universities and higher institutions, to clarify the benefits the family and the whole nation will gain by adopting such technology.
- Though male age and education negatively affect the adoption of improved stoves, however, males could be incentived to adopt such technology, by stressing the aspect of the relative advantage of the technology since this variable reflects the benefit that the husband or the male will gain (reducing the total expenditure on charcoal used by the family for cooking purposes) by using the improved stove technology.
- Regarding the reverse effect of family income on the use of the technology, messages about the device should be well designed and targeted through the appropriate communication channels for those who in need to use the device i.e. selective audience procedure should be followed.

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بسم الله الرحمن الرحيم

خلاصة الأطروحة

لقد أضحت المحافظة على البيئة موضوعا تزداد أهميته يوما بعد يوم فى كل أرجاء العالم. وتثير العوامل المؤدية إلى تدهور البيئة مخاوف الكثير من دول العالم، لذا يسعى الكثير منها لمنع أو الحد من إزالة الغطاء النباتى فى المحاولة لحفظ التوازن البيئى.

لقد خطا السودان خطوات عملية منتهجا النهج العلمى فى إجراء البحوث على بعض أنواع التكنولوجيا وإستخدام الإمكانات المحلية فى ذلك من أجل تقليل إستهلاك الطاقة من الكتلة الحية.

لقد بذلت بعض المؤسسات الحكومية والطوعية جهودا كبيرة فى إختبار كفاءة هذه التكنولوجيا والعمل على نشر المواقد المحسنة التى أثبتت التجارب فعاليتها فى تقليل إستهلاك الفحم بواسطة القطاع الأسرى الذى يعتبر أكبر القطاعات إستهلاكا للطاقة من الكتلة الحية.

هدفت هذه الدراسة فى الأساس لتقصى مدى تبنى القطاع الأسرى بالعاصمة القومية للمواقد المحسنة والعوامل المؤثرة على إنتشار وتبنى هذه الوسائل.

تم جمع المعلومات الأولية عبر المقابلات الشخصية مع المستجيبين فى ولاية الخرطوم الذين تم إختيارهم عشوائيا عن طريق الإختيار العشوائي الطبقى.

كشفت الدراسة عن محدودية معلومات السكان عن أهمية الحفاظ على البيئة كما أوضح تحليل المعلومات ضعف نسبة تبنى الأسر للمواقد المحسنة.

أوضحت نتائج التحليل، أن الأفراد يتبنون المستحدثات عند إلتماسهم بوضوح محاسنها النسبية على سابقاتها، كما إتضح تأثير التعليم فى تبنى هذه المستحدثات.

تلقى ربة الأسرة للمعلومات عبر القنوات المختلفة يجعلها أكثر تبكيرا فى تبنى المستحدثات من غيرها. ويتأثر هذا المتغير (أى تعرضها للرسائل عن المستحدثات) تأثرا معنويا بمدى تعليمها ودخل الأسرة.

تميل الأسر ذات الدخول العالية إلى إستخدام وسائل أكثر تطورا من المواقد المحسنة.

أوصت الدراسة بأهمية إختيار وسائل الإتصال المناسبة لإرشاد وتعليم المجتمع عن أهمية الحفاظ على الغطاء النباتى وحفظ التوازن البيئى. كما أدرجت الدراسة فى توصياتها ضرورة التركيز على المحاسن النسبية لتكنولوجيا المواقد المحسنة، وتوفيرها فى مواقع تجعلها متحصلة للراغبين.

** بسم الله الرحمن الرحيـــــم **

APPENDIX 1 : استبيان : حالة دراسة استخدام المواقد المحسنة في ولاية الخرطـــــوم

١- الاسم ..... العمر ..... الجنس .....

المحافظة ..... الحي ..... التعليم .....

المهنة ..... الدخل .....

- منذ متى تسكن العاصمة القوميـــة

٢- أفراد الأسرة

	الاسم	الجنس	العلاقة	المرحلة التعليمية	المهنة	الدخل
١						
٢						
٣						
٤						
٤						
٥						
٦						
٧						
٨						

٣- هل تمتلك ؟ (لا ، نعم)

راديو	تلفزيون	فديو	بوتاغاز	موقد كهربائي

٤- هل سمعت عن الموقد المحسن (كانون السرور - عزه - الدقه)

نعم		لا	

٥- اذا كانت الاجابة نعم فمن أي مصدر سمعته ؟

التلفزيون	الصحف	الراديو	المجلات	الملصقات	في معرض	من الناس

٦- متى سمعت عن الموقد المحسن لاول مرة ؟

.....

.....

٧- هل تمتلك موقد محسن ؟

نعم [ ] لا [ ]

٨- ما نوعه ؟

السرور	عزه	أى نوع آخر حدد ؟

٩- متى استعملته لأول مرة

.....

١٠- الأسباب التى دفعتك لاستخدام الموقد المحسن ؟

(سهل الاستعمال [ ] ، يوفر الفحم [ ] ، يوفر الزمن [ ]

له أثر ايجابي على البيئة)

.....

.....

.....

١١- هل تستخدم الموقد في الطبخ باستمرار أم عندما تنعدم الوسائل الأخرى فقط ؟

.....

.....

.....

- ما هى الوسيلة التى كنت تستخدمها فى الطبخ قبل الموقد المحسن وقبل أزمة الغاز ؟ .....

- من قرر شراء الموقد المحسن ؟ .....

١٢- اذا أستخدمت الموقد المحسن فما هي عيوبه ومشاكله ؟

.....

.....

.....

.....

١٣- اذا سمعت عن الموقد المحسن ولم تستعمله فما هي الاسباب ؟

.....

.....

.....

.....

١٤- اذا استخدمت الموقد المحسن فهل لا زلت تستخدمه أم لا ؟

.....

١٥- اذا توقفت عن استخدامه فما هي الأسباب ؟ (بطيء ،لا فرق بينه والموقد التقليدي ،غالي الثمن ،يتعطل بسرعة)

.....

.....

.....

.....

١٦- كم تصرف في شراء الفحم شهريا .

.....

١٧- كمية الفحم المستهلكه في الشهر في حالة استخدامك كل الشهر .

١- موقد محسن الكمية .....

٢- موقد تقليدي .....

١٨- ما هي أنسب الوسائل في رأيك لنشر استعمال الموقد المحسن ؟ (الصحف ،الراديو ،التلفزيون ،المعارض ،النداوات)

.....

.....

١٩- هل تشارك في أى من المنظمات أو اللجان أو الجمعيات ؟ أذكرهـا

.....

.....

٢٠- الوظيفة في اللجنة أو المنظمة

أ/ رئيس اللجنه ب/ عضو لجنة تنفيذية ٣/ عضو بجمعية عمومية

٢١- ما هي أهمية الأشجار فى رأيـك ؟

.....

.....

.....

٢٢- ما هي المشاكل البيئية التي تسببها ازالة أو قطع الأشجـار ؟

.....

.....

.....

.....

٢٣- ما هي فوائد الغابات في رأيك ؟

.....

.....

.....

.....

٢٤- (نوع المـنزل)

(فخم ☐ وسط ☐ عادى ☐)

٢٥- لأى مدى تشارك الزوجة في اتخاذ القرارات بالمـنزل

(لا تشارك - تشارك أحيانا - تشارك كثيرا - هى صاحبة القرار)