FACTORS INFLUENCING IMPLEMENTATION OF BIOGAS TECHNOLOGY BY HOUSEHOLDS IN KASIPUL KABONDO CONSTITUENCY, HOMABAY COUNTY

BY

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

2012

DECLARATION

This research project report is my original work and has never been presented for the award of any degree in any other university.

Signature.....

EUNICE ADHIAMBO OTIENO

L50/66446/2010

This research project report has been presented for examination with my approval as the University supervisor.

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DEDICATION

This research project report is dedicated to my beloved Husband Mr. John Otieno Ariandah and other family members Geoffrey, Lillian, Irene and Timothy. These are the people whose love and support are greatest. This research project report took longer than I thought yet they displayed unfailing patience.

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I am deeply grateful to my supervisor Mr. Joseph Awino who devoted his time to guide me in writing this project report. Without his constructive criticism and guidance I could probably have not succeeded in coming up with such a project write up.

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TABLE OF CONTENT

CHAPTER ONE

INTRODUCTION

CHAPTER TWO

LITERATURE REVIEW

CHAPTER THREE

RESEARCH METHODOLOGY

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

CHAPTER FIVE :SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS OF THE STUDY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

SEP : Special Energy Program

GTZ : German Agency for Development Co-operation

KIE : Kenya Industrial Estates

KWAP : Kenya Wood fuel and Agro forestry Project

CITC : Christian International Technology Centre

GVEP : Global Village Energy Partnership

REECON : Renewable Energy Engineering Contractors

ABCK : Biogas Contractors of Kenya

GPOBA : Global Partnership Output Based Aid

BSP : Biogas Support Programme

AEPC : Alternative Energy Promotion Centre

DEID : Department for international Development

GHG : Green House Gas

CDM : Clean Development Mechanism

VCM : Voluntary Carbon Market

GOS : Government Organizations

HIU : Heifer International Uganda

UNEP : United Nations Environment Programme

UNFCCC : United Nation's Framework Convention on Climate Change

BPD : Biogas Project Division

MARD : Ministry of Agriculture and Rural Development

DLPO : Divisional Livestock Production Office

IBBE : International Biogas and Bioenergy Centre of Expertise

RAPEMO : Rachuonyo Population and Environment Management Organization.

SNV :Netherlands Development Organization.

ABSTRACT

This study was carried out to investigate the factors influencing implementation of Biogas Technology by households in Kasipul Kabondo Constituency, Homa-Bay County. The use of biomass as a source of fuel has existed since the dark ages. It is estimated that in the past 50years, land covered by forests has dropped from about 50 percent to less than 4 percent, GTZ(2006). This is attributed to forest clearing for cultivation and cutting of trees for fuel. Biogas technology was first initiated in China around 1970 and is currently well established in several countries. Kenyans are currently embracing biogas technology including Kasipul Kabondo Constituency. This study was guided by the following objectives: to investigate how the level of training influence implementation of Biogas in Kasipul Kabondo Constituency, to examine how access to funds influence implementation of Biogas in Kasipul Kabondo Constituency, to establish how availability of raw materials influence implementation of Biogas in Kasipul Kabondo Constituency, and to determine how access to alternative sources of fuel influence implementation of Biogas in Kasipul Kabondo Constituency.The study was guided by the following research questions : How does level of training influence the implementation of Biogas in Kasipul Kabondo Constituency,how does access to funds influence the implementation of Biogas in Kasipul Kabondo Constituency, how does availability of raw materials influence implementation of Biogas in Kasipul Kabondo Constituency, and how does access to alternative sources of fuel influence the implementation of Biogas in Kasipul Kabondo Constituency. Increase in use of biomass by a big percentage of population in Kasipul Kabondo Constituency as a source of energy in form of firewood, charcoal, twigs, straws and crop residues has its own negative effects on the environment. Despite the efforts to reduce the use of firewood, charcoal and other forms of biomass, the rural families still contribute heavily to environmental degradation through cutting of trees. The effort to introduce biogas, a clean and renewable source of fuel is equally meeting challenges in Kasipul Kabondo Constituency. The findings of this study were to benefit residents of Kasipul Kabondo Constituency, the Government of Kenya and the NGOs. The study adapted descriptive survey. The study targeted 1200 farmers in Kasipul Kabondo Constituency. A Sample of 10% was used. The research instruments used was a questionnaire. The investigator did piloting using one group. Content validity was ascertained through expert judgment of colleague Master students and some experts in the field. To test reliability of the instruments, the investigator used test-retest method. The investigator used research assistants to collect data from respondents. Questionnaires were hand delivered by the researcher and research assistant and picked the same day. Data analysis was done by both quantitative and qualitative techniques. Quantitative data was analyzed by use of simple descriptive statistics that is frequencies, percentages and averages. The qualitative data was analyzed and reported in narrative form. Data analysis, presentation and interpretation was done through the use of tables and a summary of the finding, conclusions recommendations were made. The study revealed that the factors identified by the investigator influenced biogas implementation in Kasipul Kabondo Constituency Homa-Bay County. The study suggested that a similar study be conducted to establish factors influencing biogas implementation in other areas, effect of bio-slurry on crop production in the same area the influence of biogas technology in secondary schools in Kenya then finally the influence of training on biogas implementation in another region.

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

The use of biomass as a source of energy has existed since the dark ages. It is estimated that in the past 50years, the land covered by forests has dropped from about 50% to less than 4%, German Agency for Development Co-operation (2006).In the same document, experts attribute this fact to forest clearing for cultivation and cutting trees for fuel. Biogas technology is well established in several countries. Mass dissemination of biogas technology was first initiated in China around 1970. Subsequently, the technology was implemented on a large scale in India and Nepal, countries that, in addition to China, now have considerable expertise in biogas digester technology programme implementation.

In South Africa, a fairly recent report prepared by Messrs,Gavin , Herman , and Dlamini , (2006) indicate that a number of biogas pilot projects have been initiated at various districts in rural KwaZulu-Natal:The report states that two pilot biogas digesters have been installed in Ndwendwe district outside Durban. One is a residential system with a volume of $9.5m^3$, which was commissioned in November 2000. This digester takes input from a toilet and dung from three cows that are Kraaled overnight. The report further states that the second system was established at a school with 1000 learners and that it comprised of two 20 m^3 digesters, each fed from an eight-toilet block with addition of cow dung fed to the digester through separate inlet chambers.

In Ghana, use of biogas was introduced by the Ministry of energy and mines to resolve the problem of possible drastic fall of the water level of the Akosomo Dam. The anaerobic digestion of wastes which yields biogas is being utilized in Ghana for generation of electricity, generation of gas for cooking which is a better substitute for wood fuel, solving of sanitation problem, positive environmental measures and prevention of massive loss of soil fertility. Slurry which is a by- product from the digester is used as an excellent treated organic fertilizer, Osei (1998)

In Mali four households had installed a biogas plant by 1984. The demand for such projects is high and local residents were trained to construct and maintain facilities in order to involve local people as much as possible Dierkes, (1996).

For the three African countries; Ghana, South Africa and Mali, the level of training, information and knowledge need to spread among the people in order to be familiar with this type of technology. In Mali for example, when the inhabitants of a village which already use biogas talked about their experiences, their neighbors hurried to see for themselves. Another factor affecting implementation of biogas in the above African countries is funding or technology costs, Sparks, A.(2003). The cost of constructing a digester requires a means of getting funds inform of loans to individuals with interest of trying out this technology. Another factor is access to feed stock, access to water and other wastes. Biogas production is only possible where anaerobic digestion of organic waste occurs to yield the gas. It is therefore necessary to have adequate materials as feed to the digester Karekezi, (2001). Another factor affecting implementation of biogas in South Africa, Ghana and Mali is presence of trained personnel or skilled labor. According to programme planning report (2003) for Eastern Cape and Kwa-Zulu Natal, to install 72 biogas plants over a period of one year, one need 2 skilled and 3 unskilled craftsmen. This element is very important in order to assure technical capacity of the plants to meet required standards.

In Kenya, there is technical potential for domestic biogas in at least 35 districts. These projects are now found in various parts of the Country especially Kiambu, Nyandarua, Kakamega, Kisii and Nakuru. One of the factors influencing the implementation of biogas in Kenya is the level of training. Many people have seen working biogas digesters and attempted to build their own and ended up with poor plants that cannot yield biogas due to insufficient technical knowledge, Ndede (2010).

In Naivasha, before 2007, a Pilot project was developed with the aim of solving the problem of water and sanitation. The Ministry of Water and Irrigation then committed itself to facilitate improvement of water supply, sewerage and sanitation. Naivasha Bus Park was selected for a pilot public sanitation project combined with a water kiosk. Technology of biogas sanitation was identified for this project to demonstrate that biogas production from human waste is possible under Kenyan conditions, Onyango , Rieck , (2010).

In Kasipul Kabondo constituency, five households have embraced this technology. They use biogas for cooking and lighting. The slurry obtained is used as manure on farms to improve soil fertility. There are many farmers who can install and use biogas yet only few biogas plants have been installed in this region. Therefore, this study seeks to investigate factors influencing the implementation of biogas in Kasipul Kabondo Constituency.

1.2. Statement of the problem

Despite the efforts to reduce the use of firewood and charcoal among other fossil fuels, the rural families still contribute heavily to environmental degradation through cutting of trees. The effort to introduce best practices in farming such as use of biogas among other farming practices so as to safeguard the environment and ensure sufficient food security is equally meeting challenges in Kasipul Kabondo Constituency, RAPEMO (2007).The increase in use of biomass by a big percentage of population in Kasipul Kabondo constituency as a source of energy in form of firewood, charcoal, twigs, straws and crop residue has its own negative effects on the environment. Wire forest and Kodera forests have receded by about 80% in the last 20years, Rachuonyo South District Environmental Report (2011).This study therefore seeks to investigate factors influencing implementation of biogas in Kasipul Kabondo Constituency.

1.3. Purpose of the study

The purpose of this study was to investigate factors influencing implementation of domestic biogas in Kasipul Kabondo constituency.

1.4. Objectives of the study:

This study was guided by the following objectives:

1) To investigate how the level of training influences implementation of biogas in Kasipul Kabondo constituency.

2) To examine the extent to which accessibility to funds influences implementation of biogas in Kasipul Kabondo Constituency.

3) To establish the influence of raw materials on implementation of biogas in Kasipul Kabondo Constituency.

4) To explore the contribution of access to alternative sources of fuel on implementation of biogas in Kasipul Kabondo Constituency.

1.5. Research Questions

The study was guided by the following research questions

1) How does the level of training influence implementation of biogas technology in Kasipul Kabondo Constituency?

2) How does access to funds influence implementation of biogas technology in Kasipul Kabondo Constituency?

3) How does availability of raw materials influence the implementation of biogas technology in Kasipul Kabondo Constituency?

4) How does access to alternative sources of fuel influence implementation of biogas technology in Kasipul Kabondo constituency?

1.6. Significance of the study

There was hope that the study findings would be beneficial to the following category of the groups.To start with, the residents of Kasipul Kabondo constituency were expected to be able to use the recommendation of this study to conserve the environment by reducing the use of wood fuel as a source of energy. The government was expected to realize the problem facing the residents of this area especially those related to cutting of trees for wood fuel hence assist residents to install biogas plants and probably formulate policies that encourage implementation of biogas. Interested bodies like NGO's and those funding biogas projects were likely to assess the possibility of assisting the residents of Kasipul Kabondo Constituency to get an alternative source of energy in order to reduce environmental degradation brought about by use of wood fuel.

1.7. Limitations of the study

The study was limited by changes of weather especially during the process of data collection since the study was conducted in Kasipul Kabondo at a time coinciding with the period of long rains when roads were impassable. To mitigate against this, the researcher used motorbike transport to reach such areas. It was also necessary to visit such areas at around noon when the roads are fairly passable.

The study was limited by insufficient funds for developing research instruments and on spending on other research related activities such as travelling, training and hiring research assistants. This challenge was handled by sourcing for funds from friends and relatives as well as from personal savings.

Some respondents were unwilling to give information due to suspicion while others gave wrong information deliberately to impress the researcher. The researcher overcame this by persuading the respondents and explaining to them that the information given was to be treated as confidential.

1.8. Delimitations of the study

The study targeted farmers especially those involved in livestock rearing living in West Kamagak location, Kowidi Location, Ramba location, and Kasewe Location.

The interest was in these groups because they were groups that needed to establish biogas plants in their homes in order to reduce the population of people using wood fuel and other sources of fuel. These groups were also involved in dairy projects and therefore quite relevant for the study.

1.9. Basic assumptions of the study

The research operated on basis of the following assumptions:-

First, that there were factors influencing the implementation of Biogas in Kasipul Kabondo constituency. Among these factors were level of training, access to funds, availability of raw materials, and access to alternative sources of fuel. The data collection instruments were valid and reliable in measuring the desired outcome. Also that the selected sample was representative of the whole population and also that the respondents would cooperate and provide honest answers to test the research hypotheses.

1.10.Definition of significant terms as used in the study.

Biogas: This refers to a mixture of methane and carbon IV oxide produced by degradation of organic matter and used as a fuel.

Technology: A scientific knowledge used in practical ways to improve standard of life.

Technical training: This is the process of teaching employees how to perform Specific jobs accurately and thoroughly.

Funding: Investing money into a specific activity.

Raw materials: Products which are processed through the process of fermentation to yield biogas.

Alternative fuels: Sources of energy such as wood, charcoal, kerosene, petroleum gas among others.

Biogas: This refers to a mixture of methane and carbon IV oxide produced by degradation of organic matter and used as a fuel.

Conservation: The practice of preserving, guarding, protecting the available natural resources by using them in a sustainable way.

Environment: This refers to the surrounding of things and in this context, the Surrounding of households living in the area of study.

Skills: This means the display of art, exercise of ability, knowledge, and understanding or ability to perform a certain activity.

Anaerobic digestion: As used in this context refers to a series of processes in which Micro organisms break down organic materials in the absence of oxygen.

Organic waste: A compound which contains carbon compounds, derived from animal and plant remains which can undergo decomposition

Sewage: This refers to a water-carried waste, in solution or suspension that is intended to be removed from a community.

Sewage treatment: Is the process of removing contaminants from wastewater and household Sewage.

1.11. Organization of the study

This research proposal was organized in three chapters. Chapter one features, background of the study, statement to the problem, purpose of the study and significance of the study. Captured also in this chapter are the research objectives, research hypothesis, limitations of the study and the basic assumptions of the study. This chapter equally outlines the delimitations of the study and the definition of significant terms as used in the study.

Chapter two features review of literature where it focuses on installation of biogas plants and the challenges the implementers are facing. This chapter also discusses in detail the variables of the study, the finance, and training, availability of raw materials, and alternative sources of fuel.

Finally chapter three features methodology and captures details on research design, target population, sample size and sample procedure, data collection methods, data collection instruments, reliability and validity, data analysis and presentation.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter deals with literature related to the area of the study. It gives literature based on the following areas; biogas technical training, funding biogas projects, availability of raw materials, and alternative sources of fuel. This chapter also contains the theory of the study and the conceptual framework as well as summary of literature review.

2.2. Technical training and implementation of biogas technology

In 2006, the Biogas Project Division (BPD) felt a need to strengthen the technical capacity of technical staff members in delivery of services related to training and quality control of Bio digester installation and proposed for the input of flexible Senior Biogas Adviser to provide the required assistance to the BPD. The objective of the assignment was to assist the Biogas Project Division (BPD) of the Ministry of Agriculture and Rural Development (MARD) in the training of newly recruited technical staff, and in the development of training, technical standards and quality control. The general observations and recommendations concern the training of technicians (supervisors), training of masons, and quality standards and quality control systems Netherlands Development Organization (2012)

In Great Britain, the project was started with a participatory workshop producing technically skilled persons to install biogas projects to the community, Janelle and Taylor (2004).

On 20th-24th Septembers 2010, there was a 5-day international biogas training course with excursion to provide profound basic knowledge about the process of biogas formation, the principle of designing biogas plants, applied technology and safety aspects. The aspect of

training courses combines practical experience with theoretical knowledge. There is a training program held annually in the University of Hohenheim in United Kingdom. The international training focuses on the following areas: climate protection, energy potentials, introduction into digester biology, input substrates, gas yield from waste and energy plants, and basic principle of process technology, Environmental constraints, management of biogas slurry and digester, installation technology, IBBE Newsletter2010). On 18th-21st September 2012, there will be a four day intensive training to provide plant operators, decision makers and investors with profound specific operator's knowledge. The focus of this training will be to combine practical experience with theoretical and scientific knowledge. The programme topics will include day to day maintenance, trouble shooting, process control and record keeping, IBBE Newsletter (2012)

In Latin America there are publications of training manual for masons. It is a guide for trainer to assist in training purposes. Biogas Support Programme (BSP) plans and conducts various kinds of training such as biogas users training as well as training for masons, it is imperative that trainers be fully aware of all the tools and sequential procedure for organization of training programmes, Speece, (1996). To fulfill this gap, under the framework of BSP, the manual dealing with Biogas refreshers training for masons has been prepared as a guide for trainer, with tools and procedures that are easy to practice and are in accordance with the theories and principles of training. The manual will enable the trainer to plan and organize a training programme even if he or she has never done so before. Just following the steps he/she will have successfully organized a training programme, The manual ten sequential steps has presented in detail the biogas training manual for mason. The steps are; basic information sheet, work plan, course framework, session guide, evaluation of training, ceremonial training schedule, training cost estimate, training summary, conducting the programme and report writing, Karki (2011).

In Uganda, technology as a local knowledge has not been institutionally operational in many areas and the introduction of biogas will be a considerate and phased approach. Particular attention is paid to vocational training and business development. In Uganda, there are few contractors and skilled masons. Most of the registered construction companies are located in the urban centre. In the past, numerous artisans have been trained in all kinds of masonry and have now established their own micro-enterprises often not registered as a company. These artisans have basic knowledge to qualify for the bio-digester mason training and one ideally situated in the villages. Due to inadequate number of registered construction companies to satisfy demand, self employed artisans are approached to form bio-digester construction teams, Brooke Heifer international (2009)

In Kenya, 50 youths were trained by the GVEP international. A group known as Renewable Energy Engineering Contractors of Kenya (ABCK) is involved in promoting the use of Green and cleans energy technologies in Kenya. They believe that waste is not a nuisance to the wellbeing of the community but is a resource that can be used to improve the lives of the individuals. Biogas as a technology in Kenya has been proven as the most compatible energy solution to local dairy farmers. REECON offers service that aims at assisting investors to treat and disperse their waste, REECON Kenya(2009)

In Kenya, biogas technology training is offered at Kenyatta University, the department of appropriate technology which deals with all renewable energy studies including biogas energy. Also Jomo Kenyatta University of Agriculture and Technology offers renewable (alternative) energy studies as well as Sigagala Technical Training Institute where vocational training is offered for digester construction masons. Training is useful in ensuring that challenges associated with the implementation of biogas are minimized hence efficiency improved SNV Kenya (2012).

2.3. Funding and implementation of biogas technology

In October 4, 2002, the Global Partnership Output Based Aid (GPOBA) signed a grant agreement with the government of Nepal to co-finance the installation of 37,000 biogas plants under the fourth phase of the Biogas Support Programme (BSP-IV). The project was to be implemented by the Alternative Energy Promotion Center (AEPC). The programme was started in 1992 by the Netherlands' Development Organization together with the government of Nepal to promote environmentally friendly and affordable energy to remote rural areas. Since 2006, the BSP-IV is benefiting from the World Bank's community Development Carbon fund in exchange for reduction of emissions of greenhouse gases, Intergovernmental panel on climate change (1988). Since 1992, the biogas support programme has helped to install 150000 biogas plants in rural Nepal. The local non-governmental organization Biogas Sector Partnership Nepal (BSP-N) is serving as project implementing agency, Woods (2006).

Currently, the grant signed with the government of Nepal is funded by the United Kingdom Department for International Development (DFID). The project complements user contributions by the target group with an output based subsidy in order to foster local ownership, Hall (1993).

Switching to biogas reduces carbon emission as well as deforestation and decrease the frequency of respiratory infection that result from burning sooty fuels in poorly ventilated households. The community development carbon fund estimate that families will also save approximately three hours of labor per day from the conveniences of biogas in addition to financial savings from not purchasing other fuels and fertilizers, women and girls who are traditionally responsible for collecting and cooking will be among this project's primary beneficiaries, Han and Luy (2008).

Financial payments for reducing greenhouse gas (GHG) emissions can be an addition source of funding for energy projects. This so called carbon finance can be accessed by implementing a

project under requirements of the Clean Development Mechanisms (CDM) of the Kyoto protocol or for the voluntary carbon market (VCM). The CDM allows the participation of countries without targets. Emissions reduction credits that have been achieved through the CDM in a renewable energy in developing countries can be sold to a country with commitments, Intergovernmental panel on climate change (1988).

There are many Government Organization (GOS) and non-governmental organization (NGOs) worldwide that have been involved with many different biogas projects. A good example is the independent nonprofit organizations "the Nepal biogas support programme" (BSP-N) which is funded by the Netherlands. They have been very successful in the development of biogas technology in Nepal (Gautama 2009)

Heifer project is carried out in six countries; Uganda, Burkina Faso, Ethiopia, Kenya, Senegal and Tanzania is another source of funding for biogas. In Uganda, a project participant must pay at least 70% of the cost of installation. The 70% come from their own savings or through a micro-credit loan from grassroots cooperative. The remaining 30% comes from external funding. Most farmers' participants are unable to raise 70% which they consider as a hefty sum, (Brook. 2009)

Loans are an important tool in promoting biogas. Even if generous subsidies are available loans are often needed for poor rural households to be able to invest in something that has several years payback time. Loans can be granted from the government banks and other financial institutions, or from NGOs Biswat (2001)

In most countries embracing biogas technology, lack of effective and clear policies is a major hurdle to overcome in the dissemination of biogas technology. Governments need to be actively involved through set policies to promote biogas usage and encourage collaboration with

governmental organisations (GO) and nongovernmental organisations (NGO). If the country's government have little capacity of financing biogas projects, collaboration with GO:*s* and NGO:*s* can increase chances of foreign funding and technological import. If the local government doesn't have any policies to aid biogas promotion, e.g. Subsidies and loans, it will be much harder for local entrepreneurs and organisations to build biogas digesters for poor rural households. Han (2008)

In China, small biogas plants are considered to be a cheap source of energy though they are still coupled with an initial investment that can be hard to afford for poor communities and households. Calculations have shown that without any subsidies the payback time for a farmer for small scale Chinese type fix dome biogas digester would be around 3.6 to 5.8 years. This depends on how the biogas digester is used, what substrates, size, price on firewood, Woods (2006)

A small household based biogas plant with a volume 68m³ costs around €300 including rebuilding of an animal farm, a toilet and a kitchen. These figures are from China where the Chinese government also have subsidies making the investment even lower. Half of the investment is subsidised and the yields from the power plant will give estimated yearly revenue of around €100 when taking into account savings from buying firewood and electricity, produced fertilizer etc. This makes the payback time less than two years in this example. This is affordable for most rural households, even in poor areas. (Li 2005)

Subsidies are an effective way of accelerating biogas growth and are often necessary to make the technology affordable. Subsidies doesn't always have to come from the own country's government.

In Kenya, Aziza Kenya, is an empowerment organization that was founded by Nyambura Gichohi in early 2009.This is a small non-profit organization that aimed to provide institutions with renewable sources of energy, namely biogas. Kenya National Domestic Biogas Programme

(KENDBIP) funded by the Directorate General for International Cooperation (DGIS) of the Netherlands Ministry of Foreign affairs through the Dutch Development NGOs, the Humanistic Institute for Cooperation with developing countries (HIVOS) and the Netherlands Development Organisation (SNV) is funding biogas plants in six African Countries including Kenya.

2.4. Raw Materials and implementation of biogas technology

Biogas is produced when organic material is digested in an anaerobic environment. The organic materials, substrates, typically consist of kitchen waste, cattle, wastewater and wastes agricultural residues are abundant inform of waste in our environment, Nancy B.(2007)

2.4.1. Kitchen waste

Kitchen waste such as coconut shells, coir, egg shells, onion peels and bones are collected in a different container because they will not be processed in the biogas plant. Wet waste (spoilt or stale cooked food waste, milk products etc.) are collected in a separate container for use in a digester. Vegetable refuse like peels of various vegetables, rotten potatoes, tomatoes, coriander leaves etc. are also collected in garbage bags of 5kg capacity. Biogas plant at Trounbay (India) produces biogas from kitchen waste by using thermophilic microorganisms that flourish in extreme environment (high temperatures). They have developed enzymes systems that help them survive at higher temperatures, many spoilage and pathogenic organisms cannot survive in such extreme conditions. Kale and Mahetre Bhabha Atomic Research centre (2001)

Some parts of India has developed a compact biogas plant which uses waste food rather than dung manure as a feed stock, to supply biogas for cooking. The plant is sufficiently compact to be used by urban households and about 2000 are currently in use both in urban and rural household in Maharashtra. A few have been installed in other parts of India and even elsewhere in the world. Majeed (2008).

2.4.2. Human excreta as raw materials

Recycling and re-use of human excreta for biogas generation is an important way to get rid of health hazard from human excreta. Sulabh is the pioneering organization in the field of biogas generation from public toilet complexes. Human excreta contain a full spectrum of pathogens. Most of these pathogens are eliminated due to anaerobic conditions inside the digester. The biogas plant effluent can also be used as manure or discharged safely into any river or water body without causing pollution Rahman, (1996)

Human excreta based biogas technology remained unnoticed for long due to the fact that the available technology was not socially acceptable, as it required manual handling of human excreta which contains a full spectrum of pathogens. The Sulabh design does not require manual handling of human excreta and there is complete recycling and resource recovery from the wastes. The digester is built underground into which excreta from public toilets flow under gravity. Inside the digester, biogas is produced due to anaerobic fermentation by the help of methanogenic bacteria. The biogas, thus produced is stored in inbuilt liquid displacement chamber. Human excrete based biogas contains 65-66% methane, 32-34 carbon iv oxide and the rest hydrogen sulphide and other gases in traces, Bajgain, Shakya (2005)

In Uganda farmers have resorted to using human urine and excreta mixed with banana peels, algae, and water hyacinth and poultry droppings as an expensive source of biogas. This cheap alternative is being pushed by Heifer International Uganda (HIU), an NGO working to reduce hunger and poverty around the world. In an effect to stop the growing threat of deforestation in Uganda, HIU is working with several partners to build biogas plants from human excreta and human urine. According to Patrick Nalere, the Heifer project international country director, (2012) people should exploit decomposing raw materials which are free.

In Kenya, UNEP, in partnership with the Kenya National cleaner production centre selected a number of enterprises in Nairobi to demonstrate how cleaner efficiency production can be implemented jointly within the 1S0 14001. One of such projects was introducing biogas technology at Huruma. The project was named "Mji wa Huruma Bio Centre Project". The project uses harmful substances and hazardous waste by managing and reducing risks to human health and the environment posed by chemicals and hazardous waste. The project objective is to improve sanitation facilities in an informal settlement "Mji wa Huruma" by using human waste to generate biogas Ndede .(2010)

The project is benefiting the community immensely since the village lacks adequate sanitation, especially affecting the health of women and children. The community is also using biogas generated for cooking purposes to mitigate the collection of firewood from Karura forest, UNEP in Kenya-Newsletter July, (2010). In Kibera, Umande Trust, a right based agency, strategically invested in support of community-led initiatives, to improve access to water and sanitation for all, Muchiri Trust Communication Manager,(2011).The Trust partners with Community-based organizations to improve the living condition of people in places like Kibera. The Trust first set out to build toilets and bathrooms, but had a larger vision, TOSHA,(Total Sanitation and Hygiene Access).The centre has toilets and bathrooms on the ground floor. The toilets are connected to a bio- digester, with a dome-shaped holding tank in which biogas is produced. Raw human wastes from the toilets are directed to flow into the digester where it is broken down to release methane gas which is collected at the top of the domed tank. The gas is piped to collective stoves one floor up and is usually sufficient for community members to cook on throughout the day. They pay a small fixed fee for using the stoves. Some people in the community have not fully accepted the use of this biogas due to social beliefs, Ndede (2010).

In Naivasha, biogas sanitation technology has demonstrated that production of biogas from human waste is possible under Kenya conditions and that sanitation can be productive, Onyango (2010).

2.4.3 Cattle Manure as Biogas Source

In Nepal, cattle manure is used to produce biogas. The biogas program has reached an important milestone the United Nations Framework Convention on Climate Change (UNFCCC), for the first time approved and issued carbon credits to two Nepalese biogas projects.

UNEP in partnership with the Kenya National cleaner programme also started a project entitled "introducing biogas Technology for Animal Slaughter Houses in Nairobi. This was installed in Dagoretti to show case the possibility of turning a waste disposal problem into a useful energy resource using animal waste from animal slaughter houses at the Nyongara slaughter house in Kiambu District with the objective of demonstrating biogas generation from slaughter house waste,UNEP Newsletter(Jan 2011).

This project has contributed to UNEP's intervention on harmful substances and hazardous wastes by ensuring that harmful chemicals and hazardous wastes are managed in a more environmentally sound manner, through better technology and best practices UNEP in Kenya e-newsletter (Jan-Feb, 2011)

2.5. Alternative sources of fuel and implementation of biogas technology

Another factor determining the implementation of biogas in Nepal, India and China is access to alternative sources of fuel. In India, about 87% of cooking fuel comes from non-commercial fuels and these mainly consist of firewood. Bhatt, Sachan (2004). In less developed areas of china, household energy accounts for 64% of the total energy consumption. Of the total fuel consumption, 55% is from traditional biomass fuels such as firewood and straw. Even in the industrial sector, 27% of the energy comes from firewood, Tang (2005). In Cambodia, 95% of the population depends on firewood fuel for cooking, Topa (2004). The reasons for this can be attributed to availability of wood. Of the commercial fuels, coal and kerosene are most common.

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 of living. 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 Ndede (2010).

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 utilised 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 utilisation.

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 Herberj (1985). 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 with traditional biomass energy in Kenya, Zaque, (1991).

Other technical issues are mostly related to bad maintenance. A common problem is that pipes get blocked due to lack of service. Leakage is also a problem that is not unusual with fixed dome biogas plants. Methane (biogas) is a poisonous gas as well as an aggressive GHG. Longhurst, (1987)

It can be hard to collect animal dung from grazing animals, especially if they cover a large area. In several cultures dung is seen as low value and a fuel only to be used when no other fuels are available. In other cultures it is the handling of human excreta that is seen as a problem and that the produced biogas would be "unclean" as an effect of the human remnants. If this is the case it is important to spread knowledge and education about the technology to the people. Leach, and Gowen, (1987)

Public support is very important in the promotion of biogas. If the rural communities don't have confidence in investing in biogas they will continue to use firewood and other biomass that are already available. Spreading information about biogas and its positive effects is important. One approach is for the government to implement pilot biogas projects in rural agricultural areas to showcase the benefits of biogas technology. Antonio . Gerio (2011)

It is important to build up a local knowledge base to ensure that there is long term competence in the building and maintaining of biogas plants. This is also important in creating jobs and expanding the biogas sector. Rural women make money from biogas slurry, (2007)

Smoke is often used to keep insects away. Although there are huge health benefits by reducing smoke inside rooms there have been complaints from some users about an increase of especially mosquitoes. There have also been reports about mosquitoes breeding in the slurry outtake. Bajgain, Shakya, (2005)

Cold temperatures are a problem with biogas digesters. Some areas have bad prerequisites in this sense, especially mountainous regions. The temperature inside the digester needs to stay within 10°C to 35°C for the bacteria to digest the slurry. Colder temperatures will make the biogas plants more inefficient and if the temperature drops below 10°C the whole process will stop. Biogas plants built in areas where temperatures drops below 10°C will need extra insulation and possibly water heating to maintain operation. This will add to the construction costs, Chang, Chen, (2004).

Many communities in developing rural countries are situated in remote areas. Typically these areas are also poorer than the easier accessible ones. This together with inadequate infrastructure in terms of roads and transportation means that it will be harder and more expensive to build biogas plants and that the people in the districts have less ability to invest in the building costs. Without strong policies and subsidy programs it is hard to spread biogas technology to remote areas like these. Campbell, (2004)

Replacing biomass energy with biogas could help to solve a lot of the problems that are typically found with biomass fuels. Indoor climate will be dramatically improved as a result of using clean biogas stoves instead of burning firewood, straw and dung cakes. This would mean that a lot of the health problems associated with hazardous smoke particles would be avoided. (Li 2005)

Women and children would have more time for education when they don't have to spend as much time collecting firewood and other biomass fuels. The daily time spent in feeding a small biogas digester could be as little as 15 minutes compared to several hours used in collection of biomass. Time consumed cleaning pots and other kitchen equipment can also be lowered since biogas won't create as much soot as biomass generally does. Biogas can also be used for lighting which means it would be possible to study during the dark hours as well. UNEP Newsletter (2010).

Kerosene is a fossil fuel that is widely used in many developing countries for cooking and lighting. It is expensive and often needs to be imported. In areas where biogas has been utilized the use of kerosene has dropped considerably. Britton, (2005).

Many local jobs are created around biogas projects. Experienced people are needed in the building of biogas digesters and many local companies usually emerge. The biogas sector often creates spinoff jobs as well. Rickne, (2002).

The slurry that has been digested is a high grade fertilizer. In fact the processed substrates are a better fertilizer than before the procedure. Slurry from 1 kg digested dung can yield up to extra 0.5 kg nitrogen compared to fresh manure. Rural women Make Money from biogas slurry (2007) this can solve problems of soil degradation in areas where earlier dung has been used as a burning fuel. It can also mean that less artificial fertilizer have to be bought which bring revenue to the household. Braun ,(2007).

2.6. Theoretical Literature

This research project was informed by Holling C.S 2000 theories for sustainable futures and conservation ecologies.

2.6.1. Holling C.S Theories for Sustainable Future

In 2000, Holling C.S advanced the theories for sustainable future. He suggested that sustainable development and management of global and regional resources is not an economic problem, nor an ecological one, nor a social one. It is combination of all three and yet actions to integrate all three typically have short changed one or more. By starting biogas project, one is indeed applying the law of sustainable development by creating a cheap source of renewable energy at the same time contributing to solving social ecological and economic problems that face human beings. The biogas project is an action that integrates all the three aspects of sustainable future. Socially, the implementation of biogas reduces the time wasted by women as they look for firewood and other sources of energy for cooking and lighting homes. It is also reducing social problems caused by poor health because biogas is a smoke free source of energy and therefore respiratory problems affecting users of other sources of fuel are reduced.

Economically the cost of using energy for cooking and lighting houses is reduced because organic waste provides all the energy requirements.

2.6.2. Holling C.S Theory for Conservation Ecologies

In 2000 Holling C.S contributed to ecosystem conservation by stating that some of the most telling properties of ecological system emerged from the slow moving and fast moving process and between processes that have a large special reach and processes that are relatively localized. Holing argued that variability is not merely an inconvenient characteristic of productive,

dynamic systems; rather it is critically necessary to their maintenance. The idea of putting up biogas plants will contribute towards conservation of ecologies because destruction of trees for use as source of fuel will be minimized and the variability of living organisms in their dynamic ecosystem will be maintained hence conserving of ecologies.

2.7. Conceptual Framework

A conceptual framework can be defined as a set of broad ideas and principles taken from relevant fields of inquiry and used to structure a subsequent presentation, Kothari (2005). The conceptual framework in figure 1 below attempt to explain the relationship between the independent variables and the dependent variable, as identified in the statement of the problem, objectives and research questions.

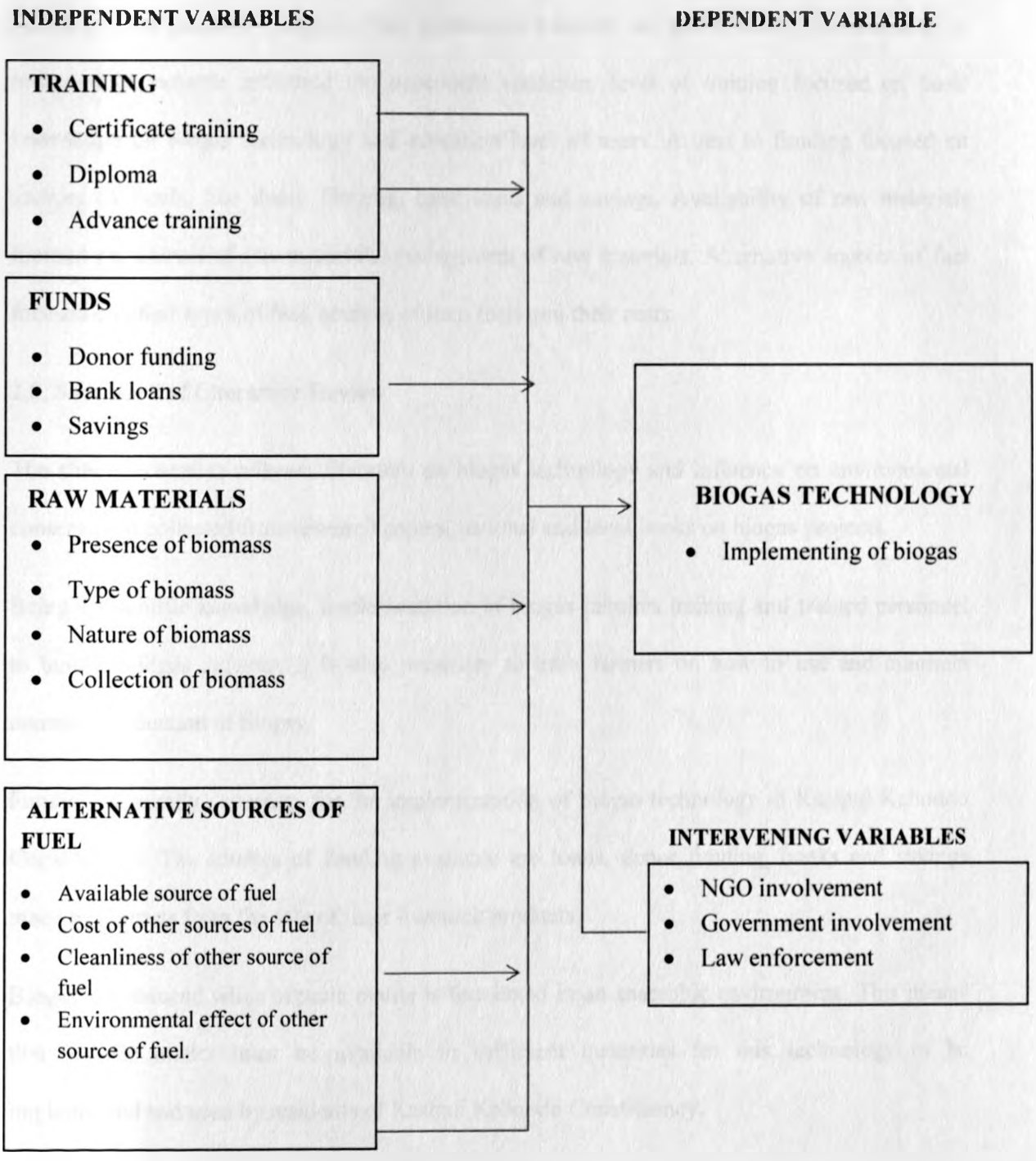

Figure 1: Conceptual Framework

Level of training, access to funding, availability of raw materials, and alternative sources of fuel constitute independent variables. The framework attempts to show how a combination of independent variable influence the dependent variables, level of training focused on basic knowledge on biogas technology and education level of users. Access to funding focused on sources of funds, like donor funding, bank loans and savings. Availability of raw materials focused on sources of raw materials, management of raw materials. Alternative sources of fuel focused on other types of fuel, sources of such fuels and their costs.

2.8. Summary of Literature Review

The chapter contains relevant literature on biogas technology and influence on environmental conservation collected from research papers, national and local books on biogas projects.

Being a scientific knowledge, implementation of biogas requires training and trained personnel to build a biogas digester. It is also necessary to train farmers on how to use and maintain constant production of biogas.

Funding is equally necessary for the implementation of biogas technology in Kasipul Kabondo Constituency. The sources of funding available are loans, donor funding, banks and savings made by farmers from the sale of their livestock products.

Biogas is produced when organic matter is fermented in an anaerobic environment. This means that organic matter must be available in sufficient quantities for this technology to be implemented and used by residents of Kasipul Kabondo Constituency.

Alternative sources of fuel used by majority of rural families in Kasipul Kabondo Constituency are significant in this study they influence implementation of biogas negatively. This is mainly

because people have not realized the benefit of biogas technology which produces clean fuel that is friendly to the environment since other sources of fuel are readily available for use.

A theoretical framework on which the study was based is also high lightened.

CHAPTER THREE

RESEARCH METHODS

3.1. Introduction

This chapter deals with the research methodology used in the study. It outlines the research design, target population, sample size and sample selection. It also features data collection instruments, instruments pre-testing (piloting), instrument validity and instrument reliability. This chapter also presents data collection techniques, methods of data analysis and operationalization of the study variable.

3.2. Research Design

The research design used in this study is descriptive survey. Descriptive survey is concerned with describing, analyzing and reporting conditions that exists in the present of a particular individual or group, Kothari, (2003). The descriptive research design is suitable in situations where the study intends to describe and portray characteristics of an event, situation or a group of people, community or a population as they exist, Dell, (2003)

3.3. Target Population

This study was concerned with farmers rearing livestock in Kasipul Kabondo constituency. The study population consists of 1200 dairy farmers, DLPO report (2012). The livestock farmers were chosen for the research because those are the people who have the ability of installing biogas plants.

3.4. Sample Size and sample procedure

3.4.1. Sample Size

The study adopted a probability sampling design in which each item in the target population was accorded equal chances of being included in final sample.

Sample size refers to the number of items to be selected from the target population, Kothari (2003). The sample size should be optimum to fulfill the requirements of efficiency, reliability, representation and flexibility. According to Mugenda and Mugenda(2003) 10% to 30% of the total population is appropriate for the study. In this study the researcher intended to use 10% of the target population (10% of 1200) giving the sample size of 120 respondents.

3.4.2. Sampling procedures

According to Mugenda and Mugenda (2003), the sample must be large enough to represent the salient characteristics of the accessible population and hence the target population. The respondents were selected from farmers using random sampling technique involving cluster sampling method. The investigator divided the target population into clusters namely: East Kabondo, West Kabondo, Kokwanyo, West Kasipul and Central Kasipul.

The sample selection procedure is illustrated in table 3.1.

Table 3.1 Total Population and sample sizes

Location(cluster)	Total population	Sample %	Sample
East Kamagak	200	10	20
West Kamagak	190	10	19
Kokwanyo	170	10	17
West Kasipul	260	10	26
East Kasipul	140	10	14
Central Kasipul	240	10	24
Total	**1200**	**10**	**120**

3.5. Research Instruments

The researcher developed one questionnaire from which several copies were produced and administrated to the farmers from a sample of 120 members. The questionnaires were administered to literate farmers while the research assistant administered face to face to illiterate farmers. Questionnaire was used as the main tool for collecting data. The selection of this tool was guided by the nature of data to be collected, the time available as well as by the objective of the study. Since the researcher was mainly concerned with views, opinions, perception, feelings and attitudes of respondents, such information can be best collected through use of questionnaire, Bell, (1993) Touliatos and Compton, (1988).

3.5.1. Piloting of the Research Instruments.

Piloting means pre-testing the instruments with a few respondents to test their accuracy. The instrument here is; data collection instrument which is the questionnaire. In carrying out pretesting, a pretest sample of 10% was used. The questions that were used are closed type to improve accuracy. Open–ended questions were avoided as much as possible to avoid obtaining misleading responses.

Investigator therefore piloted the instruments by giving them to one group that was randomly selected. After successful piloting, the investigator gave the instruments to all the sample population.

3.5.2 Validity of the Instruments

To ascertain the effectiveness of the instruments used in the soliciting for information, validation of the questionnaire was carried out. Validity is defined as the accuracy and meaningfulness of inferences which are based on research results, Mugenda (1999).

The investigator used 120 copies of questionnaire which was given to respondents. The items were based on literature review and were related accurately to the objectives and hypothesis of the research topic.

In order to achieve reasonable validity the research instruments were given to colleague Master students and some experts in the field of study to give their recommendation as to whether the content of the instrument was relevant to the study. Necessary adjustments were also made in consultation with my supervisor to improve its validity. This preceded the questionnaire by first seeking to create good rapport with respondents and reveal the ambiguities; inconsistencies hence bring into light the weaknesses of the instruments. Borg and Gall (1998)

3.5.3 Reliability of the Instruments

To test reliability of a questionnaire the investigator randomly selected one group. Reliability is a measure of the degree to which a research instrument yields consistent results after repeated trials. According to Mugenda (2003), Borg and Gall (1986) reliability is level of internal consistency or stability of the measuring device over time. The questionnaire reliability was conducted using pre-testing by the use of split half method. The results of the pilot study were used to calculate the correlation coefficient. To establish reliability of the questionnaire therefore the split half technique was used. The researcher gave questions to the sampled group. At random the researcher divided the scored items into two groups. Each subject's total scores from the two groups of items were computed and the scores correlated from all the subjects. If an index of 0.9 is attained this would be satisfactory.

3.6. Data Collection Procedures

These describe how data was collected from the respondents using questionnaires. This was done after the Ministry of Education issued an application form which was filled and forwarded to the relevant authorities together with the research proposal in order for them to give research permit. The investigator used research assistants to collect data from the respondents.

3.7. Data Analysis Techniques

The chi-square(X^2) test of independence of attributes and descriptive techniques was used to analyze the data. According to Kothari (2003), chi-square can be used to determine whether categorical data shows dependency or if the two classifications are independent. The researcher measured the relationship using a 0.05 level of significance.

3.8. Ethical Considerations

The major ethical problem in this study was the privacy and confidentiality of the respondents. Obtaining a valid sample entailed gaining access to specific lists and files from the Ministry of environment and Ministry of livestock which itself is an infringement on the privacy and confidentiality of the respondents. The respondents were allowed the freedom to ignore items that they did not wish to respond to.

TABLE 3.9: OPERATIONALIZATION TABLE

TABLE 3.2: OPERATIONALIZATION

Objective/research question	Type of variable	Indicator	Measure	Level of scale	Data collection method	Types of analysis	Level of analysis
1. To investigate how the level of training influences implementation of biogas in Kasipul Kabondo constituency.	Level of training (independent)	Certificate Diploma Degree	Standard 8 certificate Diploma certificate Degree certificate	Nominal	Survey	Quantitative /qualitative	Descriptive
	Implementation (dependent)	Knowledge on biogas plant Knowledge on use of biogas plant	Availability of biogas plant Involvement in training Rearing of animals	Nominal	Survey	Qualitative and qualitative	Descriptive
2. To examine the extent to which accessibility to funds influences implementation of biogas in Kasipul-Kabondo constituency	Accessibility to funds (independent)	Donor funding available Available bank loans Savings by farmers	More biogas plants built More farmers use biogas More farmers ready to implement biogas	Nominal	Survey	Qualitative and qualitative	Descriptive
	Implementation (dependent)	Provision of funds by donors Provision of loans by banks Use of savings	More farmers adopt the technology More farmers start livestock rearing	Nominal	Survey	Qualitative and qualitative	Descriptive
3. To establish the influence of raw materials to implementation of biogas in Kasipul-Kabondo constituency	Raw materials (independent)	Kitchen waste available Human excreta available Cattle manure available	Collection of kitchen waste More people use toilets More cattle kept for manure	Nominal	Survey	Qualitative and qualitative	Descriptive
	Implementation (dependent)	Proper management of kitchen waste Proper management of human excrete	Use of dustbins Use of toilets More cattle manure collected	Nominal	Survey	Qualitative and qualitative	Descriptive

		Proper collection of cattle manure					
4. To explore the contribution of access to alternative sources of food on implementation of biogas in Kasipul Kabondo Constituency	Alternative sources of fuel (independent)	Presence of firewood Availability of petroleum products Access to electricity	Number of households Using firewood Number of households using kerosene stoves Number of households using electricity for cooking and lighting	Nominal ratio	Survey	Qualitative and qualitative	Descriptive
	Implementation (dependent)	Households using firewood Households using kerosene Households using electricity	Number of households not willing to stop using firewood Household that continue using kerosene Households that continue using electricity	Nominal ratio	Survey	Qualitative and qualitative	Descriptive

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND ITERPRETATION

4.1 Introduction:

This chapter focuses on data analysis, presentation and interpretation. Data analysis was done on the basis of demographic characteristics of the respondents and the study variables.

4.2. Questionnaire response rates

Response rate refers to the %age subject that responds to the research instrument. A response rate of 50% is deemed adequate for analysis and reporting, a response rate of 60% is good and a response rate of 70% and over is considered very good, Mugenda & Mugenda 2003. In the light of this encounter, the study is therefore perceived to have returned an excellent questionnaire response rate of 100%. This implies excellent return rate.

4.3. Demographic characteristics of the respondent.

Demographic characteristic of the respondent were considered significant to the study for such features would influence implementation of biogas differently. Aspects of the demographics considered in the study included age, sex, marital status and level of education.

4.3.1. Characteristics of the respondent by age.

The researcher believed that age variation would have some influence on implementation of biogas technology since relatively older people are believed to be involved in farming and are better placed to implement biogas technology. The respondents were asked to give their ages and table 4.1 illustrates their responses.

Table 4.1 characteristics of respondents by Age

Age (class	Frequency	Percentage
20 – 30	11	09
31 - 40	34	28
41 – 50	51	43
51 and above	24	20
Total	**120**	**100**

Table 4.1 indicates that out of the 120 respondents who filled the questionnaire, 51 (43%) stated to be in the age bracket of 41 – 50 years, 34 (28%) mentioned being in the bracket of 31 – 40 years and 24 (20%) were in the age of over 50 years with 11 (09%) being in the age bracket of 20 – 30years.

Table 4.1 implies that relatively older people in Kasipul Kabondo constituency were in a position of implementing use of biogas technology because they were the ones engaged in farming.

Young people especially in the age bracket of 20 – 30 years were less involved in implementation of biogas technology since they were likely to be in schools or seeking for formal employment in urban centres hence did not see the need of embracing biogas technology.

4.3.2. Characteristics of the respondents by gender.

In the study, given that biogas technology results in availability of fuels and also that it is normally women who hold fuel issues as very vital, this item was hence considered to be very

significant. The respondents were therefore asked to complete the questionnaire and their responses captured in the table 4.2.

Table 4.2: Characteristics of the respondents by gender.

Sex	Frequency	Percentage
Female	83	69
Male	37	31
Total	**120**	**100**

Table 4.2 reveals that of the 120 respondents whose copies of the questionnaire were received, 83 (69%) were women and 37 (31%) were men.

Table 4.2 imply that more women than men were willing to embrace implementation of biogas technology, given that women are key participants in Agriculture in rural areas of Kasipul Kabondo constituency with most men busy looking for employment opportunities elsewhere.

4.3.3. Characteristics of respondents by level of education.

In the study, given that the majority of educated men and women are employed in urban centres or places far away from home, and also that the majority of those practicing farming have low levels of education or are those retired from professional jobs, this item was considered to be very significant. The respondents were therefore asked to complete the question and their responses captured in table 4.

Table 4.3: Character of respondents by level of education.

Level of Education	Frequency	Percentage
Primary and below	57	48
Secondary	35	29
Tertiary	24	20
University	04	03
Total	**120**	**100**

Table 4.3 reveals that of 120 respondents who filled the questionnaire, 57 (48%) were of primary and below, 35(29%) secondary level, 24(20%) were of tertiary level while 4 (3%) were of university level of education.

Table 4.3 imply that less educated persons embraced implementation of biogas technology because they are the key participants in farming. The highly educated individuals of the constituency were probably at their work places and therefore could not embrace biogas technology. Of the educated people, those who embraced the technology are likely to be retired workers practicing farming in their homes.

4.3.4: Characteristics of respondents by marital status.

The researcher believed that marital status would have some influence on use of biogas since married people are believed to be involved in farming and are in a position to implement biogas technology. The respondents were asked to state their marital status and table 4.4 illustrates their responses.

Table 4.4: Characteristics of respondents by marital status.

Marital status	Frequency	Percentage
Married	85	71
Single	07	06
Widowed	28	23
Total	**120**	**100**

Table 4.4 reveals that of 120 respondents 85(71%) were married, 7(6%) were single while 28(23%) were widowed.

Table 4.4 reveal that relatively married persons in kasipul kabondo constituency would implement biogas technology because they have families to cater for. Agricultural activity would provide food while at the same time cattle reared would provide manure for biogas production. Embracing biogas technology would provide a cheap source of fuel for the families while slurry, a bye product from the process of biogas production would be used to improve crop production.

4.4. Influence of training on implementation of biogas technology.

This variable was measured on the basis of the highest professional qualification of the respondents, possession of relevant knowledge on use of biogas and frequency of engaging in training on implementation and use of biogas.

4.4.1. Influence of professional qualification on implementation of biogas technology.

In the study, professional qualification of the respondents was considered to be of great significance. This was because training was considered as an important undertaking in sharpening the skills of individuals in embracing scientific ventures.

The respondents were requested to complete the questionnaire and their responses were recorded in table 4.5.

Table 4.5: Professional qualification of the respondents.

Qualification	Frequency	Percentage
Certificate	14	12
Diploma	10	08
Degree	04	03
Other	92	77
Total	**120**	**100**

Table 4.5 reveals that of the 120 respondents whose copies of the questionnaire were received, 92(77%) had no meaningful training, 14(12%) had attained certificate and 10(8%) had diploma while 4(3%) had degree.

Table 4.5 imply that people with professional training were less likely to embrace biogas technology because they are not engaged in farming, but were rather likely to be involved in employment in urban centers. Those without professional training would be more involved in

farming as an occupation and would likely engage in embracing biogas technology.

4.4.2: Influence of training on implementation of biogas technology.

In this study, training on use and implementation of biogas technology by respondents was considered to be of great significance to the researcher .This was because training on use of biogas would improve efficiency in the implementation and use of biogas by respondent.

The respondents were asked to complete the questionnaire and their responses were recorded in table 4.6.

Table 4.6: Influence of training on implementation of biogas technology.

Training on biogas	Frequency	Percentage
Yes	42	35
No	78	65
Total	**120**	**100**

Table 4.6 reveal that out of 120 respondents, 78(65%) had no training on biogas technology while 42(35%) had knowledge on biogas technology. The majority of people in Kasipul Kabondo constituency lacked relevant training which is essential for implementation of biogas technology.

4.4.3: Frequency of training on implementation of biogas technology.

In the study, frequency of training of respondent on use of biogas was considered very significant. This was because regular training adds value and skills required for implementation and use of biogas technology.

The respondents were required to complete the questionnaire and the responses were recorded in table 4.7.

Table 4.7 Frequency of training of respondents

Frequency of Training	Frequency	Percentage
Less often	10	02
Often	12	10
More often	20	23
Others (not trained)	78	65
Total	**120**	**100**

Table 4.7 reveals that of the 120 respondents whose copies of the questionnaire were received, 78(65%) had never trained, 20(23%) trained more often, 12(10%) trained often while 10(8%) trained less often.

Table 4.7 implies that many people in Kasipul Kabondo constituency had no training on biogas technology: Probably because few people in the constituency are engaged in serious livestock farming.

4.4.4: Influence of mode of training on implementation of biogas technology.

Normally organized formal training is regarded to be most effective in changing behavior of individuals as opposed to other modes of learning. In this regard the respondents were asked to complete the questionnaire indicating their preferred modes of training and their responses were captured as illustrated in table 4.8.

Table 4.8: Influence of mode of training on implementation of biogas technology.

Mode	Frequency	percentage
Formal	5	4
Informal	3	3
Workshops and Seminars	12	10
Others	100	83
Total	**120**	**100**

Table 4.8 indicates that out of 120 respondents who responded to the questionnaire, 5(4%) preferred formal training, 3(3%) informal training, 12(10%) workshops and seminars while100 (83%) preferred other forms of training.

Table 4.8 imply that only few people in kasipul kabondo constituency had embraced organized training as a means of changing behavior in order to adopt new technology. Those who had implemented biogas technology are the people who attend organized training and at the time of study they were few.

4.5: Influence of funding on implementation of biogas technology.

The researcher believed that funding was considered significant in the implementation of biogas technology. The respondents were then asked to state the sources of funding available for implementing biogas technology in kasipul kabondo constituency. The responses were illustrated in table 4.9 below.

Table 4.9: Influence of funding on implementation of biogas technology.

Sources of funding	Frequency	Percentage
Donor	67	56
Bank loan	10	08
Savings	43	36
Total	**120**	**100**

Table 4.9 reveals that out of 120 respondents who completed the questionnaire, 67(56%) acknowledged donor funding, 43(36%) savings while only 10(8%) bank loans.

Table 4.9 imply that many people of Kasipul Kabondo preferred donor funding as this would assist many farmers implement biogas technology. Bank loans are less preferred due to high interest rates charged for loan repayment.

4.5.1 Recommended source of funding

In the study, respondents' recommendation on the source of funding to people of Kasipul Kabondo constituency was considered significant.

The respondents were therefore asked to give their option on the sources of funding they would recommend to those interested in implementing biogas technology. The responses were illustrated in table 4.10

Table 4.10 source of funding recommended to farmers with interest to implement biogas technology.

Funding source recommended	Frequency	Percentage
Donor	70	58
Bank loan	12	10
Savings	38	32
Total	**120**	**100**

Table 4.10 reveals that out of the 120 respondents who filled the questionnaire 70(58%) recommended donor funding, 12(10%) bank loan, while 38(32%) savings.

Table 4.10 imply that a large number of people of kasipul kabondo constituency would recommend donor funding in case it is available, while a small number would recommend bank loans as a source of funding.

4.6: Influence of kind of available raw materials to implementation of biogas.

In the study, given that biogas is generated by raw materials or biomass, the kind of raw material available for use was considered significant.

The respondents were therefore asked to complete the questionnaire and their responses captured in table 4.11.

Table 4.11: Influence of kind of raw materials available for generating biogas.

Type of material	Frequency	percentage
Kitchen waste	25	21
Human excreta	12	10
Cattle manure	83	69
Total	**120**	**100**

Table 4.11 indicates that out of the 120 respondents who filled the questionnaire, 83(69%) stated that the most available source of raw material was cattle manure, 25(21%) kitchen waste while only 12(10%) considered human excreta as raw material for generating biogas.

The statistics on table 4.11 reveal that cattle manure is more available as a raw material because it is bye-product in farms where cattle are reared. Kitchen waste was available to fewer people because there is no enough quantity that can release sufficient amount of biogas.

Human excreta are least available because it is socially unacceptable to handle, however it is a means of getting rid of health hazard from the environment.

4.6.1: Opinion on the source of raw materials used to generate biogas.

The researcher believed that the opinion of respondents on the sources of raw materials used to generate biogas was significant.

The respondents were therefore asked to state the source of raw materials used to generate biogas and the responses illustrated in table 4.12.

Table 4:12: Opinion on source of raw materials used to generate biogas

Source of materials	Frequency	Percentage
Waste damping pit	25	21
Toilets	12	10
Cattle shed	83	69
Total	**120**	**100**

Table 4.12 revealed that kitchen waste was obtained from waste damping pit as indicated by 25(21%), human excreta from toilets as shown by 12(10%), while cattle manure was sourced from cattle shed as shown by 83(69%).

4.6.2: Raw materials preferred for generation of biogas.

In the study, raw materials preferred by respondent for generation of biogas were considered to be of great significance. This was because biogas cannot be generated without choice of appropriate raw materials. The respondents were requested to complete the questionnaire and the responses recorded in the table 4.13.

Table 4.13: Raw materials preferred for generation of biogas.

Raw materials	Frequency	percentage
Kitchen waste	30	25
Human excreta	11	09
Cattle manure	79	66
Total	**120**	**100**

Table 4.13 revealed that of the 120 respondents who filled the questionnaire, 79(66%) preferred to use cattle manure and that was the majority of kasipul kabondo constituents, 30(25) considered kitchen waste as raw materials while 11(9%) preferred human excreta.

The above table 4.13 implies that more people preferred use of cattle manure as raw materials for generating biogas since those are the people rearing cattle. The population that preferred use of kitchen waste are those who have access to large quantities of kitchen waste while those who preferred to use human waste were very few because that kind of material is not socially acceptable to the majority of people in Kasipul Kabondo constituency.

4.6.3: Access to enough raw materials for maintaining regular supply of biogas.

In the study, access to sufficient raw materials for maintaining regular supply of biogas was considered quite significant for the implementation of biogas technology.

This was because such materials were considered important for the generation of constant supply of biogas as source of fuel.

The respondents were required to complete the questionnaire and the responses were recorded in table 4.14.

Table 4.14: Access to enough raw materials for maintaining regular supply of biogas.

Access to enough raw materials	Frequency	Percentage
Yes	83	69
No	37	31
Total	**120**	**100**

Table 4.14 indicates that of the 120 respondents who filled the questionnaire, 83(69%) had access to sufficient raw materials for biogas generation, 37(31%) felt they could not have access to sufficient quantities of raw materials.

Table 4.14 implies that more people had access to sufficient raw materials because they were involved in cattle rearing or were in a position to access the materials from neighborhood.

Those who did not have access to sufficient raw materials are those who were not involved in rearing livestock. Such people could not be able to maintain constant supply of biogas for domestic use.

4.7: Influence of other source of fuel on implementation of biogas technology.

This variable was measured on the basis the different types of fuel used by the respondents, reasons for using the choice of fuel and the influence other sources of fuel has on implementation of biogas technology.

4.7.1: The types of fuel available in Kasipul Kabondo Constituency

In the study, other types of fuel available were considered to be of great significance. This was because other sources of fuel could still be used to provide fuel which would be used to provide the required energy by those individuals who had not embraced biogas technology.

The respondents were required to complete the questionnaire concerning other sources of fuel and their responses were recorded in table 4.15.

Table 4.15: Other types of fuel used by people in kasipul kabondo constituency.

Sources of fuel	Frequency	Percentage
Wood fuel	95	79
Petroleum products	20	17
Electricity	05	04
Total	**120**	**100**

Table 4.15 reveals that of the 120 respondents whose copies of the questionnaire were received, 95(79%) used wood fuel, 20(17%) used petroleum products while 5(4%) used electricity.

Table 4.15 imply that more people in Kasipul Kabondo Constituency adapted the use of wood fuel as a source of energy in terms firewood and charcoal, while a small number used petroleum products and a very small number used electricity.

4.7.2. Source of fuel used by respondents

In the study, the researcher believed that sources of fuel used by respondents were of great significance. The respondents were hence asked to state the sources of fuel used in their homes to establish the impact on implementation of biogas technology. The responses were illustrated in table below.

4.16: Sources of fuel used by respondents.

e of fuel	Frequency	Percentage
d fuel	89	74
eum products	20	17
icity	07	06
s	4	3
	120	**100**

4.16 reveals that of the 120 respondents who filled the questionnaire, 89(74%) used od, 20(17%) used petroleum products (kerosene), 7(6%) used electricity while 4(3%) used ources such as saw dust, recycled charcoal dust and others.

4.16 imply that more of the respondents used wood fuel inform of firewood and charcoal, e wood fuel is readily available and is relatively cheap compared to other sources of fuel. eum products however are used by few of the respondents because it is an expensive of fuel and only used by majority to light their homes.

icity is used in very few homes that have acquired power but mainly for lighting their and not for cooking. A few others have engaged in the use of recycled products such as st, charcoal dust among others for cooking purposes to save on the use of wood fuel.

Reason for choosing wood fuel.

his study, the researcher found it necessary to find out reasons why respondents chose el as a source of energy. The respondents were asked to give reasons for their choices

and the responses were illustrated in table 4.18.

Table 4.17: Reasons for choosing wood fuel.

Wood fuel	Frequency	Percentage
Easily available	58	65
Cheaper than other sources	31	35
Total	**89**	**100**

Table 4.17 implies that out of the 89 respondents who fill the questionnaire, 58(65%) choose wood fuel because it is easily available while 31(35%) although that wood fuel was cheaper than other sources of fuel.

Table 4.17 implies that wood fuel is chosen mostly because it is easily available to the majority of kasipul kabondo residents. This is because of logging of timber at wire forest and kodera forest as well as from farms. It was also noted by a good number that wood fuel is cheaper than other sources of fuel.

4.7.4: Reasons for choosing petroleum products.

Respondents were further asked to state the reasons for choosing petroleum products. The respondent gave the following responses as illustrated in table 4.18.

Table 4.18: Reasons for choosing petroleum products.

Petroleum products	Frequency	Percentage
Easily available	17	85
Cheaper than other sources	3	15
Total	**20**	**100**

Table 4.18 above shows that 17(85%) out of the respondents thought that petroleum products are easily available while 3(75%) believed that petroleum products were cheaper than other sources of fuel. **Total**

Table 4.18 imply that of those who used petroleum products a greater number thought it was easily available while a small population thought it was cheaper than other sources of fuel. However petroleum products are not preferred by majority because it is cheaper but rather that it is available and convenient for use by many.

4.7.5: Reasons for choosing Electricity as a source of fuel.

In the study, it was observed that electricity is becoming available in many rural homes of Kasipul Kabondo.This prompted the researcher to consider electricity as a source of fuel in Kasipul Kabondo Constituency. The respondents were asked to complete the questionnaire and the responses captured in table 4.19.

Table 4.19: Reasons for choosing electricity as a source of fuel.

Electricity	Frequency	Percentage
Easily available	4	100
Cheaper than other source of fuel	0	0
Total	**4**	**100**

Table 4.19 reveals that out of 4 respondents who filled and returned the questionnaire 4(100%) indicated that electricity was easily available. None indicated that electricity was cheaper than other sources of fuel.

Table 4.19 imply that electricity was used by those who had access to it and it is not cheaper than other sources of fuel.

4.7.6: The impact of biogas technology in Kasipul Kabondo Constituency

In the study, the impact of implementation of biogas technology was considered to be of great significance. This was because it is a clean source of fuel that does not release smoke into the environment and is free ones implemented.

The respondents were requested to fill the questionnaire and their responses recorded in table 4.20.

Table 4.20: Impact of biogas technology in Kasipul Kabondo Constituency.

Impact of biogas	Frequency	Percentage
Preserve trees	56	47
Environment friendly(reduce pollution)	59	49
Improve standards of living(Health)	05	04
Total	**120**	**100**

Table 4.20 reveals that out of 120 respondents who filled and returned the questionnaire, 56(47%) thought biogas technology would preserve trees by limiting cutting of trees for fire wood, while 59(49%) indicated that biogas technology would reduce pollution because it is environment friendly while 5(4%) stated that biogas technology would improve the standard of living by improving health of users.

The above statistics imply that use of biogas technology would have a positive impact on the implementers in kasipul kabondo as they would be able to conserve the environment and be free from respiratory diseases related to smoke from fire wood and generally would have improved standard of living.

4.7.7: Influence of other sources of fuel on implementation of biogas technology.

The researcher believed that other sources of fuel had direct influence on implementation of biogas technology. Since relatively few people had implemented biogas technology.

The respondents were asked to give Information on other sources of fuel on biogas technology and the responses illustrated in table 4.21.

Table 4.21: Influence of other sources of fuel on implementation of biogas technology.

Influence of other sources of fuel	Frequency	Percentage
Positive influence implementation	61	51
Negatively influence implementation	36	30
No influence	23	19
Total	**120**	**100**

Table 4.21 reveals that out of 120 respondents who filled and returned the questionnaire, 61(51%) felt that other sources of fuel positively influenced biogas implementation, 36(30%) felt there was no influence on biogas implementation.

Table 4.21 imply that a large number of people thought that other sources of fuel positively influence biogas implementation because other sources of fuel had negative influence on the environment because these sources are non renewable, speed environment pollution and a health hazard to the users while biogas technology is renewable, provide clean fuel and conserves the environment.

There are also those who thought that other sources of fuel had negative influence on implementation of biogas because they are readily available to the users and such users did not consider the long term effect of other sources.

A few members thought that other sources of fuel had no influence on biogas technology implementation because they had no information on biogas technology and its influence on the environment.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION OF THE STUDY.

5.1: Introduction

This chapter deals with summary of the findings, conclusions, recommendations for policy formulation for suggestions for further research.

5.2: Summary.

The purpose of the study was to investigate the factors influencing implementation of biogas technology by households in kasipul kabondo constituency, Homabay County. The questionnaire filled by various respondents revealed several responses on biogas technology implementation.

Demographic characteristics of the respondents revealed that 51(43%) were in the age bracket of 41 – 50 years , 34(28%) age bracket of 31 – 40years and 24(20%) were in the age bracket of over 50years with 11(09%) being in the age bracket of 20 – 30years.

On the influence on characteristics of respondents by sex, the study revealed that of the 120 respondents 83(69%) were women while 37(31%) were men.

The researcher further observed that on education out of 120 respondents 57(48%) were of primary and below, 35(29%) Secondary level, 24(20%) were of tertiary level while 4(3%) were of university education.

The researcher further observed that on characteristics of respondents by marital status out of 120 persons who filled the questionnaire 85(71%) were married, 28(23%) were widowed, while 07(06%) were single.

Concerning professional qualification on implementation of biogas technology, It was revealed that out of 120 respondents who filled the questionnaire, 92(77%) had no meaningful training, 14(12%) had attained certificate and 10(8%) had diploma while 4(3%) had degree.

The study further revealed through respondents that concerning frequency of training, out of 120 respondent who filled the questionnaire 78(65%) had never trained, 20(17%) trained more often 12(10%) trained often while 10 (8%) trained less often.

The researcher further wanted to know how many households had implemented biogas technology in Kasipul Kabondo constituency Homabay County. The study established that out of 120 respondents who responded to the questionnaire, 115 (99%) had not implemented biogas technology, 5 (4%) had implemented biogas technology.

The researcher further investigated the influence of funding on implementation of biogas technology. The findings revealed that out of 120 respondents, 67 (56%) acknowledge donor funding, 43 (36%) savings while 10 (8%) thought banks should be useful in funding.

The researcher further investigated the source of funding likely to be recommended by respondents. The questionnaire revealed that of 120 respondent, 70(58%) recommended donor funding, 12(10%) bank loan, while 38(32%) savings.

The researcher also looked into the influence of the kind of available raw materials to implementation of biogas. The questionnaire revealed that out of 120 respondents, majority 83(69%) indicated that cattle manure was the best material while a small number 12(10%) considered human excreta as a raw material for generating biogas.

In the study, access to enough raw materials for maintaining biogas technology was also considered significant. The questionnaire revealed that out of 120 respondents, 83(69%) would

access sufficient raw materials for generating biogas while 37(31%) would not be able to access sufficient quantities of such materials for maintaining regular supply of biogas.

On influence of other sources of fuel on implementation of biogas technology by households in Kasipul Kabondo constituency, the study revealed that out of 120 respondents, 95(79%) concurred that wood fuel contribute the largest source of fuel. Similarly on the source of fuel used by the respondents, study revealed that out of 120 responses, 89(74%) use wood fuel while 4(3%) use other sources of fuel.

On reasons for choice of various types of fuel the study revealed that majority made preference on availability of type of fuel while others made choices on affordability and the study revealed that out of 20 respondents, petroleum products contributed 17(85%) on availability while 3(15%) on affordability.

The study further revealed that on impact of biogas technology out of 120 respondents 56(47%) thought biogas technology would preserve trees, 59(49%) thought that it would limit cutting of trees while 5(4%) stated it would improve the standard of living by improving health of users.

The researcher further observed that on influence of other sources of fuel on implementation of biogas, majority 61(51%) indicated positive influence while 23(19%) thought there was no influence of other sources of fuel on biogas implementation.

5.3. Conclusion

The study concludes the following:

Biogas technology implementation in kasipul kabondo constituency, faces various challenges for example level of training, lack of funds, availability of raw materials and access to alternative sources of fuel. On level of training the study shows that training adds value and provides skills

required for implementation and use of biogas. Majority of residents/ households of Kasipul Kabondo constituency have no training on biogas technology and this explains why only few individuals have implemented this technology by the time this research was carried out. Training is significant because it informs and improves knowledge of trainees on what they need to know about a new idea. The training will also help in providing skilled personnel who can build the biogas digester and fix all those parts required for biogas production.

The study has also revealed that many residents of kasipul kabondo constituency have no access to funds for implementing biogas technology. This is because majority lack information on how to acquire the funds especially donor funding. At the same time, quite a number of households cannot access loans due to high interest rates. Majority of the residents cannot have enough savings for biogas technology implementation.

The study revealed that most people in kasipul kabondo constituency have access to raw materials required for biogas generation. Most of these come from cattle shed inform of cattle manure. Other forms of raw materials available are kitchen waste but this can only be accessed in sufficient quantities in institutions such as schools. Human waste as raw materials is not alternative for handling unless the biogas is generated directly from the toilets as in the case of Sulabh organization projects. The above materials need to be decomposed off in a hygienic way to avoid environment pollution. The best way to dispose of the above materials is by processing them in a digester to release biogas while the harmless product known as salary is used as manure to increase crop production in the farms.

Alternative sources of fuel such as wood fuel, petroleum products and electricity cannot compare to biogas as a source of energy. Wood fuel is contributing to deforestation which has contributed a great deal to global warming and to a greater extent climate change. Use of fuel wood should

be discouraged as it is quickly changing Kasipul Kabondo constituency into a desert. Petroleum products directly pollute the environment by producing smoke and shoot which cause respiratory diseases to the users who consist of women and girls. Use of electricity as a source of power is limited to urban centres and it is also expensive and majority of people in Kasipul Kabondo use them. Biogas is a renewable source of fuel which when installed does not have extra costs. It is safe for the users and for the environment, it also helps in destroying disease constituency cannot afford. It is the availability of above fuel source making people of Kasipul causing organisms which may be thriving in manure.

5.4: RECOMMENDATIONS.

The study recommends the following:

1. The government needs to formulate a policy that discourages the use of wood fuel in Kasipul Kabondo constituency by encouraging people in this area to embrace biogas technology. This can be done through the ministry of Agriculture and livestock development.
2. The ministry of Agriculture and livestock should put in place training programs that enlighten people in Kasipul Kabondo constituency on environment conservation so that they can see the need of conserving trees and embracing biogas technology.
3. The forestry departments need to encourage people from Kasipul Kabondo constituency to plant trees and use other sources of fuel other than wood fuel. Farmers who plant trees should be given incentives inform of rewards like the best farmer being given a cow to start livestock farming and to obtain raw materials for biogas production.
4. The area politicians need to source for donor funding for members of Kasipul Kabondo constituency in order to assist in the implementation of biogas technology.

5. Livestock farmers need to form self help groups in order to assist members of the group implement biogas technology. This will help in provision of funds to assist one member at a time.

5.5: Suggestions for further Research.

1. A similar study can be conducted to establish factors influencing implementation of biogas technology in another county in Kenya.

2. A similar study can be conducted to establish the effect of bio – slurry on crop production in kasipul kabondo constituency.

3. A similar study should be conducted to assess factors influencing

the implementation of biogas technology in all secondary schools in Kenya.

4. A similar study can be conducted to analyze the influence of training on biogas implementation in any region.

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APPENDICES

APPENDIX I: LETTER OF TRANSMITTAL

EUNICE ADHIAMBO OTIENO,
P.O BOX 453,
OYUGIS

Date.....

TO THE RESPONDENTS
RACHUONYO SOUTH DISTRICT

Dear Sir/Madam,

RE: FACTORS INFLUENCING IMPLEMENTATION OF BIOGAS TECHNOLOGY BY HOUSEHOLDS IN KASIPUL KABONDO CONSTITUENCY; HOMABAY COUNTY

I am Eunice Adhiambo Otieno, a postgraduate student of the University of Nairobi registration number L50/66446/2012 pursuing an M.A degree in Project Planning and Management. I am conducting a research study on influence of Domestic Biogas in households in Environment Conservation which requires research. To facilitate the exercise; you have been randomly selected as a participant.

You are kindly requested to participate in answering the questionnaire. Be assured that the information obtained will be held in strict confidence and will be used for academic purposes to determine influence of domestic biogas on environment conservation.

I am hereby seeking your permission to obtain data from you.

Thank you in advance.

Yours sincerely,

Eunice A. Otieno

APPENDIX II: QUESTIONNAIRE FOR FARMERS

This questionnaire seeks to obtain data on the influence of biogas technology in households on environmental conservation in Kasipul Kabondo constituency; Homabay County. Indicate your honest response by ticking/writing in the spaces provided

PART A: DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

1. Age 20-30yrs ( ) 31-40yrs ( ) 41-50yrs ( ) over 50yrs ( )
2. Gender Male ( ) Female ( )
3. Your level of education.

   Primary level and below ( ) Secondary ( ) Tertiary ( ) University

   Any other specify.....

4. State your marital status
   a) Married ( )
   b) Single ( )
   c) Widowed ( )
   d) Any other specify.....

PART B (STUDY VARIABLES)

5. Indicate your highest professional training.

   a) Certificate ( )
   b) Diploma ( )
   c) Degree ( )
   d) Other specify.....

6. Do you possess any training relevant to the use of biogas?

a) Yes ( )

b) No ( )

7. If yes, how often do you train?

a) Less often ( )

b) Often ( )

c) More often ( )

d) Other (specify).....

.....

8. In your own opinion, explain the influence training has on implementation of biogas.

.....

.....

9. Do you have a biogas plant in your home?

a) Yes ( )

b) No ( )

10. If your answer is yes, what was your source of funding?

a) Donor ( )

b) Bank loan ( )

c) Savings ( )

d) Other (specify).....

.....

11. Which source of funding would you recommend to others?

a) Donor ( )

b) Bank loan ( )

c) Savings ( )

d) Other (specify).....

.....

12. What reason would you give for your recommendation?

.....

.....

13. In your own opinion, explain the influence funding has on implementation of biogas technology.

.....

.....

14. Indicate the kind of materials available for use to generate biogas in your area.

a) Kitchen waste ( )

b) Human excreta ( )

c) Cattle manure ( )

d) Other (specify) .....

.....

15. What in your own opinion is the source of the above materials for use to generate biogas?

a) Waste damping pit ( )

b) Toilet ( )

c) Cattle shed ( )

d) Other (specify) .....

.....

16. Which of the above materials would you prefer to use to generate biogas?

a) Kitchen waste ( )

b) Human excreta ( )

c) Cattle manure ( )

d) Other (specify).....

.....

17. In your own opinion do you think you can access enough materials for maintaining regular supply of biogas / daily feeding of the digester?

a) Yes

b) No

18. If no, explain how you intend to obtain sufficient supply of materials.

.....

.....

19. In your own opinion, explain the influence of raw materials on implementation of biogas technology.

.....

.....

20. Indicate in your opinion the other types of fuel used by majority in your area.

a) Wood fuel ( )

b) Petroleum products e.g kerosene, gas ( )

c) Electricity ( )

d) Other (specify) .....

d) Other (specify) .....

.....

21. Which of the above sources of fuel do you use in your home?

a) Wood fuel ( )

b) Petroleum products ( )

c) Electricity ( )

d) Other (specify).....

22. What is your reason for your choice to use the above fuel?

a) Easily available

b) Cheaper than other sources

23. In your own opinion, what would be the impact of biogas technology in your area.

.....

.....

24. In your own opinion, explain the influence other sources of fuel has on implementation of biogas technology.

.....

.....

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

GPK6055t3mt10/2011

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS–see back page)

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Eunice Adhiambo Otieno
of (Address) University of Nairobi
P.O.Box 2461, Kisii.
has been permitted to conduct research in

Location
District
Homa Bay County

on the topic: Factors influencing implementation of biogas technology by households in Kasipul Kabondo Constituency, Homa Bay County.

Applicant's Signature

for a period ending: 31st December, 2012

PAGE 3

Research Permit No. *NCST/RCD/9/012/19*
Date of issue *24th October, 2012*
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