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ASSESSING RURAL COMMUNITIES' PROSPECTS FOR BIOGAS TECHNOLOGY ADOPTION AS CLEAN ENERGY SOURCE IN WAKISO DISTRICT, UGANDA

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ABSTRACT: *This study investigates the prospects for adopting biogas technology as clean energy by rural population in Wakiso district. Its main objective was to generate information on challenges and opportunities that exist locally for promoting biogas as an alternative source of energy in Wakiso district. A descriptive, explanatory and associational research designs was used in the study to collect information from the study areas. The design enabled qualitative and quantitative data collection and analysis of the variables under the study. It helped the researcher to obtain information in a shorter period of time. Qualitative data was obtained through questionnaires, interviews and observation while quantitative data was obtained through computation and analysis. The findings reveal that, a number of local factors influence biogas technology adoption. These factors include lack of technical services and high cost of maintenance. They led to non-adoption of biogas technology. For instance, lack of technical services was evidenced in non-completion or breakdown of biogas plants due to lack of maintenance services.*

KEYWORD: Clean Energy, Biogas, Adoption Challenges, Opportunities, Rural Community

INTRODUCTION

Energy serves humanity through provision of heat, electricity, preparing food, transportation and industrial processing. Enormous research work has been conducted on the subject and majority of studies carried out in Africa show significant disparities between the rural and urban settings due to challenges faced in putting up basic energy infrastructure (Jagan and Sundar, 2004). About 90% of rural population depends on wood fuel to meet their daily cooking energy needs (Muchiri, 2008). Biomass energy such as firewood, and charcoal, play a very important role in the basic welfare and economic activities in many sub Saharan African countries (Muchiri, 2008). According to the US department of energy (2001), total wood harvested for cooking in sub Saharan Africa is about 80%. It is estimated that in 2030, the number of people using wood fuel in Africa will increase by more than 40% to about 70 million people (Muchiri, 2008). This condition signifies available threat for human and climate security, and form a major barrier to advance in economic growth and poverty alleviation in sub Saharan Africa. In most developing countries, wood fuel and charcoal remain the major source of domestic energy, (UNDP, 2009) and a greater switch to clean energy source in the

long run seems unlikely (NEMA, 2007). Biomass is the major source of domestic energy for both rural and urban areas in Uganda. By the year 2050, Uganda will require 42.6 million tons of wood for household energy use for her estimated 55 million people then (Sebbit et. al., 2004).

This condition signifies that biomass future demand can assume to be proportional to population growth in Uganda. The consequences of over reliance on biomass energy have negative or adverse effects on the economic, social and environmental spheres of sustainability. Animals are an important source of food and income for many rural people here in Uganda, but their manure is a source of one of the world's most potent greenhouse gases. About 80% Uganda's population live in rural villages (NFA, 2009) where there are almost no alternatives to biomass fuel. The rural population is relatively poor and seriously affected by the depletion of their energy resources, especially firewood. This has put pressure on women and children and further heightens their vulnerability to falls and attacks during firewood collection. Historically, in Uganda Biogas technology have been present in Uganda since the 1950 (UDBP, 2010) and by 2008, the estimated number of systems was around 800 a great improvement over the 100 that were established to exist in 1990. The (UDBP, 2010) also point out that the main causes of biogas failure are due to limited skills by constructors of the systems and an inadequate operation and maintained by the household. According to the same source, the main challenge or barrier for the diffusion of this technology for starters have been lacks of technical capabilities and the comparatively high upfront cost. The use of biogas reduces the CO_2 emission through the reduction of the demand fossil fuel and enhances sustainable energy use in rural communities and its lower energy cost corresponds to a higher level of energy sustainability as it would propel energy access. A Castro-Gonzalez-Ingenieria's investigation (2016), according to Laramee and Davis (2013), biogas digester implementation has socioeconomic or environmental benefits. This source suggests that biogas adoption has the potential to reduce wood fuel use, energy related expenditures, and time cost of energy procurement; to low co2 emissions, and to increase farm incomes. According to Tafdrup (1995), Biogas systems can yield a whole range of benefits to the users including production of heat, light and electricity, transformation of organic waste into high quality fertilizer, improvement of hygienic and environmental conditions. In addition to the above benefits, biogas also improved Health and sanitation by reducing heath risk associated with continuous exposure to smoke (respiratory diseases) and improve hygienic conditions. Education and food security by providing quality lightening for children. Lightening that is better than that of traditional lightening (kerosene lamps) which enable them study longer hours during the night or evening.

MATERIALS AND METHODS

Research Design

This study applied a purposive design focusing on particular households where biogas projects have been implemented or initial attempts failed. It involved collecting qualitative and quantitative data through interviews, key informant interviews and observation checklist of guiding questions.

Study Area

This study was conducted in Nabweru sub-county and Naggabo sub county in Wakiso District. The district borders Nakaseke district and Luweero district to the north, Mukono district to the east, Kalangala district in Lake Victoria to the south, Mpigi district to the southwest and Mityana and Kampala district to the northwest. The town is in Kawanda Parish, Nabweru Sub-county, being one of the six parishes in that administrative unit. Kawanda is approximately 13 kilometers (8.1 mi), by road, north of Kampala, the capital and largest city in Uganda. This is approximately 247 kilometres (153 mi) south of Karuma Falls, on the Kampala-Gulu highway. The coordinates of the Kawanda are 0°25'14.0"N, 32°32'26.0"E (Latitude: 0.420556; Longitude: 32.540556). Namalere is a place with a very small population in the state/region of Kalangala, Uganda which is located in the continent/region of Africa. Cities, towns and places near Namalere include Bamba, Kiteezi, Tula and Kasangati. The coordinates of Namalere are; latitude 433333, Longitude 599994.

Kitezi, is located in Nansana Municipality, Wakiso district, off Mpererwe on Gayaza road.Nakyesanja is located in Kawanda along Bombo road, off Nanalere road. Wabitembe is located along Bombo road, 5 Kilometer away from Kawanda. Nansana is located on the main highway between Kampala and Hoima. The town is located approximately 12 km (7.5 mi), by road, northwest of Kampala, Uganda's capital and largest city. The site is located in Wakiso district, Nansana Town Council in Nabweru North.

Household Survey

A set of questionnaires was design to carry out the household survey. About 20 households in Wakiso district were interviewed and information gather was based on qualitative and quantitative data collection so that the both methods can complement each other. According to Bryman (2008), the strength of one method helps to overcome the weaknesses of another thereby achieving a cost benefit analysis balance. Key informant interviews, non-participant observations and Questionnaires administered to selected household heads were used in the study. The data variables included household socio-demographic characteristics, knowledge of biogas, local biogas production technologies, capital investments, benefits associated with biogas use and challenges in biogas adoption.

Sampling and Data Collection

A simple random approach was utilized to select the adult male and female members in different areas of the study, majorly from the selected area who use biogas, particularly from Kawanda (site 1), Kitezi (site 2), Nakyesanja (site 3) and Nabweru (site 4) in Wakiso district to represent other areas, as was chosen for the study. This helped to eliminate bias from Households with biogas plant or where previous attempts were made to adopt biogas use as clean source of energy.

We used questionnaire which comprised a set of written questions on sheet with spaces provided for respondents to reply to questions, which were administered in face –to- face interviews with respondents. The focus of the questions was placed on the availability of raw materials and relevant resources for biogas production and maintenance.

Figure 1: Illustration of Biogas Production and Use Experience of Local Communities

Data Analysis

The quantitative data was analyzed for mean frequencies and standard deviation using SPSS Software version 21 for windows xp and Microsoft excel. The analyzed data were interpreted and presented in tables, charts and graphs.

RESULTS AND DISCUSSION

The results show that 30 households had females as the majority respondents and on average the respondents aged between 29 and 34 years, which means the study comprised a group of individuals who are youthful and still hold great prospects for a better future. The findings also revealed that majority of the respondents had attained tertiary level of education, and hence were very much aware and knowledgeable on issues concerning energy use.

Table 1: Socio-Demographic Characteristics of Respondents

Variables	Frequency	Percentage
Sex		
Female	24	80%
Male	06	20%
Age		
18-25	07	23%
26-35	10	33%
36-45	08	27%
45+	05	17%
Education		
Post graduate	07	23%
Certificate holders	10	34%
Degree / diploma	13	43%
Occupation		
Farmers	18	60%
Employed	07	23%
Business	05	17%

The table above reveal that initial cost/ financial problems was the most important reasons why biogas technology has not been adopted in Wakiso. According to the respondents in the areas visited, it was found out that in Kitezi with a percentage of 20%, Nakyesanja with 17%, Wabitembe with 23% while Nabweru with 40% respectively and agreed by the respondents that those challenges lead to the failure of biogas technology in Wakiso District.

According to the findings presented in Table 2 some of the challenges faced by the residents of Wakiso district in accessing the biogas technology was that of inadequate resources for low-income earners. These include limited water supply, maintenance costs and lack of raw materials due to stolen cattle. The residents of Wakiso refore, in the areas visited, for example in Kitezi with a percentage of 16%, Nakyesanja with 31%, Wabitembe with 26% while Nabweru with 26% respectively.

Table 2: Reasons the Respondents Gave for Failure to Adopt Biogas Technology

Variables	Responses				% Total
	Site 1	Site 2	Site 3	Site 4	
Reasons for failure to adopt biogas technology					
Technical problems /services	2	1	1	1	16.67
Lack of cattle and men power to do physical work	1	3	4	6	46.67
Initial cost / financial problems	3	1	2	5	36.67
Challenges faced in accessing the biogas technology					
Law income	1	1	1	2	16.67
Limited water supply	1	3	2	2	26.67
maintenance cost	2	2	1	1	20.0
Lack of raw materials	1	3	4	3	36.67

Many factors were also found to be responsible for the low adoption levels. Family-sized biogas plants being labor intensive and yet operated by mainly family members, which implies that most households with few members had insufficient manpower to do the physical work. The average cattle herd size of most households was insufficient to produce the required cow dung for the digester. The problem of low number of cattle was compounded by theft of cattle in the area. The respondents were unanimous that they fear increasing the number of cattle holdings at household level due to lack of security. Thus, inability to get needed materials like animals' dung to generate gas for both cooking and lighting was resulting in a situation where people use unclean traditional sources of fuel such as charcoal and firewood. Results also shows that most households did not have adequate water supply. Water is equally an important raw material. Lastly, the maintenance costs for sustainable biogas energy generation in the study area, have often resulted in households abandoning the technology because of the inability of the biogas plants to generate sufficient and reliable cooking energy (Bhat et al., 2001).

Despite the many challenges cited, the respondents were aware of the economic, environmental and social benefits of using biogas as alternative energy source. Biogas energy was found to be a very fundamental resource to households where it has been adopted for use as source of energy. Its main applications to the users were cooking, lighting and generations of fertilizers. However, the technology adoption level in the district was quite low in spite of its potential benefits.

Table 3: Provides Highlight on Perceived Benefits of Biogas Technology

	Response Distribution				
Variables	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**% Total**
Local opportunities for biogas adoption					
Economic and Environmental Benefits	5	3	4	2	46.67
Access to regular waste storage	2	2	1	1	20.0
Create market for sale of local materials	2	2	1	1	20.0
Organic fertilizers production	1	1	1	1	13.33

The Table 3 above shows respondents' awareness regarding economic and environmental benefits of biogas. They explained that benefits associated with biogas use were the most important reasons for adopting biogas technology. It also gives them the opportunity to have access to regular or better waste storage system and also improved sanitation, helps create market for local materials, opportunity of using local organic compost fertilizers. Most importantly, they were inspired by the fact that biogas has clean energy and produces no smoke, helps save other fuels. Furthermore, according to respondents from sub-locations we visited for this study, which are Kitezi with a percentage of 34%, Nakyesanja with 27%, Wabitembe with 23% while Nabweru with 16% biogas technology is affordable and cost effective in the long term. This points out that though other fuel forms would have been available, but there are reasons enough to inspire the installation of biogas plant and promoting biogas use locally as an alternative source of energy.

CONCLUSION

In conclusion therefore, biogas technology offered a myriad of benefits; social, economic, and environmental, and was a major driver of livelihoods in Kawanda, Namalere, Kitezi, Nakyesanja, Wabitembe, and Nabweru in Wakiso district. Its role and potential in positively transforming livelihoods, in poverty alleviation and in environmental protection cannot be emphasized. Efforts are required to create an environment that promotes the adoption of this technology. The evaluation of biogas energy has expanded and the body of knowledge in this area is increasing. This makes a contribution to the already existing body of literature in this field. On the basis of these study findings, it can be concluded that biogas technology and utilization in Uganda is both viable and sustainable. Empirical results are in conformity with the hypotheses that guided this study that adopting biogas technology and utilization, and biogas production is a profitable and sustainable venture in Uganda. Specifically, the probability of a household adopting biogas technology increases with increasing household income, increasing number of cattle owned, increasing household size, female head of household and increasing cost of traditional fuels.

Descriptive analysis of the findings shows that a number of factors had an influence on biogas technology adoption. Adopters of biogas technology revealed that initial cost/ financial problems, lack of cattle's/ raw materials, inadequate water supply, lack of technical services, low awareness on the value of biogas technology, and high cost of maintenance were the major factors that led to non-adoption of biogas technology. Non-adopters were of the opinion that

the high cost of initial installation of the biogas plants. The cost seemed too high for most respondents because their average monthly income is low. Low levels of education and average household monthly income are explained by poverty in the area.

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REFERENCES

Akinbami J., Ilori M., Oyebisi T., Oyebisi I. and Adeoti O. (2001). Biogas energy use in Nigeria: Current Status, Future Prospects and Policy Implications. Renewable and Sustainable Energy Reviews 5, 97–112.

Amigun B., Sigamoney R. and von Blottnitz H. (2008). Commercialization of biofuels industry in Africa: A review. Renewable and Sustainable Energy Reviews 12, 690-711

Bhat P.R., Chanakya H.N. and Ravindranath N.H. (2001). Biogas plant dissemination: Success story of Sirsi, India. Energy for Sustainable Development.5 (1):39-46.

Burton I., Smith J.B. and Lenhart S. 1998, 'Adaptation to Climate Change: Theory and Assessment, 'Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies', Nairobi and Amsterdam.

Department of International Development (DFID), (1998). "Sustainable rural livelihoods", UK Department for International Development, London.

Madan B. B., Amrit B., Karki Jagan N. S. and Sundar B. (2004). Biogas as Renewable Source of Energy in Nepal Theory and development BSP – Nepal.

Mapako M. (2000). Renewable and Energy for Rural Development Theme Group: Data and Statistics Compilation - Zimbabwe.

Muchiri L. (2008). Gender and Equity in Bio Energy Access and Delivery in East Africa. Practical Action Eastern Africa.

Mugenda M.O. and Mugenda A.G. (2003). Research Methods Qualitative and Quantative Approaches. African Centre for Technology Studies (ACTS)

Mugo F. and Gathea T. (2010). Biomass energy use in Kenya. A background paper prepared for the International Institute for Environment and Development (IIED) for an international ESPA workshop on biomass energy,

Myles R. (2004). Environmental, Social and other Positive Impacts of Building Household Biogas Plants in Rural India. A paper prepared for (World-Council for Renewable-Energy) and EUROSOLAR sponsored Second World Renewable

NEMA (2005). Assessment of the Energy Policy Act of 2005. National Electrical Manufacturers Association, Ressylyn Virginia

Sapkota A., Yang H. and Wang J. (2012). Securing rural livelihoods and climate change through sustainable use of biogas and improved cooking stoves in rural Nepal. Environ Sci Techno 47(1): 330-1.