Source: Kenya Biogas Programme (KBP).

CHAPTER 5

Biogas as a Smart Investment for Women's Empowerment and Livelihood Enhancement

Judith Libaisi[1*] and Mary Njenga[2,3]

[1] SNV (Netherlands Development Organization) Kenya.
[2] World Agroforestry Centre (ICRAF), P.O. Box 30776-00100, Nairobi, Kenya.
[3] Wangari Maathai Institute for Peace and Environmental Studies, University of Nairobi, Kenya, P.O. Box 30197-00100, Nairobi, Kenya.

* Corresponding author, e-mail: jlibaisi@gmail.com

5.1 Introduction

Globally, over 1.1 billion people live without access to electricity and almost 3 billion people lack clean cooking facilities that are less harmful to human health and the environment (WEC 2013). According to the Global Alliance for Clean Cook Stoves as cited in their website, clean cookstoves and fuels have the potential to reduce deaths from smoke-related illnesses, mitigate climate change and lower air pollution (GACC 2018). They can provide new sources of livelihoods for women, reduce the risk and drudgery of fuel collection and lower household expenditures on cooking fuel. The world's poor are continuously affected by the low availability of sustainable and reliable energy, especially in remote areas. Modern energy services are crucial for human well-being as well as national economic development.

Biogas is one such promising technology. Biogas was introduced to Kenya in 1948 by Mr. Tim Hutchinson. The first biogas digester (biodigester) was built in Kenya by Hutchinson's company, Tunnel Engineering Ltd. in 1957 (Ndereba 2013). Hutchinson discovered that the effluent (or 'sludge', bioslurry or digestate) is an excellent fertilizer and that its application to his coffee trees greatly improved productivity. Two types of biogas systems were introduced: the Chinese fixed dome digester and the Indian floating drum digester. Through initiatives by the Government of Kenya and non-governmental organizations (NGOs) the technology has been promoted in different rural areas in Kenya, mostly utilizing cattle manure as the main substrate (Blanchard 2018).

Biogas is a proven and widely-used global source of energy. There has been a renewed interest in its use owing to rising concerns about greenhouse gas effects, the high prices of fossil fuels and other environmental and health concerns associated with cooking energy in the past decade (WEC 2013). Biogas has been widely adopted even in developed economies such as Japan. Similarly, emerging economies such as Brazil, India and China have promoted the importance of biogas technology (Biwas et al. 2006). In rural Kenya, among biogas users on average, expenditure on firewood declined from KES 384 to 112 (71%) per household per week equal to annual cost savings of €125 (Dohoo et al. 2013). Additional associated savings include those on chemical fertilizers and a reduction in medical

expenses from illnesses associated with indoor air pollution estimated at €249 annually; there are more savings on the former (Smith 2012). Other non-monetized biogas benefits are smoke-free indoor space and cleaner kitchens. The availability of the cooking fuel at the appropriate point and time of use (readiness) is another benefit (Blanchard 2018). Furthermore, from a gender perspective, biogas contributes to less cooking time for women, reduced walking of long distances to buy or collect firewood for women and children and attenuated back pain and other physical injuries from carrying heavy loads of firewood. The saved time is utilized for children's education and women can attend to other activities such as community development. There is also increased revenue from agricultural crops and biogas use also provides opportunities for the establishment of women's small-scale businesses such as sale of compost fertilizers and horticultural produce, among others (Warnars and Oppenoorth 2014).

With a judicious mix of approaches, solutions and technologies, the Netherlands Development Organization (SNV) works with public and private partners to empower rural and peri-urban communities to access cleaner cooking solutions. SNV is an international development organization that provides capacity development services to local institutions and organizations. Founded in the Netherlands in 1965, SNV has built a long-term, local presence in Asia, Africa and Latin America. SNV has been present in Kenya since 1967 and aligned with Kenya's Vision 2030, supports initiatives in three key sectors: agriculture; renewable energy; water, sanitation and hygiene. Under the renewable energy sector, SNV works to disseminate three renewable energy technologies to households in Kenya namely improved cookstoves (ICS), solar and biogas power. The three technologies aim at ending energy poverty and ensuring that everyone has access to clean modern energy services.

5.1.1 About the biogas initiative

SNV provides technical assistance to the Africa Biogas Partnership Programme (ABPP) supporting national programs on domestic biogas in Ethiopia, Kenya, Tanzania, Uganda and Burkina Faso (*http://www.africabiogas.org*). The ABPP's mission is to contribute to the achievement of the Sustainable Development Goals (SDGs) through the dissemination of domestic biodigester technology as a sustainable energy source for rural and peri-urban households through the development of a commercially viable market-oriented biodigester sector.

So far, the ABPP has trained 544 people (masons) in biogas construction technology in Kenya, with some of these masons now building sustainable biogas businesses across the country. Since inception in 2009, over 18,000 biodigesters have been installed across the country. The establishment of a further 30,000 biodigesters over the next three years is expected to be achieved through a market-oriented environment. A viable market-oriented biogas sector will thrive in a vibrant private sector with sufficient awareness of biogas, a team of biogas experts and an efficient quality control mechanism.

5.1.2 Methodology

This case study is based on SNV's introduction of biogas to farmers in Embu County, a coffee and tea producing area of highlands in Central Kenya. The case study approach as the preferred methodology was based on the need to obtain in-depth appreciation of the biodigester technology in its natural real-life context among the farmers concerned, especially women. The respondent was selected from the program database. The rationale for selection stipulated that the respondent must be a woman user, using both biogas and bioslurry for not more than five years. The data were collected through in-depth face-to-face interviews, observations, telephone interviews, review of the farmer's records and review of other biogas-related literature. This methodology ensured that in-depth work was undertaken in gathering relevant information on the role of biogas in improving livelihoods. However, it is important to note that other biogas users could be doing better than the selected respondent. Biodigester users tend to master the use of the technology and harness greater benefits over time so we therefore cannot claim to have followed the entire case to conclusion.

5.2 Farmer's Organization, Source of Capital and Maintenance of the Biodigesters

The installation of biodigesters in over 18,000 households by the ABPP in Kenya has led to empowerment of household women who can now engage in community projects due to time saved from former laborious chores. One such woman is Mrs. Dionesia Ireri from Embu County who is the chairlady of the New Kirimiri Coffee Farmers' Cooperative Society (CFCS). Dionesia is 70 years old and has nine children, two sons and seven daughters. Her children are all grown up and have families in major cities in Kenya. Dionesia acquired secondary-level education while her children have moved higher by acquiring degrees and diplomas from colleges and universities in Kenya. Dionesia's household comprises six grandchildren (four male and two female) aged between 10 and 21 of whom two are adults above 18 years (male and female) as well as two farm workers (male and female).

The New Kirimiri CFCS had an active membership of 1,085 members, as of November 2017, with 23% being female. Members' ages range from 35 to 85. The CFCS is run by a management committee of which Dionesia is the chairlady. The committee has nine members, two of whom are female. They are all literate and execute activities mandated by the annual general meeting (AGM), which is governed by a Supervisory Committee constituting three male members.

Leaders are elected democratically at the AGM every year. The chairlady has served two terms and hopes that she can earn a third term through her achievements. Dionesia is proud to have recruited another 15 female farmers to install biodigesters.

Funds for installing biodigesters: The CFCS gives cash advances to members to acquire the digesters; the cash advance is based on coffee cherry delivery to the CFCS (in kg [kilograms]). Seven farmers, two women and five men out of the 15 members of the CFCS who have installed the biodigesters, were given a cash advance of USD 0.15 kg^{-1}, which was later deducted at no interest from their payments for coffee cherries. The two women who are members of the CFCS received the money directly. Dionesia's motivation for incentivizing other farmers to install biodigesters was based on the savings she had made on income spent on energy and the bioslurry used on her farm. She considered the biodigester to be a home improvement innovation that every woman should have and embarked on her mission to empower her colleagues.

Dionesia aims to be the highest producer of coffee in her cooperative and, as such, lead by example. "In this male-dominated sector, a woman without actions cannot be heard," she indicated.

Technical support for the maintenance of biodigesters: Dionesia learned about biodigesters when her cooperative was incorporated into the Kenya Biogas Programme (KBP) and she adopted the technology by acquiring a 12 cubic meter digester in 2016. Dionesia, among other farmers in the CFCS, received training on bioslurry use, operation and maintenance of the digesters. In the first year of adoption, she received two aftersales service visits from the KBP (in the third and ninth months). She has access to the Client Support Centre for all biogas users which she can call toll free for support on the technology.

5.3 Role Sharing in the Installation and Management of the Home-based Biodigester

The raw material used in the biodigester is cow dung the disposal of which would be a challenge to farmers especially for those with many zero-grazed cows. Dionesia traps biogas for cooking from the dung produced by her zero-grazed four cows and six pigs. The dung which comes from the cowshed, already mixed with urine, is collected from the cowshed in a pit and fetched using a bucket (Figure 5.1 A). The dung is then mixed with rain-harvested water and at times with water from the nearby Kirimiri River at a ratio of 1:1; the mixture is fed into the digester through an inlet. Dionesia ensures that the mixture is consistent and no lumps or vegetative matter enter the digester (Figure 5.1 B). She understands that the inlet has to be clean to avoid blockages. She feeds the digester on a daily basis and has trained her household members on how to feed it. From her digester, the gas formed from the anaerobic digestion process in the unit is piped into the kitchen and is used for cooking (Figure 5.1 C). In biodigester operations, especially feeding the digester, women find it easy to feed and consistently check on the gas piping system at prescribed intervals. This could be due to their availability at the homestead and because they cook meals for the household. The biodigester is fed once a day with about 60 l (liters) of the dung: water mix and feeding ratios in the biodigesters are dependent on their size.

FIGURE 5.1. RAW DUNG PIT, FIXED DOME DIGESTER, BIOGAS COOKER

Source: SNV. **A**

Source: SNV. **B**

Source: SNV. **C**

Usually biodigester installation within the household is often approved by the husband because he is the owner of the homestead. The challenge with such a decision-making system in a household is that cooking is mainly carried out by women and hence enhancing cooking conditions may not be a priority to the spouse as the decision-maker. Furthermore, promotion, sensitization and marketing meetings are attended by men who most of the time do none of the cooking and hence may not understand the need to shift from cooking with biomass to using biogas. This problem can be addressed by employing a household approach while promoting biodigesters, if possible, holding such meetings with both men and women (this is important). The affordability of the biodigesters is a major hindering factor towards adoption by women because the cost of digesters remains unaffordable to many farmers. On average the cheapest digesters cost at least KES 70,000 (USD 700) which is not viable for many households. The KBP, in collaboration with SNV, has initiatives to address access to credit some of which include stimulating markets for wholesale financing to institutions for onward lending and triggering biogas credit product development in financial institutions through sensitization on biogas. Other initiatives include providing incentives for biogas credit to cushion institutions' transaction costs and attaching technical personnel to institutions to address any concerns that clients raise.

5.4 Benefits and Perceptions on Home-based Biogas Cooking Systems

Saves time: Dionesia says that she has managed to save time as she spends less time cooking since she acquired the biogas cooking system. She also saves time otherwise spent on fetching firewood. She has noticed that the men (husband and sons) in her household are now assisting with cooking. She thinks that their involvement could be because the process is easier, it allows for faster cooking and produces no soot so dirty hands are no longer a problem. Biogas stoves provide instant heat upon ignition, so no waiting is needed for fuel to suitably combust. There are many brands of biogas burners or stoves in the Kenya market, however a typical biogas stove usually needs a heat input of 1-2 kw and provides heat output of around 2-4 kw depending on the brand. There are locally manufactured stoves (*jua kali*) and modified liquid petroleum gas (LPG) stoves. The efficiency of the stoves depends on the manufacturers' specifications, number of cooking points and client usage. The general recommendation is to adhere to the manufacturers' specifications and regulate the burner's flow rate (reduce from high heat to low heat for simmering). Dionesia is highly satisfied with biogas which she also uses to cook all food types including that which takes longer to cook such as maize and beans (*githeri*) without worrying about the cost of energy, which is a common concern for users of LPG or charcoal.

Improves the kitchen environment and encourages men to participate in cooking: The other benefit that Dionesia has found to be very important is cooking in a smoke-free environment which she believes reduces her family's exposure to respiratory illnesses. She also states that cooking with biogas reduces the chances of burns generated by cooking with open fires. Dionesia has made a complete switch to biogas for cooking but still uses firewood/charcoal for heating, hence some soot on the kitchen walls and ceiling is unavoidable.

She thinks that women who have biodigesters have neat kitchens and are always punctual in attending cooperative meetings; also, they are not always pressed for time to run back to attend to their families. She believes that the use of biogas has improved relations in families and men are now helping with cooking, allowing more time for women to conduct community service. In such families, men find it easy to cook, which is not a common practice in the area, as cooking is smoke-free, soot-less and faster. The women using biogas units say they are safe enough for children to cook with but caution should be taken to avoid misuse.

Reduces household expenditure on cooking energy: Dionesia estimates that she saves at least KES 4,500 (USD 45) per month, otherwise spent on buying firewood/charcoal and LPG. She invests these savings in home and farm improvement, decisions made at her own discretion. Such savings are comparable to those reported by other biogas uses (Dohoo et al. 2013).

Bioslurry after biogas extraction is still available for crop production and feeding pigs: She is also happy that after extracting biogas she is still able to utilize bioslurry from the biodigester as organic fertilizer and to supplement animal feed. Bioslurry is the nutrient-rich liquid substrate discharged at the biodigester outlet after gas has been tapped for energy. It is composed of 93% water and 7% of dry matter (Warnars and Oppenoorth 2014). It contains nitrogen, phosphorus, potassium, zinc, iron, manganese, copper and other elements. Wet slurry is alkaline (pH 8.12), odorless and pathogen-free. Dionesia applies bioslurry directly and for composting. She uses bioslurry on coffee, bananas and vegetables. Dionesia has noted early flowering of her coffee shrubs and that the berries mature faster/earlier after applying bioslurry. She fondly refers to the biodigester as a fertilizer factory. She uses bioslurry to supplement pig feed and says that this has reduced the cost of feeding by 25%, making swine-raising more profitable. Dionesia started by introducing one bucket of slurry into pig feed and monitored the results. She then settled on mixing two parts of slurry to three parts of other feeding materials such as maize germ. The pigs like this combination and are less noisy. She has observed that the skin of the pigs is fairer and their rate of growth is faster after adding bioslurry into their feed. The bioslurry is also mixed with other feed for her chickens.

Her coffee farm has become a center of learning where other farmers come to learn about the benefits of bioslurry on coffee cultivation. She has opened up her farm for learning purposes because she would like to improve coffee production by members of the CFCS so that it becomes the leading cooperative in Embu County. Five other women have been convinced to install biodigesters by the learning center and the number is growing. When Dionesia compares her production over the years she estimates that her total coffee production has improved by 20%. She hopes to double production with sustained slurry application.

5.5 Challenges Faced in the Adoption of Biogas Household Cooking Systems

Some unscrupulous constructors (men) tend to make the technology sound very complicated so that this creates dependence on them for technical support by end users, especially women. Poor construction has also been noted resulting in suboptimal performance of the biodigesters. These challenges are addressed by the KBP through proper promotion and marketing, operation and maintenance training and free after sales services within 12 months after installation.

Biogas systems are expensive, which is a challenge for households that have a hard time accumulating the required capital. Other people also find the capital for initial installation of the biodigester to be high although the benefits accrued are worth it in the long term. The challenge of poor access to capital is addressed through a loaning facility that allows members of the CFCS access to money in advance, which is deducted from payments for their coffee cherries and no interest is charged.

One of the misconceptions about the technology is that the biogas production is not safe. This is not true as the cow dung is used to produce biogas and the gas production process is conducted in fixed structures (fixed domes) or tightly closed containers.

5.6 Conclusions and Recommendations to Enhance Gender Equity

The biogas cooking systems improve women's well-being by reducing the workload for collecting firewood and time spent in cooking. They also improve the kitchen environment as there is less smoke and soot formation on cooking pots, ceilings and walls of the kitchen. Such cleanliness and faster cooking capacity now encourages men to help women with cooking chores. This enhances the sharing of cooking roles. If a complete switch to biogas cannot be achieved there is a need to improve the efficiency of the three-stone open fire. This will allow families to continue enjoying the services provided by open fires while addressing high firewood consumption and health risks from smoke in the kitchen. The reduced time in cooking and collecting firewood frees up time for women to participate in other productive work such as attending community development meetings. Bioslurry is available for use as biofertilizer and pig feed after extraction of biogas. To enhance gender equity in the biodigester sector, there are many opportunities to build businesses to create employment for women. Such opportunities include training women as constructors or masons and to build their capacities to operate and maintain the digesters for a fee. Women can also be involved in the biodigester value chain by serving as dealers/suppliers of the appliance. Women can also be mobilizers, plant supervisors and extension service providers for a fee in the village. However, data need to be gathered on gender-differentiated impacts resulting from interventions for scaling up the system and resource mobilization.

There is a need to promote the technology as a home improvement technology rather than a cooking solution as the former approach might receive less attention by men who are the main decision-makers in households.

The initial cost of investing in the biodigester is too high and limits the adoption of the technology so there is a need for the development of greater credit facilities. Awareness-raising on the benefits of biogas needs to target men, as in most cases they are the ones who have access to credit facilities; by so doing they will enable their families to shift to cleaner cooking systems. Projects/programs supporting biogas adoption need to contribute to policies and guidelines for women's empowerment. This includes making budgetary allocations for such activities.

5.7 References

Biwas, J.; Chowdhury, R.; Bhattacharya, P. 2006. Kinetic studies of biogas generation using municipal waste as feed stock. *Enzyme and Microbial Technology* 38(3–4): 493–503.

Blanchard, R. 2018. An assessment of biogas as a domestic energy source in rural Kenya: Developing a sustainable business model. *Renewable Energy* 121.

Dohoo, C.; Van Leeuwen, J.; Read Guernsey, J.; Critchley, K.; Gibson, M. 2013. Impact of biogas digesters on wood utilisation and self-reported back pain for women living on rural Kenyan smallholder dairy farms. *Global Public Health* 8(2): 221–235.

GACC (Global Alliance for Clean Cookstoves). 2018. *Impact areas.* Available at: http://cleancookstoves.org/impact-areas/ (accessed on September 18, 2018).

Ndereba, P. 2013. Factors influencing the usage of biogas in Kenya: *A case of Ndaragwa Constituency, Nyandarua County.* Nairobi, Kenya: University of Nairobi. (Research project report).

Smith, J.U. 2012. *The potential of small-scale biogas digesters to alleviate poverty and improve long term sustainability of ecosystem services in sub-Saharan Africa.* Aberdeen, Scotland: University of Aberdeen, Institute of Biological and Environmental Science. (Project report).

Warnars, L.; Oppenoorth, H. 2014. *Bioslurry a supreme biofertilizer. A study on bioslurry results and uses.* Available at: https://hivos.org/sites/default/files/publications/bioslurry_a_supreme_fertiliser_a_study_on_bioslurry_results_and_uses.pdf (accessed on November 6, 2018).

WEC (World Energy Council). 2013. *World energy resources 2013 survey.* London, United Kingdom: WEC.

Acknowledgments

The authors acknowledge the financial support provided to the Kenya Biogas Program by the Ministry of Foreign Affairs of Netherlands Government (DGIS). The program management and technical support provided by Hivos and SNV-Netherlands Development Organization, respectively, is highly appreciated, and also are the advance cash payments to members for their coffee cherry by the New Kirimiri Coffee Farmers' Cooperative Society (CFCS), which helped farmers meet the costs of the installation of the biodigesters. Greatly appreciated, too, is the participation of Mrs Dionesia Ireri in the documentation of this case study.