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BENEFITS OF ADOPTING BIOGAS TECHNOLOGY IN KIAMBU COUNTY, KENYA

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Abstract
There is a close relationship between clean energy, environmental health and human livelihoods. Thus as it becomes more significant for societies to adopt clean energy, it also becomes paramount to integrate this push based on perceived benefits for adoption. Fundamental challenges and opportunities exist for adoption of biogas technology in Kiambu County. This paper documents opportunities for enhancing biogas adoption based on perceived benefits. Data was collected from four sub counties of Kiambu using household surveys (n=40 for adopters and n=40 for non-adopters). Both adopters and non-adopters were aware of benefits of adopting biogas technology and pointed out environmental, social and economic benefits (n=80; P≤0.05; X^2=84). Adopters cited the improved farm fertility and clean environment through utilization of slurry from the biogas bio-digesters in farms (n=40; P≤0.05; X^2=91). All respondents indicated that adoption of biogas technology would help mitigate climate change (n=80; P≤0.05; X^2=67). All respondents also indicated that biogas reduces indoor pollution (n=80; P≤0.05; X^2=92.4). Biogas was indicated to offer the benefit of manure waste management (n=80; P≤0.05; X^2=89.1). Respondents stated that adoption of biogas would help save on time used to fetch firewood (n=80; P≤0.05; X^2=94). Biogas was highly rated on reliability (n=80; X^2=67) and efficiency (n=80; X^2=60). Adopting respondents indicated biogas is economical (n=40; X^2=56). All respondents cited the benefit of job creation (n=80; X^2=53). Incorporation of awareness of perceived benefits could prove useful in co-designing and co-implementation of governance and management frameworks for biogas in Kiambu County and Kenya at large.

Key words: *Biogas, benefits, adoption, Kiambu County*

Introduction

Biogas is considered as a major source of clean energy (Karekezi, *et al*., 2008; IEA, 2017; Kavisi *et al*., 2018). Biogas could contribute to a shift towards clean, reliable, affordable and sustainable forms of energy, (Grübler and McDonald, 1996; Bolinger *et al*., 2001; Ploeg and Withagen, 2014; Richardson, 2016; Covert, *et al.,* 2016; IEA, 2017) and possibly allow for convenient transition from conventional to green energy (International Forum on Globalization, 2004; Hohmeyer and Bohm, 2015; Noseleit, 2018). Biogas could also lead to reduction of green house gas (GHG) emissions that have led to global warming and climate change (Dincer and Rosen, 1998; Losey *et al*., 2006; Bradshaw, 2010; Das *et al.,* 2011; Lovins, 2012; Kozinski *et al*., 2016).

Despite the above stated reasoning for adoption of biogas technology, Kiambu County continues to experience low adoption of this technology (Kavisi *et al*., 2018). The paper documents respondents' perceived benefits that could be utilized to enhance adoption of biogas technology in Kiambu. Once used as a basis for adoption of the technology, sustainable adoption could contribute towards achieving Sustainable Development Goals and most notably Goal Number 7 that focuses on access to affordable, reliable, sustainable and modern energy for all (UN, 2015).

This would also help address the gap between energy supply and demand, shortcomings of conventional forms of energy as well as the increasing desire for clean energy in Kiambu. Since there is a close-knit relationship between clean energy and sustainable environmental management, adoption of biogas would have a significant contribution to environmental health.

Materials and Methods

The conceptual framework considered benefits of biogas expected to spur the community's interest to make the people adopt the technology. Eighty (80) respondents participated in the survey (n =40 of them had adopted biogas and n = 40 had not adopted biogas). A previously described method (Kavisi *et al*., 2018) was used to collect data using a questionnaire with open and closed questions. Interviews, observation and focused group discussions (FGD) were utilized. Primary and secondary data was used and random sampling was done by selecting respondents using line transects. Every fifth household was sampled along the transect lines for each of the four wards in each sub county. Quantitative data was analysed using descriptive statistics such as frequencies, percentages and averages and the significance tested using *Student-T test (P≤0.05),* while *Chi-square test (P≤0.05)* was used to analyse qualitative data. Data collected emphasized on the respondents' benefits for adoption of biogas technology.

Results and Discussions

The results are presented in descriptive terms. Both adopters and non-adopters were aware of benefits of adopting biogas technology and pointed out environmental, social and economic benefits ($n=80$; $P\leq0.05$; $X^2=84$).

Environmental benefits

This benefit was mentioned by all respondents. Adopters cited the improved farm fertility and clean environment through utilization of slurry from the biogas bio-digesters in farms ($n=40$; $P\leq0.05$; $X^2=91$). This agrees with Heegde and Sonder (2007) who found out that slurry as a by-product of biogas brought positive changes in farms and farmers were satisfied with the outcome. Slurry helps to improve soil fertility because it is rich in nutrients and its nitrogen content is three times more than what is found in organic fertilizer (Gitonga, 1997). By increasing soil fertility, slurry removes the need to expand agricultural land in order to increase harvests (Heegde and Sonder, 2007). This benefit could be utilized to enhance biogas technology adoption in Kiambu for organic

farming (*The Organic Farmer,* 2015). These findings are also in agreement with Kebede *et al* (2016) who noted that making farmers aware of additional benefits of the technology other than energy would encourage others to invest in this type of clean energy.

All respondents indicated that adoption of biogas technology would help mitigate climate change (n=80; $P \leq 0.05$; $X^2=67$). This agrees with previous authors who described biogas as a climate-friendly technology contributing low carbon energy mix (Mengistu *et al*., 2016). This benefit could be incorporated for adoption through paid carbon credits within the REDD+ initiative (Githiru, 2016) to motivate more people to turn to biogas for additional income (NCCRS, 2010).

All respondents also indicated biogas reduces indoor pollution (n=80; $P \leq 0.05$; $X^2= 92.4$). This agrees with the WHO (2018) Report that biogas ensures homes are clean compared to when they were using fuel wood. Kitchen conditions are improved and cases of indoor air pollution (IAP), respiratory infections, eye irritation, among others are reduced (Islam and Hossein 2014; Inda and Moronge, 2015; Shane and Gheewala, 2016; WHO, 2018).

Biogas was indicated to offer the benefit of manure waste management (n=80; $P \leq 0.05$; $X^2=89.1$). This was in agreement with others who indicated effective and strategic waste management approach through use of bio-digesters (Fiorese and Guariso, 2012; Avery *et al.,* 2014). By using manure waste to generate clean energy, the degree of soil and water contamination is reduced significantly and this allows for agricultural activities to take place while at the same time minimizing cases of water-borne diseases (WHO, 2018).

Social Benefits

Respondents stated that adoption of biogas would help save on time used to fetch firewood (n=80; $P \leq 0.05$; $X^2=94$). As reported previously women and girls fetch firewood for their homes and biogas would save on that time (Maloy *et al.*, 1986; Muchiri, 2008). This could be argued to lead to higher household productivity since women and girls undertake the most household chores (UNIDO, 2009).

Biogas was highly rated on reliability (n=80; $X^2=67$) and efficiency (n=80; $X^2=60$). As reported by Shane and Gheewala (2016), compared to firewood or charcoal, biogas lights with a single turn of the knob on the burner and once it is put on, it does not require constant attention or blowing to keep the fire burning instead it burns because the gas is continuously pushed by pressure from the bio-digester through pipes up to the burner.

Economic Benefits

Adopting respondents indicated biogas is economical (n=40; $X^2=56$). Gwavuya *et al*. (2012) observed that adoption of biogas technology enables households to make substantial savings on their energy consumption and saves also on household expenses.

All respondents cited the benefit of job creation (n=80; $X^2=53$). Others have reported how biogas could enhance job creation through fuel for vehicles and also in industries (Kennes and Veiga, 2013; Bhatia, 2014; Mengistu *et al*., 2015; Feroldi *et al.,* 2016; Singhal *et al*., 2017).

Conclusion and Recommendations

There are perceived benefits of adoption of biogas technology in Kiambu County. The perceived benefits could be utilized to enhance adoption of the technology and address the reported existing challenge of low adoption of biogas in Kiambu County (Kavisi *et al*., 2018). Incorporation of awareness of such benefits could prove useful in co-designing and co-implementation of governance and management frameworks for biogas in Kiambu County and Kenya at large.

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