DETERMINANTS OF INVESTING IN BIOGAS TECHNOLOGY AMONG RURAL HOUSEHOLDS OF LANET LOCATION, DUNDORI DIVISION, NAKURU COUNTY, KENYA.

BY

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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT,OF THE UNIVERSITY OF NAIROBI

2012

DECLARATION

I declare that this research is my original work and has not been previously presented for the award of any Degree in any other university.

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L50/65733/2010

This research Project report has been submitted for examination with my approval as a University Supervisor.

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DEDICATION

This research work is dedicated to my husband John Njoroge my sons, Collins Njoroge, William Thiong'o and Jim Lawrence Gioche. To my late parents Mr and Mrs Thiong'o whose desire was to see me attain higher levels in Education

ACKNOWLEDGEMENT

I give thanks, glory and honor to the Almighty God for this far he has brought me.

I wish to thank my Supervisor, Dr Raphael O. Nyonje for his wise counsel, support and encouragement. He was very patient with me by providing vital suggestions and comments that enriched my understanding of research work in a big way.

I also acknowledge and thank the entire team of lecturers, teaching various units in the Master of Arts in Project Planning and Management course for their Academic inspiration and exposure to new areas of knowledge hitherto unknown to me.

I cannot forget the support and encouragement from members' of my family particularly my husband, John Njoroge who sponsored me financially and I was able to go through the course. For my children, Collins, William and Jim, thank you for your moral support

Lastly, I appreciate the cooperation and the spirit of sharing among students taking M.A Degree in Project Planning and Management during the 2010/2011 Academic year. Our exchange of views and ideas added great value to my research work

To you all and those that I have not mentioned, but contributed to my success in one way or another, I thank you all.

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List of Acronyms and Abbreviations

GOK	Government of Kenya
MDG	Millennium Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organizations
RET	Renewable Energy Technologies
WHO	World Health Organization
GOI	Government of India
KENGO	Kenya Energy Organization
NGOs	Non Governmental Organizations
SEP	Special Energy Programme
MOERD	Ministry of Energy and Regional Development
GTZ	German Technical Assistance
KIE	Kenya Industrial Estates
TTL	Tunnel Technology Limited
USAID	United States Agency for International Development
KWAP	Kenya Wood fuel and Agroforestry Programme
BOD	Biochemical Oxygen Demand
UNDP	United Nations Development Programme
TAM	Technology Acceptance Model
PU	Perceived usefulness
PEOU	Perceived ease-of-use

ABSTRACT

Access to energy resources in Africa presents challenges to human health, environmental health, and economic development. In 21 sub-Saharan African countries, less than 10% of the population has access to electricity necessitating the need for adoption of alternative renew-able energy sources from locally available resources. Since the introduction of biogas technology into Kenya in the mid 1950s, only a small percentage of farmers have adopted the technology. With Kenya striving to achieve the millennium development goals of 2015 and Vision 2030 that seek to integrate the principles of sustainable development into the country's policies and programmes and further reverse loss of environmental resources, there is a need to understand concerns facing the Adoption of Biogas technology in rural households. The study adopted the *ex-post-facto* survey research design with the target population being rural households in Lanet Location, Dundori Division of Nakuru North District. A sample size of 324 households was selected from a population 6956 households. Data collection was done through structured questionnaires. The data collected from the field was then organized, coded and analyzed using qualitative techniques using the SPSS version 17 software. Findings revealed an overwhelming proportion 262 (80.9%) of the respondents affirming that their level of income did influence their decision on investment of Biogas with a skewed distribution of households in favour of households without biogas 246 (75.9 %) in relation to those that had adopted the same 78(24.1%). The costs of setting up a biogas unit was cited as a key impediment to the adoption of the technology in Lanet Location. Size of household land influence did not limit their decisions to invest in biogas technology. This is in spite of an overwhelming proportion of the respondents 225 (69.4%) indicating to owning land units of ¼ acre or less. This was an indicator that with better financial arrangements being made to residents, many would easily take up the use of biogas as opposed to other conventional sources of energy such as electricity and firewood. The study further indicates that in spite of the setbacks faced, many household are keen in embracing this technology that has the potential to counteract many adverse health and environmental impacts.

CHAPTER ONE
INTRODUCTION

1.1. Background to the Study

Rising oil prices in the 1970's triggered an interest in developing "commercial farm-scale" biogas systems in the United States. During this developmental period (1975-1990) approximately 140 biogas systems were installed in the United States, of which about 71 were installed at commercial swine, dairy, and caged layer farms. Examining past failures and successes led to improvements and refinements in existing technologies and newer, more practical systems (Diaho et al, 2005). Biogas accounts for around 8% of the electricity production generated from renewable energy sources in he USA. Recent developments have witnessed a new trend of adding food waste and other wastes with a rich organic content to manure digesters to increase Biogas output. The number of operational on-farm biogas digester Systems have increased substantially in the USA in the Last five years due to increased technical reliability and new federal / state programs and funding for farms installing anaerobic digesters (Swedish Trade Council, 2008). The number of renewable energy technologies including Biogas development in the UK have received a boost following revisions to the stringent bureaucracies that have long existed. Small-scale energy installations in England built on agricultural or forestry land will now be exempt from planning permission that are meant to result in a significant boost to the rural economy by removing legislative red tape, reducing energy bills for farmers and decreasing greenhouse gas emissions . This follows an awareness and understanding of the many benefits of anaerobic digestion among potential developers, investors, customers and those involved in planning decisions.(Biogas-info.co.uk,2012).

In India, Biogas systems have since the 1950s offered an integrated system that lends itself to a rural setting. The use of biogas systems in an agrarian community has continuously led to an increase in agricultural productivity. All the agricultural residue, and dung generated within the community are made available for anaerobic digestion, whereas previously, a portion would be combusted daily for fuel. It has been argued that large scale use of biogas and realization of its potential may not be possible in a distorted policy environment where alternative fuels, such as electricity, kerosene, diesel and LPG are subsidized and where fuel wood can be collected without much cost to the household which has been the case in many rural settings (Government of India, 2002). Lawbuary (2001) cited the presence of over 2.5 million biogas plants installed in India though the potential of large-scale implementation of biogas technology still remained unrealized. In 2008, the use of electricity for cooking, which includes biogas, only accounted for about 2% and 3% for rural and urban areas respectively sharply demonstrating the continued minority status of this alternative fuel. Estimates on the adoption of Biogas technology in Cambodia indicate that by the end of 2013, there will be an additional sustainable energy supply for at least 12,800 people living in the rural areas of Cambodia; the creation of forty companies constructing bio-digesters and employing at least 300 people. Further gains are expected in an annual reduction of fuel wood consumption by 6,350 tons; annual emissions reduction by at least 10,850 tons; and improvement in the health of bio-digester users (SNV, 2012)

Africa has substantial new and renewable energy resources, most of which are under-exploited. Based on the limited initiatives that have been undertaken to date, renewable energy technologies (RETs) have been cited to contribute significantly to the development of the energy sector in eastern and southern African countries. Renewable energy technologies are well suited for meeting decentralized rural energy demand and utilize locally available resources and expertise, and would therefore provide employment opportunities for the locals. (Karekezi & Kithyoma, 2003). Placing low income households at the center of energy, sanitation, and hygiene interventions offers opportunities to address multiple development priorities effectively and simultaneously using integrated approaches. In Sub-Saharan Africa, the majority of poor households lack basic cooking facilities and even the most rudimentary latrine and engage in poor hygiene practices. An estimated 80—90 % of African households rely on traditional biomass fuel (such as firewood, charcoal, dung, and agricultural residues) to meet their daily cooking needs (WHO, 2000).

Winrock (2007) indicates that global experience shows that biogas technology is a simple and readily usable technology that does not require overtly sophisticated capacity to construct and manage. It has also been recognized as a simple, adaptable and locally acceptable technology for Africa. The use of biogas technology has been argued to improve human well-being that comprises of improved sanitation, reduced indoor smoke, better lighting, reduced drudgery for women, and employment generation. The positive environmental gains includes: improved water quality, conservation of resources especially trees, reduced greenhouse gas emissions. Despite the recognized technical viability and acceptability of biogas technology in sub-Saharan Africa; the multiple benefits recognized by users, governments and NGOs; and the estimates of large potential markets, the technology has not been widely adopted by sub-Saharan African households. The key issue for biogas in Africa is to understand why large scale-up has not occurred despite demonstration by several programs of the viability and effectiveness of biogas plants. Most household biogas programs appear to have been part of agriculture or community development projects. Most have either not been intended as models for large scale replication or were implemented on the assumption that mere demonstration would lead to replication. Such projects did not include plans for continued growth in the biogas sector upon project completion. Most African governments could not continue to subsidize biogas programs fully. The energy poor in Africa spend about $17b a year on fuel for lighting like kerosene which has been argued can be considerably reduced by replacing such fuels with biogas. Biogas is the most effective way of converting on farm biological waste into fuel. Its use translates to increased incomes through reduction in energy costs, environmental conservation, and reduced labour demand on women, who often spend many hours searching for firewood.

White & College (2005) asserts that Biogas digester technology is an appropriate resource for rural agricultural development for several reasons namely: biogas can be produced using indigenous technology and locally available resources. Biogas poses significant economic, environmental and health benefits compared to traditional energy sources. Biogas digester systems have been shown to considerably enhance energy efficiency and agricultural productivity thus increasing rural household incomes and living standards and significantly reduce the need for conventional energy sources such as fuel wood, which degrades forest resources and requires hours of strenuous labor to collect.

Wood fuel in Kenya constitutes 90% of energy consumption in the rural areas with the demand growing at 3.6% per annum. The use of such fuel has significantly contributed to deforestation through felling of trees leading to a low forest cover in Kenya of less than 4% of the total land area compared to the world requirement of 20%.The rate at which wood fuel is obtained from forests has caused alarm since the 1970's due to lack of sufficient information that would lead to sustainability planning of forest resources (GOK, 2010). Biogas technology has been in Kenya since 1950's but is restricted to the highly productive areas of Kiambu, Nakuru and Kisii (Mulwa et al, 2010). The WHO estimates that 1.6 million deaths a year worldwide and 1.4 billion illnesses can be attributed to the household burning of such solid fuels (Desai et al 2004). Clearly, the health costs of bad indoor air quality can be detrimental to a rural family, making the transition to clean energy sources such as biogas even more pertinent. Biogas digesters are extremely effective at lowing indoor air pollution by converting renewable material (dung and other organic wastes) into a gaseous fuel that burns cleanly.

Different stakeholders ranging from government ministries such as energy, agriculture and livestock, to non-governmental agencies such as Kenya Energy Organization (KENGO), Green Africa Foundation and Vanilla Development Foundation and development partners such as German Technical Cooperation have contributed to the biofuel agenda in Kenya over the years. (Matere et al, 2009). The Government of Kenya has recognised the fact that there are significant economic and environmental benefits the country could derive from undertaking increased investment in clean energy through a combination of efficient energy use and increased use of indigenous forms of renewable energy mainly leading to a reduction in global emissions of Green House gases. The projects that have received funding include those exploiting Kenya's renewable energy which exists in abundance including such as geothermal, wind solar, biomass, solid waste and other recycled power generation facilities (Ochieng & Makoloo,2007). The national energy policy as outlined in Sessional Paper No.4 of 2004 and operationalized by the Energy Act No. 12 of 2006 encourages implementation of these indigenous renewable energy sources to enhance the country's electricity supply capacity. The Sessional Paper incorporates strategies to promote the contributions of the renewable energy sources in the generation of electricity. A survey on Biogas utilization in Kenya carried out by the Ministry of Energy in 1997 and the Kenya Biogas feasibility study of 2007 , funded by the shell foundation confirmed an immense potential and demand for this technology in most agriculture areas and further identified technical and financial constraints as salient challenges in the promotion and uptake of Biogas technology in Kenya (Mulwa et al ,2010).

1.2 Statement of the Problem

Majority of Kenyans live in rural areas where traditional biomas mainly wood fuel has remained the leading source of energy both for cooking and lighting. Continued overdependence on unsustainable wood fuel and other forms of biomas as the primary source of energy has contributed to uncontrolled harvesting of trees and shrubs with negative impacts on the environment(NEMA , 2005). Appropriate and economically feasible technologies that combine solid waste and wastewater treatment and energy production can simultaneously protect the surrounding water resources and enhance energy availability. Biogas is an energy technology that has the potential to counteract many adverse health and environmental impacts. Biogas as a renewable high quality fuel can serve as a suitable energy source for rural communities that most households with two or more cattle under zero grazing or more cattle under semi zero grazing can adopt , thus reducing the use of fossil-fuel-derived energy and reduce environmental impact, including global warming and pollution. Most research have revolved around the benefits of biogas technology but little evidence is available on the determinants of investing in biogas technology among rural households in Kenya. This study aimed at establishing the determinants of investing in biogas technology among rural households of Lanet Location, Dundori Division in Nakuru County Kenya.

1.3 Purpose of the Study

The purpose of this study was to investigate on the determinants of investing in biogas technology among rural households of Lanet Location, Dundori Division in Nakuru County.

1.4 Objectives of the study

The study was guided by the following objectives:

1. To determine the extent to which the level of education influences investing in biogas technology in rural household in Lanet Location.
2. To establish the extent to which perceptions of rural households influence investing in biogas technology in rural household in Lanet Location.
3. To determine the extent to which household income level influences investing in biogas technology in rural households in Lanet Location..

4. To determine the extent to which size of household land influences investing in biogas technology in rural household in Lanet Location.

1.5 Research Questions

The study was guided by the following research questions: -

1. To what extent does the level of education influences investing in biogas technology in rural households in Lanet Location?
2. To what extent do perceptions of rural households influence investing in biogas technology in Lanet Location?
3. To what extent do household income levels influence investing in biogas technology in rural household in Lanet Location?
4. To what extent does the size of the of the household land influences investing in biogas technology in rural households in Lanet Location?

1.6 Significance of the Study

This study may provide useful information to the policy makers and other stakeholders' on factors influencing investing in biogas technology among rural households in Nakuru North District. The results of this study may also contribute to the identification of key concerns affecting investing in biogas technology and possibly provide new insights on the best approaches in enhancing investing biogas technology in rural households. This will no doubt be a major contributor towards the economy in terms of employment creation, increased incomes; reduced pollution levels from the usage of fossil fuels and the creation of a green technology. The findings from the study is hoped to bridge the literature gap in the area of Biogas technology and also provide an important source of reference to various energy and agricultural players. This is in line with the achievement of the millennium development goals of 2015 and Vision 2030 that seek to integrate the principles of sustainable development into the country's policies and programmes and further reverse loss of environmental resources.

1.7 Limitations of the Study

The study was carried out with the following assumptions in perspective: -

The residents in sampled households for the study may not reveal all the relevant information on their investing in Biogas technology due to suspicion. The time frame available for the study may not be sufficient to reach all the households in Lanet Location as well as the development of research instruments. Tracing some of the households may also be a challenge to the researcher. Investing in biogas technology in households is dependent on many variables such as attitude, level of education among other factors that are therefore bound to affect findings of the study.

1.8 Delimitation of the Study

The study was carried out in Lanet location which is 15 km from Nakuru town along Nakuru Dundori road. I used a sample of 364 out of 6956 households in Lanet location. Survey method was employed to gather data from the sampled households and is an efficient method of collecting descriptive data regarding characteristics of the population, current practices, conditions or needs and preliminary information for generating research questions. The Instruments for collection of data comprised a structured questionnaire targeting households. The researcher employed the use of an introductory letter to create a good rapport with residents in the sampled units to facilitate easy collection of data from the field.

1.9 Assumptions of the Study

The assumption of this study was that: Government agencies ,Non Governmental Organizations', Private Companies and individuals have been involved in the promotion and dissemination of biogas technology in Lanet Location; the rural households in Lanet Location have invested in biogas technology; the rural households in Lanet would provide honest responses to questions asked by the researcher and that the instruments that would be used to collect data will help to identify determinants of investing in biogas technology among rural households in Lanet Location.

1.10 Definition of significant Terms

Investing in biogas- The decision by the household to use ones savings to construct/install and operate biogas plant.

Biogas Technology-An innovation used in production of biogas.

Level of Education –A Measure of formal education received.

Perception of household-views and opinions held by residents with regard to investing in biogas technology.

Household- the investor of the biogas technology

Household Income Level- Money or other economics at the disposal of household,

Size of Household land-How big or small the land of the household is.

1.11 Organization of the study

This project is organized into five chapters. Chapter one of this study contains background of the study, statement of the study, purpose of the study and research objectives. It also contains research questions which the study seeks to answer .It also outlines the significance of the study, basic assumptions, and limitations of the study, delimitation of the study and definition of the significance terms of the study

Chapter two dealt with literature review; under the themes of level of education on investing on biogas technology, perception of household on investing on investing on biogas technology, level of income on investing on biogas technology and size of household land on investing on biogas technology.

Chapter three dealt with methodology to be used in this study. It captured the research design, target population, sample size and sampling selection, data instruments, data collection procedures .data analysis techniques and ethical considerations made during the research process and finally operational definition of the variable used in the study.

Chapter four contains the data analysis, interpretation, and discussion while chapter five contains the summary of the findings, conclusion and recommendation. It also contains contribution to the body of knowledge and suggestions for further studies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents reviewed literature on previous studies relevant to Biogas technology. Variables and concepts that have been discussed include: definition of biogas energy; Influence of education on biogas technology; influence of perceptions on investing in biogas technology; Influence of income on investing in biogas technology; influence of the size of household land on investing in biogas technology and theoretical framework.

2.2 Biogas Energy

Biogas is produced by bacteria that break down organic matter in the absence of air. The process is referred to as anaerobic digestion and takes place in a closed tank called a digester. Biogas plants are sealed containers built specifically to create the anaerobic conditions necessary for digestion and controlled production of gas. Biogas is a mixture of methane (CHJ and carbon dioxide (C02), It is a high grade fuel used for cooking and lighting. The digested residue or sludge is a good quality fertilizer. Most common biogas plants must be fed daily with feed material or slurry to ensure continuous gas production. The slurry is a mixture of organic material and water, usually in equal proportions. Many types of organic materials such as coffee husks, sisal waste and animal dung can be used (Gitonga, 1997). Biogas is an energy technology that has the potential to counteract many adverse health and environmental impacts connected with traditional biomass energy in Kenya. The technology is a manure management tool that promotes the recovery and use of biogas as energy by adapting manure management practices to collect biogas. The biogas can be used as a fuel source to generate electricity for on-farm use or for sale to the electrical grid, or for heating or cooling needs.

A typical biogas system consists of manure collection where livestock facilities use manure management systems to collect and store manure because of sanitary, environmental, and farm operational considerations. Manure is collected and stored as either liquids, slurries, semi-solids, or solids. The manure is then directed to the digester which is a component of the manure management system that optimizes naturally occurring anaerobic bacteria to decompose and treat the manure while producing biogas. Digesters are covered with an air-tight impermeable cover to trap the biogas for on-farm energy use. The choice of which digester to use is driven by the existing (or planned) manure handling system at the facility. The digester must be designed to operate as part of the facility's operations. The products of the anaerobic digestion of manure in digesters are biogas and effluent. The effluent is a stabilized organic solution that has value as a fertilizer and other potential uses. Waste storage facilities are required to store treated effluent because the nutrients in the effluent cannot be applied to land and crops year round. The size of the storage facility and storage period must be adequate to meet farm requirements during the non-growing season. Facilities with longer storage periods allow flexibility in managing the waste to accommodate weather changes, equipment availability and breakdown, and overall operation management (Winrock International, 2007).

Biogas generation involves a gas handling system that removes biogas from the digester and transports it to the end-use, such as an engine or flange. Gas handling includes: piping; gas pump or blower; gas meter; pressure regulator; and condensate drain(s). Biogas produced in the digester is trapped under an airtight cover placed over the digester. The biogas is removed by pulling a slight vacuum on the collection pipe (e.g., by connecting a gas pump/blower to the end of the pipe), which draws the collected gas from under the cover. A gas meter is used to monitor the gas flow rate. Sometimes a gas scrubber is needed to clean or "scrub" the biogas of corrosive compounds contained in the biogas (e.g., hydrogen sulfide). Warm biogas cools as it travels through the piping and water vapor in the gas condenses. A condensate drain(s) removes the condensate produced. Recovered biogas can be utilized in a variety of ways. The recovered gas is 60 - 80 percent methane, with a heating value of approximately 600 -800 Btu/ft^3. Gas of this quality can be used to generate electricity; it may be used as fuel for a boiler, space heater, or refrigeration equipment; or it may be directly combusted as a cooking and lighting fuel. Electricity can be generated for on-farm use or for sale to the local electric power grid. The most common technology for generating electricity is an internal combustion engine with a generator.

2.3 Influence of Education on biogas technology

Continued over-dependence on unsustainable wood fuel and other forms of biomass as the primary sources of energy to meet household energy needs has contributed to uncontrolled harvesting of trees and shrubs with negative impacts on the environment (deforestation). Environmental degradation is further exacerbated by climate variability and unpredictability of rainfall patterns. In addition, continued consumption of traditional biomass fuels contributes to poor health among users due to excessive products of incomplete combustion and smoke emissions in the poorly ventilated houses common in rural areas. Biogas is an energy technology that has the potential to counteract many adverse health and environmental impacts connected (NEMA, 2005). The study by Shell foundation in 2007 noted a low level of education among the targeted population owing to the scarce and fragmented promotional activities by agencies promoting the energy. Institutions promoting the technology were found to be relatively few. Poor dissemination strategy by promoters was also rife. Biogas demonstrations are carried out with little or no digester research and development to understand quality and end use issues (Shell Foundation, 2007 & Hankins, 1987).

Evidence from the UK indicate a history of local communities opposition to renewable energy sources of energy particularly with regard to wind power schemes and biomass plants (Upreti 2004, Upham and Shackley 2006).Debates about the social acceptance of new energy developments are not new and not confined to renewable energy (Wüstenhagen et al 2007). The opposition was premised based on arguments against the siting of waste disposal facilities as well as the potential risks to the environment and health, noise and odour, and the lessening of community image (Lober 1995, Butler et al. 2008).

There is growing consensus among policy makers that efforts to disseminate RETs in Africa have fallen short of expectations. While it is recognised that RETs cannot solve all of Africa's energy problems, RETs are still seen as having a significant unexploited potential to enable Africa countries to meet their growing energy requirements. Renewable energy is already the dominant source of energy for the household sub-sector (biomass energy). If properly harnessed, it could meet a significant proportion of energy demand from the industrial, agricultural, transport and commercial sub-sectors. Despite recognition that they are important sources of energy for sub-Saharan Africa, RETs have attracted neither the requisite level of investment nor tangible policy commitment. Although national and international resources allocated to developing, adapting and disseminating RETs in the last two decades may appear substantial, the total amount is still insignificant compared to that allocated to the conventional energy sector. The success of RETs in the region has been limited by a combination of factors which include: poor institutional framework and infrastructure; inadequate RET planning policies; lack of co-ordination and linkage in RETs programmes; pricing distortions which have placed renewable energy at a disadvantage; high initial capital costs; weak dissemination strategies; lack of skilled Manpower; poor baseline information; and, weak maintenance service and infrastructure. (Ochieng & Makoloo, 2007).

A study by the Shell foundation in 2007 cited several challenges facing the promotion and uptake of biogas technology that included namely poor management and maintenance emanating from lack of proper knowledge. For optimal production, a certain level of management both for the zero-grazing units and the digesters was needed but with so many competing uses for rural farm labour, management of the digesters was bound to suffer. The findings indicated that households were content to get 'acceptable' and not 'optimal' levels of production from their investments in the biogas technology. Poor maintenance was cited as a key challenge with digesters being built without proper explanation to users on how to care for them. In other cases people simply stop maintaining them, especially the repair of the gasholder. The study further noted that many potential users of the technology were found not aware of the technology with many having not seen it. There were proportions that were ignorant about how it operates/works and its benefits and personal relevance to them.

2.3.1 Policy context on Biogas Technology in Kenya

The first attempt to prepare a policy paper on energy was made in 1987, to, among other things, mitigate the adverse effects of oil importation on the domestic economy and balance of payments and the need to have a consistent policy on energy to ensure security of supply, efficient but affordable pricing and accelerated development of indigenous resources including the search for domestic fossil fuels. New challenges associated with liberalization of the economy in the 1990s, including deteriorating balance of payments, economic stagnation, rising population, rising poverty, electricity rationing and outages, dwindling official development assistance, deforestation and the recently observed phenomenon of climate change called for a new energy sector development strategy based on prudent integrated policies consistent with broader government policies on socio-economic development. In keeping with the Government's Economic Recovery Strategy for Employment and Wealth Creation, the Session Paper No. 4 of 2004 on Energy was developed spelling out the Government's aspirations towards provision of quality, adequate, sustainable, cost-effective and affordable energy services for socio-economic growth. The Session Paper points out that despite the potential benefits of biogas, the penetration rate of biogas technology is still very low and attributes this to poor management, high initial capital costs, high maintenance costs, limited water supply and weak technical support. The Energy Act 2006 has provisions for promotion of renewable energy, which includes biogas. However, the necessary legal and regulatory framework for biogas still needs to be put in place. Some of the biogas companies have come together to form a biogas installers network, which intends to collaborate with the Ministry of Trade and the Kenyan Bureau of Standards to develop standards and ensure that members operations conform to these standards (GOK, 2003).

Karekezi & Kithyoma (2003) indicates that experience in the region shows that the introduction and success of any renewable technology is to a large extent, dependent on the existing government policy. Government policies are an important factor in terms of their ability to create an enabling environment for RETs dissemination and mobilizing resources, as well as encouraging private sector investment (Sampa and Sichone, 1995). Most of the early policy initiatives on renewables in the region were driven by the oil crises of the early and late 1970s. In response to the crisis, governments established either an autonomous Ministry of Energy or a department dedicated to the promotion of sound energy policies, including the development of

RETs. For example, Zambia responded by outlining policy proposals in its Third National Development Plan (1979-83) to develop alternative forms of energy as partial substitutes for conventional energy resources. Unfortunately, once the energy crisis subsided, government support for energy development and RET activities diminished significantly. Now most of the remaining support is at rhetorical level. Most governments do not have a clear-cut policy on the development and promotion of RETs, which continue to be undertaken within an energy planning and policy vacuum (Karekezi, 1988). A survey carried out in Botswana revealed that about 57% of the respondents had no knowledge of government policies designed to promote the use of RETs (Mosimonyane, 1995). In Malawi the policy vacuum has meant that the majority of RETs dissemination efforts have not only been *ad hoc*, but have operated largely as informal sector activities outside the framework of government machinery, thus failing to mobilise the fiscal support of the central government and its major donors (Kafumba, 1994). A study on wind energy undertaken in Kenya showed that Dutch aid officials would have been interested in financing wind projects if there was an official wind energy policy strongly supported by the Government (IT Power, 1987).

Limited policy support for renewables is further demonstrated by the low budgetary allocations to renewables in most countries. Most countries place more emphasis on the petroleum and power sectors, which supply a small portion of the population, than on renewables (especially biomass) which supply a large portion of the population. Very little expenditure is allocated to small and medium scale renewable energy technologies as compared to the conventional energy sector. For example investment trends in Ethiopia's energy sector reveal heavy investments in the electricity and petroleum sub-sectors. In contrast, expenditure on traditional and alternative energy (which includes RETs) has steadily decreased from about 1% of total expenditure in 1990 to 0.1% of total expenditure in the year 2000 (Wolde-Ghiorgis, 2002).

2.3.2 Technical Barriers

The introduction of unfamiliar technologies such as RETs requires the development of technical skills. The importance of technical know-how in the increased utilisation of RETs has been recognised in the region, but in spite of efforts by governments, there is a continuing shortage of qualified personnel (Baguant and Manrakhan, 1994). Technical knowledge is important in order to build over the long term, a critical mass of professional African policy analysts, economic managers and engineers who will be able to manage all aspects of the RET development process and to ensure effective utilisation of already trained African analysts and managers (World Bank, 1991). Trained manpower capable of developing and manufacturing renewable energy technologies is a prerequisite for their successful dissemination. Government and ministries in Africa suffer from a shortage of qualified RETs personnel. In Kenya, for example, there is a lack of general expertise in all aspects of wind pumps in the relevant ministries and NGOs (IT Power, 1987). In Zambia, at one time, only one engineer was responsible for co-ordinating all renewable energy activities of the government (Sampa and Sichone, 1995). A British-financed project to map out the wind regime in Seychelles was unsuccessful due to the absence of trained personnel (Razanajatovo et al, 1994). This deficit is largely responsible for the generally under developed research and technological capability and the poor management of renewable energy programmes. Given the limited technical expertise in the formal sector, the situation in the informal sector presents a greater challenge. In the case of the informal sector, technical skills are largely mechanical. Thus, electrical technologies are more difficult to grasp for artisans in the informal sector, as well as majority of end users, especially in rural areas. This may explain the low uptake of electrical RETs such as solar PV and wind generators. These technologies are fairly complex, and with the shortage of technical skill, result in the reliance of expatriates or individuals based in urban areas. The departure of the outsiders often leads to the demise of the RET projects. This is exemplified by a case in Kenya, where an expatriate developed a low-cost, locally made control unit for PV lighting systems; on his departure, production stopped and has not resumed since (Karekezi and Maskhwe, 1991). Numerous examples of similar situations are common in the continent. The level of technical expertise existing in African countries is a key prerequisite for the successful implementation of RETs.

2.4 Perception of Households on Biogas Technology

Perception may be defined as the process by which individuals select, organize, and interpret the input from their senses to give meaning and order to the world around them. Components of perception include the perceiver, target of perception, and the situation. Factors that influence the perceiver include Schema which refers to organization and interpretation of information based on past experiences and knowledge. Motivational state further influences perception which refers to the needs, values, and desires of a perceiver at the time of perception. Mood status or emotions of the perceiver at the time of perception, ambiguity or the lack of clarity and social status in society or in an organization has long been viewed as a key determinant in perception (Leary, 1996).

Studies have shown that successful investment in technology can reap immense benefits for the adopting individuals and organizations. The primary concern of innovation diffusion research is how innovations are adopted and why some innovations are adopted at a faster or slower rate than others. As people evaluate an innovation, they decide whether to adopt or reject the innovation. Once adopted, the decision can also be reversed at a later time. The decision to reject an innovation once it had been previously adopted is called discontinuance. The rate of adoption is the relative speed with which an innovation is adopted by members of the group. It is usually measured by the number or percentage of individuals who adopt an innovation in a specified time period. When the cumulative number of adopters is plotted over time, the result is generally an s-shaped curve. The slope of the s-curve represents the adoption rate that may vary from innovation to innovation. Rogers (1983) identifies five perceptual characteristics of innovations that help explain differences in adoption rates: relative advantage, compatibility, complexity, trialability, and observability.

2.5 Influence of the Level of Income and Biogas Technology

The challenge of financing projects for RETs is to develop models that can provide these technologies to consumers (including the very poor) at affordable prices while ensuring that the industry remains sustainable. Most advanced and electrical RETs are not affordable to majority of the population in Africa who are poor, with national poverty levels of 50-70% (World Bank, 2001). This is especially true for RETs that have high cost imported components, than for those that can be locally manufactured and assembled using locally available components. Banking institutions normally lay down strict conditions for RETs investors and this deters potential users. Conditions required included a feasibility study conducted at the applicant's expense, due to the limited knowledge on renewables by banks. In addition, the banks required land titles as collateral, portfolios of project sponsors and managers, data on past and current operations, approximate value of existing investment, a valuation report, raw material procurement plans, and the marketing strategy for the finished product (Turyareeba, 1993). In cases where financing mechanisms are provided for end users, these are often not within the reach of the majority of the population. For example, the UNDP/GEF PV project in Zimbabwe benefited mainly affluent rural households, since over 80% of rural population could not afford the smallest system even at the cheapest rates. Stringent requirements for loan applications excluded the majority of the rural population from qualifying (Mulugetta et al, 2000; Mapako, 2001). In another study on the viability of PV in Manicaland, Zimbabwe, 65% of the rural population could not afford to pay the solar service fee (the lowest cost possible for providing PV-based electricity), while 91.5% could not afford a credit scheme (Cloin, 1998).

In Kenya, biomass (mostly wood fuel) accounts for about 68 percent of the total primary energy consumption, followed by petroleum at 22 percent, electricity at 9 percent and others at about less than 1 percent. In rural areas, the reliance on biomass is over 80 percent. Only approximately 15 percent of Kenyans have access to grid electricity. Access to affordable modern energy services is constrained by a combination of low consumer incomes and high costs. In the rural areas where only about 4 percent of the population has access to electricity, the scattered nature of human settlements further escalates distribution costs and reduces accessibility. The majority of Kenyans live in rural areas where traditional biomass (mainly wood fuel) has remained the leading source of energy (both for cooking, and at times for lighting). However, the potential of biomass has not been effectively utilized in the provision of modern energy for a variety of reasons. One is the failure to exploit the opportunities for transforming wastes from agricultural production and processing into locally produced modern energy. High incidence of poverty is another constraint to shift from traditional to modern biomass energy utilization (NEMA,2010).

The approach of biogas technology's economic evaluation incorporates the investment in the wider context of the economy's overall fuel and rural development policies. It can also be treated as a microeconomic problem in which the returns to a safe investment are examined at a specific location and within specific economic conditions (Mwirigi, Makenzi & Ochola, 2009). In this case, widespread adoption of the technology at individual level would have a positive impact on the overall energy balance of the country. In deciding whether to develop or adopt a new technology, individual entrepreneurs engage in calculations of expected benefits and expected costs to themselves and if the former is likely to exceed the latter then they adopt the technology (Teich, 1990). This is referred to as cost/benefit analysis. The socio-economic status of a household is based on family income, parental education level, parental occupation and social status (Demarest et al., 1993). A study by Campbell and Brue (2005) assessed a number of socio-economic factors of the study group with an aim of determining their effect on adoption of biogas technology and sustainability of the constructed plants which revealed a salient economic consideration as being that of opportunity cost. This is the value of the next best alternative foregone because of making a decision. Apart from monetary and material terms, opportunity cost evaluation is also in terms of anything that is of value. An example is that wood users generally regard firewood as a free good in spite of the fact that collection of sufficient firewood for a household uses many hours. In some regions, some households gather wood fuel. In this case, the opportunity cost is the value of the time spent in fuel gathering, time that might be spent on an alternative use."

Drechsel et al. (2005) assert that land tenure and time horizon has a strong influence on the adoption of technologies. An example is that of technologies which are inherently long term and therefore require security over land for an extended period. Many farmers may lack the land security and may therefore be unable to invest in such technologies. In the study by the Ministry of Environment in 2005, land tenure security was through ownership of land title deed. In Kenya, some of the socio-economic factors reported to be a constraint to the biogas technology adoption include high initial investment cost, negative image caused by failed biogas plants and limited private sector involvement (MOE, 2004). Despite these revelations, the adoption of the technology by farmers has remained low. The study explored the effect on adoption by other socioeconomic factors such as level of education of the household head, family income and farming system. They also extended to farm size and tenure security as well as the number and cost of animals.

Biogas technology has been actively promoted in Kenya since early 1980s. However, despite this and the apparent potential, technology uptake has been slow. A study by the Shell foundation in 2007 identified several challenges facing the promotion and uptake of biogas technology key among them being the high costs of installing the systems. Installing any biogas technology in Kenya was cited as expensive with the market for biogas technology being limited to those who can afford other sources of modern energy such LPG. Approximate costs of LPG then was €55 for a cooker, €65 for a 15kg cylinder, then €14-15 per refill plus transportation expenses which were around €1.30 per round trip in Kisii Central in a minibus taxi. A 15kg cylinder can last about a month, if used only for tea and light meals. Currently, there is a lack of capacity to install high volumes of biogas, creating a need to increase the number of technicians/artisans.

2.5.1 Financial Barriers

Financing plays a major role in the formulation of RET policies. Studies have shown that one of the main obstacles to implementing renewable energy projects is often not the technical feasibility of these projects but the absence of low-cost, long-term financing (News at Seven, 1994). This problem is complicated by competition for limited funds by the diverse projects and becomes critical if the country is operating under unfavorable macro-economic conditions. Governments and private enterprises must therefore seek creative ways of financing RETs projects.

2.6 Influence of the Size of Household Land and Biogas Technology

Economically, the evaluation of biogas technology can be approached as a macroeconomic problem incorporating the investment in the wider context of the economy's overall fuel and rural development policies. It can also be treated as a microeconomic problem in which the returns to a safe investment are examined at a specific location and within specific economic conditions (Barnet *et al.*, 1978). In deciding whether to develop or adopt a new technology, individual entrepreneurs engage in calculations of expected benefits and expected costs to themselves and if the former is likely to exceed the latter then they adopt the technology (Teich, 1990). This is referred to as cost / benefit analysis. Another economic consideration is that of alternatives where the evaluation of the impact of an investment is in principle the comparison of the investment with the next least expensive investment alternative. Land tenure and time horizon also affect the adoption of technologies. An example is that of technologies that are inherently long term and which require security such as land tenure. Many farmers are resource poor and may lack the land security and may therefore be unable to invest in such technologies. Perception and values also affect the adoption of technologies. A farmer's individual perception of the degree of a given problem affects his or her decision of possible solutions. The same applies to a farmer's preferences for certain technologies based on real experience or characteristics of a technology such as complexity; trouble free and comparative advantages (Drechsel *et al.*, 2005)

2.7 Theoretical Framework

How and why individuals adopt innovations has motivated a great deal of research. The study is built on one theory namely the Technology Acceptance Model (TAM).

This is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use the same. TAM helps to understand the role of perceptions such as usefulness and ease of use in determining technology adoption and theories that external variables influence behavioral intention to use, and actual usage of technologies, indirectly through their influence on perceived usefulness and perceived ease of use. Perceived Risk is taken as direct determinant of Attitude toward adoption of technology as in the original model of Technology Acceptance Model (TAM), Perceived Usefulness and Perceived Ease of Use are taken as direct determinant of Attitude toward using. The modified model of TAM with an additional construct of PR is shown in Figure 2.1

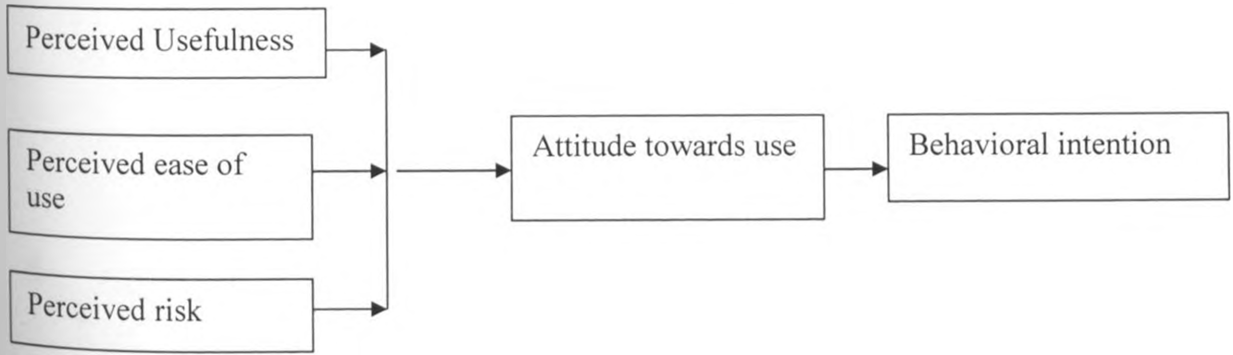

Figure 2.1. Modified model of Technology Acceptance Model (TAM)

2.7.1 Perceived usefulness (PU)

This was defined by Davis (1989) as "the degree to which a person believes that using a particular system would enhance his or her job performance". The technology acceptance model has identified the role of the perceived usefulness and perceived ease-of-use constructs in the adoption process of new technology. Whereas past research has been valuable in explaining how such beliefs lead to system use, it has not explored how and why these beliefs develop. The Technology Acceptance Model (TAM) represents an important theoretical contribution toward understanding usage and acceptance behaviors.

2.7.2 Perceived ease-of-use (PEOU)

Davis (1989) defined this as "the degree to which a person believes that using a particular system would be free from effort. Perceived ease of use has been identified as one of the key factors that motivates' individuals to accept and use specific technologies. Studies have found PEOU to be influenced by characteristics of the technology on one hand, and individual differences among the prospective users on the other hand (Hong et al., 2002). Individual differences such as personality traits determine how individuals think and behave in different situations. Therefore, personality traits are commonly used in psychological research to explain beliefs and behavior. Introduction of new technologies often involves some form of change for users. Therefore, the recent identification of the resistance to change (RTC) personality trait, and the development of a scale to measure it, provides an opportunity to assess the impact of RTC on the PEOU of users.

2.8 Conceptual Framework

The conceptual framework is based on the premise that the independent variables influence investing in Biogas technology in rural households .The intervening variables may also influence the investing in Biogas technology.

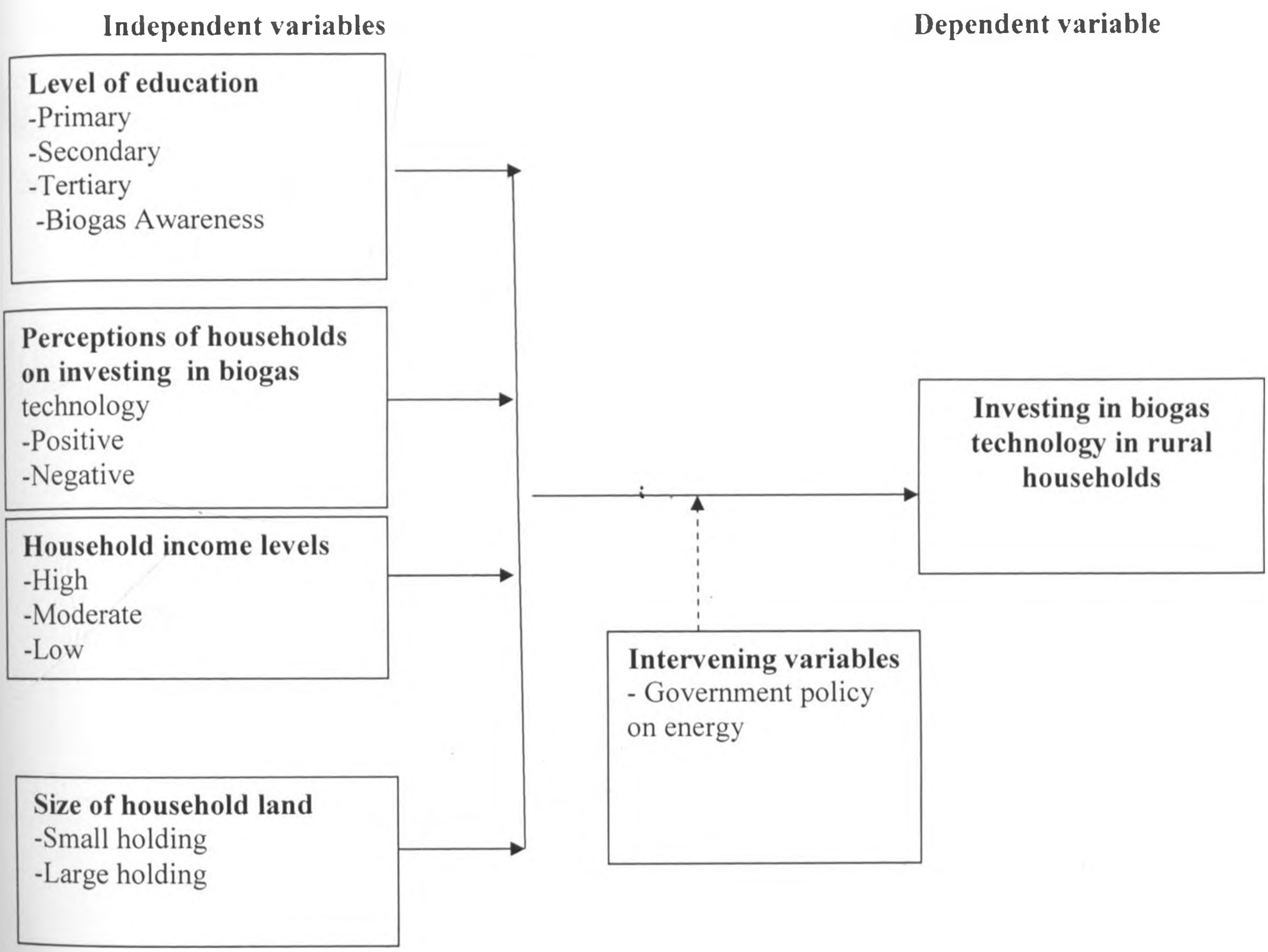

Figure 2.2: Conceptual framework

This study was guided by the conceptual framework which has the following independent variables: Level of education , Perceptions of households, Household income levels and size of household land interacting with intervening variables –government policy on energy- to give an effect on dependent variable-Investing on biogas technology. Level of education of investors is bound to affect their adoption of biogas technology since those with formal education have access to information and therefore more likely invest in biogas unlike those without formal education. How people react when presented with biogas technology will depend on their attitudes or perceptions regarding it use, cost among other factors. Perceptions may either be positive leading to their investing in the technology or negative which may mean their declining to invest. House hold incomes play an important role in determining the decision to either invest or not based on the amount of disposable income available as well as priorities that require allocation of scarce resources within the household. The size of the land available may play a critical role in determining the investment in biogas technology as this may influence the number of cows a particular size may optimally hold. This may therefore mean that the size of the land is critical in the adoption of biogas technology

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology techniques that were used to carry out the research. It contains the research design, target population, sample size, sampling design, and data collection instruments, piloting, and data collection procedures and data analysis.

3.2 Research Design

The Ex post facto research design was employed for the study; According to Kothari 2004 this design examines the effects of a naturally occurring treatment after changes have occurred rather than creating a treatment. Ex-post facto design is used to explore possible cause and effect relationship among variables that cannot be manipulated by the researcher. Survey method was employed to gather data from the sampled households. Survey type of research describes an existing phenomenon and is also referred to as normative or status study. According to Kathuri & Pals (1993) indicates that surveys are used to gather systematically factual information necessary for decision making. They are an efficient method of collecting descriptive data regarding characteristics of the population, current practices, conditions or needs and preliminary information for generating research questions. Mugenda and Mugenda (1999) argue that the method is often used because many of the cause and effect relationships that the study undertakes do not permit experimental manipulation.

3.3 Target Population

The target population comprised 6956 households drawn from Lanet location, according to 2009 population and housing census (Republic of Kenya,2009).Majority of the population have cows and chickens in their homes .

3.4 Sample Size and Sampling procedures

A sample of 364 households was derived. The determination of sample was done using Cochran's (1977) formulas. In Cochran's formula, the alpha level is incorporated into the formula by utilizing the t-value for the alpha level selected (e.g. t-value for alpha level of 0.05 is

1.96 for sample size above 120). For categorical data, 5% margin of error is acceptable (Krejcie & Morgan 1970). Cochran's sample size formula for categorical data is:

$$n = \frac{(t)^{2} * (p)(q)}{(d)^2}$$

$$n = \frac{(1.96)^2 (.5)(.5)}{(.5)} = 384$$

n= the desired sample size

t= value of selected alpha level of .025 in each tail=1.96 (the alpha level of .05 indicates the level of risk the researcher is willing to take ,true margin of error may exceed the margin of acceptable margin of error

(p)(q) =estimate of variance =.25. (Maximum possible proportion (.5)* 1-maximum possible Proportion (.5) produces maximum possible sample size)

d=acceptable margin of error for proportion being estimated=.05? (Error researcher is Willing to accept)

Therefore, for a population of 6956, the required sample is calculated as follows:

$$n_f = \frac{n}{(1+n / Population)}$$

$$n_f = \frac{384}{(1+384/6956)} = 364$$

Using the Krejcie and Morgan sample size table, the researcher found that the sample should be 364 households (Krejcie & Morgan, 1977). This is supported by what was calculated by using Cochran's (1977) formula.

Systematic sampling technique, which according to Orodho (2008) involves selecting members at equal intervals by picking some random point in the list and where then every *nth* element is selected until the desired sample size is obtained, was used to determine the representative sample of 364 out of 6956 households. The researcher systematically selected households at an interval of 19 from the sampling frame that included all households in the study location. This was done picking individual units until the last household to arrive at a sample of 364.

3.5 Data Collection Instrument

The Main instruments for collection of data comprised a structured questionnaire targeting households. Items included in the instruments were designed in a way to be relevant in achieving the research objectives outlined in chapter one. The questionnaire comprised of five sections: personal characteristics of the household respondents, level of education and technological knowhow, perceptions of respondents, level of income of respondent and size of household land of respondents.

3.5.1 Pilot Testing of the instrument

Piloting ensures that research instruments are stated clearly and have some meaning to the respondents (Mugenda & Mugenda, 1999). The research instruments were pilot tested in five households in Dundori Location, Nakuru North District that had similar characteristics as Lanet location in terms of rural setting with numerous households with zero grazing units.

3.5.2 Validity of the instrument

Best and Khan (1989) observed that validity is the extent to which an instrument measures what it is supposed to measure. According to Borg and Gall (2003), validity is the degree to which the sample of test items represents the content that the test is designed to measure. To ensure validity the researcher sought the expertise of an expert regarding the test items included in the questionnaire in order to establish their relevance in relation to the subject matter on biogas investment. The researcher further employed the use of simple language so as to make the questions easy for the respondents to understand and provide feedback on the test items used.

Side notes were also employed to clarify words appearing complex to respondents. This was to ensure that all objectives were adequately covered by the items in the instruments.

3.5.3 Reliability of the Instrument

Reliability may be defined as the degree to which test scores are free from measurement errors referred to as random error (Kathuri & Pals, 1993). The purpose of piloting was to improve on the research instruments in order to realize the research objectives. Cronbach's alpha reliability coefficient was employed to test the internal consistency. A threshold of reliability coefficient of 0.734 was established which was above the threshold of 0.7 as recommended by Borg and Gall (2003).

3.6 Data Collection Procedures

A research permit was sought from National council of science and technology and a letter of authorization from Nakuru North District Officer under whose jurisdiction Lanet Location falls. The initial step involved getting in touch with local Public administrator namely the chief and village headmen with an introductory letter and an explanation of the intended research. This then made it possible to reach out to the sampled households. The researcher then distributed the questionnaires over a period of two weeks

3.7 Ethical consideration

Project research authorization was obtained from the Provincial Administration. A copy of the letter of authorization has been appended (Appendix B).The researcher gave an assurance to the respondents regarding confidentiality regarding the information to be obtained.

3.8 Operation definition of variables

Table 3.1 gives the variables indicators, means of measurement, measuring scale and tools analysis. An operational definition is a demonstration of a process such as a variable, term or object in terms of the specific process or set of validation test used to determine its presence and quantity.

Table 3.1: Operational Definitions of Variables and Measuring Indicators

Research Questions	Independent Variable	Indicators	Measurement	Measurement scale	Tools Analysis
To what extent does the level of education Influence investing in biogas technology in rural households in Lanet Location?	Level of education of respondents	Education	Formal, primary, Secondary, tertiary	Nominal	Descriptive statistics Frequency percentages
To what extent do perception of rural households influence investing in biogas technology in Lanet Location?	Perception of household	Perceptions	Biogas usage, savings on energy, keen on expanding biogas unit, NGOs support, maintaining biogas, subsidy from government, cost of putting up biogas	Nominal Likert scale	Descriptive statistics Frequency percentages
To what extent do household income levels influence investing in Biogas technology in Lanet Location, Dundori Division in Nakuru County?	Income levels of households	Household Income	Salary ranges in ksh	Nominal Scale, ordinal	Descriptive statistics Frequency percentages

To what extent does the size of the farm influence investing in Biogas technology in households in Lanet Location, Dundori Division in Nakuru County?	Size of household land	Size of household land	Farm sizes in acres	Nominal, Scale	Descriptive statistics Frequency percentages

3.9 Data Analysis

The data collected from the field was organized, coded and analyzed using qualitative techniques using the SPSS version 17 software. Coding involved assigning values to the responses made by the respondents on the questionnaires. This made it possible to enter the raw data on the SPSS data sheet allowing for subsequent analysis generation of summaries using frequencies and cross tabulations. This then aided in the write up of the report and drawing of conclusions and recommendations

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents data analysis, interpretation and discussion. This section has been presented in the following themes namely introduction, questionnaire return rate, demographic information, extent to which level of education influences investment in biogas technology, extent to which perceptions of rural households influence investment in biogas technology, extent to which household income levels influence investment in biogas technology in rural households and extent to which the size of the of the household land influences investing in biogas technology in rural households in Lanet Location.

4.2 Questionnaire Return Rate

A total of 364 of rural households in Lanet Location in Nakuru County were sampled. However, out of the target respondents, only 324 were able to participate in the process, representing 89% as shown in table 4.1. This was a good return rate (Kothari,2008).

Table 4.1: Questionnaire response rate

The response rate of the study consists of retuned and not returned questionnaires. A total of 364 questionnaires were given for the survey, out of the 364 only 324 were returned.This was a good and high response rate(Kothari,2008).

Response	Frequency	Percentage
Returned	324	89
Not returned	40	11
Total	364	100

The high rate of response was achieved through the cooperation of respondents who set aside their daily chores to answer the questionnaires. A high rate of response was achieved because questionnaires were personally distributed and collected from respective by the researcher and her assistants. I am also a resident in Lanet and I have created good rapport with the residents.

4.3 Demographic Information

In this section the researcher sought to know information on; Gender, age and area of residence of respondents.

4.3.1 Age of respondents

The sampled respondents were asked to indicate their ages in order to understand how different segments of the population in terms of age`s perceived investing in biogas technology and response were summarised in table 4.2.

Table 4.2: Age group of respondents cross tabulated with investment in Biogas Technology

Table 4.2 shows Age group of respondents cross tabulated with investing in biogas technology. The researcher wanted to know whether different age groups influenced investing in biogas technology

Age in years	Investment in Biogas		
	Yes	No	Total
Below 25 years	2	1	3
	0.6%	0.3%	0.9%
25 to 30 years	2	19	21
	0.6%	5.9%	6.5%
31 to 40 years	16	63	79
	4.9%	19.4%	24.4%
41 to 50 years	29	97	126
	9.0%	29.9%	138.9%
above 50 years	29	66	95
	9.0%	20.4%	29.4%
Total	78	246	324
	24.1%	75.9%	100%

In Table 4.2, the age groups with the highest ratings in terms of investment in biogas accounted for 29(9%) respectively comprised those between 41 to 50 years and above 50 years the researcher and her assistants. I am also a resident in Lanet and I have created good rapport with the residents.

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	4.9%	19.4%	24.4%
41 to 50 years	29	97	126
	9.0%	29.9%	138.9%
above 50 years	29	66	95
	9.0%	20.4%	29.4%
Total	78	246	324
	24.1%	75.9%	100%

In Table 4.2, the age groups with the highest ratings in terms of investment in biogas accounted for 29(9%) respectively comprised those between 41 to 50 years and above 50 years as opposed to 16 (4.9%) and 2 (0.6%) in the age groups of 31 to 40 years and those aged below 30 years and below. The age groups below 30 years reported significantly low proportions of respondents having invested in biogas technology. This suggested that the technology was more acceptable to relatively older populations that seemed to have invested more in the technology as opposed to the younger generations.

4.3.2 Distribution of respondents based on gender

The respondent's gender was essential in order for the researcher to understand how different people adopt biogas technology based on their gender. This was analyzed and the findings presented in table 4.3.

Table 4.3: Cross tabulation based on Gender distribution of respondents in relation to Usage of Biogas in homestead

	Usage of Biogas in homestead		
Gender distribution	Yes	No	Total
Male	41	77	118
	12.7%	23.8%	36.5%
Female	37	169	206
	11.4%	52.2%	63.6%
Total	78	246	324
	24.1%	75.9%	100.0%

The study sought to determine the distribution of the sampled respondents based on their gender distribution. Findings from the study sample indicated that 206(63.6 %) were females while the males accounted for 118(36.4 %). This indicated a relatively skewed distribution in favor of the females while their male counterparts formed a minority of the study sample. The findings further indicated an almost fair distribution of males and females in the households who had invested in biogas accounting for 41(12.7%) and 37(11.4%) respectively. It is therefore evident that no status of gender did not feature highly as a factor in determining whether to invest in biogas or not as the responses from both sexes were fairly distributed.

4.3.3 Distribution of respondents by forms of energy used

An examination of the forms of energy used in households in Lanet was done with respondents being requested to indicate the various forms used from list given.

Table 4.4: Forms of energy used by respondents

Distribution of Respondents based on forms of energy used in homestead. Six forms of energy were used in lanet households; firewood, electricity, charcoal, kerosene/paraffin, gas and biogas

Forms of Energy	Frequency	Percentage
Charcoal	208	64.2
Electricity	182	56.2
Gas	149	46.0
Firewood	147	45.4
Biogas	80	24.7
Kerosene/Paraffin	53	16.4

Table 4.4 findings indicated that charcoal and electricity were the most popular accounting for 208(64.2 %) and 182(56.2 %) respectively. The usage of gas and firewood also received high ratings in terms of usage accounting for 149(46.0 %) and 147(45.4%) respectively. The usage of Biogas and kerosene as forms of energy accounted for the least proportion of 80(24.7 %) and 53(16.4 %) respectively.

These findings agree with the report that wood fuel in Kenya constitutes 90% of energy consumption in the rural areas with the demand growing at 3.6% per annum that has significantly contributed to deforestation through felling of trees leading to a low forest cover (GOK, 2010).It is evident that Biogas adoption still appears to be quite low in Lanet Location calling for the need to address the concern as it appears that other forms of energy have had a dominance.

4.4 Extent to which level of education influences investing in biogas technology in rural Households in Lanet Location

An analysis of extent to which the level of education influences investment in biogas technology was done. This was established through cross tabulating the responses given by the sampled households in Lanet location. The respondents were asked to indicate their highest level of education as well as indicate whether they used biogas in their homestead or not.

Table 4.5: Highest level of Education Cross tabulated with use of biogas at home

Table 4.5 shows highest level of education cross tabulated with use of biogas in your home.

	Highest level of Education				
Usage of Biogas in the home	non formal	Primary	secondary	Tertiary	Total
Yes	5	4	40	29	78
	1.5%	1.2%	12.3%	9%	24.1%
No	19	11	105	111	246
	5.9%	3.4%	32.4%	34.3%	75.9%
Total	24	15	145	140	324
	7.4%	4.6%	44.8%	43.2%	100.0%

Majority of the respondents 246(75.9%) acknowledges that they do not use biogas, those who use biogas were 78(24.1%). Majority of those who use biogas in their homes had secondary education 40(12.3%) followed by those educated up to tertiary level 29(9%), followed by non-formal at 5(1.5%) and lastly those with primary education at 4(1.2%). We can conclude that majority of those who use biogas in their homes have secondary and tertiary education, hence education influences investing in biogas technology.

The study further sought to establish distribution of respondents based on access of Knowledge on Biogas technology. The respondents' access to knowledge on biogas technology was important in influencing the households' adoption of biogas technology. The respondents were asked to indicate how they got to know about biogas technology. Distribution of

Respondents based on sources of Knowledge on Biogas technology revealed six sources of information; agricultural shows and exhibitions, promotional groups and agencies, media, friends and neighbors, local meetings and barazas and other sources (schools).

Table 4.6: Access of Knowledge on Biogas technology of respondents

Table 4.6 shows access of knowledge on biogas technology of respondents

Source	Frequency	Percentage
Friends & Neighbors	220	67.9
Agricultural shows & exhibitions	181	55.9
Media	150	46.3
Promotional groups and agencies	93	28.7
Local meetings & Barazas	21	6.5
Other sources (schools)	9	2.8

Table 4.6 analysis revealed that a largest proportion of the respondents 220(67.9 %) had been given details regarding biogas from their friends and neighbors'. A further 181(55.9 %) of the respondents indicated to accessing biogas information through agricultural shows & exhibitions. The presence of the media and promotional groups and agencies also accounted for a relatively large proportion accounting for150 (46.3%) and 93(28.7 %) respectively. The sources that accounted for the least included local meetings and Barazas and other sources like information from schools at 21 (6.5 %) and 9(2.8 %) respectively.

Karekezi & Kithyoma (2003) indicates that experience in the sub Saharan region shows that the introduction and success of any renewable technology is to a large extent, dependent on the existing government policy. Limited policy support for renewable energy is further demonstrated by the low budgetary allocations with most developing countries placing more emphasis on the petroleum and power sectors with very little expenditure being allocated to small and medium scale renewable energy technologies as has been the case in Ethiopia's energy sector.

Table 4.7: Cross tabulation of knowledge of biogas technology with highest level of education

Researcher wanted to know how the respondents got to know about biogas technology. It was important to know whether the level of education influenced access to the knowledge of biogas technology.

Knowledge of biogas technology Through	Highest level of education				
	Non formal	Primary	Secondary	Tertiary	Total
shows and exhibitions	21 6.9%	12 4%	133 43.9%	135 45.2%	303 100%
Promotional groups and agencies	18 10.3%	3 1.7%	77 44.3%	76 43.7%	174 100%
Media	15 6.5%	15 6.5%	106 45.9%	95 41.1%	231 100%
Friends and neighbors	24 7.6%	15 4.8%	136 43.2%	140 44.4%	315 100%
Local meetings and barazas	9 6.3%	12 8.4%	70 49%	52 36.4%	143 100%
Any other (Schools)	0 0%	9 8.7%	44 42.3%	51 49%	104 100%

Majority of respondents got to know about biogas technology from friends and neighbors at 315(100%). Those with tertiary education were the highest at 140(44.4%) followed by secondary at 136(43.2%), non-formal at 24(7.6%) and primary at 15(4.8%). The second majority got to know about biogas through agricultural show and exhibition at 313(100%), media followed at 231(100%), promotional groups and agencies was at 74(100%), local meetings and barazas at 143(100%) and any other (schools) at 104(100%). The trend shows that majority of those who knew about biogas technology had tertiary and secondary education. Hence education is a factor in influencing knowledge of biogas technology. It is evident from the cross tabulation in table 4.7 that the largest majority of respondents were either holders of a secondary level qualification or tertiary level qualification in seeking pertinent information with regard to biogas from various sources such as shows and exhibitions, promotional groups and agencies, the media among others. This was against a backdrop of relatively fewer respondents who were holders of primary level qualification and non formal qualifications that formed the least proportion of respondents seeking information. These findings bring to light the importance of education in influencing decisions on the investment in biogas technology as opposed to those with little or no formal level of education. Davis (1989) argues that the perceived ease of use has been identified as one of the key factors that motivates' individuals to accept and use specific technologies. Individual differences such as personality traits which include their level of education determines how individuals think and behave in different situations which in this case may influence on their decision to invest in biogas technology.

4.5 Extent to which perceptions of household influences investment in biogas technology

The research sought to examine the extent to which perceptions of households did influence investment decision in biogas technology

Table 4.8: Perceptions of household and investment in biogas technology

The respondents were therefore asked to respond to a set of statements related to various aspects of biogas and provide responses based on a five point likert scale that ranged from strongly disagree, degree, neutral, agree and strongly agree. These responses were then analysed and the results shown in tables 4.8.

Household perceptions	Responses(percentages)					
	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Total**
I find biogas usage easy & convenient	**1.2**	**0.9**	**4.3**	**32.1**	**61.4**	**100 %**
I have made huge savings on my energy requirements	**9.3**	**9.9**	**35.5**	**13.0**	**32.4**	**100 %**
I am keen on expanding my biogas unit for more gas	**7.7**	**10.5**	**38.9**	**21.0**	**21.9**	**100 %**
The ministry of energy & agriculture has been keen in supporting biogas technology in Lanet	**20.4**	**27.8**	**29.0**	**16.4**	**6.5**	**100 %**
NGO's & other agencies have been keen in supporting local farms embrace biogas technology	**7.1**	**16.0**	**22.5**	**39.5**	**14.8**	**100 %**

Maintaining the biogas unit has been easy & cheap	5.5	5.9	18.2	41.0	29.3	100 %
The costs of putting up the biogas unit have been high & beyond the reach of many households	8.9	5.9	5.6	25.6	60.0	100 %
The Government should consider subsidizing the costs of putting up biogas units in rural areas	2.2	0.9	6.8	14.8	75.3	100 %
Alternative forms of material should be considered in the production of biogas (Human waste)	3.4	7.1	17.9	34.9	36.7	100 %
More efforts should be put to sensitize & educate rural communities on Biogas technology	2.5	0.9	8.6	16.0	71.9	100 %
A lot of supervision is required in operating the biogas unit	12.0	19.1	32.4	20.4	16.0	100 %
Many NGO's operating in the area have played a key role in sensitizing households on Biogas technology	14.8	18.5	24.1	31.2	11.4	100 %
The adoption of biogas has mainly been the initiative of men rather than women	17.9	28.4	26.5	21.6	5.6	100 %
The amount of biogas produced is inadequate for most of the energy requirements in households	6.8	27.5	25.6	32.7	7.4	100 %
The risks of biogas leakage are minimal and the technology is relatively safe	3.4	8.3	11.4	34.9	42.0	100 %
Most households in Lanet have small plots that cannot accommodate setting up a biogas unit	13.9	28.4	13.3	31.5	13.0	100 %
The production of biogas is rather slow & often runs out making households opt for other alternatives	5.2	32.7	31.2	22.2	8.6	100 %
the sludge produced after Biogas production poses problems of disposal	11.4	21.6	21.9	38.0	7.1	100 %
The Biogas produced can easily be piped to neighbours & sold to	2.8	8.0	19.1	50.0	20.1	100 %

increase incomes for households						
The uses of biogas far outweigh the initial cost of setting up the production unit	**4.6**	**0**	**4.9**	**35.2**	**55.2**	**100 %**

The findings reported significant large proportions of respondents agreeing (31.2%) and strongly agreeing (61.4 %) that biogas usage was easy & convenient, while a further 25.6 % agreed and 60 % strongly agreeing that costs of putting up the biogas unit have been high & beyond the reach of many households. This explains a skewed distribution of households sampled for the study that ultimately reported a 24% having embraced biogas technology while 76 % of the sampled households opted for other forms of energy. The findings revealed significant responses taking neutral position on the aspect on households being keen on expanding their biogas unit as well as having made huge savings on household energy requirement that reported responses of 38.9 % and 35.5 % respectively. The respondents further presented mixed reactions on the item that the initiative of biogas investment was mainly a men affair with 26.5 % taking a neutral position , while 21.6 % agreeing and 5.6 % strongly agreeing.

The perceptions further revealed that NGO's & other agencies efforts in having local farms embrace biogas technology was much better than those of the ministry of energy & agriculture in Lanet. This was supported by the responses for agree and strongly agree for NGO's and other agencies that accounted for 39.5% and 14.8 % as opposed to those of the Ministries of energy and agriculture that accounted for 16.4% and 6.5% respectively. Ochieng & Makoloo (2007) indicate that projects that have received most funding in Kenya include those exploiting renewable energy which exists in abundance including such as geothermal, wind solar, solid waste and other recycled power generation facilities at the expense of small scale projects in rural settings such ass biogas. The findings reported significant large proportions of respondents agreeing asserting that the costs of putting up the biogas unit have been high & beyond the reach of many households. This may is supported by earlier discussion in table 4.6 where a total of 80 households (24.7 %) accounted for households with biogas in Lanet Division. A large proportion of the respondents indicated that the cost of setting up biogas units were high with 25.6 % agreeing with a further 60.0% strongly agreeing. These perceptions were further supported by a significant proportion of the respondents that advocated for Government need to consider subsidizing the costs of putting up biogas units in rural areas with 15% agreeing and a further

75% strongly agreeing. The Session Paper No. 4 of 2004 on Energy points out that despite the potential benefits of biogas, the penetration rate of biogas technology is still very low and attributes this to poor management, high initial capital costs, high maintenance costs, limited water supply and weak technical support necessitating the need for a legal and regulatory framework for promotion of renewable energy, which includes biogas (GOK, 2003). The study findings reported a high potential for Biogas producer who indicated an ease of piping it to neighbors & selling to increase incomes for households with 50% and 20% agreeing and strongly agreeing. The respondents further indicated the uses of biogas far outweighed the initial cost of

setting up the production unit accounting for 35.2% agreeing and a further 55.2 % strongly agreeing. This therefore meant that adoption of Biogas was well received by respondents and had a potential of meeting the energy needs of rural households in Lanet if proper mechanisms were put in place by relevant stockholders to make it a popular source of energy.

Table 4.9: Cross tabulation of cost of biogas unit and Government subsidies

Table 4.9 shows level of income cross tabulated with government subsidy.

Does the cost of biogas unit influence your investment in Biogas technology		the Government should consider subsidizing the costs of putting up Biogas units in rural areas					
		Strongly disagree	Disagree	neutral	Agree	strongly agree	Total
	Yes	6	3	15	34	203	261
	%	1.9%	0.9%	4.6%	10.5%	62.7%	80.6%
	No	1	0	7	14	41	63
	%	0.3%	.0%	2.2%	4.3%	12.7%	19.4%
Total		7	3	22	48	244	324
		2.2%	0.9%	6.8%	14.8%	75.3%	100.0%

Table 4.9 shows the cost of biogas unit cross tabulated with government consideration in subsidizing the cost of putting up biogas. The following results were realized. Majority of respondents who strongly agreed were 244(75.3%) that government should subsidize the cost of

putting up biogas while 7(2.2%) were in strong agreement that government should not subsidize the cost of putting up biogas. Therefore majority of the respondents were in agreement that government should subsidize the cost of putting up biogas in the rural areas.Majority of the respondents 261(80.6%) also felt that the cost of biogas unit influences their investing in biogas technology while only a few 63(19.4) felt that cost did not influence.

4.5.1: Salient factor considered by Households in investing in biogas technology in Lanet Location

The researcher sought to examine the salient factors that respondent's considered critical when investing in Biogas technology.

Table 4.10: Salient factors in investing in biogas technology

The respondents were therefore asked to indicate the factors and give a rating based on a five point likert scale that ranged from very important, important, undecided, and not important an least important. These factors were then analysed and the results shown in tables 4.8.

	Responses(percentages)					
	Very important	Important	Undecided	Not important	Least important	Total
Support from prompting agencies	65.4	19.1	8.3	2.8	4.3	100 %
Costs of setting up the unit	77.3	18.5	1.9	1.9	0.0	100 %
Labour input	59.9	33.6	4.6	1.0	0.0	100 %
Viability/maintenance	57.7	34.0	6.5	1.9	0.0	100 %
Availability of information	74.1	18.2	6.8	0.9	0.0	100 %
Owners interest	73.1	21.0	4.9	0.9	0.0	100 %
Technical problems such as leakage	50.3	26.5	13.0	1.2	9.0	100 %
Adequate supply of water	59.9	27.5	5.2	4.3	3.1	100 %
Number of cows in farm	74.1	16.0	1.2	4.6	4.0	100 %
Mode of stock keeping (zero grazing)	77.5	16.0	0.9	1.9	3.7	100 %
Farm size	48.9	20.7	5.6	14.2	10.8	100 %

The factors that received the highest rating comprised the mode of stock keeping (zero grazing) and the costs of setting up the unit study that has 77.5 % and 77.3 % responses for very important and 16% and 18.5 % responses for important respectively. The respondents further rated highly other factors namely availability of information and Number of cows in farm (74.1%) and the owners interests (73.1%). These findings suggest that the availability of an agricultural residue or dung generated within the homestead that would be made available for anaerobic digestion was critical.

Most common biogas plants must be fed daily with feed material or slurry to ensure continuous gas production (Gitonga, 1997). Most of the other factors received relatively high responses for important and very important as presented in table 4.9 including, support from prompting agencies (19.4% and 65.4 %) labor input (33.6% and 59.9%) adequate supply of water (59.9% and 27.5%) and viability and maintenance (34% and 57.7%).

4.6 Extent to which household income levels influence investment in biogas technology

The study sought to determine whether household income levels influence investment in biogas technology. The respondents were requested to indicate the sources of their income as well as indicate the range on their monthly income. They were further required to respond whether their level of income influenced their decision to invest in biogas technology. The findings were analyzed and the findings presented in tables 4.9.

Table 4.11: Distribution of Respondents based on sources of income

Respondents had five sources of income namely; salary, casuals, farming, business and donations.

Source	Frequency	Percentage
Salary	217	67.0
Casuals	22	6.8
Farming	51	15.7
Business	60	18.5
Donations	3	0.9

The findings are presented in table 4.10 shows respondent's sources on income indicated an overwhelming proportion being salaried (67%) while those that engaged in farming and business accounted for 18.7% and 15.7 % respectively. The respondents that were engaged in casual jobs and those that indicated to being recipients of donations accounted for least proportions of 6.8% and 0.9 % respectively. The findings are shown in table 4.10. Further examination of the respondent's distribution of monthly incomes that a majority (63.9%) earned below Kshs 20,000 per month which was probably inadequate to cater for family and other households priorities and be sufficient to invest in biogas technology. A relatively small proportion of the respondents (25.3 %) however indicated to earning between Kshs 20,001 to 80,000 while a further 8.3% and 2.5% indicated to earning between Kshs 50,001 to 80,000 and over Kshs 80,001 respectively. This therefore calls for concerted efforts by the Government and other partners to review polices on the financing of renewable energies in the rural sector to facilitate better uptake of this technology as it is evident that many households may not be in a position to undertake the projects without assistance

4.6.1. Distribution of Respondents based on monthly income

The respondents were asked whether their level of income influenced their decisions in investing in Biogas technology.

Table 4.12: Distribution of Respondents based on monthly income

Respondent's income fall in four levels 20000 and below, 20001-50000, 50001-80000 and 80001 and above.

Income	Frequency	Percentage
20,000 and below	207	63.9
20,001 -50,000	82	25.3
50,001- 80,000	27	8.3
80,001 and above	8	2.5
Total	324	100.0

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50,001- 80,000	27	8.3
80,001 and above	8	2.5
Total	324	100.0

The responses overwhelmingly affirmed to this With a majority of the respondents 207(63.9%) earning below Kshs 20,000 as indicated in figure 4.10, 82(25.3%) earn Ksh 20001-50000, 27(8.3%) earn Ksh 50001-80000 and 8(2.5%) Ksh 80001 and above.

Table 4.13 Cross tabulation of level of income and biogas investment

		Use of Biogas in Household		
		Yes	No	Total
Does level of income influence investment in Biogas technology	Yes	62 (19.1%)	200 (61.7%)	262 (80.9%)
	no	16 (4.9%)	46 (14.2%)	62 (19.1 %)
Total		78 (24.1 %)	246 (75.9 %)	324 (100%)

Table 4.12 shows an overwhelming proportion 262 (80.9%) of the total respondents affirmed that their level of income did influence their decision on investment of Biogas with a further 62 (19.1%) having actually invested in it .The table further illustrates that A smaller proportion (62 (19.1%) did not find their level of income a key reason for not investing in Biogas technology. These findings indicate that for a significant number of the residents of Lanet Location, access to funds was a key factor limiting their adoption of the technology, necessitating innovative approaches from the Government and other stakeholders in assisting rural communities' access affordable credit to aid in the uptake of Biogas technology. The table further presents a skewed distribution of households in favour of households without biogas 246 (75.9 %) in relation to those that had adopted the same 78(24.1%). Shell (2007), indicate that in spite of Biogas technology having been actively promoted in Kenya since early 1980s, the uptake has been slow. The study by shell further identified several challenges facing the promotion and uptake of biogas technology key among them being the high costs of installing the systems. Installing any biogas technology in Kenya was cited as expensive with the market for biogas technology being limited to those who can afford other sources of modern energy such LPG.

4.7 Extent to which size of household land influences investment in biogas technology

The study sought to determine whether size of household land influence investment in biogas technology. The respondents were requested to indicate the average size of their land and whether in their opinion, land limited their ability to invest in biogas technology. The findings were analyzed and the findings presented in tables 4.12 and 4.13.

Table 4.14: Respondents average acreage of land

Respondents were asked to state acreage of land as follows; ¼ acre and below, ½ acre, 1 to 2 acres and 2 to 5 acres.

Acreages	Frequency	Percentage
¼ acre and below	225	69.4
½ acre	21	6.5
1 to 2 acres	42	13.0
2 to 5 acres	36	11.1
Total	324	100.0

An examination of the respondent's average size of land indicated a significant proportion (69.4%) had holdings of ¼ acre or below. Respondents with ½ acre accounted for 6.5% of the study sample. The sample had holders with relatively large pieces of land ranging from 1 to 2 acres and between 2 to 5 acres accounting for 13% and 11.1% respectively. The distribution of land was therefore bound to influence decisions on whether to adopt biogas technology as most households require a zero grazing unit and construction of a digester among other facilities to make production of the gas viable. This may not be feasible in land units` under 1/4 acre or below which comprised of most households sampled in the study. Drechsel *et al.*, (2005) argues that many farmers are resource poor and may lack the land security and may therefore be unable to invest in such technologies. A farmer's preferences for certain technologies are based on real experience or characteristics of a technology such as complexity; trouble free and comparative advantages. With subsistence farming being the mainstay in rural settings, a careful cost benefit analysis is made expected returns and provision of food for local consumption and biogas may be a distance priority for many homes.

The respondents were asked whether size of land influenced their decisions in investing in Biogas technology. The responses were relatively skewed in favor of the no responses that accounted for 53.7% to the yes responses that accounted for 46.3%. This was an indicator that in spite of the majority of resident of Lanet having small land holdings, many were eager in adopting the technology as for land was not a significant factor. This therefore means that with better sensitization and support in the area, the uptake of the technology may be increased. The findings are presented in table 4.13

Table 4.15: Cross tabulation of household land and biogas investment

		Use of Biogas in Household		
		Yes	No	Total
Does the size of your household land limit investing in Biogas technology	Yes	32 (9.9%)	118 (36.4%)	150 (46.3%)
	no	46 (14.2%)	128 (39.5%)	174(53.7%)
Total		78 (24.1 %)	246 (75.9 %)	324 (100%)

Table 4.15 shows a significant proportion 174 (53.7%) of the total respondents indicating that the size of their land did not limit their decisions to invest in biogas technology. This is in spite of an overwhelming proportion of the respondents 225 (69.4%) indicating to owning land units of ¼ acre or less as shown in table 4.12. This was an indicator that with better financial arrangements being made to residents of Lanet, many would easily take up the use of biogas as opposed to other conventional sources of energy such as electricity and firewood as highlighted form the analysis of their perceptions in table 4.8. Respondents that affirmed to the size of the land unit being significant in the consideration of biogas invested accounted for 150 (46.3%) of the households.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains summary of the findings, conclusion, recommendations and suggestion for further studies. This chapter summarizes and concludes the research findings as carried out. At the end of the chapter, some useful recommendations are proposed by the researcher to the organization under study in order to solve the problem under study, based on research findings.

5.2 Summary of research findings

This section presents a summary of the research findings arising from the study based on how each objective was addressed. Data on the household respondents ' ages indicated that most of the sampled residents were aged between 41 and 50 years(37.3 %) 31 and 40 years and those aged above 50 years accounted for 22.8 % and 27.8% respectively. The age groups with the least number of respondents comprised of those aged 25 to 30 years and those aged below 25 years accounting for 5.6% and 6.5 % respectively. Findings on gender distribution indicated that 63.6 % were females while the males accounted for 36.4 %. The findings further indicated an almost fair distribution of males and females in the households who had invested in biogas accounting for 41(12.7%) and 37(11.4%) respectively.

An analysis on the qualifications of respondents that had invested in biogas technology revealed that a large proportion of the respondents 40 (12.3 %) had completed Secondary level education with a further 29 (9.0)% affirming to having attained tertiary level training as opposed to respondents with primary level education and non formal education accounting for 4(1.2%) % and 5(1.5%) respectively. It was therefore evident that the level of education to a great extent did influence household decision in investment in biogas with people with high levels formal education being easier to take up the investment and use of biogas technology.

An examination of the forms of energy used in households in Lanet indicated that charcoal and electricity as the most popular accounting for 64.2 % and 56.2 % with the usage of Biogas and kerosene accounting for the least proportion of 24.7 % and 16.4 % respectively. An analysis on the sources of information with regard to biogas revealed that a largest proportion of the respondents (67.9 %) had been given details from their friends and neighbors with a further 55.9 % indicated to accessing biogas information through agricultural shows & exhibitions.

The research sought to examine the extent to which perceptions of households did influence investment decision in biogas technology. The findings reported significant large proportions of respondents agreeing (31.2%) and strongly agreeing (61.4 %) that biogas usage was easy & convenient, while a further 25.6 % agreed and 60 % strongly agreeing that costs of putting up the biogas unit have been high & beyond the reach of many households. The distribution of households sampled for the study that ultimately reported investment in biogas technology accounted for 24% while 76 % of the sampled households opted for other forms of energy. There were mixed reactions on the item that the initiative of biogas investment was mainly a men affair with 26.5 % taking a neutral position, while 21.6 % agreeing and 5.6 % strongly agreeing. The perceptions further revealed that NGO's & other agencies efforts in having local farms embrace biogas technology was much better than those of the ministry of energy & agriculture in Lanet. The factors that received the highest rating comprised the mode of stock keeping (zero grazing) and the costs of setting up the unit study that has 77.5 % and 77.3 % responses for very important and 16% and 18.5 % responses for important respectively. The respondents further rated highly other factors namely availability of information and Number of cows in farm (74.1%) and the owners interests (73.1%).

The study sought to determine whether household income levels influence investment in biogas technology. An overwhelming proportion 262 (80.9%) of the total respondents affirmed that their level of income did influence their decision on investment of Biogas with a further 62 (19.1%) having actually invested in it. A smaller proportion (62 (19.1%) did not find their level of income a key reason for not investing in Biogas technology. The findings reported a skewed distribution of households in favour of households without biogas 246 (75.9 %) in relation to those that had invested in the technology the same 78(24.1%).

The study sought to determine whether size of household land influence investment in biogas technology. The findings indicated a significant proportion 174 (53.7%) of the total respondents indicating that the size of their land did not limit their decisions to invest in biogas technology. This is in spite of an overwhelming proportion of the respondents 225 (69.4%) indicating to owning land units of ¼ acre or less as shown in table 4.13. This was an indicator that with better financial arrangements being made to residents of Lanet, many would easily take up the use of biogas as opposed to other conventional sources of energy such as electricity and firewood. Respondents that affirmed to the size of the land unit being significant in the consideration of biogas invested accounted for 150 (46.3%) of the households. This was an indicator that in spite of the majority of resident of Lanet having small land holdings, many were eager in investing in the technology as for land was not a significant factor.

5.3 Conclusion

It is evident from the study that biogas investment has lagged behind in spite of major efforts by the Government and other partners being involved in the task of striving to remove the dependency of rural communities on wood fuel and charcoal for cooking and lighting. Biogas has been documented as an appropriate and economically feasible technology that has enabled the use of solid waste mainly from cows for energy production but several setbacks have affected its adoption ranging from rising costs of setting up biogas units to lack of adequate and appropriate knowledge and land size which require urgent attention. The study indicates that charcoal and electricity were the most popular forms of energy with Biogas and kerosene accounting for the least in terms of usage. These findings agree with the report that wood fuel in Kenya constitutes 90% of energy consumption in the rural areas with the demand growing at 3.6% per annum that has significantly contributed to deforestation through felling of trees leading to a low forest cover. It is evident that Biogas investment still appears to be quite low in Lanet Location calling for the need to address the concern as it appears that other forms of energy have had a dominance. Level of education was cited as a key factor in influencing knowledge of biogas technology with the largest majority of respondents being holders of secondary level and tertiary level qualifications. These educated respondents indicated a high level of curiosity in seeking pertinent information with regard to biogas from various sources such as shows and exhibitions, promotional groups and agencies, the media among others. This was against a backdrop of relatively fewer respondents who were holders of primary level qualification and non formal qualifications that formed the least proportion of respondents seeking information. These findings bring to light the importance of education in influencing decisions on the investment in biogas technology as opposed to those with little or no formal level of education. The findings reported significant large proportions of respondents affirming that biogas usage was easy & convenient, but the costs of putting up the biogas unit have been high & beyond the reach of many households. The findings further noted that investment of biogas was relatively low with 24% of the sampled households having invested in it against 76% who embraced other forms of energy. The perceptions further revealed that NGO's & other agencies efforts in having local farms embrace biogas technology was much better than those of the Ministry of energy & agriculture. The study noted that household income levels influence did to great extent influence on their decision to invest in biogas technology. The study further noted that the size of household land did not seem to influence investment in biogas technology. in spite of an overwhelming majority owning land units of ¼ acre or less. The study brings to light that in spite of the setbacks faced, many household are keen in embracing this technology that has the potential to counteract many adverse health and environmental impacts.

5.4 Recommendations

The following recommendations were made, based on the study conclusion:

1. There is a need for concerted efforts in conveying and organization of seminars and workshops on Biogas targeting rural households in an attempt to raise more awareness on the technology and its benefits and applicability
2. There is need for better sensitization and support in the area in biogas technology to increase the uptake of the technology may be increased. Innovative strategies such as biogas loans as has been done by Kenya power (stima loan) may be considered as a mechanism of helping rural households take up its use in the long term.
3. The government, NGO'S and other agencies promoting the use of biogas technology need to incorporate and emphasize aspects that appear to hinder adoption of technology namely costs and access to information.They should consider subsiding the cost,
4. Enactment of strong legislation to deter use of firewood and charcoal and provide incentives to the private sector through tax waivers on materials to encourage more private sector participation in provision of renewable energy solutions to the rural and urban households
5. The need for more research on the usage of alternative biomass materials in the generation of biogas such as human waste and kitchen refuse so as to encourage more households to consider investment in the technology

6. The need to offer incentives to large scale establishment to consider adopting biogas technology as well as offer more funds for research on the same so as to generate more innovations
7. The Government and other partners may consider setting up demonstrations on biogas units on small plots to encourage uptake of the same in rural areas.

5.5 Contribution to the body of knowledge

(i) Table 5.1 below indicates the contributions made by this study to the body of knowledge

Table 5.1 Contribution to the body of knowledge

Objectives	Contribution to the body of knowledge
To determine the extent to which the level of education influences investing in biogas technology in rural household in Lanet Location.	A large proportion of the respondents (44.8 %) had completed Secondary level education with a further 43.2% affirming to having attained tertiary level training. Respondents with primary level education and non-formal education accounted for 4.6 % and 7.4 % respectively.
To establish the extent to which perceptions of rural households influence investing in biogas technology in rural household in Lanet Location.	The distribution of households sampled for the study that ultimately reported adoption of biogas accounted for 24% while 76 % of the sampled households opted for other forms of energy.
To determine to what extent household income levels influences investing in biogas technology in rural households in Lanet Location.	The respondents overwhelmingly affirmed to the fact that income influenced decisions to adopt biogas with 80.8 % responding with yes while 19.1 % responded with a no.
To determine to what extent the size of household land influences investing in biogas technology in rural household in Lanet Location	The responses were relatively skewed in favor of the no responses that accounted for 53.7% to the yes responses that accounted for 46.3%.

5.6 Suggestions for Further Research

1. There is need to further investigation on the determinants of investing in biogas technology among rural households using a larger sample and in a different Division or District to allow the comparison of the findings and generate information that would allow for wider discussions and generalization.
2. Challenges faced by households in the adoption of biogas technology
3. Challenges faced by NGO's and other promotional agencies in advocating for the adoption and use of biogas technology

REFERENCES

Barnet, A., Pyle, L. P., & Subramanian, S. K. (1978). *Biogas technology in the third world.* off way Canada IDRC 103e: International Development research centre.

Best, J. W. and Khan, J. V. (2000). *Educational Research: An Introduction.* New Delhi: Asoke K Goshi.

Campbell M, Brue L. (2005).*Microeconomics: principals, problems, and policies.* http://books.google.com/books?id=hlwqualKNjEC&printsec=frontcover#PPA27;. Retrieved 14/3/2012.

Cortright J. (2001).*New Growth Theory, Technology and Learning A Practitioners Guide Reviews of Economic Development.* Literature and Practice: No. 4

Drechsel P, Olaleye A, Adeoti A, Thiombiano L, Barry B, Vohland K.(2008). *Adoption driver And constraints of resource conservation technologies in Sub-Saharan Africa.*

Demarest EJ, Reisner ER, Anderson LM, Humprey DC, Farquhar E, Stein SE.(1993). Review of research on achieving the nation's readiness goal.Washington, D.C: U.S. Department of Education.

Desai, Manish A; Mehta, Sumi; Smith, "*Indoor Smoke From Solid Fuels: Assessing the Environmental Burden of Disease at the National and Local Levels*" World Health Organization (WHO), 2004

Davis, F. (1989). *Perceived usefulness, perceived ease of use, and user acceptance of information technology.* MIS Quarterly, 13(3), 319–340.

Diaho IL, Tunga US, Umar MK (2005). *Effect of abdominal waste on biogas production from cow dung.* Botswana J. Technol. 14: 21-24.

Fagbenle RO (2001). *National renewable energy policy objectives and programmes in Botswana.* Renew. Energ. 24: 419-437.

Gitonga S.(1997). *Biogas Promotion in Kenya: A Review of Experiences* -Practical Action – Eastern Africa Africa Church Information Service, Nairobi

Gwebu TD (2003). *Population, development and waste management in Botswana: Conceptual and policy implications for climate change.* Environ. 31: 348-354

Government of India (2002).*Evaluation Study On National Project on Biogas Development.* Programme Evaluation Organisation Planning Commission New Delhi May, 2002

GOK (2010). *Feed-In-Tariffs Policy On Wind, Biomass, Small-Hydro,Geothermal, Biogas And Solar Resource Generated Electricity.* Minstry of Energy Initial Issue: March 2008 1st Revision: January 2010

Government of Kenya. (1998). *National Development Plan 1997 – 2010.* Nairobi: Government Printers.

Government of Kenya (2003). *Economic Recovery Strategy for Wealth and Employment Creation, 2003 – 2007*, Government of Kenya 2003.Goverrnment Printers

Hankins, M., 1987. *Renewable energy in Kenya.* Motif Creative Arts Ltd., Nairobi, pp. 83.

Hong, W., Wong, W., Thong, J., & Tam, K. (2002). *Determinants of user acceptance of digital libraries: An empirical examination of individual differences and system characteristics.* Journal of Management Information Systems, 18(3), 97–124.

Kassum, A. N. (1976). Minister of Finance and Administration, *East African Community, Opening address to the 12th Annual Symposium of the East African Academy on Energy Resources in East Africa held in Nairobi*

Karekezi S.& Kithyoma W.(2003).*Renewable Energy in Africa: Prospects and Limits. Renewable Energy Development.* The Workshop for African Energy Experts on Operationalizing the NEPAD Energy Initiative Operationalizing the NEPAD Energy Initiative 2- 4 June, 2003 Novotel, Dakar, Senegal

Karekezi, S., and Ranja, T. (1997). *Renewable Energy Technologies in Africa.* ZED Books and AFREPREN. OxfordU.K.

Karekezi, S. and Kithyoma, W., (2002). '*Renewable Energy Strategies for Rural Africa: is a PV-led renewable energy strategy the right approach for providing modern energy to the rural poor of sub-Saharan Africa?*' Energy Policy, Vol. 30 Nos. 11-12, Special Issue – Africa: Improving Modern Energy Services for the Poor. Oxford: Elsevier Science Limited

Kathuri, N. J. and Pals, D. A. (1993). *Introduction to Educational Research.* Egerton University, Njoro: Educational Media Centre

KIPRA (2006). *Improving Public Policy Making for Economic Growth and Poverty Reduction* Kenya Institute for Public Policy Research and Analysis

Kothari, C.R. (2004). Research Methodology methods and techniques.2nd Revised edition, New Age International Publishers,Delhi.

Lawbuary J. (2001) *Biogas Technology in India: More than Gandhi's Dream?* HE230: Energy in the natural environment dissertation

Leary, M. R. (1996). *Self-presentation: Impression management and interpersonal behavior.* Westview Press (Oxford, England).

Mulwa C., Birech R., Freyer B., Ngetich K. (2010). *Analysis of Biogas Innovations in Smallholder Farms in Kenya.* "World Food System — A Contribution from Europe" Tropentag, September 14-16, 2010, Zurich

Mshandete A.M and Parawira W. (2009). *Biogas technology research in selected sub-Saharan African countries – A review.* African Journal of Biotechnology Vol. 8 (2), pp. 116-125, 19 January, 2009 http://www.academicjournals.org/AJB

Matere S, Musembi F., Nandokha T., Mbure G., Njeru P., and Emongor R. (2009). *Kajiado Report on The Current Status of Biofuel Production, Processing and Utilization.*

Mwirigi J.W., Makenzi P.M., & Ochola W.O (2009).*Socio-economic constraints to adoption and sustainability of biogas technology by farmers in Nakuru Districts, Kenya* Energy for sustainable Development (13) 2009 106-115

Mugenda, O. M. and Mugenda, A. (1999) *Research Methods.* Quantitative and Qualitative Approaches. Nairobi: African Centre for Technology Studies Press.

NEMA (2005).*Session Paper No. 4 of 2004 on Energy*, Ministry of Energy, October 2004; *State of Environment Report Kenya 2004. Land Use and Environment.*

Overview of Biogas Technology : A U.S.A experience .www.Biogas epa.gov accessed on 12/2/2012

Ochieng B.O & Makoloo M.O. (2007) *Climate Change Adaptation & Mitigation.* Institute For Law And Environmental Governance Nairobi

Rogers, E.M. (1983). *Diffusion of Innovations.* 3rd Ed. New York: The Free Press.

Romer, P. M. (1994). "*New goods, old theory and the welfare costs of trade restrictions.*" Journal of Development Economics 43: 5.

Sampa, R. C., 1994. '*Renewable Energy Technologies Dissemination in Zambia* ', paper prepared for the first Regional RETs Workshop, 31May- 1 June 1994, Naivasha, Kenya,

SNV Netherlands Development Organisation 2012 | http://www.snvworld.org

Shell Foundation (2007).*Promoting Biogas Systems In Kenya -A Feasibility Study* October 2007 Biogas for Better Life An African Initiative

Teich HA,(1990)/ editor. Technology and the future. New York: St. Martins Press; 1990.

Winrock International (2007).*Biogas For Better Life: An African Initiative A Cost-Benefit Analysis Of National And Regional Integrated Biogas And Sanitation Programs In Sub-Saharan Africa.* Draft Final Report Prepared For The Dutch Ministry Of Foreign Affairs April ,2007

Winrock International (2007). *Africa Biogas Initiative Potential for Growth and Models for Commercialization.* May 2007

White R.A.& College G. (2005).*The Role of Biogas in Rural Development and Resource Protection in China: A Case Study of Lijiang Municipality, Yunnan Province, China* .National Science Foundation and Michigan State University July 8, 2005

APPENDIX A
TRANSMITTAL LETTER

ROSE WANJUGU
Nakuru Extra Mural Centre
College of Education and
External Studies
University of Nairobi
P.O. Box 30197
NAIROBI

Dear respondent,

I am a student at Nairobi University undertaking a Masters of Arts degree in Project Planning and Management. As part of the requirements of the course, I am required to undertake a research project in my area of study. My research topic is on '**Determinant of investing in biogas technology among rural households of Lanet location Nakuru county, Kenya.** You have been selected as one of the respondents in this project. Your sincere and correct responses will be important in attaining this goal. All information will be treated with utmost confidentiality.

Yours faithfully,

Rose Wanjugu

APPENDIX B

QUESTIONAIRE FOR HOUSEHOLDS

This questionnaire is meant for soliciting information pertaining to factors influencing investing in biogas related projects among rural households in Lanet Location in Nakuru County.
The information provided will be treated with the utmost confidentiality.

SECTION A: GENERAL INFORMATION ABOUT YOURSELF.

1. Your age in years

   a) Below 25 b) 25 to 30 c) 31 to 40 d) 41 to 50 e) above 50

2. Sex ☐ Male ☐ Female
3. Area of residence

   Location ....

   Village ....

   Street ....

SECTION 2: LEVEL OF EDUCATION

1. Highest level of education

a) Non formal. ☐ b) Primary ☐

c) Secondary ☐ d) Tertiary ☐

Any other(s), please specify ________________________________

2. What forms of energy do you use in your homestead?

a) Firewood ☐ b) Electricity ☐

c) Charcoal ☐ d) Kerosene/Paraffin ☐

e) Gas ☐ e) Biogas

Any other(s), please specify ________________________________

3. Do you use Biogas technology in your home?

☐ Yes ☐ no

4. How did you get to know about Biogas technology (tick any appropriate answer)

a) Agricultural shows and exhibitions ☐

b) Promotional groups and agencies ☐

c) Media ☐

b) Friends and neighbors ☐

e) Local meetings and Barazas ☐

Any other(s), please specify ________________________________

____

What factors would you consider most when considering adopting Biogas technology (tick the response that best suits your position?)

Factor	**Very important**	**important**	**undecided**	**Not important**	**Least important**
Support from promoting agencies					
Costs of setting up the unit					
Labour input					
Viability/maintenance					
Availability of information					
Owners' interest					
Technical problems such as leakage					
Adequate supply of Water					
Number of cows in farm					
Mode of stock keeping (zero grazing unit)					
Farm size					

SECTION 3: PERCEPTIONS OF HOUSEHOLD

Directions: This measure is designed to determine how you currently feel about Biogas and its related aspects. There is no right or wrong answers. Please indicate the degree to which each statement applies to you by marking whether you:

Strongly Disagree,	**Disagree,**	**Neutral,**	**Agree,**	**Strongly Agree**
1	**2**	**3**	**4**	**5**

	SD	**D**	**N**	**A**	**SA**
1. I find biogas usage easy and convenient	1	2	3	4	5
2. I have made huge savings on my energy requirements	1	2	3	4	5
3. I am keen on expanding my biogas unit for more gas	1	2	3	4	5
4. The ministry of energy and agriculture has been Keen in supporting Biogas technology in Lanet	1	2	3	4	5
5. NGO's and other agencies have been keen In supporting local farms embrace Biogas technology	1	2	3	4	5
6. Maintaining the Biogas unit has been easy and cheap	1	2	3	4	5
7. The costs of putting up the Biogas unit have been high and beyond the reach on many households	1	2	3	4	5
8. The Government should consider subsidizing the cost Of putting up Biogas units in rural areas	1	2	3	4	5
9. Alternative forms of material should be considered In the production of Biogas (human waste, etc)	1	2	3	4	5
10. More efforts should be put to sensitize and educate Rural communities on Biogas technology	1	2	3	4	5
11. A lot of supervision is required in operating the Biogas unit	1	2	3	4	5
12. Many NGO's operating in the area have played a key role in sensitizing households on Biogas technology	1	2	3	4	5
13. The adoption of Biogas has mainly been the initiative of men rather than women	1	2	3	4	5
14. The amount of Biogas produced is inadequate for most of the energy requirements in households	1	2	3	4	5

15. The risks of Biogas leakage are minimal and the technology is relatively safe 1 2 3 4 5

16. Most households in Lanet have small plots that cannot accommodate setting up a Biogas unit 1 2 3 4 5

17. The production of Biogas is rather slow and often runs out Making household opt for other alternatives 1 2 3 4 5

18. The sludge produced after Biogas production poses problems of disposal 1 2 3 4 5

19. The Biogas produced can be easily piped to neighbours and sold to increase incomes for households 1 2 3 4 5

20. The uses of Biogas far outweigh the initial cost of setting up the production unit 1 2 3 4 5

What challenges have you faced in the putting up and running of your Biogas Unit?

____

____

____

SECTION 4: LEVEL OF INCOME

1. What is the source of your income ?

   a) salary ☐ b) casual work ☐

   c) farming ☐ d) business ☐

   e) donation ☐

Any other(s), please specify ______________________________

2. Indicate your monthly income

   a) 20000 and below ☐ b) 20001-50000 ☐

   c) 50001 -80000 ☐ d) 80001 and above

3. Does the level of income influence your investing in biogas technology?

   Yes ☐ No ☐

SECTION 5: SIZE OF HOUSEHOLD LAND

1. What is the acreage of your land?

   a) ¼ acre or below ☐ b) ½ acre ☐

   c) 1 – 2 acres ☐ 2 to 5 acres ☐

2. Does the size of your household land limit investing in Biogas technology?

   Yes ☐ No ☐

3.In your own opinion is the size of the household land significant in influencing your adoption of Biogas technology

   very important ☐ important ☐ undecided ☐

   unimportant ☐ least important ☐

APPENDIX C

RESEARCH AUTHORIZATION FROM NATIONAL COUNCIL FOR SCIENCE & TECHNOLOGY

REPUBLIC OF KENYA

HARAMBEE

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349
254-020-310571, 2213123, 2219420
Fax: 254-020-318245, 318249
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/9/012/07**

Date: **22nd June 2012**

Rose Wanjugu Njoroge
University of Nairobi
P.O.Box 30197-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Determinants of investing in Biogas technology among rural households of Lanet Location, Dundori Division, Nakuru County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for a period ending **15th August, *2012.***

You are advised to report to **the District Commissioner and the District Education Officer, Nakuru County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

SAID HUSSEIN
FOR: SECRETARY/CEO

Copy to:

The District Commissioner
The District Education Officer
Nakuru County.

APPENDIX D

RESEARCH AUTHORIZATION FROM PROVINCIAL ADMINISTRATION

OFFICE OF THE PRESIDENT

PROVINCIAL ADMINISTRATION

Telegram:"DISTRICTER"
Telephone: 0203528050
Fax: 0203528050

When replying please quote

Ref. No. ED.12/10/56

The District Commissioner,
Nakuru North District,
P. O. Box 21,
BAHATI

Date: 5th July, 2012

Rose Wanjugu Njoroge
University of Nairobi
P.O. Box 30197-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your request for authority to carry out research on Determinants of investing in Biogas technology among rural households of Lanet location, Dundori Division, Nakuru County, Kenya, I note the National Council for Science and Technology vide their letter Ref.No.NCST/RCD/9/012/07 of 22nd June, 2012 authorized you to carry out the research in the District for a period ending 15th July, 2012.

In light of the above, you are authorized to carry out the study in the District during the stipulated period.

Please keep this office informed of your research progress in terms of area covered. This will enable liaison with the respective area administrative officers.

G.K.ITHAI
FOR: DISTRICT COMMISSIONER

CC

-National Council
-District Education Officer

APPENDIX E

RESEARCH CLEARANCE PERMIT

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Rose Wanjugu Njoroge
of (Address) University of Nairobi
P.O.Box 30197-00100, Nairobi.
has been permitted to conduct research in

Location
District
Nakuru **County**

on the topic: Determinants of investing in biogas technology among rural households of Lanet Location, Dundori Division, Nakuru County, Kenya.

for a period ending: 15th August, 2012.

PAGE 3

Research Permit No. *NCST/RCD/9/012/07*
Date of issue *22nd June, 2012*
Fee received *KSH. 1,000*

Applicant's Signature

For Secretary
National Council for Science & Technology

APPENDIX F:

TABLE FOR DETERMINATION OF SAMPLE SIZE

Table for determining needed size *s* of a randomly chosen sample from a given finite population on *n* cases such that the sample proportion *p* will be within .+.05 of the population proportion *p* with a 95 percent level of confidence

Population	Sample size	Population	Sample	Population	Sample size
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

Adapted from R.V. Krejecie and D.W. Morgan, "Determining sample size for Research Activities, " *Educational and Psychological Measurement,* 30(3), p, 608, copyright q 1970 by sage publications, Inc.