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Biogas Technology Practices and Opportunities in Selected Districts of Hadiya Zone, Southern Ethiopia

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Abstract

Background: Rural households in Ethiopia are dependent on biomass for their energy needs and this exacerbates deforestation. Therefore, building small-scale biogas is one of the abating means of these challenges. The objective of this study was to assess the practices and opportunities of small-scale biogas technology in selected Districts' Hadiya zone, southern Ethiopia.

Methods: To achieve this objective, fifty-six informants were selected from the seven districts of Hadiya Zone, semi-structured questionnaires and field observations were used as the instruments to collect the data.

Result: This survey revealed that small-scale biogas technology in the study area is recent and it needs certain requirements for its construction and due to the stopped feeding, most of the biogas plants were non-functional. Despite this, the presence of many cattle and optimum climate are among the essential opportunities to expand biogas distribution in the study area. Therefore, farmers and the concerned stakeholders should use the available opportunity to maximize the distribution of biogas technology in the study area.

Key words: Biogas, Distribution, Opportunities, Practices.

Introduction

The majority of the Africa population lacks access to clean energy even though the continent is a net energy exporter (Amigun, 2012). Interim of fuel wood, biomass is the dominant energy source used in sub-Saharan Africa (SSA) including Ethiopia (Parawira, 2009).

In Ethiopia currently, due to the increasing price of imported oil, most Ethiopians remains on biomass fuels (Mshandete and Parawira, 2009). Moreover, it is estimated that 89.6% of the total energy consumption in Ethiopia is composed of conventional biomass fuels of which 10.4% come from modern energy sources (Mekonnen and Köhlin, 2008).

Most rural households in Ethiopia are highly dependent on biomass for their energy needs. Arthur *et al*. (2011) stated, with the increasing population pressure, the stress on firewood is increasing which causes deforestation, land degradation and loss of soil nutrients leading to food insecurity and energy crises. On the other hand, with the increasing shortage of ûre wood, households are turning to dung cakes and crop residues for energy. This new reliance creates additional environmental and food security problems as these residues are being used largely for energy purposes than being used as an organic fertilizer for crop production, which in the long run affects food security (Mekonnen and Köhlin, 2008).

In this regard, to abate the challenges of domestic energy and associated environmental and socio-economic problems, Ethiopia has launched the implementation of successive domestic biogas programs as National Biogas Program (NBPE) in 2008 (Amare, 2014). Biogas is produced from agriculture (animal farming) and household waste through an anaerobic digestion process at low temperatures and without air (Amare, 2014). At the start of the launching biogas program in Ethiopia, the distribution was very high whereas now a day its number is too few. Specifically, in Hadiya Zone, southern Ethiopia the operational small-scale biogas and its distribution is still relatively low compared to the huge potential of agricultural and domestic waste as raw material to biogas. Moreover, to resolve the problems associated with small-scale biogas and to fill the gaps yet no studies have been conducted in the study area.

Therefore, this study was designed with the objective of assessing Biogas Technology Practices and Opportunities in selected Districts of Hadiya Zone, Southern.

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Materials and Methods

Description of the study area

This study was conducted in 2019-20 at the selected districts of Hadiya Zone, Southern Ethiopia (Fig 1). It has thirteen districts and four cities administrative while its geographic location lies between 7°.22″ to 7°.45′00″ Latitude and 37°.40" to 38°.00' Longitude with an altitude range of 1271-2800 m.a.s.l. The mean annual rainfall varies between 1001 mm to 1200 mm and the mean annual temperature varies between 15°C and 20°C. It is bordered by Gurage Zone in the North, Kembata Tembaro Zone in the South, Yem special woreda and Oromia region in the West, Silte zone in the North East and Alaba special woreda in the East. According to the 2008 national census of Ethiopia, the total population of the Hadiya zone is 1,300,000. The average population density is 470 persons per kilometer square. The population is increasing at a rate of 2.6%/year. Wood fuel is the most important energy source for cooking and kerosene for lighting purposes. Charcoal burning is also an important economic activity in some parts of the zone. The high population density and the dependence on wood fuel as the major energy source are the cause of deforestation and other forms of environmental degradation in the zone. Hadiya zone is classified into three climatic zones: Dega or the highland (33%), *Weina Dega* or midland (50%) and *kola* or lowland (17%). The soil type of the area is loam soil. Types of crops grown in the area are wheat, bean, Enset, maize, coffee and pea.

Data collection

Hadiya zone has thirteen districts and four city administrations including the newly added districts and city administration. To collect the data, seven districts namely *Shashogo, Annalemmo, Misrak Badawaccho, soro, Gombora, Gibe* and *Lemmo* districts were selected purposively based on the existence of small-scale biogas plants. Fourteen kebele (peasant association) *i.e.* two peasant associations from each district were purposively selected based on which one has biogas plant and has no biogas plant. Moreover, 56 respondents that mean two-biogas user and two non-user farmers were selected from each peasant association, in addition to these, one energy office expert from each district were purposively selected as a key informant because they are knowledgeable and experienced in this specific sector. Gay and Airasian (2003) define purposive sampling as one which involves selecting a sample based on experiences or knowledge of the group to be sampled.

Data collection was done by using different methods depending on the specific objectives. To gather the appropriate and reliable data, this research has relied on both primary and secondary sources of data. The primary data is derived from the field surveys using questionnaires and key informant discussion. The questionnaires were self-constructed based on the study objectives and the questions. Additional investigation tools include field observations, especially on the use of biogas and bio-slurry at the farm level. The secondary data were also synthesized in Wachemo University from reports, journals, newsletters and electronic media.

Data analysis

The Quantitative data were subjected to the computer for analysis using Statistical Package for Social Sciences SPSS Version 11.5 computer package and Microsoft excel-2010. Moreover, tables and figures summarized the findings as appropriate.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

This survey revealed that only 29% of the sampled (56) households were female-headed while 71% were male-headed (Table 1). Most of the biogas users in the study area were male-headed households. It suggests that the accepting status of biogas technology of male-headed households was higher than that of the female-headed household in the study area. On the other hand, the majority of the respondents were over 40 years (89%). this indicates that there were no farmers under the age of 18 because most young people are migrating from rural areas to town

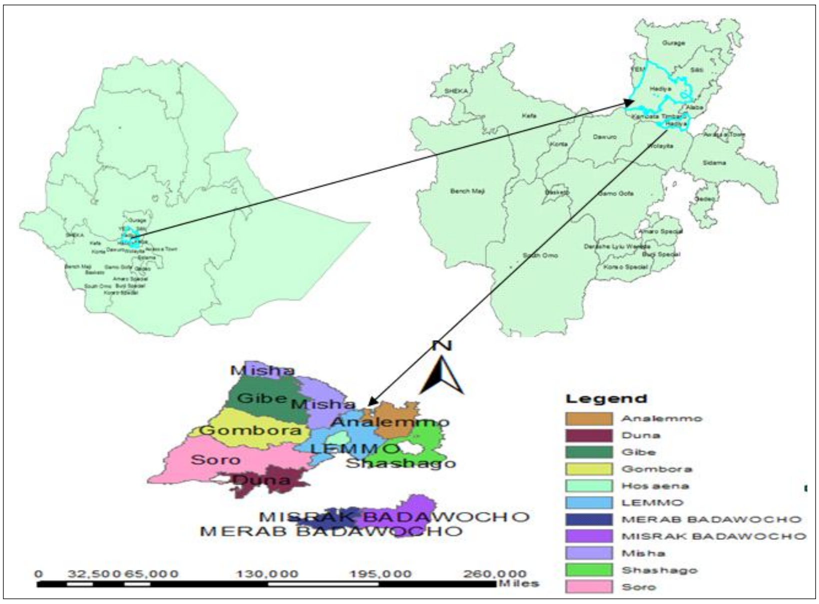

Fig 1: Map of the study area.

to get the daily payer job. Of the respondents, in the study area, 50% and 32% were attended primary and secondary school respectively (Table 1). Whereas a few numbers of farmers had a University degree. Accordingly, in a study carried out by Wakaje (2008) in Tanzania, the likelihood of receiving biogas energy increased with more years of formal education of the household head. This does not coincide with the results of this study.

Biogas practices in the study area

According to this survey, Small-scale Biogas technology in the study area is recent and it needs certain requirements for its installation. In this regard, respondents revealed that to construct a Biogas plant it must fulfill several requirements such as owning at least 6 cows/oxen, near access to water supply, sufficient area for biogas plant installment, access to construction materials (sand, crushed and dry stone) and physical capability to excavate the pit for a biogas plant, to mix-up the manure with water, to enter the manure and put out the slurry from the digester. This result suggests that the average cattle herd size used to produce sufficient quantities of cow dung to generate adequate amount of gas for both cooking and lighting while the other requirements are very essential to successful construction of the biogas plant. Similarly, insufficient dung (cattle number) often resulted in households abandoning the technology because of their inability of the biogas plants to generate adequate cooking energy (Gautam *et al*., 2009).

All types of biogas plant that constructed in the study area were fixed dome while their size was (6-10 m^3) which depended on the number of cattle and labor in the household level. In Uganda, the fixed dome and floating drums were the most preferred types of biogas digesters due to their longer life spans when compared to the plastic tubular design Walekhwa *et al*. (2009). Relative to the other district, the highest numbers of biogas plants were constructed in the Lemo district (Table 2). This is because of lemo district is located near to hosana town. Furthermore, the farmers in this district had access to information about biogas, construction material and the government's technical support. After all, the situations maximize the expansion of biogas in the Lemo district.

According to the field observation, the significant numbers (72.7%) of biogas plants in the study area were not functional (Table 2). The main reasons for the non-functionality of the biogas might be stopped feeding and poor quality of construction. So far, most of the biogas owners were non-willing to maintain their biogas plant because of feeding problems and others. The results of this study agrees with the research findings of Karanja and Kiruiro (2004), where 100% of the

Table 1: Social demographic characteristics of the sampled population.

	Characteristics	Frequency	Percentage
Gender	Male	40	71
	Female	16	29
Age	20-35	6	11
	35-50	32	57
	Over 50	18	32
Educational	Never had	6	11
Level	Primary	28	50
	Secondary	18	32
	Diploma	3	5.3
	University	1	1.7
Size of HH	2-3	2	3.5
	3-5	19	33.9
	>6	35	62.5

Table 2: The distribution of biogas in the study area.

Name of district	Number of biogas	Functional	Non-functional
Annalemo	16	6	10
Gibe	3	2	1
Gombora	8	3	5
Lemo	42	4	38
Misrak-badawacho	22	7	15
Soro	11	7	4
Shashogo	19	4	15
Total	121 (100%)	33 (27.3%)	88 (72.7%)

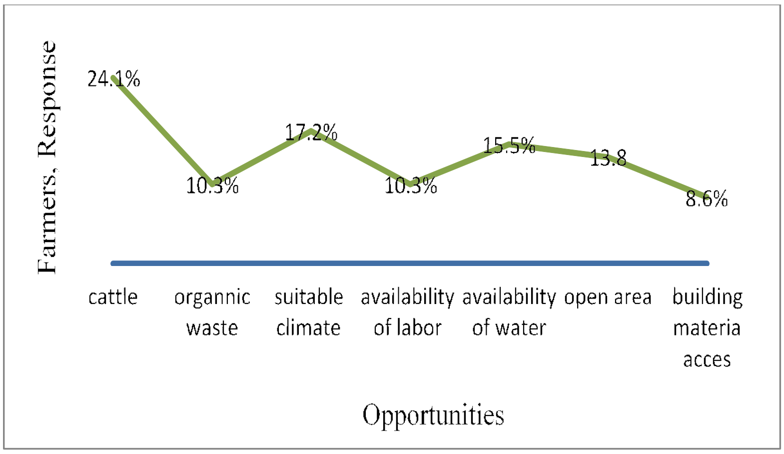

Fig 2: opportunities for biogas distribution in the study area.

respondents in Central Kenya Highlands reported, low quality in construction reduce the productivity and finally lead to cease operation of biogas plant. Moreover, the most challenging maintenance for the biogas users comprises removing sludge from the digester, blocking possible cracks in the fixed digesters and repairing damages Ferrer-Martí *et al.* (2018). Therefore, the installed digesters' functionality depends on continuous management and supervision of operation and maintenance Breitenmoser *et al*. (2019).

Opportunities of biogas in the study area

The data in (Fig 2) shows, the informants were revealed that there are many favorable opportunities for biogas expansion in the study area. Prominently, the identified opportunities by them were the presence of many cattle and organic wastes, the suitability of climate of the area, the availability of labor and nearby water, open area and access to building materials. Consequently, the result indicates all the distinguished opportunities are very important without any significant difference for biogas distribution because most of these are natural and available resources in the study area. Therefore, identification of prospects before and during the actual implementation of the different biogas development programmes could play remarkable role in mass dissemination of the domestic biogas digesters (Amigun, 2012).

CONCLUSION AND RECOMMENDATION

This study shows that Small-scale Biogas technology in hadiya zone is recent and there are several naturally available opportunities to expand its distribution in the study area. In this regard, the availability of organic waste, cattle, water, construction materials and suitable climate were considered as good opportunity for its construction. However, the previously constructed biogas digesters in the study area were poor in quality and most of them were non-functional. Consequently, the sustainability of biogas sector needs multi-stakeholder approach, which requires the active participation and support of governmental organizations, non-governmental organizations and community based organizations. Therefore, the farmers and other stakeholders should use these opportunities effectively to maximize the distribution of biogas in the study area while assist to recover the non-functional biogas plants by providing maintenance and creating awareness for those who stop cow dung feeding to the biogas plant.

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Conflict of interest: None.

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