Potential Combaction of Deforestation Through Adoption of Some Energy Substitutes, Case of White Nile State

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DEDICATION

To my parents

To my brothers and my sister

To my husband

To my dear friends and colleagues
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I would like to express my deep gratitude to my supervisor Dr. El-Amin Sanjak Mohamed for his helpful guidance and consistent supervision during the study period. My great thanks to the staff of the Desertification and Desert Cultivation Studies Institute, University of Khartoum. I would like to express unlimited gratitude to Ustaza Mahasin M. Salih for her great support and encouragement for me all through my research. Many thanks are expressed to Mr. Anwar A. Hameed, director of FNC, in White Nile State, for his kind help during data collection. I am also very grateful to miss Huda Ali, Shadia, Majda Ahmed, drivers El-Fatih and Bashir. I will never forget the great financial support and encouragement of my father, mother, husband and my brother Mohamed and their patience in guiding and helping me through the study period.

ABSTRACT

potential Combaction of Deforestation Through Adoption of Some Energy Substitutes in White Nile State

Generally energy use is associated with an adverse effect on environment. In rural areas, fuel wood is very widely used, but serious shortages will be expected to occur in the century. In many poor countries, firewood gather are stripping huge areas of their tree and bush cover and this accelerates the process of desertification. Energy being one of the most fundamental factors for development, it enhances
sustainable livelihood and provides the power to make use of the natural resources to make life easier. This research attempts to investigate the efficiency and feasibility of using Liquid Petroleum Gas (LPG) and the improved cooking stoves in White Nile State and their contribution in reducing reliance on forest resources. Two types of data were used in this research, namely primary and secondary data. The secondary data includes files and documents. While primary data was collected through personal interviews with individuals using structured questionnaire, group discussion and observations.

The main findings of the research are; despite the meager resources of the vegetation cover in the study area, still the local people due to acute poverty rely on the natural resources for the provision of fuelwood. The main sources of fuel in the study area are; fuelwood, agricultural residues, animal dung, kerosene, LPG. The level of LPG adoption is relatively high when the majority of the respondents possessed the appliances and the cylinders. Plan-Sudan Organization and the other private companies under the complete absence of the FNC LPG program, are the main sources of LPG in the study area. The majority of the respondents showed their ignorance of LPG program a clear indication of the limited dispersion of the intervention. However, the adopters of the program of LPG showed their interest to continue their reliance on the intervention for several factors like saving of time and money besides guarantee a healthy conditions indoors. Moreover, the adoption of improved cooking stoves is relatively low where the local people rely on the traditional and three stones stoves for cooking. The main reasons behind the low adoption of improve cooking stoves are; lack of sale centers, lack of training and extension services.

The main conclusions drawn from the research are; fuel wood is one of the main items on which households expend their income. Fuel wood is collected directly from the reserved and natural forests due to the lack of governmental control over the vegetation cover and lack of enforcement of forest laws; The level of adoption of LPG in the study area is relatively high. Moreover, the study raised the following recommendation; The government should help to provide LPG and encourage use of improved cooking stoves, the FNC with NGOs should encourage local people to adopt LPG and improved cooking stove by given them loans and long period of installment to reduce the pressure on vegetation cover and reduce the rate of desertification.
اشجارها و شجيراتها مما يزيد معدلات التصحر. تعتبر الطاقة أحد أهم العوائد الأساسية للتنمية لأنها تعزز استدامية المعيشة كما يمكن من استخدام الموارد الطبيعية لجعل الحياة أسهل.

تهدف هذه الدراسة لمعرفة فعالية و ملاءمة استخدام الغاز والمواقد المحسنة في ولاية الينابي البيض ومساعدها في تقليل الاعتماد على مواقد الغابات.

استخدم نموذج من جمع المعلومات في هذه الدراسة، معلومات أولية و معلومات ثانية. المعلومات ثانية جمعت من ملفات و وثائق المشروعات. بينما المعلومات الأولية جمعت من خلال المقابلات الشخصية من خلال الاستبيان وناقشة المجموعات و الملاحظات.

خلصت الدراسة إلى أنه بالرغم من ضغف الغاز النباتي في منطقة الدراسة إلا أنه مازال السكان المحليون يعتمدون على الموارد الطبيعية للحصول على حطب الوقود نسبةً لحالة الفقر التي يعيشونها. المصادر الرئيسية للوقود في منطقة الدراسة تتضمن، حطب الوقود، الكهرباء، الغاز. مستوى تبني الغاز مرفوع نسبياً في المناطق التي يمتلك فيها السكان البونجزاو الاستفادة منظمة "بان سودان" و شركات القطاع الخاص هي المصدر الرسمي للغاز مع الغياب التام لبرنامج غاز الهيئة القومية للغازات. الغالبية العظمى من المستجيبين أظهروا عدم معرفتهم لبرنامج الغاز وهذا يمر بحدودية انتشار المدخلات. من ناحية ثانية اظهر المتبقيين استعدادهم للاستمرار في الاعتماد على المدخلات نتيجة لعدة عوامل مثل توفير الوقت و المال بالإضافة إلى النواحي الصحية. الاعتماد على المواقد المحسنة منخفض نسبياً فمازال السكان المحليون يعتمدون على الوقود التقليدي و الموقود ذو الثلاثة حجارة للطيخ. الإسباب الرئيسية التي تحد من استخدام المواقد المحسنة هي عدم وجود اماكن للبيع وقلة التدريب و خدمات الارشاد.

من هذه الدراسة يضح أن حطب الوقود هو الشيء الأساسي الذي يتفق عليه السكان داخلهم. حطب الوقود يجمع مباشرة من الغازات الطبيعية في ظل غياب تطبيق القوانين و التشريعات الخاصة بالغازات. توحي الدراسة بتعلم الحكومة و الهيئة القومية للغازات بالإضافة للمؤسسات المعنية لتشجيع السكان المحليين باستخدام الغاز السائل والمواقد المحسنة لتقليل الضغط على الغازات النباتي و تقليل معدلات التصحر.

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CHAPTER I
INTRODUCTION

1.1. Background
Energy is a very critical factor in stimulating the development of any country. The quantity and quality of energy use determines the quality of life, while energy services contribute substantially to the national economies.

Energy use is inadvertently associated with adverse effects on environment. The global 2000 report on energy sector gives an overview of the various energy forms and their future. Fuel wood is very widely used, but serious shortages will be expected to occur at the turn of the century. For poor people, at less developed countries, the energy crisis means something quite different from one region to another. Roughly one-third of the world’s people have far more pressing worry whether they can gather enough firewood to cook their meals. In most less developed countries, forest sector represents the main source of fuel for 90% or more of population. Firewood shortages are probably most severe in the Indian subcontinent, and the semi-arid regions of central Africa where wood has become scarce and expensive.

In many poor countries, firewood gathers are stripping huge areas of their tree and brush cover. In Upper Volta all the trees within a 40 kilometer (64-mile) radius of the city of the Ouagadougou have been cleared and burned by the city’s inhabitants. Such stripping has disastrous ecological effects. Soil eroded rapidly from the denuded land and silts up rivers and reservoirs. Soil erosion also reduces the productivity of agriculture land; thereby putting an additional burden. Firewood becomes scarce, people often turn to dried animal dung for fuel. This practice further reduces agriculture production, since less animal manure is then available for use as fertilizer. Moreover; firewood stripping accelerates the
process of desertification. According to the report of the Ministry of Energy in the year 2003, the total of energy in Sudan amounted to about 13 million ton of oil equivalent (TOE), out of this energy supply 75% only reached the end users. Losses about 3.2 million ton of oil equivalent occurred during conversion, transport and distribution. A considerable amount of losses occurred in biomass energy. The total of energy consumption in the year 2003, was 9.7 million TOE; biomass share was 70%, petroleum share 28% and electricity share was only 2%.

The main end use sectors of energy are categorized as household, transport, service, agriculture, and industry. The respective share of these sectors out of the total energy consumption in 2003, are 55%, 23%, 12%, 10% and less than 1.5%, respectively (Ministry of Energy, 2005). The household sector is by large the biggest energy consuming sector accounting for more than 55% of the total energy consumed in year 2003, compared to about 77% of total energy consumption in 1990. This share is expected to decrease with the country’s economic development and the discovery of oil. About 95% of energy consumed in household sector comes from biomass resources (mainly firewood, charcoal and crop residues). The other energy resources are petroleum products (mainly liquefied petroleum gas (LPG) and kerosene) and electricity. The respective shares of these resources are 3% and 2%, respectively. These latest energy resources is expected to increase their contribution much at the expense of the former one due to substitution of biomass fuels by LPG after the completion of Khartoum refinery and increasing electrification rate which is expected take place as a result of implementing government strategic plans in energy sector (Ministry of Electricity and National Energy Affairs, 2004).

1.2. Scope of research
Energy being one of the most fundamental factors for development, it enhance sustainable livelihood and provides the power to make use of the natural
resources to make the life easier. Therefore, it is needed to be sustainable. Using bio mass energy for cooking and other processes is well known for most people world-wide. The other sources of energy are very expensive, so using bio mass energy will be more essential at a large scale for a lot of people, not only in developing countries, but also in most developed countries. Charcoal plays an important role in energy sector, despite the ways it is produced and used. The families prefer using it, which makes more difficulties for the resources of wood. The hungry thresh on forest products as a source of energy may lead to negative environmental impact.

This research attempts to investigate the efficiency and feasibility of using LPG and the improved cooking stoves in White Nile State and their contribution in reducing reliance on forest sector for the provision of wood for fuel.

1.3. Problem statement
More than 60% of the country need of energy come from forest production; the average use by year equals 15 million cubic meters in North Sudan. A study on energy sector in the Sudan revealed that 93% of forest wood is used for cooking and 5% for building and 2% for sawn timber (Baddon, 1992). In Sudan, household sector is the biggest consumer for energy that is produced from forests (charcoal and firewood). In urban areas people use 88% of charcoal and 65% firewood, whereas in rural areas, the percentage mount to 85% for firewood and 32% for charcoal. This clearly shows the degree of reliance of people in urban areas on charcoal for fuel. This indicates the deterioration of forests resources, on one land, and social economic change which accompanies this reliance, on the other hand trading in charcoal become has a major source of income to a wide sector of local communities (Suliman et. al., 1996).

Despite the great efforts exerted by several Non-governmental Organizations in the field of forests sector since mid eighties, still the degree of reliance on forest
products for provision of fuel is relatively high. These organizations attempted to raise the ecological awareness and adoption of energy substitutes (LPG and improved cooking stoves) interventions for the sake of mitigating reliance on forest products as a source of energy. The level of adoption of energy substitutes lag far behind the expectations of these organizations. Several factors were behind the low level of adoption of the energy substitute's interventions like the lack of accessibility to these interventions and their high prices. This study attempted to tackle the issue of energy substitutes in terms of their dispersion, adoption and sustainability.

1.4. Objective of the research
The broad objective of the research is to investigate the pattern and trend of dispersion of energy substitute's interventions for the sake of mitigating deforestation and restoring the ecological balance in the study area, more specifically;

- To determine factors responsible for the lack or poor adoption of LPG and improved cooking stoves in the study area.
- To investigate people's perceptions of energy substitutes in terms of efficiency and economical feasibility.
- To highlight the institutional plans for enhancing adoption of energy substitutes.
- To investigate measures of risks confronting the adoption of energy substitutes.

1.5. Research Questions
To tackle the issue of energy substitute broad questions were formulated in attempt to fined answer to these Questions. These Questions are;

- What are the methods deployed by the FNC to enhance the adoption of LPG and improved cooking stoves and their sustainability?
- How the local people perceive the interventions of energy substitutes in terms of efficiency and feasibility?
- Are the energy substitutes accessible to the local people?
- What are the measures of risks and constraints confronting the adoption and sustainability of energy substitutes in the study area?
CHAPTER II
LITERATURE REVIEW

2.1. Background

Almost three billion people worldwide cook their meals on simple stove that use biomass fuels such as wood, charcoal, dung and crop residues. This accounts for approximately half of the total energy consumption in the developing countries. In industrial countries the switch to more efficient stoves took place when fuel wood prices increased and stove makers increased effort to build more efficient models. This followed transition to cleaner fuels for cooking such as cook coal and petroleum based fuel (Karabi, 2003).

In the past few decades, urban household in developing countries have made the switch to cleaner fuel like kerosene for cooking. Most rural household in these countries, are not endowed with the infrastructure that would bring them cleaner fuels and they don't have adequate income to pay for the fuels, if they were available, specially compared to biomass resources an which freely available. The management of natural resources such as forests remain a critical issue in development debate (Heddon, 2007). This is more pronounced in developing regions such as Africa, where natural resources under increasing strain due to population pressure and inadequate access to improved technologies that can improve natural resource use efficiency. Although land clearing for agriculture activities and lumbering contributer significantly to deforestation, the demand for energy for domestic activities such as cooking and home-based micro-enterprises are also an important contribute to deforestation. In Africa as in most of the parts of the least developed world, fuel wood is burnt in three stone fires or inefficient stoves. This practice not only contributes to deforestation but has adverse impacts on the health of the solid biomass users, especially women and young
children who spend most of their time in kitchen environments polluted by wood smoke (Margarate, 2004).

2.2. World energy overview
In the developed countries energy shortage means a shut down of air conditioning units, a decrease in indoor temperature from 24°C to 22°C, less use of private cars and more use of public transport. In developing countries energy shortage means fewer meals to be cooked, longer distance to be walked, more time spent to collect fuel wood, fewer hospitals to be built no means of transportation in the village even at emergency cases. This would have a direct impact on morbidity and mortality rates particularly in the rural areas of developing countries (Self Reliance, 1987). Consumption of world commercial energy resources is heavily concentrated in the developed countries; these countries contribute with about 30% of consumption of commercial energy. The other 70% of the population, comprising developing countries, consume less than 20% as a result average per capita of commercial energy consumption in developed countries is about 12 times of developing countries. A country per capita energy use depends on its level of economic development, its geographical and climatic conditions, its social customs, the structure and the relative price of energy compared to other factors of production and consumption. Often poorer groups are compelled to consume more energy per capita than richer because they are using less efficient energy production methods and appliances (Morgan et. al., 1980). The United States per capita energy use was 7265 kilogram of oil equivalent (KgOE) in 1987, which was 15 times greater than that of India and China receptively (Flagan et. al., 1988).

2.3. Biomass fuel
Biomass can be derived from both woody (trees and shrubs) and non-woody biomass (crop residues and other vegetation). Trees, crop residues and other
vegetation can be converted into charcoal (Heddon, 2007). Biomass was always
the main energy source in the developing world. It is used in cooking, lighting,
heating and generally linked with household energy issues in these countries. In
most of the developing country 80% of households rely on biomass for energy.
The available of sufficient fuel (biomass fuel- wood, charcoal etc.) is
indispensable for the quality of live of rural and urban population by enabling
them to meet their energy needs in a socially and environmentally sustainable
manner (Action Program on Forest, Final Report 2002). Increasingly, biomass is
being considered a major source of energy development. Until now, energy
planners in developing countries have thought of bio fuels as suitable alternative
for traditional uses, such as domestic cooking and small-scale rural industries.

2.4 Fuel wood consumption
It is estimated that more than ¾ of the world’s population depend on wood and
other biomass fuels. Asian countries face an increasing need for energy to
support their economy and social development. Currently 30-80% of their overall
energy needs are met by wood fuel (Heddon, 2007). Biomass for cooking and
heat dominate household energy use in majority of the least developed countries.
Fuel wood is also used in many types of rural industries, (sugar palm, cassava
processing, brick and lime burning etc…). Cooking predominate the use fuel and
charcoal, in India that estimated the total energy consumption of rural
households; is 5,479 thousand TOE per year. In Philippine the estimates of the
percentage household energy used for cooking range from 50-80%, while 93%
household charcoal using for ironing clothes and both fuel wood and charcoal use
for boiling water. According to statistics of 1980 the output of fuel wood and
charcoal in some countries in Africa reached 375.8 m³. This represents about
87% of the total forest output and more than 60% of the total energy
consumption. In some countries such as Ethiopia and Mali wood represents 90%
of energy consumption in rural area. The fuel wood represents almost all the
energy resources consumed except in certain limited region where there may be recuperation of agriculture residues (center Upper Volta, northern Nigeria, Rwanda). In towns fuel wood uses is usually made of charcoal, because it is more convenient. It is appreciated by home-makers and its consumption increases with appearance of ways of life different from that in rural communities, fuel wood still retains a certain place. However commercial fuels, particularly oil products, are more widely used in the larger towns and where the purchasing power is higher 20-50%. In towns, in addition to handicraft and semi-industrial requirements, fuel wood and charcoal also used by public and private groups. In case of land locked countries without other resources (e.g. Mali, Burundi, Rwanda, Chad), wood is required for certain industrial activities; cigarette and match-making, large-scale bakeries, breweries, tea factories (Heddon, 2007).

In Sudan, Forest Products Consumption Study (FPCS) managed to assess Sudan's consumption of forest products in quantitative terms. In these respects, the study was indexed to a recent population census, covered all categories of consumption by rural and urban population, focused on specific aspects of consumption. The major findings of the study showed that Sudan consumed a total of 15.77 million m³ round wood in 1994 for Woodfuel, construction, maintenance and furniture wood. Of the various economic sectors, the household sector has the highest share of total consumption. The remainder is distributed among the industrial, commercial and services sectors and Quranic schools. The analysis of aggregate consumption by product shows that wood fuel (firewood and charcoal) forms the bulk of the consumption. The Woodfuel share of the total is estimated to be 87.5%. Annual wood per capita consumption was estimated as 09.73 m³ of round wood using 1994 total consumption figures and estimated population (Ministry of Energy and Mining, 2004). The annual household wood per capita consumption constitutes the highest component of the overall national wood per capita and is estimated to average 0.653 m³ for urban households and 0.37 m³ for rural
households. Furthermore, per capita estimates also tend to vary with income, ecological zone and education. Survey analysis revealed tendencies of decreased wood consumption with income rise, increased aridity and rise in educational level. However, despite these overall aggregate levels, distincte variation between products were observed. Whereas consumption of firewood and construction wood tends to decrease with income, charcoal and furniture wood consumption show the reverse. Charcoal on average constitutes the highest component of annual household wood consumption, reaching 43% of the total wood consumption. Per capita consumption ranged between 0.493 m³ for urban households and 0.162 m³ in rural households. Firewood on average formed 41.8% of the total annual household per capita consumption. The estimated per capita varied between 0.116 m³ for urban households and 0.354 in rural households with national average of 0.273 m³.

2.5. Wood as a source of biomass energy
The forest source is one of many sources of fuel wood production. In recent years non-industrial plantations of different types have gained recognition as important sources of fuel wood supply (Khatun and Fahmida, 1998). In the countries of South-East Asia, forest sources contribute between 10 and 50% of total national fuel wood supplies. The share of non-forest wood fuels in total household-level consumption in Indonesia is reported to be as high as 93%, and the share in total fuel wood supply in the Philippines and Thailand as 85% and 50%, respectively. Alternatively, wood fuels are obtained as lops and tops from forest harvesting operations; as dead wood, fallen branches, twigs and dead stumps at site; as by-products of wood-based industries; as surplus non-commercial wood derived from land clearing; or as recovered wood from replacement or demolition of old structures and constructions. The latter are used mostly by the urban poor (Goodlet, 1989). Agro residues are the other main sources of biomass fuels. They are important for both the domestic and the
industrial sectors. In Thailand, the energy balance shows that bagasse and rice husks accounted respectively for 7.9% and 1.6% of total energy used in the country in 1995 and in Indonesia accounted for 7–8% in 1992. These amounts are basically consumed in the industrial sector (Soesastro et al., 1983). Data for the domestic sector are often not available, but evidence indicates that biomass in the form of residues plays an important role where wood as a source of energy is in short supply (Ellenbroek, 1988).

The main unmet demand for fuel wood is from rural consumers in areas with few trees on public land or forests who do not have budget to purchase it. They will benefit if public lands are afforested. More trees planted on private land will be of only marginal benefit to them (Smiet, 1990). Fuel wood gaps can thus be best met by planting trees on public lands which produce a lot of twigs and branches which can be gathered. (Piadozo, 1987). There are several policy initiatives that have to be taken in the forestry sector. Firstly, a distinction should differentiate between fuel wood from logs and fuel wood from twigs and branches. Secondly, twigs and branches as fuels are best made available to the poor through shrubs and bushes. It is also acknowledged that the objective of Community Forestry and Joint Forest Management (JFM) should be on producing twigs and branches and other locally desired species through micro-planning. Last initiative is greening of degraded forests (Municipal and Provincial Development Office, 1989).

In countries with low forest cover, effective management of forest resources is vital to promote ecological stability and provide food security (National Statistics Coordination Board. 1989). The adoption of scientific practices and modern technologies in forestry, coupled with the active involvement of the people and voluntary organizations, should focus on arresting the rate of forest degradation and will substantially augment greening efforts (Munslow, 1988).
2.6. **Firewood collections and the environmental**

Firewood collection and unregulated timber harvesting are the principle and immediate reasons for deforestation. Today 100 million people in developing countries, can not meet their minimum need of energy, and close to 1.3 billion consume fuel wood resources faster than they are being replenished. In the part of West Africa, some urban families spend 25% of their income on wood or charcoal for cooking. In India firewood is subsidized for the poorest people to prevent starvation. Deforestation can lead to several secondary hazards; landslides, drought, famine, desertification, flooding and possible global warming (Nour, 2006). Also the unsustainable use of biomass energy is increasingly being associated with land degradation, loss of soil fertility, deforestation, loss of biodiversity and desertification process. Desertification was defined by (1992) conference on environment in Rio de Janeiro, Brazil, as: “land degradation in arid, semi-arid, and dry-sub humid area resulting from various factors including, climatic variation and human activities” (Earth Summit, 1992). By definition desertification is caused primarily by human activities and climate variation. The determinative desertification process include, wind erosion, water erosion, vegetation degradation and salinization and sodication (Mustafa, 2007).

2.7. **Energy and poverty**

Poverty has commonly been assessed in terms of income or consumption with reference to a determined poverty line. However, income-based definitions are now widely agreed to be too narrow and there have been various attempts, for instance through the Human Development Index, to consider a wider set of variables and in some cases to draw in qualitative indicators such as dignity and autonomy (Baulch, 1996). Some of the wider dimensions of poverty are particularly important in forest contexts.
It is imperative to consider a broader array of assets and rights in order to understand who among those who draw on forests are poor, as well as how forest resources contribute to livelihoods. In this context assets are taken to be more than just resources to use, they give people the capability to act (Bebbington, 1999). These capabilities perspective is captured in the latest conceptualizations of livelihoods, wherein a livelihood is defined as comprising of the capabilities, assets and activities required for a means of living (DFID, 1999). Assets are vehicles for making a living, making living meaningful, and they provide the capabilities to challenge and change the world.

A livelihoods approach acknowledges that most households depend on a complex web of support and is of particular importance in a forest context as dependence of the poor on forests is rarely, if ever, total. It is essential to be aware of the other components of poor peoples livelihoods in order to understand what policies and programmes may reduce poverty and reduce forest degradation. The relationship between poverty, deforestation and forest degradation is complicated. The belief in a negative downward spiral of poverty and environmental degradation is now widely challenged (Forsyth, et. al., 1998), has been taken as gospel in the forest sector as in many others. Yet there is now sufficient evidence to demonstrate that this reductionism generalization does not hold true (Brown and Pearce 1994). Although cumulative human action affects national and international rates of deforestation, these actions take place in a diverse range of settings and macro-level studies have failed to show a common pattern in the relationship between poverty and forests. In order to understand the complex links between poverty and forests it is necessary to distinguish between direct and indirect causes of deforestation, as well as the prevailing conditions that make it more likely for deforestation to occur. The direct causes are easily recognisable in the field, behind them there may be a whole sequence of indirect causes each more remote from the forest itself (Heddon, 2007).
Poverty is manifested in many different ways and has a number of different dimensions. Citing poverty as a blanket underlying cause of deforestation is inaccurate, particularly since reduction in forest cover and quality is not the prerogative of developing countries alone. Micro-level studies have illustrated that poverty may result in a shortage of options forcing people to clear forest cover in order to gain access to land for cultivation or to use natural resources in an unsustainable manner, but they also demonstrate that poor people can and do invest considerable time and resources in forest management. The linkages between poverty and forests are complex and require locally-specific analysis to be adequately understood - there is no simple causal link. To understand what role forestry might play in a particular situation and what form it might take, it is important to examine how forests and forest outputs contribute to livelihoods, how supply and use patterns are changing, and the reasons for these changes.

2.8. Gender, energy and climate change

The lack of information and knowledge regarding issues in energy and climate change, as well as the need for more information in most of the fields of action is a fact that needs attention. Climate change is likely to affect food production and floods will threaten houses. Both endanger human security and the poor are the most vulnerable groups since they have less access to resources to respond to the threats posed by unstable and shifting weather patterns. Women feature strongly in the groups which are most at risk since they form the majority amongst low-income earners and they play a key role in food security for the family. It is estimated that 59% of the world’s food production (80% in some part of Africa) is by women (Denton, 2000). At present, we are in a period of uncertainty since no one knows with any degree of certainty what the effects of climate change are likely to be on food production. However, if the negative scenarios of increased crop failures become real, then the fear is that women’s low incomes and role as food provider could become negatively re-enforcing and increase their
vulnerability and stress. Women will not be able to afford to buy nutritious food to replace failed crops. In addition, their own calorie intake will be reduced even further (in many cultures women eat last and eat least) reducing their own energy levels on which so much of household survival tasks depend on. In addition, the sorts of crops that will grow under new weather patterns may require longer cooking; hence, food preparation could be more energy expensive. Agricultural residues output could also fall, affected both animal feed and household energy supplies (including reduce dung production through lower food intake levels for animals. Any reduction in biomass availability threatens a household’s capacity to boil which in turn increase the transmission of water born diseases (Denton, 2000).

2.9. Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) is the generic name for commercial propane and commercial butane gases. It is called Liquefied Petroleum Gas because these gases liquefy under moderate pressure, readily vaporizing upon release of pressure. It is the property that permits transportation of and storage of LPG in concentrated liquid form (iei-asia.org, 2007). LPG comes from two sources; it can be obtained from the refining of crude oil. When produced through this way it is generally in pressurized form. LPG is also extracted from natural gas or crude oil streams coming under ground reservoirs. Sixty percent of LPG in the world today is produced this way whereas 40% of LPG is extracted from refining of crude oil. It is colorless and odorless. It slightly heavier than air and hence if there is a leak it flows to lower lying areas. In liquid form, its density is half that of water and hence it floats initially before it is vaporized. It is non- toxic but can causes asphyxiation in very high concentrations in air. LPG expands upon release and one liter of liquid will approximately make 250 liters of vapor. LPG is used as fuel for domestic (cooking), industrial, horticulture, agriculture, heating and drying process. The clean burning properties and portability of LPG make it
an excellent substitute for traditional biomass fuel such as wood, coal, and other
organic matter like cow dung cakes, and charcoal (Heddon, 2007). The LPG has
become very popular fuel source because it is a mixture of relatively few
components, so it easy to achieve the correct fuel to air mix ratio that allows the
complete combustion of the product. This gives LPG it’s clean burning
characteristics. Both Propane and Butane are easily liquefy and stored in pressure
containers. It is a good replacement for aerosol propellants and refrigerants; LPG
provides alternatives to chlorofluorocarbons (CFC) which are responsible for the
depletion of ozone layer (Hedon, 2007).

2.10 Improved Stoves
The most promising approach to reducing demand for fuelwood is to increase the
efficiency with which it is used. Most studies suggest that only 5-10 percent of
the calorific value of wood goes into heating the pot. Improved stoves promise a
number benifits. In labrotary conditions they have efficiencies of 25-38 percent.
This means they can cook the same meal with a half or a third of the firewood
used by the traditional three-stone fire, with corresponding reduction in smoke
(Harrison, 1987). Improved cooking stoves programs can help to bridge the gap
of fuel scarcity. They do not require a lot of money, but they need a long-term
commitment of donor and implementing organizations. Governments, NGOs and
donors can provide stove makers with technical and managerial assistance in
stove making. They can also contribute by promoting stoves in publicity
campaigns. The ultimate goal of improved stoves program should be to reach
self-sustainability of the production and distribution of improved cooking stoves
(FAO, 1993). Improved cooking stove programs can fail or succeed depending on
several factors. It has a higher chance of success in areas where people already
buy both the stove and the fuel, so they have an incentive to save on fuel use and
they are willing to pay for a better stove. Also when timesaving is considered
valuable or smoke is a problem for users, they tend to adopt an improved stove
easier. In stove design and production several factors play a role. Stoves should be designed according to user preferences; they should be designed with assistance from local artisans, and should perform the same functions as the ones used traditionally. In the design several factors (social, technical, economic and environmental) have to be considered. Also the fuels that are used play an important role, because different stoves are needed for wood, charcoal and loose residues. Stoves should be produced by local manufacturers, preferably with minimal or no subsidy. Also the subsidy for the stove purchase should be minimal, because generally people don't value things that are given for free (FAO, 1993).

Cooking stoves design for biomass fuels come in confusing variety of designs made of variety material. There are several of types stove designs, according to the type fuel used, purpose of the stove, and size of the family. The designs range from open combustion to partly open combustion to enclosed chamber and enclosed chamber with flue (WHO, 1992). During the last 35 years, large efforts have been put into improving traditional cooking stoves and disseminating them in Africa and Asia. Many programs have been successful such as in India, China and Kenya. Almost all the countries in Eastern and Southern Africa have improved stove projects either national or grassroots level (Karekezi et. al. 1991). The technologists were seeking a universally acceptable stove of high efficiency; while energy specialists were searching a solution to the “world fuel crisis” which was through single most important contribute to deforestation and desertification (Karekezi, 1991). The establishment of valid and cost effective dissemination system that could reach many rural and urban households was difficult and complex task, it require long-term commitment, substantial personal and financial sources (Karekezi, 1991). The advantages of using improved cooking stoves include:

- Reduced concentrations of smoke and indoor air pollution;
- Money and time saved in acquiring fuel;
- Less pressure on forest and energy resources;
- Reduced greenhouse gases; and
- Skill development and job creation in the community (Barnes et. al., 1993).

2.11. Fuel wood view in Sudan
The supplies wood and charcoal which at present constitute about 80% of final energy. The last estimation depend on result of studies with joint effort between National Energy Affairs and Forests National Corporation (FNC) in 1980 by using land sat photo-imagery, from which estimate of total area and volume of Sudan’s forest resource were about 1.08 million hectares and 1.96 million cubic meter respectively. About 70% of this in the Southern region, and the forestry in area decrease toward the Northern part of Sudan (ME, 2004). According to Ibrahim (1980) the average family in north Darfur, where the process of desertification is severest consume almost 200 trees or large shrubs every year for fire wood, fencing and bulding new huts. In addition numbers of trees and shrubs are also eliminated on large plots of mechanized farming, often by being up-rooted and burned the loss of trees in poor agricultural societies all over Sudan; as a result local communities suffer as is fuel as concern.

2.12. Energy consumption in Sudan
The total energy consumption in the year 2003 was 9.7 million of TOE; biomass share was 70%, petroleum share 28%, electricity share only 2% (ME, 2004). The transport sector consume 2256 thousand of TOE, represented about 23% of the total energy consumed in 2003. The services sector include; government and services such as hotels, restaurants and coffee shops in addition to other lace. This sector consumed about 12% of the total energy consumption in the year 2003, about 95% consumption in this sector mainly met by biomass, about 68% as
biogases in sugar industry, groundnut in vegetable oil industry and firewood use in bakeries and brick kilns. The energy consumption in this sector is accounted for 10% of the country total consumption. The second fuel petroleum, which accounted for 28% of the total sector consumption. The remaining 4% of energy demand consumed in this was electricity. Agriculture sector consume less than 1% energy consumption of the country (ME, 2004).

House hold energy consumption in Sudan is the biggest energy consuming, sector accounting for more than 55% of total energy consumed in the year 2003, compared to about 77% of total energy consumption in the year 1990. This share is expected to decrease further with the countries economic development. About 95% energy consumed in this sector came from biomass resources. These resources mainly firewood, charcoal and crop residues. The other energy resources are petroleum products (mainly LPG and kerosene) and electricity. The respective shares of these resources are 3% and 2% (ME, 2004).

2.13. Improved cooking stoves in Sudan
The first improved cooking stove in Sudan was made in 1980, by the Faculty of Engineering (University of Khartoum). It is known as EL Duga stove. Subsequently CARE Sudan introduced and alternative improved charcoal stove based on the Kenyan Ceramic Jiko design this was original EL Sarour charcoal stove, to reduce fuel consumption by the FAO- FNC fuel-wood development project. The low of adoption rate in improved cooking stove in Sudan adds to the many example of potential useful technologies that had not been widely adopted. This is because of failure to understand the social setting in which they were introduced and identify the actual decision makers regarding their adoption. There are several types of improved cooking stoves, like;
- Azza stove: The Bio-mass Energy conservation section of the FAO Fuel-wood Development for Energy in Sudan, promoted the manufacture and dissemination
of a simple bucket stove, based on Thai-bucket design which also consisted of metal casing and fired clay liner. The metal casing could be made of of a light gauge metal for this reason its price was less; the stove is suitable for rural and urban areas. A small production unit has been established in Rufaa as commercial enterprise, with the fund from the Irish Aid project. Azza stove program started in 1992 and about 60000 stoves were distributed in collaboration with NGOs, FNC and UNHCR (Salih, 2006).

- Butana stove: it’s a brick-ceramic stove. The stove was designed, tested, introduced and disseminated by the Irish Aid project. It was designed to satisfy the user need; and to eliminate the metal casing, which is the main limiting factor for producing Azza stove. The stove consists of two or three liners with different size. The stove is suitable for urban suburban regions and even in the rural areas in places where people began to shift from firewood to charcoal. Laboratory test carried out for this stove by ERI, showed 30% - 40% efficiency and saving 0 – 20%, although saving up to 55% was reported by users in Omdurman due to the ceramic liner which retains heat, and thus reduce consumption at the end or simmering phase of cooking.

- Mud stoves: they are oldest improved firewood stoves promoted by extension service of the FNC throughout both rural and suburban areas of Sudan. Women constructed stoves of this type using local clay and animal dung. Women were trained to make the stove that suits their own cooking and types of fuel available. The stove requires constant repair, maintenance and shelter from rain and other physical effect. Mud stoves take time to light because the walls are cool and absorb most of the heat during the initial stages.

- Badia stove (Upesi): its simple pottery cylinder which builds into a mud surround in the kitchen. The Irish Aid has adopted the stove to assist the mud stove, as from the monitoring survey which was conducted to assess the performance and the durability of the mud stove proved that the stove is very
fragile and users didn’t concern to re-build the stove. It was first installed in selected houses in the refugee camps (Hawata environmental model project).
- Kisra stove: as well as the mud stove the FDES project has made improvements to the three-stone for cooking sorghum pan cake (Kisra).
- Injera stove: Injera is a type of thick flat bread made from sorghum baked on a pan. An average of 0.74 kg firewood is required for 1 kg of Injera dough which shows very low stove efficiency. Based on institutional stove design, a new has been developed, tested and introduced by Azza workshop to the refugees in eastern Sudan.
- The institutional stove: it is a firewood stove by the FDES project. It’s constructed out of brick and mortar and it’s not more than 0.8 meters high. It has a chimney to produce drought for combustion and remove the smoke from the kitchen, assisted with a baffle for blocking the flue gas. There are two inlets, the upper one through which the fuel is fed and the bottom one to draw the preheated air into the chamber. The fuel inlet has a door to control the entry of cold air.
CHAPTER 111
STUDY AREA

3.1. Location
The study area is a part of the White Nile State, which lies between latitude 13° 30’ N., and longitudes 32° and 32° 32’ E. Administratively the state shares borders with six states, Khartoum to the north, South and North Kordofan to west and south west, Sennar and El-Gezira state to the east, the Upper Nile to the south (see map, 3.1). The total are of the state is 39,701, km² about 9,452,620 feddans. Administratively the state is divided into four localities namely: Jablien, Elduiem, Gitaina and Kosti. Each locality is headed by a commissioner. The capital of the state is Rabak and is headed by a governor or (wali) and his cabinete. There are three Omoudiyas in the study area, based on tribal structure. Each Omoudiya has its court which is held weekly. The village’s leaders are the sheikhs who are usually chosen according to the ethnic weight. Most of the sheikhs in a village is mostly bound to a certain family to decades. The sheikh is responsible to the rural councils and the Omdas. The sheikhs are entrusted to the collection of livestock tax, and has considerable responsibility towards maintaining security in the village and mediate with elders resolving disputes and also represent the community to the outside world.

Two types of community institutions are found, socially organized and politically created institutions. The socially organized institutions are based on traditional relation, tribal weight, wealth and the social viability of individuals are some of the traits influencing the selection of a person. The (sheikh) is one of the institutions of social foundation, originating in the tribal leadership structure.
Fig. (3.1): Map of White Nile State

Source: White Nile State Development Atlas
To manage the village affairs, the sheikh is usually assisted by some distinguishable village elders in the communal social life. Within the community other forms of committees are found. These are mostly created to run specific tasks or activities. Some of which are; building and running of schools, health services, mosques, water and hafirs and other activities related to the development of the community. The politically created organizations are those initiated by the government regime, covering popular salvation committees, rural councils, women and youth union and religious societies. These organizations are created to promote certain government policies and programs, and act as facilitators of local administration. The selection of individuals to the institutions is based on the individual, tribal, wealth and leadership weights. It is normal that one person could be a member in more than one committee, and as a result that leadership roles in the community confined to a few members. It is obvious that institutions are weak and slow in activities and some times have no power to exert upon the community members (EDS, 1996).

3.2. Climate

A tropical dry climate prevails in the area, characterized by high temperature for most of the year, with mean of 21°C and 37°C and maximum of 35-38°C and minimum of 16-23° for the cool and hot months respectively (EDS, 1996). Rainfall is a determinant factor of vegetation growth, crop farming and range productivity. The rainy season usually lasts from June to September, but 90% of the total rainfalls occur in the months of July and August. Rainfall in the form of shower of varying intensity and duration which is not exceed few hours. The variability in the frequency of onset and distribution is quite prominent, while variability in total area rains amount to 30-40%. Recent drought has resulted in general decrease rainfalls. The mean annual rainfall over the area (1961-1990) varies from around 150mm in the north to around 250mm in the south clearly
indicates to preponderance of semi-arid conditions short rainy season, low means and annual variation (EDS, 1996).

3.3. Water resources
The available water resources in the area besides the White Nile, the rain fall comprise surface and ground water. In spite of the arid conditions dominating the area, the surface runoff entertains a humid period for some days every year. The convective nature of rainfall provides fairly large quantities of water at relatively short period. On the other hand, the sandy nature of the top soil and flatness of the area allow the greater part of rain water either to evaporate or accumulate in topographical depressions forming Rahads and maya’as that dry up shortly after the rainy season (Salih, 2006).

3.4. Soil and topography
The dominant soil type in the study area is purely sand, with loamy sands. The sand dunes are separated by valley like clay plains, which sometimes change into depressions and maya’as. The most striking feature of the landscape is flatness between the gozes and sometimes changes into clay depressions or maya’as in which water accumulates in the rainy season “marked by huge sunt trees (Acacia nilotica) making and oasis feature. Also there are a few small mountains scattered on the area, slopes are found After the elevations mantled with debris of coarse grave of um_ruaba basement complex origin. Small khors also found to run for short period of time for short distances down mountains. The sand dunes are found to be oriented in a particular order, they are elongated from north to south follow the prevailing direction of wind throughout the year, indicating that the dunes are formed by creep sands through the past years (DECARP, 1976).

3.5. Vegetation
According to study for (EDS, 1996) the prevalence of dry climate has given rise to a poor vegetation, both in terms of cover and intensity with regarding from
north to south, following rainfall pattern and the variation in soil. The dominant
trees species are _Acacia tortilis_, _Acacia seyal_, _Acacia nubica_, _Balanites aegyptiaca_, and _Acacia mellifera_. The main grass species are _Panicum urgidum_, _Cenchrus spp._, _Cenchrus prietii_ and _Ipomea Caprica_. Besides the above prevalent types species such as _Acacia nilotica_ and _Ziziphus spina-christi_ are characteristically found on the banks of the White Nile and on the depression amongst the dunes when run off water accumulate. The human influences on vegetation conditions are exemplified, first in change in plant communities with the invasion of inferior species such as _Leptadenia pyrotechnica_, and secondly, the evident loss of the vegetation cover around settlements, due to over grazing expansion of cultivation and the removal of trees for different purposes. Thirdly, the southern part of the study area invaded with _prosopis chillensis_ which occupied patches of farming areas on top of Goz land and stunted-bush like growth of the same species on the clay plains down the sandy soils (EDS, 1996).

3.6. Population

The population in White Nile State according to 2002 state census is around 1,595,000 capita distributed in the four localities, which are divided into 26 administrational units with about 838 villages. The range of village population sizes are 450 – 4329 person and 90 – 526 house holds. The average family size is 7.5 persons with sex variation of 52.75% males and 47.3% females. The main tribal groups are: Hassaniya, Hessinnat, Kwahla, Shenabla, Sheweihat, Kurtan, and Ga’alyeen, these are dominant in the northern part of the study area, where as the major groups in the southern part are Bani Jarrar and Shankhab, with these major groups, there exist minorities such as Kababeesh of Northern Kordofan origin which were induced by the 1984 drought to settle in the area.

3.7. Land use and economic activities
Agriculture is the major source of food and income, where various agricultural schemes exist. Mechanized farming accounts for 60% of the total area under cultivation and irrigated schemes and traditional farming systems for the remainder. The majority of the resident population in the state is agro-pastoralists. They have large livestock holding comprising sheep, goats, cattle and camels, in addition to agricultural land. Poor house holds typically own 10 – 15 feddans, middle house holds 20 – 25 feddan and rich house holds up to 30 feddans. The types of crop farming in the state are: Goz farming, terrace farming, clay plain farming and livestock raising besides other activities, but originally the population and the communities of the study area are pastorals, living adjacent to the nomadic tribes of the North Kordofan. The majority of inhabitants practice shifting cultivation. Livestock raising is a tradition in rural communities in the study area for centuries. Most, if not all, the community owns animals with varying numbers and types. Recently, due to the factor of drought, insufficiency of grazing plants, and conflicts on land, there is a tendency to minimize the number of animals per house and diversification to procure the cereals needed for annually, which means the communities are changing to be sedentary and stable (Elkhidir, 2003).

3.8. Non-Governmental Organizations
Several NGOs projects worked in the state like; FINNIDA (the Finish International Development Agency), ILO (International Labor organization), Plan-Sudan and CONCERN. These projects worked in different fields of forestry with special emphasis on afforestation and desertification control programs. Other activities include; private forests on an individual basis, community woodlots, sand dune fixation and windbreaks, agroforestry, fuel substitutes and other activities.

3.9. Improved Stoves Program
This program started in White Nile State since 1988 by SFAP in Kosti and Tendelti areas. It focused on training and dissemination of mud stoves as a suitable alternative for the traditional three-stones stove (the main stove in the rural areas in White Nile State). These efforts were continued by CONCERN Organization in the early 1990s followed by IFAD and Plan-Sudan organizations which cooperate with FNC to construct two improved stove production units in Kosti and Duiem in 1996 – 1997 for production of Azza and Butana stoves. Workshops held in Kosti and Duiem (1997-2000) for training and build of institution stoves by FNC, IFAD and Plan-Sudan, stoves were constructed for prisons in Kosti and Duiem, some restaurants and sweet factory in Kosti and they showed very good results in fuel and time saving and removal of smoke from the kitchen. They were used for some years, but after their break down most of them were not rebuilt. Also there has been a very successful work in Shegage village north east of Duiem, for constructing kisra-stove which is a modification of the institution stoves, where every 6–10 near-by women share one stove (Salih, 2006).

3.10. Liquefied Petroleum Gas Program

This program started in White Nile State in 2001 by FNC, where 3150 LPG Appliances were distributed (the cost of LPG cylinder and gas cooker is 8000 SD paid in four to six equal monthly installments), in urban and rural areas. Plan-Sudan organization contributed to this program by paying around 2/3 of the price of LPG household in Duiem and Guli villages and the organization is still going on with dissemination while FNC almost stopped distribution except refilling of cylinder in Tendelti and Kosti areas.
CHAPTER IV
METHODOLOGY

4.1 Introduction
Two types of data were used in this research, namely primary and secondary data. The sources of secondary data include files, article, and documents. While primary data was collected through personal interviews with individuals using structured questionnaire, group discussions and observations.

4.2. Selection of the study area
White Nile State is subjected to desert encroachment, wind erosion and the rate of deforestation is alarming. There are several NGOs working in the study area for the sake of mitigating the degradation of the environment through the adoption of energy substitutes. Selection of villages for projects interventions was based on certain criteria set by the projects. Therefore, some villages participated in the projects' activities while others were not. Selection of villages for this research focused on those villages which were covered by NGOs projects. The selection of villages started with reconnaissance survey to determine the NGOs that worked in the field of energy substitutes. The findings of the reconnaissance survey revealed the implication of energy substitutes in two provinces namely; Gulli and El Dueim provinces. Three villages were selected for this research, Abareeg village (Gulli), El Tahra and Abusunot villages (El Dueim). The selection of villages was made randomly.

4.3. Selection of respondents
Being the nuclear base of the local community, the household was selected to be the unit of analysis for this study. The primary data was collected from the surveyed population using the questionnaire as a tool for face-to face interview. A total sample of 75 respondents was selected for this research (25 respondents from each village). It worth mentioning the interviews were made purposely to
address females because they have direct and close relationship with fuel wood collected and consumption. Therefore, each respondent represented a household i.e. no two respondents were interviewed from a same house. No fixed percent of sampling was considered for the selection of respondents due to the great similarities among the villages in terms of tribal composition of the villages, traditions, socio-economic characteristics and economic activities. Generally, the 25 respondents represent a sampling percentages varying between 17 – 23% (20% average).

4.4. Other methods and sources of data

For this research different sources of information were tapped to enrich the findings and clarify ambiguities. Key informants were consulted in the early stage of the research to pretest the questionnaire and for the identification of stakeholders (households engaged in the programs of energy substitutes). Self-administered questionnaire was also used to collect data from FNC staff where the questionnaire format distributed to the staff to fill it on their leisure time.

For data collection, besides group discussion with key informants, self-administered questionnaire and face to face interview with households representatives, Participatory Rural Appraisal (PRA) was used to verify initial findings. The secondary data was collected from the records of FNC and the archive of the projects. Moreover, relevant previous studies were consulted for the provision of basic socioeconomic information.

4.5. Construction of questionnaire

The construction of the questionnaire was made according to the guidance of FAO (1985). The suggestion of the supervisor as well as idea of other experts in the field of study helped to reach the final format of questionnaire. The following guidelines of Burchinal (1985) were also given special consideration in the construction of the questionnaire:
- To be certain that each question was relevant and necessary to topic.
- To ask the questions that the respondent can and are willing to answer.
- To express each question simply as possible.
- State questions in specific concrete terms.
- To obtain criticism of all prepared items by colleague or a friend.
- State the items in the language respondents’ use in everyday conversation.

Two types of questions were used in the questionnaire. Closed-end questions, with mostly multiple choices or yes and no style of answers, and dichotomous questions in step-wise style, each answer leading to specific set of follow up questions with no open-ended questions except where it is inevitable. These types of questions were used in the questionnaire in order to:

- Make the least demand upon respondents.
- Permit quick, efficient collection of data.
- Permit easy, quick and accurate analysis of answers.
- The combination of question and associated response categories sometimes help respondents to understand the questions more clearly.
- They are more useful in obtaining answer to sensitive questions.

The open-ended questions were avoided except where it is inevitable because of their negative drawbacks, which are responded in:

- The difficulty of constructing questions at the proper level of generality.
- Response is difficult to analyze and summarize.
- They may impose considerable burdens on respondent and interviewees.
- They more likely to produce irrelevant and worthless data.

### 4.6. Organization of data

The conceptualization step was followed by the organization of the questions. The following guidelines were considered:
- To begin with simple, easy to answer questions.
- To place sensitive or more complex questions late in the questionnaire.
- Where it makes sense, to place the items in logical order.
- To try to create an interesting mix of items within the questionnaire.

An introduction as set to the questionnaire at the top of the first page of questionnaire, the introduction was written in short, simple sentences in the local language used by the respondents and in wards they understand. The introduction composed of the following elements:

- Identification of the person conducting the research.
- Explanation of the purpose of the study and why it is important.
- Explanation of how respondents were selected.
- Assurance that answers would be protected and not made known to anyone else to assure confidentiality.

4.7. Pre-testing

The formulation of questionnaire was followed by a pre-test step to discover and correct any flaws in it. The purpose of the pre-test is to make sure that the questionnaire would deliver reliable and valid data for answering the problem under investigation. The final year students of Faculty of Forestry, University of Khartoum, as part of their study course, were asked to criticize the questionnaire, and estimate how the respondents will be able to respond to questionnaire. According to comments of the students, the draft questionnaire was revised. Finally, the supervisor checked the questionnaire, and accordingly, some questions were removed. After pre-test, the contents of questionnaire were materialized into simple form with minimum items to obtain necessary information.
4.8. Permission for data collection
After reaching any selected village, the first step involved obtaining permission from local authorities before conducting the survey. This permission is certainly recommended for surveys in rural areas where residents may be more suspicious to outsiders. The permission was taken from the local authorities. The leaders were also asked to convince the local respondents to cooperate in conducting the research.

4.9. Statistical analysis
The statistical analysis was commenced through exploratory manipulations of the data obtained in the study area. This process was accomplished by critically examining the data through the use sampling of techniques of analysis. The main tools are construction of simple tables and selected cross-tabulation which allows tentative answers to questions being asked. Descriptive statistics using SPSS computer program were applied to data. Summary information of the socio-economic characteristics of the study sample was obtained in form of frequency, percentage, distribution and cross-tabulation.
CHAPTER V
RESULTS AND DISCUSSION

5.1. General characteristics of respondents
5.1.1. Household size and age groups

The household is a unit consisting of a group of related or unrelated persons who normally share a living quarter and eat together. The average household in Sudan has increased from 5 persons in 1955/56 to 5.7 in 1983, to 7.5 in 1989. The average size of family in White Nile State is estimated as 7 capita (Statistics Department. White Nile State, 2003). In the study area the majority of the households (45.3%) consist of 1-5 members, 40% consists of 5-9 members and (14.7%) of household consists of 9-12 members (Table (5.1)). Theoretically, as the members of the family increase the amount of fuelwood consumed increase proportionally. Therefore, large families need more food to be cooked and more fuel to be used. This, in turn is reflected in deterioration in the vegetation cover.

Table (5.1): Family sizes and age groups of the respondents in the study area

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Members of household (%)</th>
<th>Age group years (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-5</td>
<td>5-9</td>
<td>9-12</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>44</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>44</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>48</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>34</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>45.3</td>
<td>40</td>
<td>14.7</td>
</tr>
</tbody>
</table>

As far as the age groups are concerned, in Sudan a rural woman’s age can indicate her level of education, marital status and responsibilities in the household. Most of the respondents (49.3%) were within the range of 20-35 years and (26.7%) are of the range of 35-45 years of age. The rest of respondents 24% have age more than 45 years. This result shows that the bulk of the respondents as young (less than 45 years). This would suggest that they are
more likely to accept the adoption of new interventions if delivered properly by specialized extension unit.

5.1.2. Educational level

The educational level is an important indicator for community development. Hence activities would be directed and performed by respectful, literate people who have enough experience and knowledge. In addition illiterate people need special types of extension messages using symbols instead of written communication. Moreover, early marriage is a common cultural practice in the study area, and as a result women have little chance to pursue their education compared to men. Table (5.2) shows the level of education in the study area.

Table (5.2): Educational level of respondents

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Illiterate</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>80</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>32.3</td>
<td>51.6</td>
<td>16.1</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>70.4</td>
<td>29.6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>46</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Average%</td>
<td>59</td>
<td>34.9</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

In the study area the level of illiteracy is relatively high, 59% of the respondents were illiterate, particularly in Abareeg village where 80% of the respondents of the village are illiterates, followed by respondents from Abusunot village (70.4%). Thirty-five per cent of the interviewed sample ceased their education enrollment at the preliminary level. The rest of the respondents (6%) had the chance to pursue their education to secondary level. All the respondents of this category are from Eltahrah village. Osman (2006) in survey carried out in the study area found that the usage of energy alternatives such as LPG increased with increasing level of education, so clear message should focus towards level of education.
5.1.3. Source of income and expenditure of households

Agriculture is the main source of income in the study area like most of the rural areas of the country. Generally, the share of agriculture sector was accounted for about 46% of GDP for the year 2002 (Ministry of Finance 2002). In the study area 84.3% of the respondents asserted that agriculture is the main economical activity and they participate in the cultivation operations. Dura, millet and vegetables are the main agricultural crops grown almost by all the farmers. Fig. (5.1) shows the main sources of income in the study area.

![Fig. (5.1): Source of income in the study area](image)

The other economical activities include animal rearing as mentioned by 15.7% of the respondents. It worth mentioning that, the study area represents a theatre for the movement of pastoralists from the state and from Northern Kordofan State. This annual movement of livestock has its implication on the vegetation cover particularly the tree cover. Trading also represent a source of income generation for a considerable sector of the community where 21.7% emphasized indulge of the local people in trading due to limited alternatives of income generation (Unfortunately, the majority of this group stated that they trade in forest products like fuelwood and Non-timber Forest Products), while 20.5% work as wage
labors during the dry season. A considerable proportion of the respondents (24.1%) showed their reliance on private business for income generation (building construction activities, fishing and carpentry besides the kinship from expatriate).

Although agriculture is the main economical activity in the study area, substantially no progress in farming techniques has been introduced to traditional agriculture for decades. Farmer copes with this situation through expansion of cultivable land. The impact of this coping mechanism declines the soil fertility, deforestation and environmental degradation. This process increased since early 1960s where rainfalls become always below average. The deterioration of harvest and agriculture led to increased off farm economic activities among the respondents in the study area.

5.2. Households expenditure for fuel wood
Vegetation cover in the study area is very poor and the study area is jeopardized by the advancing walls of sand dunes and desert encouragement. The gloomy situation of the study area is further aggravated by chronic poverty level. Despite the scarcity of the vegetation cover, still local people have to rely on it for provision of fuel for sake of reducing the household expenditures. However, Table (5.3) shows the trend of household's expenditure per day. Almost half of the respondents (50.6%) spend between 3.0-5.5 Sudanese pounds (SDG) per day (average 4.25 SDG per day). Considering the average number of members in households (7), the daily expenditure for an individual is and expenditure is around 0.60 SDG per day which is less than 0.5$. Some household indicated miserable financial situation compared to the above mentioned case where 10.8% showed that their daily expenditure varies between 0.5 – 2.5 SDG per day. On the other hand some households are well-to-do compared with the two above mentioned cases where 24.1% of the households spend 6.0 – 8.5 SDG per day,
while 14.5% of households are financially potential to spend more than 15.00 SDG per day. Table (5.3) shows households' expenditures in the study area.

Despite the low expenditure level, households through certain coping mechanisms manage to withstand and tolerate harsh conditions and external stresses represented in fluctuating rainfall, long periods of episodes, insects and pests infestations and low agricultural crop productivity.

**Table (5.3): Households expenditure in SDG per day in the study area**

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Expenditure (SDG/day) %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.5-2.5</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>0.0</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>14.8</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>10.8</td>
</tr>
</tbody>
</table>

Food storage (sawmaa and sweeba) is one of the mechanisms for sustainable livelihood in the study area. Through food storage, households minimize their expenditure to the necessities like sugar and tea. Fuel wood is one of the main items on which households expend their income. Fig. (5.2) shows the expenditures of households for fuelwood. Some respondents (30.8%) expend between 0.5-1.00 SDG per day on fuel wood, while 9.2% expend 1.00 - 2.00 SDG. Due to poverty, as a coping mechanism, households manage to minimize their expenditure on fuel through collection of fuel wood from reserved and natural forests as asserted by 46.2% of the households. As mentioned earlier, the vegetation cover is scarce and fragmented into isolated communities or groups along seasonal watercourses. Heavy reliance on vegetation cover would enhance the process of desert encouragement and exert negative impacts for the resilience of local communities. Some respondents (13.8%) showed their reliance on energy substitutes like kerosene, improved stoves and LPG. It seems that this group is from the well-to-do inhabitants.
5.2.1. Types of fuel in the study area

The United Nation Millennium Development goals set target for poverty eradication, improvement in health, environmental conservation and education, they represent the accepted framework for the world community to achieve measurable progress. In the study area it seems difficult to attain the goals of UNMD where rural communities assume natural resources are gifts of the God and they have to enjoy their free access. Table (5.4) shows types of fuel used for cooking in the study area. The majority of the respondents (78.3%) rely on the fuelwood for cooking.
Table (5.4): Type of fuel used for cooking in the study area.

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Type of fuel used for cooking %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fuel wood</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>68.0</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>87.1</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>77.8</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>58</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>78.3</td>
</tr>
</tbody>
</table>

Most of respondent rely on trees and shrubs for the provision fuel of wood as asserted by 78.3% of the respondents, while 69.3% use charcoal. These findings reflect the level of deforestation in the study area which in turn threw it shadow in the deterioration of the environment. About 53.3% use animal dung as a source of fuel due to scarcity of tree cover. In general, the consumption of animal dung in White Nile State as fuel was 30.7% of the whole country and considered as the second state in Sudan after Northern State, (Ministry of Energy, 2000). Reliance on animal dung would deprive the soil from the necessary nutrients, and therefore disrupt the soil nutrient cycle. The same is true in the case of reliance on agricultural residues for fuel. In the study area 24.7% of the households asserted their reliance on agricultural residues for provision of energy. The adoption of LPG as a source of energy is relatively high as indicated by 66.7% of the respondents, while kerosene is used by 6.7% of respondents (only in Etahrah village).

This shows clearly the reliance of people on the vegetation cover, particularly shrubs and trees, for the provision of fuel seems to be ever lasting. This agrees with Abdelslam (2005) showing that the traditional fuel used for energy was strongly built and can not easily be replaced by other types of fuel. Other reasons might be unavailability of alternative sources (Osman, 2006). The heat efficiency of LPG (Ton of LPG = 1.08) will save 3 tons of charcoal (Ton of charcoal = 0.72
heat efficiency), equivalent to 57,692 m³ which suffice consumption of a household for 18 month (Osama and Hanadi, 2005).

5.2.2. Firewood

Firewood is an important fuel to be used for cooking and heating purposes, since it is easy to obtain and burn. Still, many of the developing countries depend on wood for survival. Irrational use has led to serious environmental problems such as, deterioration of natural resources, deforestation and land degradation. In Sudan the urban household obtains firewood mainly from “zaribas” special please for selling wood product, while the rural household area obtains firewood from trees and shrubs free of charge. In the rural areas of the study area, tree cover is diminishing due to irrational use. Firewood collection is restricted to those who are physically fit to cross-devastating areas searching for trees and shrubs. Fig (5.3) shows the source of firewood in the study area. Free collection of fuel wood from the natural and reserved forests is the most common source of firewood as mentioned by 43.9% of respondents, while 31.7% indicated their reliance on local markets besides free collection of fuel wood. Markets represent a source of fuel wood for 14.9%, while 13.8% of respondents do not use fuel wood.

![Fig (5.3): Source of firewood in the study area.](image-url)
5.2.2.1. Trees and shrubs preference for firewood

As mentioned earlier, the vegetation cover represents the main source of firewood in the study area despite its scarcity. Poverty is the main responsible factor for this attitude. Although the FNC formulated sound legislation and laws to protect the vegetation cover, the trend of deforestation is alarming. This is attributed mainly to the fact that the FNC is always under funded and under staffed. Table (5.5) shows the trees and shrubs preference by the local people in the study area. From the above-table it clear that there is no clear preference of certain trees and shrubs species for firewood, and the percentages of the local people are distributed among the different trees and shrubs species with the out a clear significant differences. It seems that the type of species collected is determined by the availability of the species, around the village. This fact is supported by the high preference gave to Laot (*Acacia nubica*) where the majority of the respondents (56%) rely on laot as firewood. Therefore, the availability of the species in the study area on the expense of the preferred species lead to its exploitation for firewood. Talih (*Acacia seyal*), Kitir (*Acacia mellifera*) and Sunt (*Acacia nilotica*) which are well known for the good quality fuelwood are less preferred by the local people for use as firewood. Kitir is preferred in Eltahrah while sunt is preferred in Abareeg village *Ziziphus spinachristi* is gathered by 12% of the respondents, while *Cassia sina* is gathered by 4% for providing fuel wood.

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of trees species gathered for firewood %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kitir</td>
</tr>
<tr>
<td>Abareeg</td>
<td>0.0</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>34.6</td>
</tr>
<tr>
<td>Abusunot</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
</tr>
<tr>
<td><strong>Average%</strong></td>
<td>13.3</td>
</tr>
</tbody>
</table>
5.2.2.2. Firewood collection

In the study area, firewood collection needs time and efforts to be obtained due to the scarcity of the vegetation cover. The study area stretches across semi arid region which is fragile. The distance crossed by the firewood collectors, irrespective of gender or age, exceed several km. Table (5.6) shows the distance crossed by the firewood collectors and the means of transportation.

It is clear from the table that firewood collection is the task of women and children indiscriminately. It seems firewood collection is the responsibility of women in near areas, while for remote areas it becomes the task of men. However, 49.1% asserted that firewood collection is women task, while 41.8% stated its children task. Few respondents (9.1%) showed that firewood collection could be men task.

Table (5.6): Firewood collection and distance crossed for collection

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Collection %</th>
<th>Distance</th>
<th>Transportation %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Women</td>
<td>Children</td>
<td>1-2</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>47.1</td>
<td>35.3</td>
<td>35.3</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>55.6</td>
<td>38.9</td>
<td>72.2</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>45</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>27</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>49.1</td>
<td>41.8</td>
<td>36.4</td>
</tr>
</tbody>
</table>

The area from which firewood is collected has become far with time. Almost half the respondents (50.9%) stated that they have to cross distance between 2-3 km for firewood collection, while 36.4% cover a distance of 1-2 km and 12.7% of the respondents collect firewood from 3-4 km. Transportation of firewood from sites of collection to houses differs according to physical fitness and availability of transportation mean. In the study area 14.3% of the respondents rely on carts, while 23.6% depend on donkeys for transporting the collected firewood. Sixty one per cent of the interviewed sample used to load collected firewood on their heads.
5.2.2.3. Time spent in firewood collection and amount collected

In the study area the respondents may spend 1-4 hours to collect firewood. About 34.5% of the respondents spend between 1-2 hours for collection of firewood, while 65.6% spend more than hours.

Table (5.7): Time spent in firewood collection and consumption per week

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Time of collection %</th>
<th>No of Bundles/week %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-2</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>47.1</td>
<td>53</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>38.9</td>
<td>61.1</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>34.5</td>
<td>65.6</td>
</tr>
</tbody>
</table>

The longer the time spent in firewood collection indicates the remoteness of collection site and the amount collected. The researcher encountered extreme difficulty in determining the exact amount of firewood collected each time. The difficulty is attributed to variations in the measuring units. The bundle which is the acceptable measurement unit have different dimensions and weight, the same is true for the donkey’s load. However, 40% of the respondents showed their consumption of firewood as more than 6 bundles per week, while 29.1% consume between 1-3 bundles and 30.9% of respondents consume 4-6 bundles per week (bundles weight about 1.5 kg).

5.2.3. Charcoal

Charcoal is an important source of fuel for the developing countries. It is used for cooking, small industries and a source of livelihood for a large number of people who produce, distribute and sell it (Foley, 1986). Charcoal consumption is low in the study area. Table (5.8) shows the trends of charcoal consumption in the study area. The majority of the respondents (80.4%) consume one sack per month, while 19.6% consume two sacks of charcoal per month. Irrespective of family
sizes, none of the household showed consumption of more than two sacks per month. The respondents rely on local market for the provision of charcoal.

**Table (5.8): tree species preference for charcoal and trend of consumption**

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Tree preferring of charcoal %</th>
<th>Consumption/month %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Talh</td>
<td>Sunt</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>71.4</td>
<td>28.6</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>95.6</td>
<td>0</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>Average%</td>
<td>74</td>
<td>9.5</td>
<td>4.9</td>
</tr>
</tbody>
</table>

The majority of the respondents (74%) preferred Talh tree for charcoal followed by sunt as asserted by 9.5%. Few respondents (4.9%) prefer charcoal made from Kitir.

**5.2.4. Liquified Petroleum Gas**

LPG is produced from Khartoum petroleum refinery. The production is about 750 tons per day and the consumption is 450 tons per day. The White Nile State consumes 3.2% of LPG produced from Khartoum refinery (Ministry of energy, 2004). In the study area 65.3% of the respondents possess LPG appliance and cylinder, but only 64% actually use it for cooking. The level of Adoption of LPG intervention varies among villages, being high in Abareeg village and low in Abusunot village. The main reasons behind the lack of adoption of LPG intervention as perceived by the households are; acute poverty levels which deprives families from the financial power to purchase and refill the cylinder as asserted by 86.7% of the respondents. Lack of sale centres is also considered as a factor hindering the adoption of LPG intervention as stated by 8% (all from Eltahrah village), while 5.3% attribute the lack of adoption of LPG intervention to fears of explosions and fire hazards.
Table (5.9): Liquified Petroleum Gas appliances, causes of lack using it and source of it

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>LPG appliance %</th>
<th>Causes not using LPG %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Possess Using</td>
<td>Poverty No centers Fears of Explosion</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>80 76</td>
<td>84 0 12</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>76 76</td>
<td>76 24 4</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>40 100</td>
<td>100 0 0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>49 26</td>
<td>65 6 4</td>
</tr>
<tr>
<td>Average %</td>
<td></td>
<td>65.3 64</td>
<td>86.7 8.0 5.3</td>
</tr>
</tbody>
</table>

5.2.4.1. Sources of Liquified Petroleum Gas in the study area

Table (5.10) shows the main sources of LPG in the study area. Local people rely on private companies and Plan-Sudan organization for the provision of LPG. Distribution of LPG appliances in study area by Plan-Sudan started in 2003 in an attempt to reduce the pressure on tree cover as a source of fuel wood and poverty alleviation. The program lunched a campaign and encouraged the local people to adopt LPG cylinders at reasonable prices and through installments.

From the above-mentioned table it is clear that Plan-Sudan Organization intensified its activities in certain localities of the White Nile State where its activities is highly pronounced in Abareeg village (Gulli Locality) while it is poor or almost absent in the other villages. From these findings it is clear that the FNC did not play any role as far as the LPG is concerned despite the establishment of a specialized unit within the administration hierarchy of the FNC "investment unit" that deals with the program of Gabat Gaz. This program is assumed to cover the rural areas of the country in an attempt to reduce reliance on the vegetation cover through providing LPG appliances and cylinders at reasonable prices through installments. Several pitfalls associated with the implementation of the program and as a result the program collapsed.
Table (5.10): Sources of Liquified Petroleum Gas in the study area

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Source of LPG (%)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plan-Sudan Organization</td>
<td>Private companies</td>
<td>Gabat-Gaz</td>
<td></td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>5</td>
<td>95</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>30</td>
<td>45</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Average%</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

5.2.4.2. Perception of local people towards Gabat-Gaz

Gabat –Gaz program was established in 2001 by the FNC for the sake of mitigating the environmental deterioration in the country. Accordingly, several units were established within the administration hierarchy of the FNC to tackle the issue of LPG through dissemination of information regarding ways and means for possessing the appliance and the cylinder in one hand, and guarantee a sustainable supply of LPG. It seems that there were no sound extension messages directed to the local people to enlighten them about the intervention. Table (5.11) shows the perception of the local people towards the program of Gabat-Gaz where the majority of the respondents (92%) asserted that they have never heard about Gabat-Gas programs. However 8% heard about the Gabat-Gas either directly from radio or from mouth to mouth.

Table (5.11): Heard about and source

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Heard about G-G</th>
<th>Source %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>FNC extension team</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>24</td>
<td>76</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>6</td>
<td>69</td>
</tr>
<tr>
<td>Average%</td>
<td>8</td>
<td>92</td>
<td>0</td>
</tr>
</tbody>
</table>
Table (5.12) shows the majority of respondents (97.3%) claimed their ignorance if there is any difference between Gabat-Gaz and the other agents, while 2.7% of the respondents believe that other agents are better than Gabat-Gas program.

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Comparing Gabat-Gas with others institution %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>G-G better</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>0</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

5.2.4.3. Sustainability of Liquified Petroleum Gas intervention

As mentioned earlier 65.3% of the respondents possess LPG appliance and 64% actually use their appliances. Fig. (5.4) shows that 85.4% of those who possess LPG appliance are used to refill their cylinders when they run out of stock, while 4.2% stated that they never filled their cylinders.

Fig. (5.4): Reliance on liquid petroleum gas as energy substitute in the study area
Some respondents (10.4%) used to refill their cylinders occasionally. This situation reflects the importance of extension services for raising awareness and enhancing the adoption of LPG interventions. The extension services could enhance the adoption of the LPG through verifying the different allegations concerning the fears of using the LPG appliance.

5.2.4.4. Advantages and disadvantages of Liquified Petroleum Gas as perceived by households

In an attempt to assess the usefulness and feasibility of adoption of LPG the respondents were interrogated to evaluate the LPG intervention in terms of advantages and disadvantages. Table (5.13) shows LPG advantages and disadvantages as perceive by the respondents.

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Advantage of LPG %</th>
<th>Disadvantages %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Saving  Quick  Healthy Low cost</td>
<td>Refilling cost Dangers</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>60      15   15    10</td>
<td>32               8</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>0       80   10    10</td>
<td>0                16</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>0       10   90    0</td>
<td>36               20</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>15      30   21    5</td>
<td>17               11</td>
</tr>
<tr>
<td>Average %</td>
<td></td>
<td>20      40   28    6.7</td>
<td>22.7             14.7</td>
</tr>
</tbody>
</table>

Forty per cent of the interviewed sample asserted that LPG is faster in cooking compared to other energy alternatives, particularly the traditional ones, while 28% focused on the healthy advantages of installing LPG where smoke and air pollutants can be avoided through adoption of LPG. Twenty per cent emphasized the advantage of LPG is represented in the saving of time and money compared with other energy alternatives. Some respondents (6.7%) described the advantages of LPG as its relative low cost for the long run compared to other energy alternatives. As far as the disadvantage of the LPG intervention is concerned, 22.7% of the respondents complained from the high cost of refilling the cylinder, while 14.7% fear explosion of cylinder.
5.2.4.5. Suggestions for the improvement of Liquified Petroleum Gas adoption in the study area

In this study, perceptions of households regarding the improvement of dissemination and adoption of LPG intervention were given special emphasis. Table (5.14) shows the proposals of the respondents regarding the improvement of activity in the study area. About 45.3% of the respondents addressed the importance of subsidizing the cost of cylinders refilling under the assumption that most of the households in the study area suffer from acute poverty. This fact is supported by the fact that some respondents were able to possess the appliance but they have not used it more than once due to financial inability to fill the cylinders.

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Availability of LPG (%)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cylinders</td>
<td>Appliances</td>
<td>Centers</td>
<td>Reasonable prices</td>
<td>Cooperative</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>84</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Eltaarah</td>
<td>25</td>
<td>0</td>
<td>8</td>
<td>24</td>
<td>48</td>
<td>20</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>0</td>
<td>28</td>
<td>0</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>21</td>
<td>9</td>
<td>6</td>
<td>34</td>
<td>5</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>28</td>
<td>12</td>
<td>8</td>
<td>45.3</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Some respondents (28%) suggested provision of LPG cylinders. This indicates the lack of interest or keenness of the FNC to provide cylinders at reasonable prices, while 8% suggested the importance of establishing centers for refilling cylinders. Some respondents (12%) call for provision of LPG appliances at the village levels at reasonable price. From the above findings it is clear that the FNC has different role to play if there is a proper extension unit which assumed to provide the local people with the necessary information regarding possession of the appliance, refilling of the cylinders and raise the awareness for safety measures. Few respondents (6.7%) suggested establishment of local organization in the form of cooperatives to tackle the issue of provision of LPG appliance and
cylinders and refilling of cylinders due to the lack of committed body to play this role in the study area.

5.3. Improved cooking stoves (ICS)

Although most of the least developed countries suffer from deforestation, desertification and other environmental problems, yet the intensive use of firewood and charcoal represent the real challenge to the resilience of local communities. In the study area, it is common to find high percentage of the respondents still relying on the traditional stoves for cooking. Table (5.15) shows the different types of cooking stoves as possessed by the interviewed sample. The bulk of the respondents (68%) showed the high reliance of households in the study area on the three-stone stoves (Ladaya). They attribute their preference to this type of stoves to their suitability for making thin pancake (kisra) and porridge (Asida). Reliance on this type of stoves reflects the deforestation trends where most of the households rely on natural and reserved forests for the provision of fuel wood. It worth mentioning, the three-stone stoves consume relatively higher quantity of firewood compared with other types of stoves. Thirty-six per cent of the interviewed sample use traditional cooking stove. These types of stoves consume less quantity of firewood compared to the three-stove stoves, but higher quantities than the improved cooking stoves.

Table (5.15): Types of stoves in the study area

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Traditional cooking stoves</th>
<th>Improved cooking stoves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Traditional</td>
<td>3-stones</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>8</td>
<td>68</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>88</td>
<td>68</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>12</td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>27</td>
<td>51</td>
</tr>
<tr>
<td>Average %</td>
<td></td>
<td>36</td>
<td>68</td>
</tr>
</tbody>
</table>
Adoption of improved cooking stoves is relatively high in the study area where 58.7% of the respondents showed their reliance on improved cooking stove of bucket type for cooking. The level of adoption of other improved cooking stoves is low. Mud improved cooking stove receive appreciable consideration by the households where 37.3% adopted this type of stove. Some respondents of this group stated that they had adopted this type of stoves earlier, but after its damage they could not managed to reconstruct it. This also shows the pitfalls of the extension services in the study area. The adoption of the intervention should be linked with training sessions, particularly demonstrations, to train the local people how to construct and maintain improved cooking stoves. Other types of improved cooking stoves is improved charcoal stove (Azza and Butana stoves) which were adopted by 6.7% of the respondents, while 18.7% of the respondents adopted improved kisra stove, the majority of these from Abusunt village.

5.3.1. The main reasons for low adoption of improved stoves
Despite the efforts exerted by Plan-Sudan and the FNC in the field of energy, particularly improved cooking stoves, still the level of adoption lags far behind expectations. Fig (5.5) shows the main factors behind the low adoption and distribution of improved cooking stoves in the study area. Lack of monitoring unit to patrol the ongoing of the process of adoption of the intervention is the main responsible factor for the low adoption of improved cooking stoves as asserted by 68%. Several extension methods were built based on the initial trend of adoption to be a focal point to expand the level of adoption. The best example is the ideal farmer method in which the first adopters of an intervention act as a focal point to attract and encourage others to adopt the intervention. Therefore, lack of follow up visits to assess the level of adoption is one of the factors behind the low adoption of improved stoves. The second factor agreed upon by 42.7% of the respondents is lack of sustainability of the program of improved cooking
stoves. It worth mentioning that the program after a short time of its launch ceased for unknown and clear reasons.

![Bar chart showing reasons for low adoption of ICS](image)

**Figure (5.5) Main reasons behind low adoption of ICS in the study area.**

Thirty-two per cent of the respondents attributed the low adoption to lack of training. However 24% of the respondents believed that the extension message is not enough and (4%) of respondents mentioned other factors like spread of LPG.

### 5.3.2. Advantages and disadvantages of improved cooking stoves

Assessment of the advantages and disadvantages of improve cooking stoves according to the perception of the respondents is shown in Table (5.16). The advantages are represented in saving time and money as stated by 77.3% of the respondents for each variable. Save time with respect of the time spent by household members in search for firewood, and save money with respect to the amount of money spent for buying fuelwood.
Table (5.16): Advantages and disadvantages of improve stoves.

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Advantage of ICS %</th>
<th>Disadvantage %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Save money</td>
<td>Save time</td>
</tr>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>64</td>
<td>92</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>68</td>
<td>40</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>77.3</td>
<td>77.3</td>
</tr>
</tbody>
</table>

Moreover, 21.3% of the respondents appreciate the healthy role of the improved cooking stoves where the amount of smoke is relatively low compared with the traditional stoves. Therefore, the adoption of the improved stoves mitigate diseases of respiratory tract organs. Furthermore, some respondents mentioned the safety measures is almost nil compared to traditional stoves. The disadvantages are represented in breakage and importable are mentioned by 2.7% and 16% of the respondents respectively.

5.3.3. Improved kisra stoves

The bigger portions of population in Sudan who are classified as rural depend on sorghum (dura) and millet (dukhn) for their nutrition (Abdelsalam, 1994). Dura is made in the form of thin pane cake, called kisra which is consumed by local people. In the study area for the majority of households, the fuel is burned indoor or outdoor on open fires or poorly functioning stoves, usually with no chimney, except in Abusnot village where 48% of the respondents using fuel-efficient kisra stoves in group cooking. These stoves are constructed by Plan-Sudan for fuel saving and reducing of the smoke. The device supported by chimney to expel the smoke out the kitchen. There are two inlets, the upper one through which the fuel is fed and the bottom one to draw preheated air into the chamber. The fuel supported by a door to block the cool air in take. The stove was supposed to be used by 10 families. The respondents using improved kisra stove mentioned that they are using one bundle compared with old three-stone using two bundles. The improved stoves which were used by a group of people have some disadvantages;
the circumstances of people of the house in which it is built and the time of
people using it. Another problem the public committees nepotism and give the
other ICS also supplying nomad tribes with improved kisra stoves is a problem
because they close them up and they move with their cattle seasonally. Table
(5.17) show the advantage of improved kisra stove
The advantage of kisra stove as; fast and healthy (20%), save time and money
(5.3%), reduce fire heat (1.3%).

Table (5.17) advantages of improved kisra stove

<table>
<thead>
<tr>
<th>Area</th>
<th>F</th>
<th>Save fuel &amp; time</th>
<th>Quick &amp; cleaning</th>
<th>Protection from heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abareeg</td>
<td>25</td>
<td>12</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Eltahrah</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Abusunot</td>
<td>25</td>
<td>4</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>4</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Average%</td>
<td></td>
<td>5.3</td>
<td>20</td>
<td>1.3</td>
</tr>
</tbody>
</table>

4% of the respondent mentioned that they received application incentive of ICS
(Plan-Sudan has supplied Buttana stove with pottery, built and training the people
to use the ICS).
CHAPTER VI
CONCLUSIONS AND RECOMMENDATION

6.1. Conclusions

- Fuelwood is main source of energy in the study. Animal dung and agriculture residues also used for fuel.
- Fuelwood is collected directly from the reserved and natural forests due to the lack of the governmental control over the vegetation cover and lack of enforcement of forest laws. Well-to-do household manage to collect their fuelwood from the markets.
- The level of adoption of LPG in the study area is high (65.3%) of the households possess LPG appliances and cylinder, but less than this percentage of households are actually using the LPG appliance, due to lack of fund to refill the cylinder, lack of sale centres and fear of explosion.
- The main sources of LPG in the study area are private companies and Plan-Sudan Organization with complete absence of FNC which introduced Gabat gas program to reduce the reliance on the vegetation cover.
- The perception of the local people to the Gabat gas program reveal complete absence of extension services to dissemination information regarding adoption of the intervention.
- The advantages of LPG as perceive by the households are; fast preparation of cooking, safety and healthy measures, time saving, money and relative low cost compared to other energy alternatives. The disadvantages are represented in the high cost of refilling the cylinder and fear of explosion.
- Despite the great efforts exerted by the FNC and NGOs in the field of energy, still the bulk inhabitants rely on the three-stone stoves (Ladaya) or traditional stoves for cooking. It worth mentioning, the three-stone stoves consume relatively higher quantity of firwood compared with other types of stoves.
- Lack of a monitoring unit to patrol ongoing of the process of adoption of the intervention, lack of follow up visits, lack of sustainability of the program of improved cooking stoves are the main factors behind the low adoption of improved cooking stoves.
- The advantages of improved cooking stoves are represented in; saving time and money, healthy measures and safety measures, while disadvantages are liable to breakage and continuous maintenance.

6.2. Recommendation
- There should be an extension governmental commitment improving access of the rural population to alternative energy such as LPG fuel for basic needs as well as encouraging using of ICS to promote their life and mitigate the pressure on vegetation cover.
- The FNC should develop extension message remedy to table the issue of alternative energy as possible to reduce the rate of desertification.
- The FNC with NGOs should intensify their efforts to encourage local to adopt LPG and ICS by giving them loans and long period of installment.
- Renewable biomass resource such as briquettes from aquatic weeds.
- A greater use of wind power for pumping irrigation water would release diesel fuel that could then be converted into kerosene, thus reducing some pressure on fuelwood supplies.
- Promotion of less wasteful methods of producing charcoal.
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Appendix (1)
Household questionnaire

This questionnaire was made to collect information about household energy to for MSc.degree the research deal with strategies for promotion of liquefied petroleum gas and improved stoves in rural Sudan. Please answer the following questions as accurately as possible. Where actual data are not available please use your closest estimation your answers will be strictly confidential. In the questions where you are asked to tick one or more of the cases, indicate this in the space provided.

- Village
- Locality
- State

### Household members

<table>
<thead>
<tr>
<th>No. of household members</th>
<th>Tick where appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>5-9</td>
<td></td>
</tr>
<tr>
<td>9-12</td>
<td></td>
</tr>
</tbody>
</table>

### Age Distribution

<table>
<thead>
<tr>
<th>Age groups (years)</th>
<th>Tick where appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-35</td>
<td></td>
</tr>
<tr>
<td>35-45</td>
<td></td>
</tr>
<tr>
<td>&gt;45</td>
<td></td>
</tr>
</tbody>
</table>

### Educational level:

<table>
<thead>
<tr>
<th>Educational level</th>
<th>Tick where appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

### Land tenure family:

<table>
<thead>
<tr>
<th>feddan</th>
<th>irrigate</th>
<th>rain fed</th>
<th>Irrigated and rain fed</th>
</tr>
</thead>
</table>

### Type of crops:

<table>
<thead>
<tr>
<th>sorghum</th>
<th>sesame</th>
<th>groundnut</th>
<th>cotton</th>
<th>Others</th>
</tr>
</thead>
</table>

### Vegetation cover:

<table>
<thead>
<tr>
<th>Forest</th>
<th>Range</th>
<th>Species</th>
</tr>
</thead>
</table>
Type of animals:

<table>
<thead>
<tr>
<th>cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>camels</th>
<th>Others</th>
</tr>
</thead>
</table>

Source of income:

<table>
<thead>
<tr>
<th>A agriculture</th>
<th>Livestock</th>
<th>Labour</th>
<th>Trade</th>
<th>Others</th>
</tr>
</thead>
</table>

Expenditure (SDG/per day)

Expenditure (SDG/day) | Tick where appropriate
200-50 |
500-100 |
1000-1500 |
>1500 |

Types of fuels used for cooking:

<table>
<thead>
<tr>
<th>Firewood</th>
<th>Charcoal</th>
<th>Agriculture Residues</th>
<th>Animal Dung</th>
<th>kerosene/Gas oil</th>
<th>LPG</th>
</tr>
</thead>
</table>

Source of firewood

<table>
<thead>
<tr>
<th>Market</th>
<th>Collection</th>
<th>Market and collection</th>
<th>No use of firewood</th>
</tr>
</thead>
</table>

- What are the preferred of trees species gathered for firewood?

- Who are responsible for the collection of fuel wood?
  - Women ( ) Men ( ) children ( )

- What is the distance you cross to collect fuel?

- How you transport for collected fuel wood?
  - Head load ( ) Trucks ( ) Animals ( ) Others ( )

- How much time does take to collect fuel wood?

- What is the quantity of fuel wood you consume per day?
  1-3 bundles ( ) 4-6 bundles ( ) More than 6 bundles ( )

- What is cost of bundles?

- What is the amount of charcoal you consume per month?
  1-sack ( ) 2-sacks ( ) 3-sacks ( )

- What is cost of charcoal sack per (month, week, and day)?

- What is the preferred species for charcoal?
- Do you use kerosene for cooking?
  1/Yes ( )  2/No ( )
- Do you use gas oil for cooking?
  1/Yes ( )  2/No ( )
- Is it available in the village?
  1/Yes ( )  2/No ( )
- What are the reasons behind limited usage of LPG in the village in your option?
  1/……………………………..  2/ ……………………………….
  3/………………………….  4/……………………………….
- Did you receive any extension message about LPG?
- From who?
- Have you LPG appliances?
  1/Yes ( )  2/No ( )
- If yes, from where?
  1-Plan-Sudan ( )  2-Gabat-Gas ( )  3-Market ( )
- Do you use it for cooking?
  1/ Yes. ( )  2/ No. ( )
- If it is not in use; why?
  1-fear of explosion ( )  2-No cash for refilling ( )
  3-Modes and traditions ( )
- When do you own the LPG appliances?
- How many times do you refill it?
  1-continuously ( )  2-Seldom ( )  3-One time ( )  4-Never ( )
- How the number days; for refilling?
- What are the advantages and disadvantages of LPG compared to other types of fuel?
- Is there any extension message deal with LPG?
- Have many extension sessions you exposed to about LPG?
- Have you ever heard about Gabat-Gas Program?
  1/yes ( )  2/No ( )
- What is your source?
1-FNC-extension team ( )  2-Radio & T.V ( )  3-Mouth to mouth ( )
- Is there any coordination between village and FNC regarding LPG?
- What are your suggestions for the adoption of LPG?
1/ ………………………………  2/……………………………
3/……………………………  4/……………………………
- Are there times of LPG shortage? Why?
- What do you think are the disadvantages of Gabat-Gas?
- What are constraints confronting adoption of LPG?
- Is there any incident associated with adoption LPG?
- Comparing Gabat-Gas with other institutions; what are the differences?
 1-G-G better ( )  2-Others better ( )  3-No difference ( )
 4-Do not know ( )
- Have you received any message about improved stoves?
 1/Yes ( )  2/No ( )
- Have you received any training in improved stoves?
 1/Yes ( )  2/No ( )
- What do you think are the main disadvantages of improved stoves program?
 1/Extension message not enough ( )  2/Training not enough ( )
 3/Weak follow up ( )  4/Stoping of program ( )
5/others, specify…………………………………………………………
- What are the types of the stoves you have?
 1-Traditional stove ( )  2-Bucket stove ( )  3- Three-stone stove ( )
 4-Improved mud stove ( )  5-Improved charcoal stove ( )
 6-Improved kisra stove ( )
- Is it easy or difficult for you to afford improved stoves?
 1/Easy ( )  2/Difficult ( )
- What do you think about the price of improved stoves?
 1-Expensive ( )  2-Cheap ( )  3-Reasonable ( )
What do you think are the advantages and disadvantage of improved stoves?
 1-Save money ( )  2-Save time ( )  3-Safety ( )  4- Unmovable ( )
Which types of stoves do you preferred?
What do you think are the main reasons, behind the low adoption of improved stoves?

1-…………………   2-……………………..   3-………………
4-………………..   5-……………………….

- Kisra stove:
- If you have improved kisra stove, how many families are sharing the stove?
  1. One family ( )  2. (2-3) families ( )  3. (3-4) families ( )
  4. (4-10) families ( )
- The quantity of firewood per by improved kisra stove compared to traditional three stone stove?

<table>
<thead>
<tr>
<th>Type of stove</th>
<th>The old stove (Three stone stove)</th>
<th>Improved kisra stove</th>
</tr>
</thead>
<tbody>
<tr>
<td>KG</td>
<td></td>
<td></td>
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</tbody>
</table>

- Is the old stove (3-stones stove) still on using?
- What are the advantages of the improved kisra stove?

- Is there extension messages dealing with the improved cooking stoves?
- Have you receive any training on improved cooking stoves?

What the number of the sessions?

- Is the extensionist visits regular or sporadic?
- Is there application of incentives for the adoption of improve stove and LPG?

If, yes what are they?

Compare the amount used for cooking by traditional stoves and

1- LPG similar ( ) lower ( ) greater ( )
2- Improve stove similar ( ) lower ( ) greater ( )