

**SOCIO-ECONOMIC FACTORS AND POLICY INCENTIVES INFLUENCING THE
ADOPTION OF BIO-GAS TECHNOLOGY IN GULU CITY**

BY

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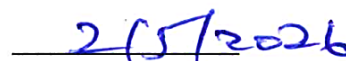
DECLARATION

This is to declare that this dissertation is a product of my own work and that it has never been presented at any higher institution of learning for academic or any other award before.

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Date

APPROVAL

This research dissertation entitled “Adoption of biogas technology in Gulu City” has been submitted with our approval as supervisors

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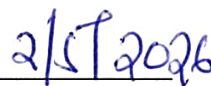
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DEDICATION

This research dissertation is dedicated to my family (wife and children), who have been my rock and source of unconditional love, encouragement, and belief in my abilities. This piece of work will inspire them to achieving greater heights.

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LIST OF ABBREVIATIONS AND ACRONYMS

MEMD: Ministry of Energy and Mineral Development

RE: Renewable Energy

UBOS: Uganda Bureau of Statistics

UNDP: United Nations Development Programme.

ABSTRACT

Social economic factors play crucial role in the adoption of bio-gas in any economy. This study investigated socio-economic factors influencing the adoption of bio-gas technology in Gulu city. The study was guided by the following objectives: To assess the adoption of biogas technology among households in Gulu City; to assess the benefits of biogas technology among households; to assess the factors affecting adoption of biogas technology among households in Gulu City; and to assess the moderating effect of policy intervention on the relationship between socio-economic factors and the adoption of biogas technology. The study used descriptive and cross-sectional research design with a mixed method approach of both quantitative and qualitative. Data was collected from a sample of 88 households using questionnaires and interview guides by employing simple random and purposive sampling techniques. Key study findings revealed high level of perception about the socio-economic benefits of bio-gas adoption; and low level of bio-gas adoption among households. The finding shows that economic and technological factors have significant effect on adoption of bio-gas technology, while social factors do not have any significant effect on adoption of bio-gas technology. From the study, policy incentives have a significant moderating effect on the relationship between socio-economic factors and bio-gas adoption. The study concluded that economic and technological factors are crucial for the adoption of biogas technology. The study recommends that measures aimed at improving bio-gas adoption should focus on economic and technological measures. The study also concludes that policy incentives should be integrated in to key technological and economic factors for increased adoption of biogas technology.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

In recent years, there has been an increasing global focus on renewable energy sources as a means to mitigate environmental degradation, reduce greenhouse gas emissions, and achieve sustainable development goals. Biogas technology, derived from the anaerobic digestion of organic materials such as agricultural waste, animal manure, and sewage, has emerged as a promising renewable energy solution with the potential to address both energy and environmental challenges (Koirala, 2018). However, the adoption of biogas technology varies significantly across different regions and communities, driven by different forces such as socio-economic factors.

One of the primary determinants of biogas adoption is the perceived economic viability and affordability of the technology. Research by Miah, Griffith & Shrestha (2020) found that households are more likely to adopt biogas systems when they perceive tangible economic benefits, such as cost savings on energy expenditures, income generation from biogas by-products, and potential subsidies or financial incentives offered by government or non-governmental organizations (NGOs). Furthermore, social and cultural factors play a significant role in shaping attitudes and behaviors towards biogas adoption. Studies have shown that social networks, community cohesion, and cultural norms influence the diffusion of biogas technology within communities (Nakaziba, Byakola & Nansereko, 2019). This study therefore investigated the factors associated with the adoption of biogas technology in Gulu City.

1.1 Background

The adoption of biogas technology has evolved over several decades, shaped by historical, technological, and socio-economic factors. The roots of biogas technology can be traced back to the late 19th and early 20th centuries when researchers began experimenting with anaerobic

digestion processes to produce methane gas from organic waste. In 1859, the French engineer, Eugène Ducretet, patented the first biogas digester, laying the foundation for further advancements in biogas technology (Weiland, 2010).

During World War II, biogas gained attention as an alternative fuel source in response to fuel shortages and rationing. In the 1940s, Germany pioneered the development of biogas technology for rural energy production, utilizing digesters to convert agricultural waste into methane for cooking and lighting (Eschemuller, 1950). After the war, biogas continued to be used in Europe and other regions as a decentralized energy solution for rural communities.

The 1960s and 1970s saw increased international interest in biogas technology as a means to address energy and environmental challenges in developing countries. Organizations such as the United Nations Development Programme (UNDP) and the World Bank supported pilot biogas projects in countries like India, China, and Nepal (Jha et al., 1980). These initiatives aimed to promote rural electrification, improve sanitation, and reduce deforestation by replacing traditional biomass fuels with biogas.

The 1980s and 1990s witnessed significant advancements in biogas technology, including the development of standardized digester designs, improved feedstock processing methods, and the introduction of small-scale biogas systems for household use. Research institutions, NGOs, and government agencies played a crucial role in disseminating knowledge and expertise on biogas technology through capacity-building programs and technical assistance (Werner et al., 2009).

In the 21st century, biogas technology continues to evolve, driven by growing concerns over energy security, climate change, and sustainable development. Countries around the world are increasingly adopting biogas as part of their renewable energy portfolios, with applications ranging from household cooking and heating to industrial-scale electricity generation and biofuel production (Angelidaki & Bjoern, 2013). However, challenges such as high initial

investment costs, feedstock availability, and policy barriers persist, hindering the widespread adoption of biogas technology in many regions (Kemausuor et al., 2013).

The Diffusion of Innovations theory, developed by Everett Rogers, provides insights into how innovations, such as biogas technology, are adopted and spread through a population. Biogas technology adoption is influenced by the extent to which potential adopters can observe and understand the practices involved. Diffusion theory suggests that innovations that are visible and easily understood are more likely to be adopted and practiced (Rogers, 2003). Therefore, clear and accessible information about the installation, operation, and maintenance of biogas systems can facilitate adoption practices.

According to diffusion theory, the adoption process involves several stages or levels, including knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). The level of adoption of biogas technology can be assessed by examining the distribution of adopters across these stages. Early adopters, for example, are those who embrace biogas technology soon after its introduction, while laggards are those who adopt much later.

Diffusion theory emphasizes the importance of the perceived relative advantage of an innovation compared to existing alternatives (Rogers, 2003). In the case of biogas technology, potential adopters assess its benefits, such as environmental sustainability, energy cost savings, waste management, and potential income generation from by-products, against traditional energy sources like firewood or fossil fuels. The Diffusion of Innovations theory offers a comprehensive framework for understanding the adoption of biogas technology by considering factors such as adoption practices, level of adoption and benefits of adoption.

The adoption of biogas technology is influenced by a complex interplay of socio-economic factors that vary across different regions and countries. Understanding these factors is crucial for promoting the widespread adoption of biogas technology and realizing its potential benefits for sustainable energy development. Economic incentives play a significant role in driving the

adoption of biogas technology. Studies in America have shown that financial incentives, such as subsidies, tax credits, and grants, can stimulate investment in biogas projects and offset the initial costs of implementation (US Department of Energy, 2020). Government policies and regulatory frameworks play a critical role in creating an enabling environment for biogas adoption. In America, supportive policies at the federal and state levels, such as the Renewable Fuel Standard and Clean Water Act, have incentivized biogas production and utilization (US Environmental Protection Agency, 2020).

In Europe, countries like Germany and Denmark have implemented feed-in tariffs and favorable renewable energy policies, which have incentivized the adoption of biogas technology among farmers and rural communities (Petersen & Pedersen, 2015). The availability of technological infrastructure and support services influences the adoption of biogas technology. In Europe, well-established biogas industries with access to advanced technology, research institutions, and technical expertise have facilitated widespread adoption (Jensen et al., 2018). The European Union's Renewable Energy Directive and national renewable energy targets have provided a policy framework for promoting biogas as part of the energy mix (European Commission, 2020).

In Asia, rapid industrialization and urbanization have led to increasing energy demand, prompting governments to promote biogas as a renewable energy source. In countries like China and India, financial incentives and supportive policies have contributed to the expansion of biogas technology adoption (Li et al., 2019). In Asia, investments in biogas infrastructure, including biogas plants, distribution networks, and training facilities, have helped overcome technological barriers and promote adoption in rural and peri-urban areas (Sharma & Gupta, 2016). Cultural acceptance of biogas technology as a clean and sustainable energy source has facilitated adoption, particularly in rural areas where traditional biomass fuels are still widely used (Sharma & Gupta, 2016). Governments in Asia have implemented renewable energy

policies, feed-in tariffs, and energy subsidies to promote biogas adoption and address energy security and environmental challenges (ADB, 2019).

In Uganda, where access to modern energy sources is limited, economic incentives such as grants and subsidies have been crucial in promoting biogas adoption among rural households and small-scale farmers (Nakaziba et al., 2019). Initiatives by government agencies, NGOs, and development partners to provide technical assistance, training programs, and extension services have supported the adoption of biogas technology among smallholder farmers (Nakaziba et al., 2019). Cultural norms related to waste management and livestock rearing practices have influenced the adoption of biogas technology, with communities recognizing the benefits of converting organic waste into energy (Nakaziba et al., 2019). Government has developed the Renewable Energy Policy and National Biomass Energy Strategy, which prioritize the promotion of biogas technology as a renewable energy source (Ministry of Energy and Mineral Development, Uganda, 2020).

The adoption and implementation of biogas technology in Uganda, particularly in Northern Uganda and Gulu, have been influenced by various factors including economic conditions, agricultural practices, government policies, and socio-cultural dynamics.

The Ugandan government has recognized biogas as a sustainable energy solution and has implemented policies to promote its adoption. The Renewable Energy Policy of Uganda prioritizes the promotion of renewable energy technologies, including biogas, to enhance energy access and reduce reliance on traditional biomass fuels (Ministry of Energy and Mineral Development, Uganda, 2020). The Uganda National Biomass Energy Strategy provides a roadmap for the development and utilization of biomass energy resources, including biogas, to meet the country's energy needs in an environmentally sustainable manner (Ministry of Energy and Mineral Development, Uganda, 2018).

Rural areas in Uganda, including Northern Uganda, face challenges related to energy access, with a significant portion of the population relying on biomass fuels such as firewood and charcoal for cooking and heating (UBOS, 2017). Biogas technology offers a clean and renewable energy alternative, particularly for rural households engaged in agriculture and livestock farming, which generate organic waste suitable for biogas production (Nakaziba et al., 2019).

The adoption of biogas technology in Northern Uganda has been primarily driven by government-supported initiatives, NGOs, and development partners, which provide technical assistance, training, and financial incentives to promote biogas projects (Nakaziba et al., 2019). However, the adoption of biogas technology in Uganda, including in Northern Uganda and Gulu, has been relatively slow compared to other renewable energy sources such as solar and hydroelectric power (Karekezi & Kithyoma, 2013).

Challenges such as high upfront costs, limited awareness, technical know-how, and access to financing have hindered widespread adoption of biogas technology in Uganda (Nakaziba et al., 2019). Despite the challenges, there is significant potential for biogas technology to contribute to energy access, environmental sustainability, and rural development in Uganda. Biogas systems can provide clean cooking fuel, reduce deforestation, improve waste management, and generate income opportunities for rural communities (Nakaziba et al., 2019). Initiatives such as the Biogas Support Program implemented by the Ugandan government and development partners aim to address barriers to biogas adoption and promote its sustainable development across the country, including in Northern Uganda and Gulu (Nakaziba et al., 2019).

1.2 Problem Statement

Despite the potential of biogas technology to offer numerous benefits such as improved energy access, income generation opportunities, waste management benefits, and reduced deforestation, and its potential for sustainable development in Uganda, the adoption of biogas

technology in Uganda remains limited (Nakaziba et al., 2019; Ministry of Energy and Mineral Development, Uganda, 2023). Understanding the socio-economic, technological, and policy factors influencing biogas technology adoption is crucial for developing effective strategies to overcome barriers and promote its widespread adoption. Karekezi & Kithyoma (2023) further revealed that the adoption of biogas technology in Uganda, including in Northern Uganda and has been relatively slow compared to other renewable energy sources such as solar and hydroelectric power. Karekezi & Kithyoma (2023) add that less than 15% of households are involved in the utilization of this technology despite huge investments in this initiative. The role of socio-economic factors in influencing the adoption of biogas technology remains underexplored and unclear within the context of Uganda particularly Northern Uganda. This study aimed to examine the socio-economic factors influencing the adoption of biogas technology in Northern Uganda, particularly in Gulu City.

1.3 Purpose of the Study

The main purpose of the study was to examine the socio-economic factors and policy incentives influencing the adoption of bio-gas technology in Gulu City.

1.4 Objectives of the Study

- i. To assess the nature of biogas technology adoption among households in Gulu City.
- ii. To assess the benefits of biogas technology among households in Gulu City.
- iii. To assess the factors influencing the adoption of biogas technology among households in Gulu City.
- iv. To assess the moderating effect of policy incentives on the relationship between socio-economic factors and the adoption of biogas technology in Gulu City.

1.5 Research Questions

- i. What is the nature of biogas technology adoption among households in Gulu City?

- ii. What are the key factors influencing the adoption of biogas technology among households in Gulu City.
- iii. What are the benefits associated with biogas technology adoption among households in Gulu City?
- iv. What is the moderating effect of policy incentives on the relationship between socio-economic factors and the adoption of biogas technology in Gulu City?

1.6 Scope of the Study

1.6.1 Content scope

The study evaluated the factors affecting the adoptions of biogas technology in Gulu City. Specifically, this study focused on social, economic and technological factors. The adoption of biogas technology was limited to the adoption practices, adoption level and benefits of adoption. Policy intervention on monetary and non-monetary incentives was also covered under the content scope.

1.6.2 Geographical scope

This study was carried out in Gulu City most specifically in Pece-Laroo and Bardge-Layibi Division in Gulu City. Gulu City is bounded by latitude 02°-04° North and longitude 30°-32° east. The City is surrounded by the districts of Amuru, Nwoya, and Omoro, respectively.

1.6.3 Time scope

The research looked at the trend of affairs between 2018 and 2023. The time period is believed to offer enough information regarding the matter since new interventions were initiated. Therefore, the adoption of biogas technology was popularized within this selected time frame.

1.7 Significance of the Study

The study is significant to government and organizations who are interested in promoting biogas technology as an alternative source of renewable energy. The data collected contribute to the pool of knowledge in the study area and it will help in shaping on renewable energy and

environment policies as highlighted in the National development plan regarding resource use and environmental conservation.

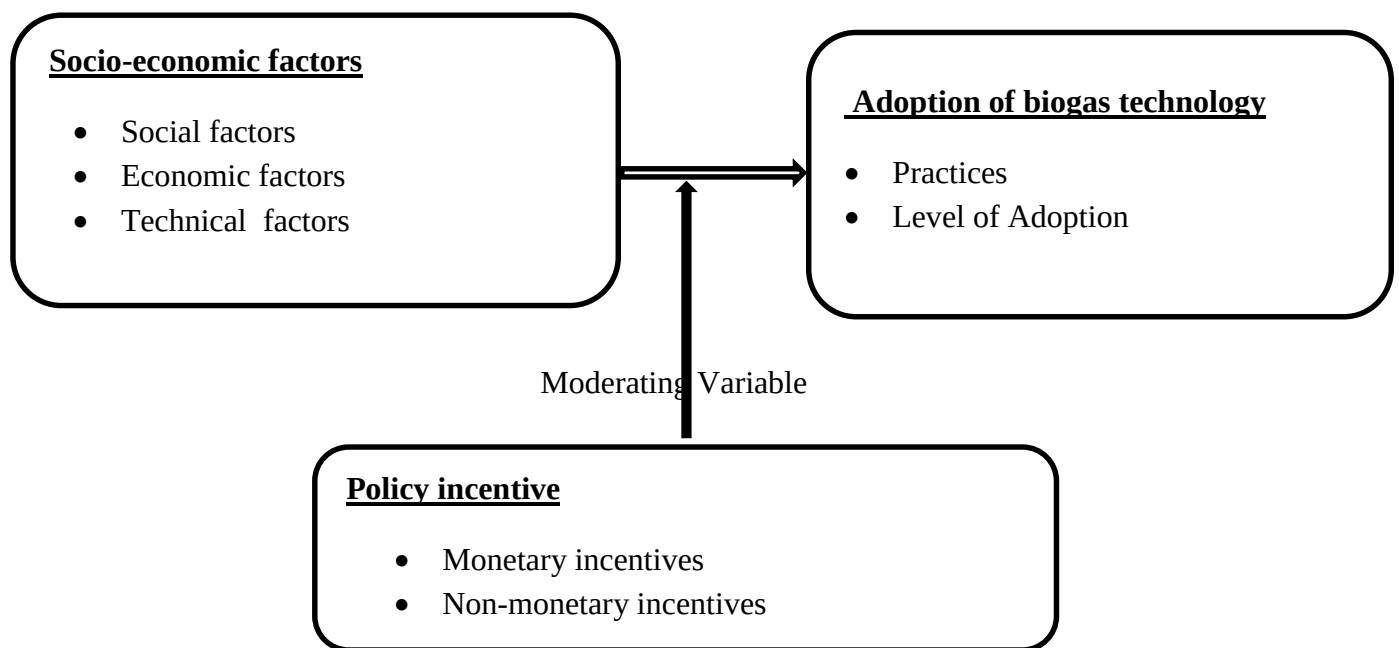
To the future scholars and academicians, the study help to provide related literatures that expand research into the factors associated with the adoption of biogas technology in different contexts.

To the different implementers and support institutions of the biogas technology, the study help provide evidence-based factors that contribute to improvement of the adoption rates of biogas technology.

1.8 Conceptual Framework

Independent Variable

Dependent Variable



Source: Adapted with modification from (Koirala, 2018; Rogers, 2003)

Figure1: Conceptual framework showing socio-economic factors and adoption of biogas technology.

The conceptual framework presented above revealed socio-economic factors as independent variable and the adoption of biogas technology as the dependent variable measured by the adoption practices, adoption level and benefits of adoption. Policy interventions on monetary

and non-monetary incentives have been conceptualized as the moderating variable in influencing the relationship between socio-economic factors and adoption of biogas technology.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literatures on socio-economic factors influencing the adoption of biogas technology. The literatures are reviewed based on previous studies on adoption of biogas technology in different contexts; the literatures are reviewed from different journal articles and published reports. Theoretical review is also covered in this chapter.

2.1 Theoretical Review

2.1.1 Diffusion of Innovation Theory

Everett Rogers developed the Diffusion of Innovations Theory. He first introduced this theory in his seminal work titled "Diffusion of Innovations," which was first published in 1962. Since then, the theory has undergone revisions and updates, but Rogers is credited with its original formulation. Biogas technology possesses several attributes that align with the innovation characteristics outlined by Rogers. Studies such as Wang and Zhao (2019) highlight its relative advantage over conventional energy sources in terms of environmental sustainability and waste management. The compatibility of biogas systems with existing agricultural practices and infrastructure is highlighted by Akter et al. (2020), making it more feasible for adoption in rural settings. Furthermore, innovations in biogas digester designs, feedstock preprocessing techniques, and utilization technologies address concerns regarding complexity and trialability, as noted by Khanal et al. (2018) and Derese et al. (2020).

In addition effective communication channels as one of the key features of the theory play a crucial role in disseminating information about biogas technology and shaping public perceptions. Research by Alemagi et al. (2018) emphasizes the role of interpersonal networks and community-based organizations in promoting awareness and knowledge sharing about biogas systems. Mass media campaigns and targeted outreach programs, as highlighted by

Bhattarai and Timilsina (2019) and Gebreegziabher et al. (2020), contribute to raising awareness and facilitating information exchange among potential adopters.

The diffusion of biogas technology is influenced by the characteristics of the social systems in which it is introduced. Rahman et al. (2021) examine the role of social norms and cultural values in shaping attitudes towards biogas adoption within communities. Opinion leaders and influential stakeholders, identified by Chatterjee (2022) and Munyao (2023), can play pivotal roles in championing biogas initiatives and mobilizing support from various sectors.

Furthermore, the readiness of individuals and organizations to adopt biogas technology is influenced by their characteristics and predispositions. Sarker (2020) and Koirala (2022) explore the socio-economic factors that affect adoption decisions, highlighting the importance of financial incentives and institutional support in overcoming barriers to adoption. Innovators and early adopters, as identified by Li et al. (2018) and Amigun et al. (2020), serve as catalysts for biogas diffusion, showcasing successful implementations and inspiring confidence among potential adopters.

The diffusion process of biogas technology unfolds over time, following a trajectory of awareness, interest, evaluation, trial, and adoption. Schaller et al. (2019) and Zhou et al. (2021) examine adoption curves and temporal dynamics, shedding light on the factors that influence the pace and extent of biogas diffusion within different contexts. Understanding the temporal dimensions of adoption is essential for designing targeted interventions and strategies to accelerate the uptake of biogas technology. Therefore, the social and economic factors including the benefits of adoption as derived from this theory becomes major constructs in this study of socio-economic factors influencing the adoption of bio-gas technology.

2.2 Socio-economic factors

2.2.1 Social factors

The adoption of biogas technology is significantly influenced by various social factors. Research indicates that societal attitudes, perceptions, and cultural values play a crucial role in shaping individuals' decisions regarding the adoption of renewable energy technologies like biogas. Studies by Wang and Zhao (2019) and Akter et al. (2020) emphasize the importance of understanding public attitudes and perceptions towards biogas technology. Positive attitudes towards environmental conservation and sustainable living often correlate with higher acceptance rates of biogas systems. Conversely, negative perceptions, such as concerns about odor or aesthetics, can hinder adoption. Research by Alemagi (2018) and Rahman et al. (2021) highlights the role of social norms and networks in the diffusion of biogas technology. Peer influence, community networks, and social acceptance within local communities can facilitate or impede the spread of biogas adoption.

Studies by Bhattarai and Timilsina (2019) and Gebreegziabher et al. (2020) emphasize the significance of knowledge and awareness campaigns in promoting biogas adoption. Education initiatives, demonstration projects, and outreach programs can enhance public understanding of biogas technology and its benefits, thereby increasing acceptance rates. Furthermore, Chatterjee et al. (2022) and Munyao et al. (2023) highlight the importance of supportive policy frameworks and governance structures in fostering biogas adoption. Policies that incentivize biogas production, provide financial support, and streamline regulatory processes can encourage investment and uptake among individuals and communities.

Social factors play a crucial role in shaping socioeconomic outcomes, influencing individuals' well-being, opportunities, and overall quality of life as far as utilization of biogas system is concerned. These factors interact with economic conditions, policies, and institutions to shape individuals' socioeconomic status and opportunities (Smith & Johnson, 2021). For example,

access to quality education can improve human capital development necessitating adoption of modern technology and biogas is one such a technology (Wilkinson and Pickett (2019)

2.2.2 Economic Factors

Economic considerations play a pivotal role in determining the viability and adoption of biogas technology. From initial investment costs to long-term financial benefits, various economic factors influence stakeholders' decisions. Studies by Schaller et al. (2019) and Zhou et al. (2021) highlight the importance of conducting thorough cost-benefit analyses to assess the economic feasibility of biogas projects. Factors such as capital investment, operational costs, revenue generation from biogas production, and potential savings on energy bills and waste management expenses need to be evaluated.

Research by Sarker et al. (2020) and Koirala et al. (2022) emphasizes the role of financial incentives in promoting biogas adoption. Subsidies, grants, tax credits, and favorable financing options can significantly reduce the financial barriers associated with implementing biogas systems, making them more attractive to investors and end-users. Studies by Li et al. (2018) and Amigun (2020) explore emerging market opportunities for biogas technology. The potential for revenue generation through the sale of biogas, bio-fertilizers, and carbon credits, as well as the creation of new business models and value chains, can enhance the economic viability of biogas projects.

Furthermore, Gebreegziabher (2019) and Demirbas (2021) highlights the importance of considering resource availability and access to feedstock for biogas production. Factors such as the availability of organic waste, biomass resources, and land for biogas plant installations can impact the economic sustainability of biogas projects.

Economic factors are critical components of socioeconomic development, influencing individuals' livelihoods, opportunities, and overall intention to adopt biogas technology. This factor encompasses various dimensions of economic life, including income, employment,

wealth distribution, access to resources, and economic infrastructure. These factors interact with social conditions, cultural norms, and institutional frameworks to shape individuals' socioeconomic status and opportunities for biogas adoption (Stiglitz, Sen, & Fitoussi, 2019). Policies that promote job creation, entrepreneurship, investment in infrastructure, and access to financial services can foster economic development and social progress that aid in the adoption of mechanisms to improve wellbeing including the utilization of biogas technology within households (World Bank, 2019).

2.2.3 Technological Factors

Technological advancements and innovations play a crucial role in driving the adoption and diffusion of biogas technology. From improvements in biogas production efficiency to the development of integrated systems, various technological factors influence the uptake of biogas solutions. Studies by Khanal (2018) and Derese (2020) highlight ongoing efforts to innovate and improve biogas technology. Advances in digester design, feedstock preprocessing techniques, biogas purification, and utilization technologies contribute to higher efficiency, reliability, and scalability of biogas systems, making them more attractive to users.

Pandey (2019) and explored the integration of biogas systems with other renewable energy technologies and infrastructures. Combined heat and power (CHP) systems, biogas upgrading for injection into natural gas grids, and integration with solar or wind power generation enhance the versatility and value proposition of biogas solutions. Studies by Weiland (2019) and Alemagi et al. (2021) discuss the importance of scalability and modularization in biogas technology arguing that modular digester designs, decentralized biogas production units, and plug-and-play systems offer flexibility and adaptability to varying feedstock types, production scales, and user needs, facilitating broader adoption across diverse contexts.

Furthermore, research by Devkota (2020) and Kafle (2022) highlight the significance of technological access and knowledge transfer mechanisms in promoting biogas adoption,

particularly in rural and underserved areas. Capacity building initiatives, technology transfer programs, and knowledge sharing platforms enable users to acquire the necessary skills and expertise for successful biogas implementation.

Acemoglu and Restrepo (2017) highlight the role of technological change in shaping individuals intentions to adopt biogas technology. Technological advancements drive structural transformation, create new job opportunities, and improve living standards, while also posing challenges such as job displacement and skills mismatch. Addressing technical factors as part of socioeconomic development requires policy interventions aimed at promoting innovation, technology adoption, and industrial upgrading. Governments, businesses, and institutions play a crucial role in fostering an enabling environment for technological advancement through policies that support R&D investment, skills development, entrepreneurship, and infrastructure development (World Economic Forum, 2020). In conclusion, the adoption of biogas technology is influenced by a complex interplay of social, economic, and technological factors. Understanding these factors and their interactions is essential for developing effective strategies to promote biogas adoption and realizing its potential

2.3 Adoption of biogas Technology

2.3.1 Practice

Technical practices refer to the design, construction, and operation of biogas systems. This includes considerations such as the selection of suitable feedstock, system sizing, process optimization, and maintenance procedures. Research by Kumar et al. (2020) emphasizes the importance of technical knowledge and expertise in ensuring the efficient performance of biogas digesters and maximizing energy production from organic waste. Social practices encompass the socio-cultural norms, beliefs, and attitudes that influence the acceptance and adoption of biogas technology within communities. Studies by Asante and Darkwah (2019) highlight the role of social networks, community engagement, and knowledge sharing in

facilitating the adoption of biogas systems. Social practices also include user behavior, preferences, and perceptions regarding biogas technology, which can affect its uptake and sustainability. Institutional practices relate to the policy, regulatory, and institutional frameworks that shape the adoption and diffusion of biogas technology at the national, regional, and local levels.

Gebrezgabher et al. (2018) highlight the importance of supportive policies, financial incentives, and institutional capacity building in promoting the widespread adoption of biogas technology. Institutional practices also include the involvement of government agencies, NGOs, and private sector actors in providing technical assistance, training, and financial support to biogas users. In summaries, practices play a crucial role in the adoption and utilization of biogas technology, encompassing technical, social, and institutional dimensions. By understanding and addressing the key practices associated with biogas technology adoption, policymakers, practitioners, and stakeholders can promote its sustainable implementation and maximize its potential benefits for energy access, environmental sustainability, and rural development.

2.3.2 Level of adoption

The level of adoption is a critical component in assessing the uptake and diffusion of biogas technology within communities or regions. Understanding the factors influencing the level of adoption provides insights into the barriers, facilitators, and dynamics shaping the widespread implementation of biogas systems for renewable energy production and waste management. Individual adoption refers to the decision-making process and actions of individual households or businesses in adopting biogas technology.

Mekonnen et al. (2019) examines the factors influencing individual-level adoption of biogas digesters in rural communities, including socioeconomic characteristics, awareness, perceived benefits, and access to support services. Individual adoption is influenced by factors such as affordability, perceived usefulness, and compatibility with existing practices and preferences.

Community adoption involves the collective adoption of biogas technology within a community or region. Studies by Gebreegziabher et al. (2018) explore the determinants of community-level adoption of biogas systems, including social networks, cultural norms, and local institutions. Community adoption influenced by factors such as social learning, peer influence, and community cohesion, which can facilitate the diffusion of biogas technology within a social context.

Policy and institutional adoption refer to the adoption of supportive policies, regulations, and institutional frameworks that promote the widespread implementation of biogas technology at the national or regional level. Research by Ayugi et al. (2020) examines the role of government policies, financial incentives, and institutional capacity building in fostering the adoption of biogas technology. Policy and institutional adoption are influenced by factors such as political commitment, resource allocation, and coordination among government agencies, NGOs, and private sector stakeholders. In conclusion, the level of adoption is a multifaceted component of the adoption of biogas technology, encompassing individual, community, and policy dimensions. By understanding the factors influencing the level of adoption at different levels, policymakers, practitioners, and stakeholders can design targeted interventions and strategies to promote the widespread uptake and utilization of biogas systems for sustainable energy and environmental management.

2.3.3 Benefits of adoption

Adoption of biogas technology offers numerous benefits, both environmental and socio-economic, making it a compelling component of sustainable development efforts. The literature extensively discusses these advantages, highlighting its potential to mitigate greenhouse gas emissions, improve waste management, and enhance energy security. One key benefit is the reduction of greenhouse gas emissions. Biogas production from organic waste helps to capture methane, a potent greenhouse gas, which would otherwise be released into the atmosphere

during decomposition. According to Smith et al. (2014), biogas systems can significantly reduce methane emissions from organic waste, thereby contributing to climate change mitigation efforts.

Moreover, biogas technology facilitates efficient waste management by converting organic waste into valuable energy and fertilizer. This process not only reduces the environmental burden of waste disposal but also provides a renewable source of energy for households and communities (Sikora et al., 2020). By diverting organic waste from landfills and incinerators, biogas adoption helps alleviate pollution and conserves valuable landfill space. Additionally, the adoption of biogas technology has socio-economic benefits, particularly in rural areas. Small-scale biogas digesters can provide clean cooking fuel for households, thereby reducing reliance on traditional biomass fuels like firewood or charcoal. This not only improves indoor air quality and reduces respiratory illnesses but also saves time and labor spent on fuel collection (Kammen & Lew, 2005).

Furthermore, biogas technology promotes rural development by creating employment opportunities and generating additional income streams for farmers. By utilizing agricultural residues and livestock manure as feedstock, farmers can produce biogas for cooking, lighting, and heating, while the digestive can be used as organic fertilizer to enhance soil fertility and crop yields (Parawira, 2009). In summaries, the multifaceted benefits of adopting biogas technology, encompassing environmental sustainability, waste management, and socio-economic development. Integrating biogas into energy systems offers a promising pathway towards achieving sustainable development goals, particularly in rural and resource-constrained settings.

2.4 Policy Incentive

2.4.1 Monetary incentives

Monetary incentives play a significant role as moderating factors in the adoption of various technologies, including biogas technology. The literature suggests that financial incentives can influence individuals' decisions by mitigating initial investment costs and providing tangible returns on investment, thus accelerating the adoption process. For instance, studies have shown that government subsidies and financial incentives can effectively stimulate adoption rates of renewable energy technologies, including biogas systems (Alam et al., 2017). These incentives may include grants, tax credits, feed-in tariffs, or low-interest loans, which reduce the financial barriers associated with technology adoption and encourage uptake among individuals and businesses.

Moreover, monetary incentives can enhance the economic viability of biogas projects, particularly in regions where the cost of conventional energy sources is high or where there are limited access and affordability of clean energy alternatives (Koirala et al., 2016). By providing a financial return on investment through revenue generation from biogas production or savings on energy costs, monetary incentives increase the attractiveness of adopting biogas technology. Studies have highlighted the importance of financial incentives in influencing farmers' decisions to adopt biogas technology for waste management and energy production on farms. Research by Rai et al. (2017) found that subsidies and financial support schemes significantly influenced farmers' willingness to invest in biogas digesters, particularly in developing countries where agricultural waste management is a pressing issue.

The effectiveness of monetary incentives as moderating factors may vary depending on contextual factors such as policy support, market conditions, and socio-economic considerations. While financial incentives can spur initial adoption, sustained market development and supportive policies are essential for long-term sustainability and scalability of biogas technology adoption (Murphy & Hall, 2011). Monetary incentives serve as crucial

moderating factors in the adoption of biogas technology and other renewable energy solutions. By addressing financial barriers and providing tangible benefits, such incentives can accelerate technology uptake and contribute to the transition towards a more sustainable energy future

2.4.2 Non- Monetary Incentive

Non-monetary incentives play a crucial role in motivating individuals and moderating their behavior in various contexts, including the workplace, education, and public health. Understanding the effectiveness of non-monetary incentives as moderating factors provides insights into their impact on behavior change, performance, and decision-making. In the workplace, non-monetary incentives such as recognition, praise, autonomy, and opportunities for personal development can moderate employee motivation and performance. Research by Deci et al. (2017) demonstrates that intrinsic rewards, such as meaningful work and autonomy, are often more effective than extrinsic rewards in enhancing employee engagement and job satisfaction. Non-monetary incentives can foster a positive work environment, promote teamwork, and increase employee morale, ultimately leading to improved organizational performance.

Hattie and Timperley (2017) highlight the importance of feedback and praise in shaping student engagement, self-efficacy, and academic achievement. Non-monetary incentives can enhance students' intrinsic motivation, foster a growth mindset, and promote active learning, thereby improving educational outcomes and retention rates. Effectiveness of non-monetary incentives, such as lottery-based incentives and social incentives, in encouraging smoking cessation, weight loss, and medication adherence. Non-monetary incentives can leverage social norms, peer influence, and intrinsic motivations to promote healthy behaviors and lifestyle changes. In conclusion, non-monetary incentives serve as effective moderating factors in influencing behavior change, performance, and decision-making across various domains. By understanding the role of non-monetary incentives in motivating individuals and fostering positive outcomes,

policymakers, practitioners, and organizations can design interventions and strategies that leverage these incentives to achieve desired goals and outcomes.

2.5 Summary of Literature Gaps

Existing studies on biogas adoption have largely focused on Asian countries such as India and China, with limited empirical evidence from Sub-Saharan Africa, particularly Northern Uganda. While studies in Uganda (e.g., Okello et al., 2022; Katuura & Wafula, 2021) have examined renewable energy adoption, they tend to focus on rural or national-level analysis without giving specific attention to urbanizing areas like Gulu City. Gulu has unique socio-economic characteristics, including post-conflict recovery, rapid urbanization, and changing energy demand patterns, which are not sufficiently captured in existing literature. Therefore, there was a need for context-specific research that reflects the realities of households and businesses in Gulu City.

Many previous studies have relied heavily on quantitative approaches, particularly cross-sectional surveys and regression analysis (Bamwesigye et al., 2020; Kabir et al., 2022). While these methods are useful for identifying relationships, they often fail to capture deeper insights into user experiences, perceptions, and barriers to adoption. Few studies have adopted mixed-method approaches that combine quantitative data with qualitative insights such as interviews or focus group discussions. In the context of Gulu City, there was a need for methodological triangulation to provide a more comprehensive understanding of the factors influencing biogas adoption.

The existing literature often examines socio-economic factors (such as income, education, and household size) and policy factors (such as subsidies and regulations) independently rather than in an integrated framework. Studies such as Mwirigi et al. (2014) and Walekhwa et al. (2009) emphasize economic and technical factors but give limited attention to how policy interventions interact with socio-economic conditions to influence adoption. Additionally,

variables such as awareness, cultural beliefs, and access to technology are often underexplored or treated as secondary factors. There was therefore a need for a comprehensive conceptual framework that links socio-economic characteristics, policy environment, and adoption outcomes in a single model.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the research methodology and approaches that was used in conducting the study. It covers the research design, study population, sample size, data sources, data collection instruments, measurement of variables, data validity and reliability, data analysis, the limitations that were faced during the study, and the ethical issues to be considered in the research.

3.1 Research Design

The study adopted a descriptive and cross-sectional research designs. The design was chosen because it is appropriate in describing the status of the variables under study. In addition, the design permits determination of the effect of one variable on another. Cross-sectional design enabled the study to be carried out at a particular time and the notion of combining quantitative and qualitative data in this research offers the benefit of gathering wider and in-depth data and above all allows for methodological triangulation. Besides, the study used a mixed method approach that employs both quantitative and qualitative research approaches. The reason is that the research is interested in collecting data from large numbers of respondents and to get details explanation on adoption of biogas technology in the study area and for the purpose of triangulation.

3.2 Study Population

A population is the entire group or number of items that a researcher uses in order to draw conclusions about a study (Kothari, 2014). The study population comprised of the households in Gulu City particularly in Bardege and Layibi sub-constituencies that are implementing (adopted) the bio-gas technology. Accordingly, the researcher considered the 98 households that have adopted the technology in the city. Project coordinators and officers from NGOs that implemented the biogas project were identified as the key informants.

3.3 Sample Size

A sample size is the selection of a subset of the population of interest in a research study. The sample size for the study was selected based on Krejcie and Morgan (1970) whereby, from the total of 98 households, 88 households were selected for the study since it is highly representative of the entire population. The sample of 88 households has been summarized in the table below:

Table 1: Sample size determination

Departments	Population Size	Sample Size	Sampling Technique
Bar-dege -Layibi	56	48	Simple Random
Pece -Laroo	42	40	Simple Random
Total	98	88	

Source: Gulu District Local Government, 2024

3.5 Sampling Techniques

The sampling of the respondents was carried out using stratified simple random sampling and purposive sampling techniques. Gulu City was stratified into sub-divisions of Bar-dege-Layibi and Pece-Laroo from where respondents (households) were selected based on simple random sampling procedure where each household were assigned a number and the number were picked at random.

3.6 Data Sources

Both primary and secondary data were used in this study. Primary data on socio-economic factors influencing adoption of biogas technology was obtained through direct contact with the respondents. Relevant documents such as project reports and other published reports and literatures on adoption of biogas technology constituted the secondary data to be considered in this study.

3.6.1 Primary data

Primary data was generated from the field by direct contact with the respondents. Information was also obtained through the use of self-administered questionnaires to respondents and interview guides.

3.6.2 Secondary data

Secondary data was obtained through the already existing information on bio-gas technology. Literatures (data) from journals and NGO reports on bio-gas technology were utilized for this purpose. These data was used since they are published by reputable institutions, from journals, the internet and other publications.

3.7 Data Collection methods

The researcher adopted both the Questionnaire and Interview methods to collect data so that no relevant data is missed out.

3.7 .1 Survey

Survey is a common and effective data collection method that was employed in this research study investigating the adoption of biogas technology in the study area. This allowed the researcher to gather data directly from the respondents. Besides, survey method was adopted because of its efficiency, allowing the researcher to collect data from a larger number of respondents efficiently. In addition, survey enable researcher to use standardized questionnaires, ensuring consistency in data collection allowing the researcher to analyses quantitative data on adoption of biogas technology.

3.7.2 Interview Method

The interview method is a data collection technique widely used in research and involves direct interaction between the interviewer and the participant. In this interview method, researcher asked questions face to face with participants and record the responses, allowing for in-depth exploration of the participant's experiences, perspectives, and insights on socio-economic factors influencing adoption of biogas technology.

3.8 Data Collection Instruments

The data collection instruments that was used in this study included questionnaires and interview guide.

3.8.1 Questionnaires

Questionnaire was designed to constitute closed-ended questions. Close-ended questions were provided since they are simple to administer and analyze. Questionnaire was structured with four sections: Section A comprised of the demographic profile, section B constituted socio-economic factors, section C covered policy interventions and section D covered adoption of biogas. Questionnaires were administered to household heads implementing biogas technology in Gulu City.

3.8.2 Interview Guide

An interview guide is a structured outline or set of questions that researchers use to conduct interviews. It serves as a roadmap for the interviewer, ensuring that important topics are covered facilitating a consistent and systematic data collection process. The researcher organized the Structure and flow of the interview guide in a logical and coherent manner. The guide covered the key components of the study including the socio-economic factors and adoption of bio-gas technology. Interviews were administered to the project coordinators and officers from NGOs that implemented the biogas project in Gulu City.

3.9 Data quality control

Data quality was ensured through reliability and validity as presented below:

3.9.1 Reliability

The reliability of the instruments was improved through pretesting of pilot samples. This allowed for the re-phrasing of some questions. Furthermore, reliability of the scales was done with the application of the Cronbach's Alpha Coefficient for the computations so as to check for the internal consistency of the scales, Cronbach's alpha was used to determine the reliability

of data. A cronbach's alpha value of 0.7 and above was considered reliable as noted by (George and Mallery, 2003). The result of reliability using Cronbach's alpha coefficient is as presented in the table below:

Table 2: Reliability Output

Variables/Constructs	Number of items	Cronbach's alpha
Social factors	7	0.740
Economic factors	6	0.777
Technological factors	5	0.717
Policy Incentives	4	0.785
Adoption	11	0.769

Source: Primary Data, 2024

3.9.2 Validity

Validity refers to the extent to which a test measures what the researcher actually is interested to measure. Therefore, the research instruments were presented to the research experts to give their assessment of the items in the instruments from where content validity index (CVI) was computed using the formula below:

$$\text{CVI} = \frac{\text{Number of items considered relevant}}{\text{Total number of items in the instrument}}$$

The researcher then determined the validity using content validity index. According to Amin, (2005), the instrument with CVI of 0.7 and above was acceptable and considered a valid instrument. Therefore, the overall CVI was found to be 0.862 as presented below:

Table 3: Content Validity Index Output

Experts	Computations	CVI
Experts 1	50/56	0.926
Experts 2	48/56	0.857
Experts 3	45/56	0.803
Average	48/56	0.862

Source: Primary Data, 2021

3.10 Data Analysis

Data from the field was sorted, edited and coded to have the required quality, accuracy and completeness. The Statistical Package for Social Sciences (SPSS) version 26.0 was used for analysis of data collected. Descriptive statistics was used to present the results in terms of mean, standard deviation, frequency and percentages. Inferential statistics was employed to analyze the relationship and effect that exist between or among the study variables by using correlation and regression analysis respectively. Correlation was used to analyze the relationship between socio-economic factors and adoption of bio-gas technology, while hierarchical regression was used to analyze the effect of each element of socio-economic factors, and policy incentives on the adoption of biogas technology. Furthermore, the process macro-procedure in SPSS version 26 as proposed by F. Hayes was used to analyze the moderating effect of policy interventions. For analysis of qualitative data, thematic analysis was used. This included data transcription, coding and categorization in to themes. The finding was then be presented in a coherent and organized manner with narratives to support the analysis and reported verbatim.

3.11 Study limitations and Delimitations

Some respondents were unwilling to reveal the required responses to the researcher. This was delimited by informing the respondents that information they provide is purely for research purposes and the information revealed by them were kept confidential.

The study proposed cross-sectional study and as such the long-term impact of socio-economic factors on adoption of bio-gas technology overtime may not be ascertained. The researcher proposed further studies to focus on longitudinal timeframe.

Additionally, the study relied on self-reported data which made it difficult to eliminate biases from the respondent. However, the researcher was able to mitigate this by using comprehensive data both qualitative and quantitative and triangulation of findings.

3.11. Ethical considerations

The researcher sought necessary approvals and permissions from relevant authorities before conducting the study. In this case, researcher obtained an introductory letter from faculty of business and development studies, Gulu University that was presented to the different respondents.

The researcher obtained informed consent from all participants involved in the study. The researcher further provided clear and understandable information about the study's purpose, procedures, potential risks and benefits, and participants' rights to voluntary participation, confidentiality, and withdrawal from the study at any time.

The researcher safeguarded the confidentiality and anonymity of participants by ensuring that their personal information and responses were kept confidential and couldn't be linked back to individual participants. In this case, the names of respondents did not appear in any research instrument being used by the researcher.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

This chapter presents data analyses and interpretation of findings from the study covering demographic characteristics, socio-economic factors, Bio-gas adoption and policy incentives. The findings are analyzed, interpreted, and presented in relation to the objectives of the study. The data was collected from a total of 88 respondents.

4.1 Demographic Background

The analysis of demographic background of respondents comprised of sex, age bracket, and duration of bio-gas usage, marital status and education level as presented below:

Table 4: Characteristics of respondents

Sex	Frequency	Percent
Male	34	38.6
Female	54	61.4
Age		
18-24	9	10.2
28-38	10	11.4
38-48	40	45.5
above 49 years	29	33.0
Duration of Bio-gas Usage		
Less than 1year	4	4.5
1-3years	58	65.9
4-6years	13	14.8
above 6years	13	14.8
Education		
No formal education	4	4.5
Primary	15	17.0
Secondary	13	14.8
Certificate	25	28.4
Diploma	6	6.8
Undergraduate	11	12.5
Postgraduate	14	15.9
Marital status		
Single	9	10.2
Married	29	33.0
separated/divorced	24	27.3
Widowed	26	29.5
Total	152	100

Source: Primary data

The demographic profile of the respondents provides a diverse representation in terms of gender, age, duration of biogas usage, education level, and marital status. The majority of the respondents were female, accounting for 61.4% of the sample, while 38.6% were male. This suggests a higher female participation in the usage of bio-gas, which may reflect a greater involvement of women in household energy management or decision-making regarding biogas adoption.

The age distribution shows that most respondents fall into the older age categories. The largest group, 45.5%, is between the ages of 38 and 48, followed by 33.0% who were above 49 years. A smaller percentage, 11.4%, was aged 28 to 38, and only 10.2% were between 18 and 24 years old. This age distribution suggests that older individuals may have a higher likelihood of adopting or being responsible for biogas technology within households, possibly due to greater financial stability or household decision-making roles.

A significant proportion of respondents, 65.9%, have been using biogas for a period of 1 to 3 years, indicating that the technology has gained traction recently in the community. Smaller groups have used biogas for longer periods, with 14.8% each reporting usage for 4 to 6 years and above 6 years. Only 4.5% have used biogas for less than a year, suggesting that biogas adoption may be steady, with many users having had enough time to experience its benefits.

The educational background of the respondents is varied, with the largest group (28.4%) holding a certificate qualification. A significant portion of respondents, 15.9%, had postgraduate education, while 12.5% held undergraduate degrees. A smaller percentage (6.8%) had a diploma qualification. A considerable number of respondents, 17.0%, reported primary education, and 14.8% had secondary education. A minority, 4.5%, had no formal education. This indicates that a wide range of education levels is represented, with the majority having at least some level of formal education, potentially influencing their understanding and acceptance of biogas technology.

In terms of marital status, the respondents were quite varied. The largest groups, 33.0%, were married, reflecting traditional family structures. Widowed individuals made up 29.5%, and separated or divorced individuals accounted for 27.3%, indicating that a significant portion of respondents may be managing households independently. Only 10.2% of respondents were single. This diversity in marital status suggests a range of household dynamics, potentially affecting biogas adoption and usage.

In summary, the demographic characteristics show a majority of female respondents, an age group dominated by individuals above 38 years, a broad range of education levels, and a significant portion of married, separated, or widowed individuals, with most respondents having used biogas for more than a year.

4.2 Adoption of Biogas technology

The analysis of adoption of biogas technology focused on the analysis of practices involved in the adoption and the level of adoption as presented below:

4.2.1 Practice in Biogas adoption

The analysis of practice as a component of biogas adoption covers feeding of digesters, monitoring of substrates, mixing of substrates, regular removal of water along the pipe as presented in the table below:

Table 5: Practice in Bio-gas adoption

Practice	SD %	D %	SD+D%	NS%	A %	SA%	A+SA %
I undertake daily feeding of the digester.	5.7	5.7	11.4	27.3	36.4	25.0	61.4
I regularly monitor the substrate level in the digester	0.0	4.5	4.5	17.0	38.6	39.8	78.4
Cleaning of the mixing chamber is undertaken frequently	4.5	11.4	15.9	4.5	47.7	31.8	79.5
I have a consistent and sufficient supply of organic waste for plant production.	0.0	0.0	0.0	14.8	47.7	37.5	85.2
I regular remove the bi-slurry from the slurry pit to the storage tank	4.5	5.7	10.2	9.1	36.4	44.3	80.7
I Regularly remove water along the pipe to get maximum gas pressure	4.5	9.1	13.6	15.9	36.4	34.1	70.5
I do provide clean water for mixing the cow dung and other animals waste,	0.0	4.5	4.5	36.4	36.4	22.7	59.1
I regular use the biogas produce from the digester	0.0	11.4	11.4	17.0	40.9	30.7	71.6
I regular turn off and turn on the gas gently while cooking	0.0	4.5	4.5	17.0	40.9	37.5	78.4
I regular control the burning status of gas produce from the digester while cooking	0.0	17.0	17.0	21.6	27.3	34.1	61.4
I regular check the gas level from the digester using the pressure gauge installed on the wall.	10.2	22.7	33.0	22.7	28.4	15.9	44.3
Average	2.67	8.77	11.45	18.48	37.92	32.13	70.05

Source: Primary data, 2024

The table above present's data on the practices associated with the adoption and maintenance of biogas technology. The highest level of agreement pertains to having a consistent and sufficient supply of organic waste for biogas production, with 85.2% of respondents agreeing and strongly agreeing. This highlights that most users have access to the essential raw materials required to sustain biogas production. Availability of organic waste, such as cow dung or other animal waste is a critical factor for biogas adoption, as it directly influences the viability and continued use of the digester system.

The second most agreed-upon practice is the frequent cleaning of the mixing chamber, with 79.5% of respondents in agreement. This suggests that users are diligent in ensuring the proper maintenance of the biogas system by regularly cleaning the chamber where organic waste is mixed before digestion. Cleaning helps maintain the efficiency and hygiene of the system, which in turn affects the quality of gas produced and the longevity of the equipment.

The third-highest level of agreement, at 80.7%, is related to the regular removal of bi-slurry (a byproduct of biogas production) from the slurry pit to the storage tank. This practice indicates that users are not only using the biogas technology but are also aware of the need to manage the byproducts effectively. Proper management of bi-slurry is important for maintaining the digester's efficiency and preventing overflow, while also providing a useful byproduct for agriculture.

A large majority of respondents (78.4%) reported that they regularly monitor the substrate level in the digester, indicating that users are actively involved in ensuring that the right amount of organic material is present to maintain efficient gas production. In addition, 71.6% of respondents regularly use the biogas produced from the digester, which shows that most users are actively utilizing the gas for cooking or other domestic purposes, fulfilling the primary goal of biogas adoption. Another significant practice involves the regular removal of water from the pipes to achieve maximum gas pressure, with 70.5% of users engaging in this task. This ensures optimal gas flow, which is necessary for efficient cooking or other uses.

The overall average level of agreement for the adoption and practice of biogas-related tasks is 70.05%, indicating a high level of participation and commitment to biogas technology practices. This suggests that the majority of users are actively involved in maintaining their biogas systems, from feeding and monitoring the digester to managing byproducts and ensuring safe and efficient usage of the produced gas. The relatively high levels of agreement across

these practices demonstrate that biogas technology is well integrated into the daily routines of users, fostering its long-term sustainability.

4.2.2 Level of Adoption of Biogas technology

The analysis of level of adoption of bio-gas technology is as presented in the table below:

Table 6: Level of Adoption of Bio-gas Technology

Adoption	Very low %	Low %	VL+L%	Moderate %	High %	Very high %	H+VH %
To what extent do you use biogas for cooking	15.9	39.8	55.7	26.1	10.2	0.8	18.2
To what extent do you use biogas for lighting	8.0	44.3	52.3	33.0	14.8	0.0	14.8
To what extent do you use biogas for production	10.2	34.1	44.3	33.0	20.7	0.2	22.
Average	11.37	39.40	50.77	30.70	15.23	0.33	18.57

Source: Primary data, 2024

The data presented illustrates the level of adoption of biogas technology in three key areas of application: cooking, lighting, and production. The data reveals that the majority of respondents have minimal adoption of biogas technology. The average percentage across the three categories (cooking, lighting, and production) stands at 50.77%. The highest rate of low adoption is observed in cooking (55.7%), indicating that a significant portion of respondents use biogas sparingly for household cooking purposes. Similarly, 52.3% of respondents report low adoption of biogas for lighting, and 44.3% for production. This suggests that despite the availability of biogas technology, the majority of users have not integrated it deeply into their energy routines.

Moderate adoption levels are observed with an average of 30.7% across the three applications. Biogas for lighting and production shows the highest rates of moderate adoption, both at 33.0%, implying that there is a notable portion of respondents who engage with biogas for these

purposes but not extensively. For cooking, the moderate adoption is 26.1%, which aligns with the expectation that cooking is a common use for biogas in households, though it is still not fully maximized.

Adoption rates as reflected in overall average value of 18.57%, reflects a relatively low level of intensive use of biogas technology. The highest levels of high adoption are observed in the use of biogas for production (22.7%), followed by cooking (18.2%) and lighting (14.8%). The low percentages in this category suggest that, while some users have adopted biogas, the majority are not relying on it extensively, particularly for cooking and lighting.

The overall data reveal a trend of low to moderate adoption of biogas technology, with an average of 50.77% of respondents in the very low and low adoption category. Moderate adoption averages 30.7%, suggesting that while many users are experimenting with biogas, they have not yet adopted it as a primary energy source.

The adoption of biogas technology remains relatively limited, with most users falling within the very low or low adoption levels. While there is moderate use, particularly for lighting and production, the technology has not yet reached widespread high adoption.

4.3 Social factors

The analysis of social factors is as presented in the table below:

Table 7: Analysis of Social Factors

Social Factor	S D %	D%	SD+D		NS %	A %	SA %	A+SA %
			%	%				
The biogas technology is well accepted within the cultural set-up of my community.	5.7	2.3	8.0	0.0	56.8	35.2	92.0	
I have positive attitude towards the usage of bio-gas technology.	0.0	5.7	5.7	4.5	43.2	46.6	89.8	
My family provide labour support in the biogas production	0.0	4.5	4.5	5.7	46.6	43.2	89.8	
My family provide financial support for biogas production	0.0	5.7	5.7	14.8	48.9	30.7	79.5	
Women provide more labour for biogas production	0.0	14.9	14.9	19.5	33.3	32.2	65.5	
Men provide more labour for biogas production.	0.0	10.2	10.2	14.8	39.8	35.2	75.0	
I received regular extension services on biogas production	0.0	15.9	15.9	20.5	34.1	29.5	63.6	
Average	0.81	8.46	9.27	11.40	43.24	36.09	79.31	

Source: Primary data, 2024

Based on the analysis of social factors above, the highest level of agreement is seen in the statement that biogas technology is well accepted within the cultural setup of the community. An overwhelming 92.0% of respondents agreed and strongly agreed with this sentiment. This suggests that biogas technology is not only viewed favorably but has also been integrated into the community's social fabric, which is crucial for widespread adoption. Cultural acceptance indicates that any potential cultural barriers to biogas adoption are minimal, making it easier for the technology to gain traction.

Another strong indicator of social factors in biogas adoption is the personal attitude towards the technology, with 89.8% of respondents agreeing and strongly agreeing that they have a positive attitude towards biogas technology. This reflects a favorable perception of biogas among the majority of the population, implying that many view the technology as beneficial

and worth pursuing. Personal attitudes are critical because they often translate into actual behavior and decision-making regarding technology usage.

The same high level of agreement (89.8%) is observed regarding family labor support for biogas production. This suggests that biogas technology adoption benefits from collective family involvement, where labor is a shared responsibility. In contexts where household participation in tasks is essential, this factor is particularly important for the long-term sustainability of biogas technology.

The fourth most supported factor is the financial support provided by family members for biogas production, with 79.5% agreement. This highlights that while biogas adoption requires financial resources, many families are willing to invest in the technology, which can reduce financial barriers. 75.0% of respondents agreed or strongly agreed that men provide more labor in biogas production. 65.5% of respondents agreed or strongly agreed that women provide more labor in biogas production. Both men and women contribute to biogas production, but men seem to be perceived as contributing more, although women still play a significant role.

The average level of agreement across all social factors is 79.31%, suggesting that the majority of respondents view biogas technology favorably across various social dimensions. This high overall agreement indicates that social factors—ranging from cultural acceptance and positive attitudes to family involvement and gender roles—are generally supportive of biogas technology adoption.

In contrast, the analysis suggests that social factors do not significantly influence the decision to adopt biogas technology. This result aligns with the qualitative finding on the idea that, even though social influences like peer recommendations or community norms may be present, they do not strongly sway individuals towards adopting biogas. One of the respondents was quoted saying:

“Even if my neighbor has biogas that alone isn’t enough for me to switch. It’s more about the practical benefits I’ll get from it.”

This indicates that while social factors may be considered, they are not decisive in the adoption process.

4.4 Economic factors

The analysis of economic factors is presented in the table below:

Table 8: Analysis of economic Factors.

Economic Factor	SD+D			A+SA			
	SD %	D %	%	NS %	A%	SA %	%
I receive regular income from biogas production	5.7	26.1	31.8	19.3	29.5	19.3	48.9
Maintenance costs for biogas technology are manageable.	5.7	11.4	17.0	26.1	35.2	21.6	56.8
I am willing to invest in biogas technology because it saves money in the long run.	5.7	20.5	26.1	2.3	42.0	29.5	71.6
I like to use biogas technology because of its time saving	10.2	8.0	18.2	17.0	28.4	36.4	64.8
My household expenses on fuel has reduced because of using biogas	9.1	11.4	20.5	27.3	31.8	20.5	52.3
The biogas technology is highly affordable.	5.7	20.5	26.1	30.7	22.7	20.5	43.2
Average	7.02	16.32	23.28	20.45	31.60	24.63	56.27

Source: Primary data, 2024

The analysis of economic factors in the adoption of biogas technology revealed that, the highest level of agreement is related to the willingness to invest in biogas technology, with 71.6% of respondents agreeing and strongly agreeing that they are inclined to invest because it saves money in the long run. This suggests that while there may be an upfront cost associated with biogas technology, many individuals view it as a cost-effective solution over time, providing economic incentives for households to adopt it.

The second most supported economic factor is the time-saving benefit of biogas technology, with 64.8% of respondents agreeing and strongly agreeing. This implies that biogas technology is appreciated not only for its economic benefits but also for the convenience and efficiency it brings, reducing the time required for energy production compared to traditional fuel sources. This is significant, especially for households that value time management in daily activities.

The third highest level of agreement pertains to the affordability of maintaining biogas systems, with 56.8% of respondents agreeing and strongly agreeing that the costs are manageable. This factor is crucial as it implies that once installed, biogas technology does not pose a significant financial burden for ongoing maintenance, encouraging more people to adopt it.

Although less than half (48.9%) of respondents agree and strongly agree that they receive regular income from biogas production, this still represents a substantial portion. It suggests that biogas technology can be a source of supplementary income for some households, even if it is not universally profitable. Over half (52.3%) of respondents reported a reduction in household fuel expenses due to using biogas. This highlights one of the primary economic advantages of biogas technology, especially for households aiming to cut down on energy costs. Only 43.2% of respondents agree or strongly agree that biogas technology is highly affordable. This relatively lower level of agreement suggests that the initial installation costs may still be a barrier for some households, even if they recognize the long-term savings associated with the technology.

The average agreement across all economic factors is 56.27%, indicating that a little more than half of the respondents perceive biogas technology as economically beneficial. This is a positive indicator for biogas adoption, as it suggests that most individuals see the technology as financially viable, despite some concerns around affordability and the ability to generate regular income from it.

Qualitative Results

The qualitative analysis of the economic factors influencing the adoption of biogas technology reveals several essential themes that reflect people's perceptions of its financial benefits. These include long-term cost savings, time efficiency, affordability of maintenance, reduction in household fuel expenses, and initial affordability challenges.

Long-term Cost Savings

One of the most significant economic advantages of biogas technology is its long-term cost-saving potential. During an interview, a substantial number of respondents express a strong willingness to invest in biogas despite its upfront cost, mainly because they perceive it as a solution that will save money over time. This sentiment indicates that many households prioritize future economic benefits over the immediate costs of installation. To capture this sentiment, one of the respondents remarked

“At first, the installation seemed expensive, but over time, it’s clear that biogas saves us a lot on fuel costs. It’s a smart investment for the future.”

The above sentiment indicates key benefit of biogas adoption in its long-term ability to save cost as a form of financial benefits to households. Cost saving come with replacing chemical fertilizer with bi-slurry which when use by a farmer will increase crop productivity hence high income for livelihoods. There is cost saving benefits in term of cooking and lighting, improved health status of the farmers and sanitation, reduces labour requirement, reduction in greenhouse gas emission and improvement in environment.

Time Efficiency

Time efficiency also emerged as one of the key themes in assessing economic benefits of biogas adoption. The time-saving aspect of biogas is also highlighted as a significant factor influencing adoption. Many respondents appreciate that using biogas reduces the time required

for energy production compared to traditional methods such as gathering firewood or using charcoal. For households where time management is crucial, this efficiency is a compelling economic benefit. One of the respondents had this to say during an interview:

“Biogas has freed up so much time for us. I no longer need to spend hours collecting firewood, and lighting the charcoal stoves which means I can focus on other important things like running my business.”

In this case therefore, time saving or efficiency emerged as one of the key economic benefits of bio-gas adoption by households. Time saving are reported by many households/ respondents, biogas save time compared with traditional cook stoves user where it involves fuelwood collection, charcoal burning etc.

Affordability of Maintenance

Furthermore, during the interviews, another important theme identified was affordability of maintenance of the bio-gas system. After installation, maintaining a biogas system is viewed as relatively affordable by many respondents. This factor is crucial because it suggests that once the initial investment is made, the ongoing financial burden of maintaining the system is low, encouraging more households to adopt the technology. One of the respondents remarked:

“Once we had the system installed, we found that it didn’t cost much to maintain it. It’s become an easy and reliable part of our daily routine.”

The above sentiment and quotation elaborate the key importance of bio-gas adoption in ensuring affordability of maintenance and less cost in the long-run.

Reduction in Household Fuel Expenses

During the interview, reduction in household fuel expenses was also identified as one of the most important themes. A widely recognized benefit of biogas technology is its ability to

reduce household fuel expenses. Many respondents report that using biogas has led to a noticeable decrease in the amount of money they spend on traditional fuel sources. This reduction in expenses is especially appealing to households looking to cut down on energy costs. One of the respondents stated:

“We’ve saved so much on fuel since switching to biogas. It’s one of the main reasons we decided to make the change.”

The above expression point out to the crucial benefits of bio-gas adoption in ensuring reduction in household fuel expenses compared to other traditional fuel sources.

In summary, respondents perceive biogas technology as financially beneficial, although initial cost of affordability remain concerns for some. The overall perception is cautiously optimistic, with most households recognizing the long-term financial advantages of adopting biogas, despite some challenges in the initial phase. The economic benefits of biogas technology are primarily centered around its long-term cost savings, time efficiency, and manageable maintenance costs. While initial affordability is a concern for some households, the potential for reduced energy expenses makes biogas an appealing option for many.

The findings from the qualitative analysis reveal insightful themes regarding the factors influencing the adoption of biogas technology. A key theme that emerges is the importance of **economic factors** in driving the adoption process. Economic elements, such as the affordability of biogas systems or the availability of financial incentives, play a crucial role in determining whether individuals or communities choose to adopt this technology. As one key informant noted:

“When people see biogas as a cost-effective option that can save money in the long run, they are more likely to invest in it.”

This highlights the idea that financial considerations often weigh heavily in the decision-making process.

4.5 Technological Factors

The analysis of technological factors covers trust in safety of biogas, reliability of biogas technology among others as presented in the table below:

Table 9: Analysis of Technological Factors

Technological Factor	SD+D				A+SA		
	SD %	D %	%	NS %	A %	SA %	%
I have access to the technical support needed for installing biogas technology.	4.5	26.1	30.7	15.9	33.0	20.5	53.4
The materials required for biogas technology are readily available.	5.7	10.2	15.9	21.6	42.0	20.5	62.5
Biogas technology is easy to use and maintain.	5.7	14.8	20.5	14.8	28.4	36.4	64.8
I believe that biogas technology is reliable	0.0	18.2	18.2	25.0	30.7	26.1	56.8
I trust the safety of biogas technology.	8.0	4.5	12.5	20.5	45.5	21.6	67.0
Average	4.78	14.76	19.56	19.56	35.92	25.02	60.90

Source: Primary data, 2024

The result of technological factors revealed that the highest level of agreement is related to the safety of biogas technology, with 67.0% of respondents agreeing and strongly agreeing that they trust the safety of the technology. Safety is a crucial concern when adopting any new technology and this high level of confidence is an encouraging sign. It suggests that most users feel secure in using biogas technology, which could drive wider adoption, particularly among risk-averse individuals or households. The second most agreed-upon factor is the ease of use and maintenance of biogas technology, with 64.8% of respondents either agreeing or strongly agreeing. This implies that users find the technology relatively simple to operate and maintain

once installed. Ease of use is an important factor in adoption, especially in rural or resource-constrained environments where technical expertise might be limited.

The third highest level of agreement is on the availability of materials required for biogas technology, with 62.5% of respondents agreeing and strongly agreeing. This indicates that most users feel that the necessary materials to implement biogas systems are accessible, which reduces barriers related to resource availability. This can promote higher rates of adoption as it eliminates the need to source rare or expensive materials.

Slightly over half (53.4%) of respondents agree and strongly agree that they have access to the technical support needed for installing biogas technology. While this is a positive result, it suggests that nearly half of the respondents may still feel underserved in terms of technical assistance, which could hinder adoption for those who require more specialized help during the installation phase. Over half (56.8%) of respondents believe that biogas technology is reliable. While this is a moderately positive result, it highlights that there are still concerns around the consistent performance of the technology. Reliability is a key factor in adoption, and any perceived doubts about its dependability could slow down its widespread acceptance.

The overall average agreement across all technological factors is 60.90%, indicating a strong majority of respondents perceive biogas technology as technologically feasible and user-friendly. This is a positive indicator that most users are comfortable with the technology in terms of safety, ease of use, and availability of materials.

On the other hand, the role of technological factors stands out as another critical theme. Technological considerations, such as the ease of using biogas systems, reliability, and technological advancements, were identified during interviews as key factors that affect adoption. One respondent remarked:

“If the technology is reliable and easy to use, I’m more inclined to adopt it.”

This highlights the importance of ensuring that the technology is accessible, user-friendly, and effective, which encourages broader uptake.

4.6 Policy Incentives

Data analysis of policy incentives was performed following the key dimensions of monetary and non-monetary incentives as presented below:

4.6.1 Monetary Incentives

The analysis of monetary incentives as a component of policy incentives covers information on financial incentives, government subsidies, among others as presented in the table below:

Table 10: Analysis Monetary Incentives

Monetary incentives	SD %	D %	SD+D %	NS %	A %	SA %	A+SA %
Information about financial incentives for biogas adoption is easily accessible.	5.7	14.8	20.5	14.8	28.4	36.4	64.8
Government and organizations provide monetary incentives for biogas adoption.	0.0	18.2	18.2	25.0	30.7	26.1	56.8
I have been informed about financial benefits of adopting biogas technology through various channels.	8.0	4.5	12.5	20.5	45.5	21.6	67.0
Government subsidies significantly reduce the initial cost of installing biogas technology.	5.7	5.7	11.4	27.3	36.4	25.0	61.4
Average	4.85	10.80	15.65	21.90	35.25	27.28	62.50

Source: Primary data, 2024

The data on monetary incentives as a component of policy incentives for biogas adoption reveals important insights into how financial motivators influence adoption rates. The responses show that 64.8% of the respondents agree and strongly agree that information about

financial incentives for adopting biogas is easily accessible. This indicates that the majority of participants have access to knowledge regarding financial support, which is crucial in encouraging biogas adoption.

A total of 56.8% of respondents agree or strongly agree that government and organizations provide monetary incentives for biogas adoption. This suggests that monetary incentives are available, but the moderate rate of agreement indicates that these incentives may not be uniformly accessible or well-promoted.

Awareness of the financial benefits of biogas adoption through various channels is relatively high, with 67.0% of respondents agreeing and strongly agreeing. This suggests that communication efforts, whether through media, community programs, or other channels, have been somewhat effective. However, 12.5% of respondents disagree or strongly disagree, indicating room for improvement in increasing awareness and understanding of these financial benefits across broader sections of the population. Significant proportions of respondents (61.4%) agree and strongly agree that government subsidies reduce the initial cost of installing biogas technology. This highlights the importance of subsidies in making biogas technology more financially accessible to households, as the initial cost is often a barrier to adoption.

On average, 62.5% of respondents agree and strongly agree with the statements about monetary incentives, while only 15.65% disagree or strongly disagree. This suggests that monetary incentives, such as accessible information, subsidies, and financial benefits, play a significant role in encouraging biogas adoption. Monetary incentives are a key component in promoting biogas adoption, with the majority of respondents acknowledging the availability of financial support, subsidies, and information on financial benefits. However, there are still notable gaps in accessibility and awareness that need to be addressed.

4.6.2 Non-Monetary Incentives

The analysis of Non-monetary incentives covering technical support, government program, training program among others is as presented in the table below:

Table 11: Analysis of non-Monetary Incentives

	SD %	D %	SD+D %	NS %	A %	SA %	A+SA %
Non-monetary incentives							
Technical support for biogas installation is readily available in my area.	0.0	4.5	4.5	17.0	38.6	39.8	78.4
Non-monetary incentives from the government (such as free training, recognition, etc.) make biogas adoption more appealing.	4.5	11.4	15.9	4.5	47.7	31.8	79.5
Government policies favor the adoption of biogas over other energy sources.	0.0	0.0	0.0	14.8	47.7	37.5	85.2
I am aware of government programs that promote biogas adoption through non-monetary incentives.	4.5	5.7	10.2	9.1	36.4	44.3	80.7
The government provides adequate training programs for biogas technology.	4.5	9.1	13.6	15.9	36.4	34.1	70.5
Average	2.70	6.14	8.84	12.26	41.36	37.50	78.86

Source: Primary data, 2024

The data on non-monetary incentives as a component of policy incentives for biogas adoption provides significant insights into the availability and effectiveness of support mechanisms beyond direct financial aid. A substantial 78.4% of respondents agree and strongly agree that technical support for biogas installation is readily available in their area. This indicates that technical assistance, an essential component of successful adoption, is generally accessible to most households.

Non-monetary incentives provided by the government, such as free training or recognition, appear to be highly effective in promoting biogas adoption, with 79.5% of respondents agreeing and strongly agreeing that these incentives make biogas adoption more appealing. An overwhelming 85.2% of respondents agree or strongly agree that government policies favor the adoption of biogas over other energy sources, making this the highest level of agreement across

the different factors assessed. This high rate of agreement suggests that government regulations and policies are effectively structured to support biogas adoption and create a favorable environment for households to switch from traditional energy sources to biogas technology. With 80.7% of respondents agreeing and strongly agreeing that they are aware of government programs promoting biogas adoption through non-monetary incentives, awareness appears to be relatively high. This reflects successful communication of government initiatives, although 10.2% of respondents disagree or strongly disagree, suggesting that certain segments of the population may not be sufficiently informed. The responses indicate that 70.5% of participants agree and strongly agree that the government provides adequate training programs for biogas technology.

On average, 78.86% of respondents agree and strongly agree with the various statements related to non-monetary incentives, while only 8.84% disagree or strongly disagree. This shows a generally positive reception of non-monetary incentives, with most respondents finding them useful and beneficial for promoting biogas adoption. Non-monetary incentives, such as technical support, favorable government policies, training, and awareness programs, are highly effective in promoting biogas adoption, as reflected by the high levels of agreement across all categories.

4.7 Correlation between socio-economic factors and adoption.

Correlation analysis particularly Bivariate correlation using pearson's correlation was performed to determine the relationship between the study variables and the result is presented below:

Table 12: Correlation Analysis

	1	2	3	4	5	6	7	8	8	10
Attitude (1)	1									
Family Support (2)	0.577**	1								
Social Factors (3)	0.911**	0.862**	1							
Income (4)	0.380**	0.298**	0.386**	1						
Cost Efficiency (5)	0.459**	0.582**	0.578**	0.521**	1					
Economic Factors (6)	0.477**	0.491**	0.543**	0.893**	0.850**	1				
Ease of Use (7)	0.188	0.063	0.148	0.639**	0.018	0.404**	1			
Accessibility (8)	0.464**	0.312**	0.445**	0.474**	0.283**	0.443**	0.425**	1		
Technoly Factors (9)	0.371**	0.209	0.335**	0.667**	0.164	0.499**	0.873**	0.812**	1	
Adoption (10)	0.573**	0.471**	0.593**	0.556**	0.439**	0.575**	0.324**	0.881**	0.68**	1

** . Correlation is significant at the 0.01 level (2-tailed).

The correlation result presented above revealed that social factors have a moderate significant positive relationship with adoption of biogas technology as shown by ($r=0.593$; $p<0.01$). This shows that improvement in social factors is associated with improvement in the adoption of biogas technology. The individual factors of socio-economic factors shows that attitude and family support are positively and significantly correlated with adoption of bio-gas technology as revealed by ($r=0.573$; $p<0.01$) and ($r=0.471$; $p<0.01$) respectively.

The result further shows a significant moderate but positive relationship between economic factors and adoption of biogas technology as shown by ($r=0.575$; $p<.01$). This implies that an improvement in economic factors is associated with improvement in the adoption of biogas technology. The components of economic factors (income and cost efficiency) have a moderately positive and significant relationship with adoption of bio-gas as reflected by ($r=0.556$; $p<0.01$) and ($r=0.439$; $p<0.01$) respectively.

Furthermore, the result revealed a significant strong positive relationship between technological factors and bio-gas adoption as shown by ($r=0.683$; $p<0.01$) indicating that an improvement in technological factor is associated with improvement in biogas adoption. The individual components of technological factors (ease of use and accessibility) are positively

and significantly related with adoption of bio-gas as reflected by ($r=0.334$; $p<0.01$) and ($r=0.881$; $p<0.01$) respectively.

4.6 Hierarchical Regression Analysis

Hierarchical regression model was performed to determine the effect of social, economic and technological factors on adoption of biogas in Gulu city. The result is presented in the table below:

Table 13 Regression Analysis

Variables	Coefficient s	Standard error	Multicollinearity Statistics	
			Tolerance	VIF
(Constant)	0.881**	-	-	-
Education Level	0.049**	2.45	0.998	1.002
Age of Respondents	0.105**	-5.25	0.998	1.002
Attitude	0.068*	3.40	0.684	1.462
Family Support	0.019	0.95	0.750	1.333
Income	0.039	-	0.555	1.802
Cost Effectiveness	0.149**	7.45	0.649	1.540
Ease of Use	0.222**	11.10	0.364	2.745
Accessibility	0.146**	7.30	0.313	1.323
R ²	0.634	-	-	-
Adjusted R ²	0.625	-	-	-
F change-statistics	45.732	-	-	-
Sig	0.000	-	-	-

Dependent Variable: Adoption of Bio-gas

As presented in the table above, the hierarchical regression results show the coefficients for different models predicting adoption of bio-gas with age and education level of respondents as the control variables.

In the regression model above, the overall result indicates that technological factors significantly affect bio-gas adoption and it explains variation in adoption by 8.9% as reflected by ($\Delta R^2=.089$; $p<.01$).

Analysis of the individual dimensions of technological factors indicate that both ease of use and accessibility have significant effect on adoption as reflected by ($B= .222^{**}$; $P<.01$) and ($B= .146^{**}$; $P<.01$) respectively. Overall technological factors have significant effect on adoption as revealed by ($B= .146^{**}$; $P<.01$).

Overall, all tolerance values are close to 1, and all VIF values are below 5, suggesting low multicollinearity in the model. In summary, the regression models suggest that social factors, economic factors and technological factors are significant in explaining bio-gas adoption

4.5 Test of Moderation

Moderation test was performed using PROCESS procedure in SPSS (Hayes, 2020) to determine the moderating effect of policy incentives on the relationship between socio-economic factors and adoption of bio-gas technology as presented in the table below:

Table 14 Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.9629	.9273	.0256	1682.9588	3.0000	396.0000	.0000
Model							
	Coeff		se	t	p	LLCI	ULCI
Constant	3.8004		.0092	415.0454	.0000	3.7824	3.8184
Social Economic Factors	.4055		.0254	15.9762	.0000	.3556	.4554
Policy Incentives	.3146		.0221	14.2369	.0000	.2712	.3581
Int_1	.1967		.0153	12.8726	.0000	.2267	.1667

Independent Variables (X): Social Economic Factors

Moderator Variable (W): Policy Incentives

Dependent Variable (Y): Adoption of Biogas

As presented in the above tables, test of moderation was performed using PROCESS procedure as advanced by Andre F. Hayes. According to the result, the model summary table represents an R-Square value of 0.9273, indicating that socio-economic factors together with policy incentives collectively explain variation in adoption of bio-gas technology by up to 92.7%.

Looking at the p-value of the interaction term ($p=.000$; $p<.05$) it indicates that policy incentives moderate the relationship between socio-economic factors and adoption of biogas technology since the p-value of the interaction term is less than 0.05.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Introduction

The adoption of biogas technology is influenced by a variety of socio-economic factors, which play a critical role in determining its uptake. The discussion of the findings on socio-economic factors and the adoption of biogas technology explore how the study's findings align or contrast with existing literature on the subject. Previous studies have emphasized the importance of income, education, and access to information in shaping adoption decisions, but there remains some debate regarding the relative significance of these factors and the role of external influences, such as policy incentives and financial support mechanisms. The discussion on the subject is as presented below.

5.1 Socio-economic factors

The study found high level of perception on economic factors for the adoption of bio-gas technology. One of the key economic factors influencing biogas adoption is the financial capacity of households or communities. High-income households are more likely to adopt biogas technology because they can afford the initial installation costs, which can be prohibitive for lower-income groups. This finding aligns with the research of Mwirigi et al. (2014), who emphasize that the economic status of households is directly related to their ability to adopt renewable energy technologies, including biogas. Kabir et al. (2015) also found that higher-income households in Bangladesh were more likely to invest in biogas systems due to their higher disposable income.

However, other scholars have pointed out that income as a component of economic factor is not the only determinant of adoption. Walekhwa, Mugisha, & Drake (2019) argue that government subsidies and financial incentives can mitigate the high upfront costs, making biogas technology accessible even to lower-income households. Their research in Uganda shows that when appropriate financial mechanisms are in place, income plays a less significant

role in adoption decisions, suggesting that financial support schemes can offset the effects of income disparities.

The study also found a high level of perception on the social factors for the adoption of biogas. Education and social awareness are frequently cited as critical socio-economic factors for the adoption of new technologies. Households with higher education levels are more likely to understand the benefits of biogas technology, such as energy savings, improved sanitation, and environmental conservation. Walekhwa et al. (2009) confirm that better-educated individuals tend to have more information about biogas systems and are, therefore, more willing to adopt the technology.

Conversely, Njenga et al. (2019) emphasize that community awareness programs play an equally important role, even in less educated populations. They argue that targeted awareness campaigns can overcome educational barriers by providing practical demonstrations and case studies that show the tangible benefits of biogas. This suggests that while education is an important factor, awareness initiatives can compensate for lower formal education levels, leading to broader adoption across different social strata.

Social influence and cultural acceptance are also pivotal in determining the adoption of biogas technology. In societies where traditional practices such as wood or charcoal use are deeply embedded, the adoption of biogas technology may face resistance despite its socio-economic advantages. Njenga et al. (2019) observed that in Kenya, cultural factors such as preferences for wood fuel cooking were significant barriers to biogas adoption. This contrasts with findings from Bensah & Brew-Hammond (2020), who note that in communities where social leaders and early adopters champion biogas technology, cultural resistance tends to diminish, and adoption rates increase. The influence of social networks and peer learning, therefore, plays a crucial role in technology uptake.

As a component of social factors, perception of the environmental and health benefits associated with biogas technology also significantly influences its adoption. Many scholars agree that households perceiving high environmental and health risks from traditional fuels (e.g., wood, charcoal) are more inclined to switch to biogas. Kabir et al. (2013) found that the realization of reduced indoor air pollution and its associated health benefits encouraged many Bangladeshi households to adopt biogas systems. Similarly, Mwirigi et al. (2014) suggest that households in Kenya that understood the environmental advantages, such as reduced deforestation and lower greenhouse gas emissions, were more willing to transition to biogas technology.

In contrast, Amigun, Sigamoney, & von Blottnitz (2018) argue that in some cases, the perceived benefits of biogas technology are overshadowed by the challenges of maintenance and operational issues. These operational concerns can diminish the attractiveness of biogas, particularly in rural areas where technical support and repair services may be limited. Thus, while many agree that the environmental and health benefits of biogas are significant motivators, the practical challenges of operating the technology can dampen enthusiasm and long-term adoption.

Overall, there is a general consensus among scholars that socio-economic factors, including income levels, education, and social influence, play a critical role in the adoption of biogas technology. Many studies agree that higher income and education levels facilitate adoption, but some scholars argue that financial incentives and community awareness programs can compensate for these socio-economic barriers. Additionally, while cultural factors and social networks can either hinder or promote adoption, the perceived environmental and health benefits of biogas remain universally acknowledged as positive drivers. However, disagreements arise in terms of the relative importance of these factors. For instance, while some scholars highlight income as a primary factor, others suggest that well-designed financial

interventions can neutralize this barrier. Additionally, while some studies emphasize the challenges of operational maintenance as a deterrent to adoption, others focus more on the long-term benefits that outweigh such issues.

5.2 Adoption of Bio-gas Technology

The study found that the adoption of biogas technology remained low despite its potential to address energy needs, improve sanitation, and mitigate environmental issues. A range of factors has been identified in the literature as contributing to the slow uptake of biogas systems, including socio-economic, cultural, technical, and policy barriers. A dominant theme in the literature is the influence of socio-economic factors such as income levels, affordability, and the availability of financial support. Kabir et al. (2015) argue that the high initial costs of biogas installation present a significant barrier for lower-income households, particularly in rural areas. This finding is echoed by Parawira (2019), who notes that the capital-intensive nature of biogas technology is beyond the financial reach of many rural households in sub-Saharan Africa, contributing to the low levels of adoption.

However, Mwirigi et al. (2014) propose that government subsidies and microcredit schemes could alleviate this barrier. In their study of biogas adoption in Kenya, they observed that households with access to financial assistance were more likely to invest in biogas technology, despite having similar income levels to non-adopters. This view contrasts with Walekhwa, Mugisha, & Drake (2019), who suggest that even when financial support is available, social perceptions and prioritization of immediate needs (e.g., food security) over long-term investments in energy solutions continue to hinder adoption.

Lack of awareness and understanding of biogas technology also contributes to its low adoption. Amigun and von Blottnitz (2020) report that in many African countries, the general population is unaware of the existence or benefits of biogas, limiting their willingness to adopt it. Their findings are supported by Njenga et al. (2019), who argue that in Kenya, limited awareness

campaigns and insufficient knowledge transfer about biogas technology have resulted in low uptake.

While these scholars agree on the importance of awareness, Mshandete and Parawira (2018) add another dimension by suggesting that awareness alone is not enough. They argue that even in communities where awareness is relatively high, biogas adoption rates remain low due to operational challenges and skepticism about the technology's long-term reliability. This indicates that awareness needs to be complemented by practical demonstrations and sustained support to overcome mistrust and build confidence in biogas systems.

Furthermore, cultural norms and social structures also play a critical role in the low adoption of biogas technology. Njenga et al. (2019) found that traditional cooking practices, such as using firewood, are deeply entrenched in many rural communities, making it difficult for new technologies like biogas to gain acceptance. This cultural attachment to wood fuel is further reinforced by the social status associated with certain energy sources. For instance, in some communities, owning a wood-fired stove is considered a symbol of wealth and status, making the transition to biogas less appealing.

In contrast, Bensah & Brew-Hammond (2010) suggest that social barriers can be overcome through community-led initiatives, where local leaders or early adopters demonstrate the benefits of biogas technology. They found that in communities where influential figures promoted biogas, adoption rates increased, indicating that social influence and leadership can counteract cultural resistance. This suggests that while cultural barriers exist, they are not insurmountable if targeted through the right social mechanisms.

Technical difficulties, such as the lack of skilled personnel for installation and maintenance, have also been identified as significant obstacles to biogas adoption. Amigun, Sigamoney, & von Blottnitz (2008) argue that the absence of adequate technical expertise in rural areas often results in poorly constructed biogas plants that fail to operate efficiently, leading to

dissatisfaction and abandonment of the technology. Similarly, Walekhwa et al. (2009) emphasize that without proper maintenance and follow-up services, biogas systems tend to break down frequently, discouraging further adoption. This technical gap is often exacerbated by weak infrastructure, such as poor road networks and limited access to spare parts, which makes it difficult to sustain biogas operations in remote areas.

However, Parawira (2019) presents a contrasting perspective, arguing that biogas technology, once successfully implemented, can be relatively low-maintenance and self-sustaining. Parawira's study in Zimbabwe showed that biogas systems that were correctly installed and well-supported by local technicians experienced fewer breakdowns and maintained higher rates of functionality over time. This suggests that while technical challenges are a barrier, they can be mitigated through better training and infrastructure support.

5.3 Socio-economic factors and Biogas adoption

The study finding shows that economic factors have significant effect on adoption of bio-gas technology. Economic factors, particularly the cost of installation, affordability, and the availability of financial incentives, have been widely recognized as major determinants of biogas adoption. Recent studies affirm the significant positive effect of economic factors on biogas uptake. For instance, Kabir et al. (2013) highlight that household with higher income levels or access to subsidies is more likely to adopt biogas technology due to the reduced financial burden. Their study in Bangladesh found that when households received financial support or were provided with low-interest loans, the adoption rate increased significantly. This aligns with the findings of Mwirigi et al. (2014), who noted that households with access to micro-financing options in Kenya were more willing to invest in biogas systems, particularly when installation costs were spread over time.

Njenga et al. (2019) add that economic incentives such as tax rebates and subsidies play a crucial role in lowering the barriers to adoption. Their study in East Africa shows that financial

assistance from governments or NGOs directly influences the decision-making process of potential adopters by making biogas technology more accessible. Similarly, Parawira (2019) points out that the high upfront costs associated with biogas installation remain the primary barrier for low-income households, and without targeted financial interventions, widespread adoption is unlikely to occur.

In contrast, Amigun and von Blottnitz (2010) present a slightly differing perspective by suggesting that while economic factors are significant, they are not the sole determinant. They argue that even in regions where economic barriers have been reduced, other factors such as awareness and trust in the technology also play a role in adoption rates. Therefore, while economic factors have a significant positive impact on adoption, they must be considered alongside other influences for a more comprehensive understanding.

Technological factors, including the availability of technical support, system reliability, and ease of use, have been shown to have a significant positive effect on the adoption of biogas technology. This finding agrees with Amigun, Sigamoney, and von Blottnitz (2018) who argue that the success of biogas systems largely depends on the availability of technical expertise. In their study on biogas commercialization in Africa, they found that regions with trained technicians experienced higher adoption rates, as households were more confident in the long-term functionality of their systems. This finding is supported by Mshandete and Parawira (2018), who emphasize the need for local capacity building to ensure that biogas systems are properly maintained, thereby increasing their adoption.

The role of social factors in biogas adoption is a topic of debate among scholars. This study suggests that social factors, such as cultural practices and community influence, have no significant effect on the decision to adopt biogas technology. This finding contrasts with earlier research that emphasized the importance of social acceptance and peer influence. Research by Njenga et al. (2019) found that in East African communities, social factors such as the approval

of community leaders or the adoption behavior of neighbors had no significant impact on individual decisions to adopt biogas technology. Their study indicates that economic and technological factors were the primary determinants of adoption, while social dynamics played a minor role. This finding is supported by Parawira (2019), who argues that cultural resistance to new technology, such as biogas, is less influential than previously thought, especially when economic incentives and technological improvements are in place.

5.4 Moderating Roles of policy incentives

The moderating role of policy incentives in the relationship between socio-economic factors and the adoption of biogas technology is crucial in shaping the pace and extent of biogas adoption across various regions. Socio-economic factors, such as household income, education, and awareness, are key drivers of adoption, but their effects can be amplified or diminished depending on the presence and effectiveness of policy incentives such as subsidies, tax rebates, and low-interest loans. Several studies support the idea that policy incentives can significantly enhance the effect of socio-economic factors on the adoption of biogas technology. For example, Mwirigi et al. (2014) found that in Kenya, households with moderate income levels were more likely to adopt biogas technology when policy incentives such as government subsidies or grants were available. The researchers noted that these incentives reduced the financial burden on households, enabling those who otherwise could not afford the technology to adopt it. This finding is consistent with Kabir et al. (2015), who showed that the impact of socio-economic factors such as income and education levels was positively moderated by the presence of subsidies and government support.

Similarly, Walekhwa, Mugisha, and Drake (2019) observed that policy incentives played a crucial role in making biogas technology more accessible to rural households in Uganda, where socio-economic barriers, particularly low income and limited education, were common. In areas where financial incentives were available, households with relatively low income were more likely to adopt biogas technology compared to those in regions without such incentives.

This suggests that policy interventions can mitigate the economic constraints that typically hinder adoption.

However, some scholars argue that while policy incentives can enhance the effect of socio-economic factors, they must be well-targeted and sustainable. Amigun and von Blottnitz (2020) highlight that poorly designed or short-lived incentives can have limited long-term impact on adoption. They argue that while initial subsidies or financial assistance may encourage adoption, without continuous support or complementary measures, such as maintenance services or education campaigns, the adoption rate can stagnate or even decline over time. Therefore, policy incentives should not only be aimed at reducing upfront costs but should also include long-term support mechanisms to ensure the sustainability of biogas technology.

This view is echoed by Parawira (2019), who contends that in many developing countries, policy incentives may only benefit a certain segment of the population. He suggests that without addressing other socio-economic factors, such as access to education and awareness about the benefits of biogas, policy incentives may have limited impact. Parawira's research indicates that in some cases, households are unaware of available incentives or do not trust the long-term viability of the technology, regardless of financial support. This highlights the need for policy incentives to be accompanied by educational campaigns to raise awareness and trust in the technology, especially among lower-income and less-educated groups.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This study focused on socio-economic factors and adoption of bio-gas technology. This section however focuses on the summary of key findings, conclusion in line with the study findings and recommendations that are derived from the study findings. This section also covers the areas that should be considered for future research in line with bio-gas adoption.

6.1 Summary of findings

From the study focusing on socio-economic factors and bio-gas adoption, the following key findings were derived as presented:

The study found high level of perception about the socio-economic benefits of bio-gas adoption; and low level of bio-gas adoption among households

The study finding shows a significant positive relationship between all the factors (social, economic and technological) with the adoption of bio-gas technology.

The finding shows that economic and technological factors have significant effect on adoption of bio-gas technology, while social factors do not have any significant effect on adoption of bio-gas technology.

From the study, policy incentives have a significant moderating effect on the relationship between socio-economic factors and bio-gas adoption.

6.2 Conclusion

The study reveals a high level of awareness and positive perception regarding the socio-economic benefits of biogas technology, yet paradoxically, adoption rates remain low among households. This highlights a critical gap between knowledge of biogas advantages and actual implementation, suggesting the presence of unaddressed barriers, such as affordability, access to technology, or a lack of policy support. Therefore, bridging the gap between perception and

adoption requires a deeper understanding of the underlying factors that inhibit households from translating awareness into action. The study therefore concludes that bio-gas adoption remains low among households in Gulu City.

Additionally, the study demonstrates that all three factors—social, economic, and technological are significantly and positively related to the adoption of biogas technology. The study concludes that the integration of social dynamics, economic capacity, and technological availability is essential for driving the adoption of sustainable energy solutions. However, while all these factors are related to adoption, their level of influence differs, requiring tailored interventions for each dimension.

Notably, economic and technological factors show a significant direct effect on biogas technology adoption, whereas social factors do not have a statistically significant effect. This suggests the critical roles of financial capacity and access to technology in adoption decisions, but it also challenges the traditional view that social dynamics, such as community acceptance and cultural practices, play a decisive role. The study thus concludes that in the context of biogas adoption, economic and technological accessibility are the primary drivers, overshadowing the role of social influences.

Finally, the study elaborates the significant moderating role of policy incentives in enhancing the relationship between socio-economic factors and the adoption of biogas technology. Policy incentives, such as subsidies, tax breaks, and grants, act as catalysts that amplify the effect of economic and technological factors on adoption. This reinforces the need for governments and policymakers to craft targeted policies that not only address economic barriers but also facilitate easier access to biogas technology. Without such interventions, efforts to promote biogas adoption may continue to face obstacles, despite the potential socio-economic benefits identified.

6.3 Recommendations

Based on the study findings, the following recommendations are suggested to promote the adoption of biogas technology:

Despite the high perception of the socio-economic benefits of biogas technology, adoption rates remain low among households. Policymakers, non-governmental organizations (NGOs), and biogas technology providers should focus on practical strategies to convert awareness into adoption. This could involve creating demonstration projects, establishing household pilot programs, and engaging in targeted community outreach that emphasizes the direct and tangible benefits of biogas for energy savings and environmental sustainability.

Since economic factors significantly influence biogas adoption, financial incentives such as subsidies, low-interest loans, and flexible financing schemes should be implemented. Governments and financial institutions should collaborate to provide affordable financing options that lower the initial cost of acquiring biogas technology. Additionally, integrating biogas technology into community development programs could help households that face financial constraints adopt this sustainable energy solution.

There is need to Enhance technological access and support. The significant role of technological factors in the adoption of biogas technology implies that increasing access to biogas systems and ensuring their ease of use is essential. Governments and technology providers should invest in creating affordable, reliable, and user-friendly biogas solutions. Training programs should also be established to build local capacity in the installation, operation, and maintenance of biogas systems, ensuring their long-term sustainability.

While social factors did not show a significant direct effect on adoption in this study, this does not mean they should be entirely neglected. Community-based approaches and peer-to-peer learning models could help influence adoption rates, particularly by leveraging local champions and early adopters to demonstrate the benefits. Local governments and NGOs could

further foster supportive social environments by organizing community meetings and creating platforms for sharing success stories of biogas adopters.

There is need to strengthen policy Incentives. The study highlights the critical moderating role of policy incentives in facilitating biogas adoption. Policymakers should continue to design and implement robust policy frameworks that include financial incentives, regulatory support, and public-private partnerships to encourage biogas adoption. Policies that promote biogas as part of broader renewable energy and environmental conservation initiatives will provide additional motivation for households to adopt this technology. This includes offering tax breaks, reducing import tariffs on biogas equipment, and incorporating biogas adoption into national clean energy programs.

Governments, researchers, and development organizations should establish systems for long-term monitoring and evaluation of biogas adoption programs. Tracking adoption trends, the effectiveness of policy incentives, and the socio-economic impact of biogas technology on households will provide valuable insights into the success of current strategies and guide future interventions.

6.4 Areas of Future Research

Based on the study of socio economic factors and bio-gas adoption, the following areas of future research have been proposed.

- i. Bio-gas adoption and household livelihoods in Gulu City, Northern Uganda
- ii. The role of bio-gas technology in enhancing economic sustainability of households in Gulu City, Northern Uganda.
- iii. Bio-gas adoption and socio-economic empowerment of households in Gulu City, Northern Uganda

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Dear Sir/Madam,

SECTION A: BACKGROUND INFORMATION

Tick only what is applicable

1. Gender

i) Male () ii) Female ()

2. Age bracket

i) 18 – 28 years () ii) 28 – 38 years () iii) 38 – 48 years () and other
.....

3. Marital status

i) Single () ii) Married () iii) Separated/Divorced () iv) Widowed ()

4. Highest education qualification acquired

i) No formal education () ii) Primary () iii) Secondary () iv) Certificate ()
v) Diploma () vi) Undergraduate () vii) Postgraduate ()

5. For how long have you been using biogas?

i) Less than 1 year () ii) 1 - 3years () iii) 4 - 6years () iv) Above 6 years ()

SECTION B: SOCIO-ECONOMIC FACTORS

Please tick the most appropriate option.

KEY

SD= Strongly Disagree, **D**= Disagree, **NS**= Not sure, **A**= Agree and **SA**= Strongly Agree

S/n	Statement of inquiry (Social factors)	SD	D	NS	A	SA
1	The biogas technology is well accepted within the cultural set-up of my community.					
2	I have positive attitude towards the usage of bio-gas technology.					
3	My family provide labour support in the biogas production					
4	My family provide financial support for biogas production					
5	Women provide more labour for biogas production					
6	Men provide more labour for biogas production.					
7	I received regular extension services on biogas production					
S/n	Statement of inquiry (Economic Factors)	SD	D	NS	A	SA
1	I receive regular income from biogas production					
2	Maintenance costs for biogas technology are manageable.					
3	I am willing to invest in biogas technology because it saves money in the long run.					
4	I like to use biogas technology because of its time saving					
5	My household expenses on fuel has reduced because of using biogas					
6	The bio-gas technology is highly affordable.					
S/n	Statement of inquiry (Technological Factors)	SD	D	NS	A	SA
1	I have access to the technical support needed for installing biogas technology.					
2	The materials required for biogas technology are readily available.					
3	Biogas technology is easy to use and maintain.					
4	I believe that biogas technology is reliable					
5	I trust the safety of biogas technology.					

SECTION C: ADOPTION OF BIOGAS TECHNOLOGY

Please tick the most appropriate option.

SECTION C1: Practice

KEY

SD= Strongly Disagree, **D**= Disagree, **NS**= Not sure, **A**= Agree and **SA**= Strongly Agree

S/n	Statement of inquiry (Practice)	SD	D	NS	A	SA
1	I undertake daily feeding of the digester.					
2	I regularly monitor the substrate level in the digester					
3	Cleaning of the mixing chamber is undertaken frequently					
4	I have a consistent and sufficient supply of organic waste for plant production.					
5	I regular remove the bi-slurry from the slurry pit to the storage tank					
6	I Regularly remove water along the pipe to get maximum gas pressure					
7	I do provide clean water for mixing the cow dung and other animals waste,					
8	I regular use the biogas produce from the digester					
9	I regular turn off and turn on the gas gently while cooking					
10	I regular control the burning status of gas produce from the digester while cooking					
11	I regular check the gas level from the digester using the pressure gauge installed on the wall.					

Do you produce biogas jointly or collectively Yes/No

Are you connected with pipe or tube?.....

With how many households are sharing the produce biogas right now?.....

What is your contribution to join biogas production?.....

.....

What are the benefits of collective biogas production?.....

.....

.....

What are the challenges of collective biogas production?.....

.....

.....

.....

Which size of digester do you have?

What is your household size?.....

Do you store your biogas? Yes /No

Give reason for your choice.....

.....

What are the challenges of using the specified biogas storage material?.....

.....

.....

Which type of burner/stove do you use? (BSU/Gulu University/ Modified BSU)

Why do you prefer this burner?.....

.....

Are you already used to the new cooking method? Yes/No

If no, why?.....

How satisfied are you with the biogas system on a range of 1-10?.....

Are you already aware of how to use biogas plants properly? Yes/No

.....

Do you use the bi-slurry of the biogas plants as fertilizer for your crop's plants? Yes/No

If no, why?.....

Are you sharing the bi-slurry for fertilizing the crops plants equally with your neighbor?

Yes/No

What are the benefits of using bi-slurry from the biogas plants in crop production

.....

.....

.....

.....

Section C2: Adoption

Tick the most appropriate option where:

1 – Very Low (VL), 2 – Low (L), 3 – Moderate (M), 4 – High (H) and 5 – Very High (VH)

For what purpose do your biogas plant? (Select/tick the appropriate option)

1. Lighting only ()
2. Cooking only ()
3. Cooking and lighting only ()
4. Production and lighting or cooking ()
5. Lighting, cooking and production ()

S/n	Statement of inquiry (Adoption)	VL	L	M	H	VH
1	To what extent do you use biogas for cooking					
2	To what extent do you use biogas for lighting					
3	To what extent do you use biogas for production					

SECTION D: POLICY INTERVENTIONS

Please tick the most appropriate options

KEY

SD= Strongly Disagree, **D=** Disagree, **NS=** Not sure, **A=** Agree and **SA=** Strongly Agree

S/N	Statement of inquiry (Monetary Incentives)	SD	D	NS	A	SA
1	Information about financial incentives for biogas adoption is easily accessible.					
2	Government and organizations provide monetary incentives for biogas adoption.					
3	I have been informed about financial benefits of adopting biogas technology through various channels.					
4	Government subsidies significantly reduce the initial cost of installing biogas technology.					
S/n	Statement of inquiry (Non-Monetary Incentives)					

1	Technical support for biogas installation is readily available in my area.					
2	Non-monetary incentives from the government (such as free training, recognition, etc.) make biogas adoption more appealing.					
3	Government policies favor the adoption of biogas over other energy sources.					
4	I am aware of government programs that promote biogas adoption through non-monetary incentives.					
5	The government provides adequate training programs for biogas technology.					

Thank you for your response!

APPENDIX II: INTERVIEW GUIDE

Dear Sir/Madam,

I am Charles, a student of Gulu University, Faculty of Business and Development Studies, pursuing Master's Degree at Gulu University. I am carrying out research titled "Socio-economic Factors Influencing the adoption of Bio Gas technology in Gulu City". You have been identified as the right respondent. This study is purely for academic purpose and therefore all responses you provide will be treated with utmost confidentiality. Please spare some few minutes of your time to respond to the questions below.

KEY QUESTIONS

Do you know of any factors that influence adoption of biogas technology by households?

1. If yes, what are the different factors influencing adoption of biogas technology by households?
2. Provide some explanations on the factors influencing adoption of biogas technology in the forms of:
 - a) Social factors
 - b) Economic factors
 - c) Technological factors
3. How have the factors mentioned above affected adoption of biogas technology?
4. How has policy intervention affected adoption of biogas technology?
5. Comment on the status of biogas adoption by households in Gulu City?
6. Comment on the benefits of bio-gas adoption

End of Interview:

Thank you for your participation

