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Examine of Status and Factors Influence Biogas Technology Adoption in Arsi Nagelle District, Central Rift Valley of Ethiopia

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ABSTRACT

In Ethiopia more than 93% population relies on traditional biomass fuels for cooking. This heavy dependency on biomass fuel leads to negative effect on social, economic and environment. For this reasons, the government has attempted to reduce dependence on biomass as a source of energy by promoting adoption of biogas technology since 2009. However, biogas technology adoption is underscored in the country. The purpose of this study thus, to examine current status and factors affecting household decision to biogas technology adoption in rural areas in Arsi Nagelle District, Central Rift Valley of Ethiopia. A sample of 279 households with 85 biogas adopters and 195 non-adopters were surveyed using simple random sampling techniques. The data were collected through individual interviews of households using a semi structured questionnaire. Descriptive statistics and a binary logistic regression model were to examine current status and identify determinant factors affecting the adoption of biogas technology. The results of the study shown majority of biogas digester were not give service due to feeding related problem (50%), technical (30.6) and others. The result also indicated education level, family size, and household income as well as access to credit, access of awareness creation and access of technician had significantly positive influence on the adoption of biogas technology. Therefore, government sectors, non-governments should emphasise on awareness creation and technical service support through training and equipped the beneficiaries. Micro finance enterprise should afford credit for initial investment costs for bio-digester installation, maintenance services and purchasing bio-digester spare parts.

Keywords: Biog-digester; Current status; Determinant factors; Renewable energy; Technology adoption; Central Ethiopia.

INTRODUCTION

Climate change has become one of the most complex environmental challenges facing the world in our century. The most increase temperature in global since the mid-20th century is very likely due to the increase in anthropogenic greenhouse gas concentrations (IPCC, 2013). Fossil fuels have been the major source of carbon concentrated global energy supply. Moreover, The heavy consumption of the fossil fuels from biomass-based energy have negative consequences on worsening health and environmental consequences by increasing greenhouse gases (Shrestha, 2010; Anand, S. et al., 2014). However, Biomass energy is the major source of primary energy for rural households of Africa. In most of the sub-Saharan African countries, more than 80% of biomass energy is used in the form of wood, agricultural residues and animal dung (Wawa, 2012).

In Ethiopia, the consumption of biomass fuel, including charcoal, firewood, agricultural residues and animal dung remains the main source of energy (Guta, 2020). More than 93% of the households in the country are also still dependent on biomass fuel for cooking, which surpasses 99% in rural areas (IEA, 2011; Gurmessa et al., 2012). Besides, the dependence on biomass energy is increasing the rate of deforestation and forest degradation in the country, due to much of the fuel wood comes from both natural forest and planted vegetation.

One of the means to reduce dependence on traditional use of biomass energy is to promote and supply energy efficient technologies for alternative energy sources such as biogas technology which is currently in wide use and being introduced in some areas in developing countries (IEA, 2011). Biogas production makes use of domestic resources such as agricultural crop wastes, animal wastes, and poultry as well as human excreta. Biogas production using existing domestic resources therefore has the potential to provide a number of benefits to rural communities (Amigun & Von Blottnitz, 2010). Several studies also revealed that Ethiopia has a huge potential such as cattle, land, availability of water and excess of labor (Alemayehu, G.,et al., 2014; Zebider, 2011; Asnake, 2008) which is suitable for production of biogas. Based on this, Biogas technology in Ethiopia has continuously been promoted by national and International Government and Non-Government (IEA, 2011). National Biogas Program (NBP) has planned 14,500 biogas plants for first phase (2009–2013) and the program has targeted to install 20,000 biogas plants for second phase (2014-2017) in 163 Districts including the study area. However, only 8,063 and 1762 biogas plants were installed in first phase and second phase respectively (EREDPC and SNV, 2008; Mengistu M, et al., 2016 ; Berhe TG, et al., 2017). This indicates that although its benefit is enormous and available potential resource, the rate of adoption of biogas technology is very limited and the vast majority of the population in country still depends on traditional energy systems. According to (Rogers, 1983) definition, Adoption of technology is a process that ranges from hearing about the technology, gathering information about the technology, developing interest, and evaluating attributes of the technology for making the eventual decision of either taking up or rejecting the technology. There are some factors influencing household decision to adoption biogas technology in rural area of the country.

A few research studies were conducted about factors that affect the transfer of household-level biogas technology. Factors that identified as main constraints for household decision to adopt biogas by some studies are income level, access to water, access to infrastructure, gender education level, heads of cattle, access to credit, distance to firewood sources the number of planted trees age, access to electricity (Eshete G, Sonder K, 2006; Mengistu M, et al., 2016 ; Berhe TG, et al., 2017, Shallo et al.,2020). However, none of the previous studies has considered the current status of biogas digesters and factors such as livestock managelemt system, off-farm activities, awareness creation activities, access to credit and access to technician as among those that might influence the adoption of biogas technology or not. Therefore, this finding examines status of biogas digesters and factors such as socio-economic, environmental, infrastructural and institutional that influence biogas adoption decisions in the Central Rift Valley of Ethiopia and provides recommendations for future advances in the biogas technology adoption.

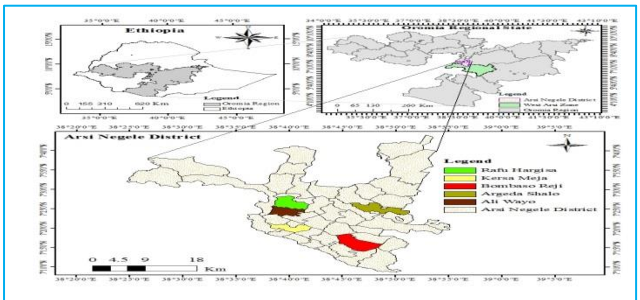
MATERIALS AND METHODS

Description of the study area

The study was conducted in Arsi Negele district, located in the southeastern part of the Ethiopian Great Rift Valley (7005'N to 70 45'N, 38005 'E to 38055' E; (Figure 1) approximately 225km south of Addis Ababa. The altitude ranges from 1500 to 2300m above sea level. The average yearly rainfall is between 500-1000mm, with a rainy season during March to September, and a relatively dry period from December to February. Average minimum and maximum temperatures are 10 and 25 C, respectively (ICRA., 2002).

The total population of the district is estimated to be 264,314 of which 80.2% of them live in rural (CSA., 2007). The livelihoods of people depend on subsistence mixed farming, which includes crop production and livestock husbandry. The major annual crops produced in area are wheat (Triticum sp.), maize (Zea mays), teff (Eragrostis tef), barley (Hordeum vulgare) and potato (Solanum tuberosum), and perennial crops includes sugarcane (Saccharum officinarum), Coffee Arabica, onion and Enset (Abate A., 2004). Biomass-based energy source such as firewood and charcoal are the domestic energy in study (Nejibe, 2008). Furthermore, Renewable energy like improved stove and biogas technologies has also been promoted in the area. Fixed dome model (local name- 'SINIDU') of biogas digester with different volumes including 6m2, 8m2 and 10m2 were installed in this study area.

Figure 5: Location map of the study area



DATA SOURCE AND SAMPLING PROCEDURES

In this study, multi-stage stratified sampling techniques were used to select sample kebeles and households. At the first stage, 5 rural kebeles, which have more biogas users than other kebeles, were purposively selected. Those kebeles are Bombaso Reji, Ali wayo, Rafu Hargisa, Qarsa Maja and Argeda Shaldo. In second stage, households in each of selected kebeles were stratified based on biogas technology adoption namely biogas users and biogas non-users. From each stratum, the sample households were selected using random sampling technique. This is done to reduce the biasness of respondents selected for the study.

The general formula developed by (Yamane, 1967) and (Israel, 2012) was used to determine the sample size of biogas users and biogas non-users households. The total sample size for this study were determined by using 93% confidence level and a ±7% level of precision (e). Accordingly, the sample size was determined using the following formula:

$$n = \frac{N}{1 + N(e)2} \quad (1)$$

Where "n" is the sample size, "N" is the population size (total household heads size), and "e" is the level of precision. Accordingly, 194 non-biogas user households and 85 biogas users' household, 279 households in total were considered in the study (Table 1).

Table1: Sample size and proportional distribution across study kebeles

S. no	Name of kebeles	Non-biogas adopter		Biogas adopters		Total sample household
		Total	sample selected	Total	sample selected	
1	Rafu Hargisa	713	35	25	14	50
2	Aliwayyo	871	43	35	20	63
3	Bambaso Reji	964	48	36	21	68
4	Qarsa Maja	599	30	19	11	41
5	Argeda Shaldo	780	39	32	19	57
Grand total		3927	194	147	85	279

The questionnaire survey was administered to collect cross sectional data on demographic and socio-economic characteristics of households; such as age, gender, educational status, family size, cattle holding, total land ownership and Off-farm activities. Data of environmental factors (availability of fuel wood and water resources), access to institutional supports (awareness creation and technical support) were also collected. Qualitative data were gathered from Key informant interview (involving district experts, Zone experts and NGOs involved in the energy program), and focus group decision based on a list of key themes drawn up from each kebelles. Each group involved 8-15 individuals from elders, women and youth from both biogas users and non-users who did not involve in household survey. Secondary data were also collected from published and unpublished research findings, official reports of government offices, and scientific journal papers and books.

METHOD OF DATA ANALYSIS AND MODEL SPECIFICATION

The data were presented and analysed by means of statistical techniques, principally descriptive statistics, such as mean values and percentages, as well as a binary logistic regression model using SPSS software package version 20. An independent sample t test and chi-square test were used to compare the difference between the mean values of the explanatory variables of the biogas user and non-biogas user households to determine whether the difference was significant or not. Moreover, a binary logistic regression model was applied to determine the underlying factors influencing the adoption of biogas technology.

Technology adoption is a binary decision on whether to have or not to have the biogas. Thus, a household is labelled as a biogas technology adopter if it has a bio-digester installation and non-adopter if it does not have a bio-digester installation for a biogas technology adoption. The dependent variable in this case is dummy variable, which take the value of one or zero depending on the biogas technology user. The following assumption was used:

$Y_i = 1$ if a household i owns a bio-digester
$Y_i = 0$ otherwise

Where Y denotes the dependent variable, that is, biogas technology adoption and Y takes a value of either 1 or 0.

VARIABLES REGRESSING ADOPTION OF BIOGAS TECHNOLOGY

The selection of explanatory variables that could affect households' decision to adopt biogas energy was based on the existing literatures and experience from field observations. According to (Whiteman, A.et al., 2002), an extensive amount of existing literature on adoption behavior agree the social, personal, economic and institutional factors that are key determinants of the adoption process. In this study, demographic, socioeconomic, and institutional characters were expected to be the key factors determining the household's decision to adopt biogas technology. Additionally, household's access to firewood and water supply were considered as major factors that could affect biogas adoption decision of rural households. Accordingly, a full list of selected explanatory variables as well as their descriptions and presumed influences on the adoption of biogas technology are summarized in Table 2.

Gender

Biogas technology is expected to lessen woman's workload particularly firewood collection task and hence it may more be adopted by women headed household than male headed household. Thus the effect of sex in biogas adoption is hypothesized to be indeterminate (Damte, A. and Koch, 2011). In Ethiopia, men dominantly control and make decisions regarding household access and ownerships to resources (Lim SS, Winter-Nelson A, 2007), and could, therefore, directly influence decisions in biogas technology adoption. Therefore, in this study, the gender of a household head was expected to have either a positive or a negative effect on biogas technology adoption.

Age

Older household heads are expected to have more resources like cattle and total land size ownership as compare to younger people (Sufdar, et al., 2013) hence potentially capable of adopting biogas technology. On the other hand, older may tend to be conservative in accepting new technologies than younger household (Walekhwa PN, Mugisha J, 2009). In this study, the age of the household head was expected to have a positive or a negative influence on the decision to adopt biogas technology.

Family Size

A large family often has a large number of working members and thus more labor for biogas operation and maintenance activities, and hence, the higher the probability of adopting biogas energy. Study conducted by (Walekhwa PN, Mugisha J, 2009) argued the above explanation that a larger family could apply a heavier load of dependence on the family resources to the extent that there are hardly any savings available for investment in biogas adoption decision. Therefore, in this study family size is expected to be negatively and positively related with household decision for adopting biogas technology.

Education

Evidence from various studies indicates that there is a positive relationship between the education level of the household head and the adoption of improved technologies (Lin, 1991 ; Riddell, W.C. and Song, 2012). Household head that have higher education can adopt technology than household head that do have lower education. Hence, in this study household head with higher levels of education expected to be positively related to biogas technology adoption.

Table 2: Explanatory variables and their hypothesized effect.

variable code	Type	Description & measurements	Expected sign
Gender	Dummy	Sex of the household head(male =1, female=0)	±
Age of hhh	Contin.	Age of household head (in year)	±
Family size	Contin.	Household size (total numbers of family in household)	±
Education level	Contin.	Formal education of household head in year	+
Cattle	Contin.	Total number of cattle owned by the household	+
Total income	Contin.	Total annual income of the household in Birr	+
Livestock mang.nt system	Dummy	Livestock managenet system (0=Zero grazing and 1= otherwise	±
OFF-Farm activities	Dummy	household engaged in off-farm (1 = engaged and 0= non-engaged)	+
access to credit	Dummy	Access of credit for household(access to credit =1, otherwise=0	+
Awareness	Dummy	Awareness of households towards bio-gas technology ("1"=for aware and "o"= otherwise)	+
Technician	Dummy	Availability of technician (1 = easily access and 0= otherwise)	+
Water	Dummy	Availability of reliable water to household (1= easily access of water and 0 =otherwise)	+
Fuel wood	Dummy	Availability of fuel wood to household (1= access of fuel wood and 0 =otherwise)	-

Number of cattle

Household head that owned a greater number of cattle have higher probability of adopting biogas technology than household head that have small numbers of cattle (Kabir H, et al., 2013). This is due to the nature of the technology where cattle ownership is a prerequisite to ensure availability of feed-stocks for operation of biogas plants. Thus, in this study, numbers of cattle is expected to be positively correlated to biogas adoption

Total income

Technology adoption is influenced by household income. Households with a higher income level are more likely to adopt biogas technology than their counterparts. Thus, household income was assumed to positively influence biogas technology adoption. Household income is thus expected to be positively correlated with the decision to adopt biogas technology.

Livestock mangent system

Most of Livestock management system in rural area of Ethiopia is out door grazing system which is difficult to harvest dung for biogas digesters. Therefore, livestock managyment system was expected to be either positive or negative influence household decition to adopt biogas technology in study area.

Off-farm activities

Households that have off-farm activities such as, petty trading, wage employment and other business for income generation, in addition to, farm activity could encourage household's decision for biogas technology adoption. Therefore, in this study, off-farm activities were expected to be positive influence household decision to biogas technology adoption.

Access to credit

Access to credit for bio- digester installation and for buy spar part is one factor that influences household decision to adopt biogas technology. In Ethiopia, the initial investment for bio-digester installation is unaffordable for a considerable number of rural households (SNV, 2017). Thus, households' access to credit was expected to positively influence biogas technology adoption.

Awareness creation

Several study observed that technology adoption is higher for individual having awareness than who had never access of awareness to new technology (Baidu F. J., 1999). Households those have awareness through training, workshop, demonstrate etc., on biogas technology could more adopt than households those never attend any awareness creation activities of biogas technology. So, in this study, awareness creation was supposed to have a positive influence on biogas technology adoption.

Availability of technical services

Due to lack of technicians new technologies can inappropriately adopt in rural areas. Study by (Nasery, 2012) found out that when people at the grassroots had access to technicians who provided maintenance services, many households able to adopt biogas and its production will be sustainable. Thus in this study, access of technical services was expected to positive influence biogas technology adoption.

Availability of water source

Since Water is one substrate for biogas production process where the access of water is available in area, the adoption of biogas technology is great (Wawa, 2012). The access of water is positively correlation with the adoption of biogas technology decision. Therefore, in study, it was hypothesized that the availability of water can positively influence biogas technology adoption.

Availability of fuel wood

Several literatures investigated that the access of fuel wood from open forest is found to be negatively correlation and statistically significant with the probability of fuel efficiency technology adoption. In other word, lack of fire wood in area may initiate household to adopt biogas technology (Troncoso, K.,et al., 2007). Therefore, in this study, availability of fuel wood was expected to be negatively correlate with household decision to biogas technology adoption.

RESULTS AND DISCUSSION

Profile of sample households

The mean and percentage values of the variables predicted to determine a household's decision to adopt biogas technology are computed and listed in Table 3. On average, Age, Education levels of household headed, total annual income of biogas adopters are greater than non-biogas adopters. Additionally, Family size and number od cattl held by biogas adopters are greater than non-biogas adopters (Table 3).

Table 3: Descriptive statistics for variables explaining the adoption of biogas technology.

Variable	Adopter(N=84)	Non-adopter (N=195)	t-test	Sig.
Age	44.8	42.2	-1.62	0.107
Education level	6.3	4.5	-3.54	0.000
Family size	7.6	7.2	-1.35	0.179
Number of Cattle	8.7	7.8	-1.43	0.153
Total Income (birr)	10875.8	7850.5	-5.54	0.006
			$\chi 2$ test	
Gander (%)				
Male	92.9	76.9	9.98	0.001
Female	7.1	23.1		
Access to credit (%)				
access to credit	90.8	22.5	153.35	0.001
Otherwise	9.2	77.5		
livestock mang.system %				
Zero Grazing	21.43	33.85	3.09	0.085
Otherwise	78.57	66.15		
Off-farm activities				
engaged	33.33	15.90	10.70	0.002
nen engaged	66.67	84.10		
Water availability (%)				
easily available	41.7	51.3	2.17	0.152
Otherwise	47.8	94.5		
Wood Availability (%)				
easily available	72.6	70.3	0.16	0.773
Otherwise	27.4	29.7		
Awareness creation (%)				
attended on	95.2	12.8	169.91	0.000
not attended on	4.8	87.2		
Technician availability (%)				
easily available	22.6	9.7	8.27	0.007
Otherwise	77.4	90.3		

Furthermore, The percent of biogas adopter household headed having access to credit, engaged off-farm activities, attended on biogas awareness and easily access technician was greater than non-biogas adopter of household headed. This shows that adopter households had better knowledge, easly access of technicial, engaged in off-farm activities, in addition of their regular farm activiets, for income generation and have more annual income for early adopt new technology than their corresponding households those do not have adequate knowledge, unaccess of technicial and insufficient annual income for their livelihood. On the other hand, biogas adopters were less followed zero grazing livestock management system non biogas adopters. This indicats that lovistock management system is not factors that influence biogas technology in study area.

The significant mean differences in education level, total income and access of credit between biogas adopter and non-adopter households (Table 3) were mostly corresponding with previous findings in Ethiopia and other countries (Mengistu M, et al., 2016 ;Uaiene, R.et al., 2009; Adeoti O,et al., 2000). In addition, numbers of household head having awareness about biogas technology and easily access of technician for biodigester installation as well as technical support for maintenance service was significantly higher for biogas adopters than non-adopters. This indicate that, rural households those do not get access of awareness creation such as, training, workshop and/or demonstration and technical support cannot easily adopt new technology.

Current Status of Biogas digester in study area

Majority of biogas adopters have biogas digester size of 6m3 (Table 4). This is basically expected that a family sized digester which can be run with small number of cattle as they can produce enough substrate for the digester.

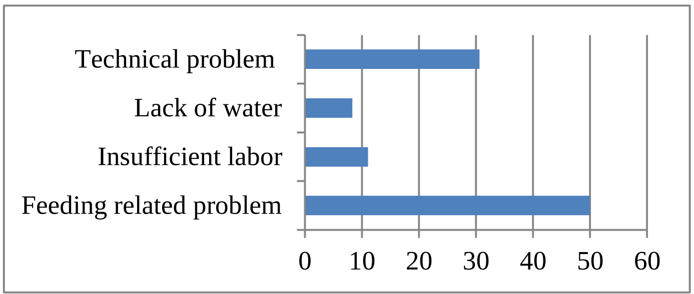
Table 4: size and Status of constructed biogas plants in the study area.

	Categories	Respondents N	Respondents %
Size of biogas plant	$6m^3$	56	66.67
	$8m^3$	21	25
	$10m^3$	7	8.3
	Total	84	100
production of biogas	Function	28	33.3
	Non function	56	66.7
	Total	36	100

The results from Table 4 further indicate that only 33.3% of biogas plants are in working condition. On the other hond, majorities of biogas digestrs instudy area are not give service in study area. Hence, low function of biogas could be attributed to other sources of energy such as charcoal and firewood for cooking and kerosene for light. Low function of biogas digesters are an indication of other factor influence biogas technology adoption in study area.

As account of respondents, the main reason for non-function of biogas digester was due to Feeding related problem. Results in figure 2 indicates that,50% of non-functioned biogas plants were due to lack of feedstock which is relation to the amounts of cattle and their management system. As previously mentioned in section, majority of respondents have been managing their cattle by outdoor grazing system(table 3). This management system can limit cattle dung spatially for small number of animals owned. This situation can influence the production of biogas digester directly.

Figure 2: Reason for non-function of biogas pants in study area.



The second main and very essential reason for non-functional biogas technology in study area is due to technical problem. Result in figure 2 revealed that, 30.6% biogas digester stopped their production is due to lack of technical service support. Biogas digester types in study area are fixed dome model (local name- 'SINIDU')which could be recommended only where construction can be supervised by experienced biogas technicians (Kauzeni et al., 1989); however, inversely technical services was reported by biogas users to be factor which impeded the functioning of biogas digester.

The lack of technical services in the study area was evidenced by either broken down biogas plants refer to (Plate 1) or incomplete biogas plants refer to (Plate 2) as shown in figure 3. this implies that new technology such as biogas need technical assistance frequently to check their performance and maintenance them; unless dissatisfaction of biogas adopters due to poor performance of biogas plants in the study area spread negative information about biogas technology, hence reduce an enhancement of technology adoption. This results are similar with findings reported by Bensah and Brew, (2010) who indicated that lack of skilled personnel in repair of biogas plants had led to most being abandoned and hence, los adoption.

Figure 3: biogas plant that has been abandoned due to lack of maintenance. Source: Photo taken during field observation.

Factors influencing biogas technology adoption

The estimated results of the binary logistic regression model indicated that the estimated values fit the observed data reasonably well. The LR $\chi2$ test was based on the assumption that at least one of the coefficients of the regression predictor was not equal to zero. The estimated LR $\chi2$ test value was 92.1, which indicated that the predictors' coefficients were different from 0. Furthermore, the complete model comprising the full number of predictors was found to be highly significant (Prob > $\chi2$ (DF = 11) = 223.989, p = 0.000), with a high Pseudo R2 value (69.9%). Measures of goodness-of-fit of the model results indicated that the independent variables were simultaneously related to the log odds of adoption. Moreover, the chosen independent variables correctly predicted households' biogas adoption conditions for the entire observed data.

Among the 13 explanatory variable identified, 6 variables had a significant influence on the household's decision to adopt biogas technology (Table 4). The Educational level of household head, total annual income of household, access to credit and awareness creation activity was highly significant variable influencing decision to adopt biogas technology ($p < 0.01$). Furthermore, access to technician was significant variables in influencing the decision to adopt biogas technology ($p < 0.05$), while family size of households did also significantly ($p < 0.1$) influence the decision to adopt biogas technology.

Table 4: Binary logistic regression model results for the factors affecting biogas technology adoption (Yi).

Adoption (Yi)	Odd ratio	standard error	Z value	P value
Constant	0.052	2.3	0.524	0.82
Gender of hhh(male=1)	0.064	0.879	-0.222	0.801
Age of hhh	0.205	0.031	0.014	0.651
Education of hhh	8.365	0.1	0.29	0.004
Family size of hhh	2.797	0.116	0.194	0.094
Total income of hhh	6.767	0.641	1.667	0.009
Credit access (available=1)	35.257	0.678	6.251	0.000
Cattle hold by hhh	2.047	0.054	0.077	0.152
livestock mang.system(otherwise=1)	0.207	0.659	-0.2995	0.649
Off-farm activity (engaged=1)	0.0639	0.0535	1.19	0.232
water(available=1)	1.511	0.592	-0.728	0.219
Fuel Wood(Otherwise=1)	0.752	0.761	-0.66	0.386
Awareness(never attended=1)	54.154	0.856	6.297	0.000
Technician(available=1)	4.544	0.849	1.809	0.033

On the other hand, gender, Age of household head, cattle held by household, water availabilities and fuel wood availabilities were statistically non-significance ($p>0.1$) (Table 3). These results highlight that the household's socio-economic characteristics and institutional activities could be a real source of information on the reasons why households decide whether to adopt biogas technology or not.

Education level of household head

The results of the logistic regression analysis specified a positive correlation between the educational level of household heads and the decision of adopting biogas technology (Table 4). Accordingly, the probability of biogas technology adoption increases by a factor of 8.365 with a one-year increase in the educational level of household heads. Moreover, there was a significant ($p < 0.01$) mean difference of the education level between adopter and non-adopter households of biogas technology (Table 4). This indicates that Household heads with a higher education level have better ability to adopt a technology than their counterparts. On the other hand, households with no or low formal education did not adopt biogas technology. Similar findings were reported on the positive relationship between education and adoption of new technologies (Guta, 2020 ; Kabir H, et al., 2013; Riddell, W.C. and Song, 2012 ; Hilawi, 2014). This shows that an increase in an educational level might possibly increase the ability of households to use available information in decision-making to adopt biogas technology.Thus, at study are, education level of the house head is one of the major factors of households' influence to adopt biogas technology.

Family size

The logistic regression result revealed that there was significant ($p< 0.1$) positively association between family size and the adoption of biogas technology (Table 4). When the family size increase by one, the likelihood of households to adopt biogas technology increase by a factor of 2.797.This indicates that the number of family size is one factor influence biogas technology adoption in this study area. This study is lined with the findings of (Walekhwa PN, Mugisha J, 2009) who indicated that house-hold size and biogas adoption have significantly positive inter-relationship. However, this study was contrast with finding with (Kabir H, et al., 2013), where household size is negative relation with biogas adoption.

Total income of household

The result of logistics regression revealed that there was highly significant ($P<0.01$) different between total income of biogas adopters and non-biogas adopters. Furthermore, Total annual income of household is positively correlated with biogas technology. Accordingly, an increase household annual income level by 1.00birr was found the likelihood of biogas technology adoption increase by a factor of 5.602 (table 4). Thus household's income was found to be the other key factors affecting the adoption of biogas technology in study area. This indicates that annual income is one factor that influences household decision to adopt new technology in rural area.

More annual income might provide more economic capacity for a biogas digester installation and for buying spare parts for maintaining an installed biogas digester operational. This finding is consistent with the findings of (Mwirigi JW,et al., 2009; Walekhwa PN, Mugisha J, 2009 ; Kabir H, et al., 2013)that a household income level has a positive influence on the household's decision of biogas technology adoption in Kenya, Uganda, and Bangladesh.

Access to credit

The result of logistic regression revealed that Access to credit had significantly ($p < 0.01$) and positively influenced biogas technology adoption (Table 4). Having access to credit by households increased the probability of biogas technology adoption by a factor of 35.257compared to their counterparts. This indicated that access to credit is a key factor in enhancing the rural households particularly, poor households' affordability of biogas technology adoption. These findings are supported by previous studies conducted by (Mengistu M, et al., 2016; Berhe TG, et al., 2017), which described the existence of a significant positive relationship between access to credit and biogas technology adoption. Therefore, access to credit services is an important variable in biogas technology adoption.

Awareness creation on biogas technology

Economic theory predicts a positive association between adoption of new technology and Awareness creation activities such as training, workshop, seminar and demonstration. Results in table 4 also revealed that the coefficient on biogas awareness is highly significant ($p<0.01$) positively related with biogas technology adoption. Furthermore, the logistic regression revealed that the probability of adopting biogas technology is increased by 54.154 with increase of awareness creation activity level by one. This result indicated that households who have an opportunity to attend on awareness creation activities such as training, workshop, seminar and/or demonstration are more likely adopt technology than household who never attended on such awareness creation activities. This result was in line with other finding by (Rogers, 1983) who reported that, awareness is just the first stage of adoption process, and it has to be followed by accumulation of knowledge which in turn induces the perception of people on new technology. The key informants and focus group discussion also reported that there exists a lack of promotion activities for enhance biogas technology adoption in the district. Focus group discussion also revealed that due to lack of awareness creation activities in study area, some households have poor attitude towards biogas digester. Hence, shortages of awareness creation activities are one of the main factors that influence biogas technology adoption in study area.

Technician availability

Availability of technician is expected of factor influencing biogas technology adoption. This study revealed that access of technician was statistically significant ($p<0.05$) and positively correlated with biogas technology adoption (Table 24). Moreover, the result of logistic revealed that, the probability of household decision to adopt biogas technology increase by 4.544 with one level increase of technician for technical service. The result indicates that many households might adopt biogas technology when access technician for bio digester installation and affording technical service for maintenance found around them. This result in line with findings by (Nasery, 2012) who indicates households with access to technical support services were more likely to adopt biogas technology than those do not have access technician. Focus group discussants also confirmed the presence of non-functioning and poorly functioning bio-digesters of those adopting households, lack technician in district even to operate and maintain bio-digesters. These challenges have constrained the proper functioning of bio-digesters, and because of this, some non-adopters in the study, have resisted adopting the biogas technology.

CONCLUSION AND RECOMMENDATION

Biogas technology is help to reduce burden on forest by replace biomass fuel consumption though its adoption in Ethiopia is at low levels. The main purpose of this study is to identify the factors affecting biogas technology adoption in rural areas in Arsi Nagelle district, Central Rift Valley of Ethiopia. Simple disciptive statistics was used to analysis demographic and socio-economic characteristics of respondents, current status of biogas technology as well as Binary logistic regression model was used to analyze the household's adoption behavior toward biogas technology.

majorities of biogas digestrs in study area are not give service due to the main reason of feeding resource related problem and lack of technicial. The main factors identified as positively significant affect household's decision to adopt biogas technology are, education level, family size, total annual income of household, access to credit, promotion methods through awareness creation activities and access of technical service. As the level of educated increase, understandings of household towards technology can be increased and have more interest to adopt new technologies like biogas. Concerning the initial investments required, total income of household or access to credit in rural area is key factors to bio-digester installation and for purchasing spare parts for maintenance. Thus, initial investment cost should be considered for enhancement of biogas technology adoption rural area. On the other hand, lack of awareness creation activities such as training, demonstration, etc., is discourage households towards new technology. Furthermore, lack of technician around them in the main factors affecting household decision to adopt new technology. Technical support service is a vital point for bio-digester installation and technical support during.

Thus, to overcome those obstacles of the adoption of biogas technology, integrated sectors in all levels particularly, energy sectors with forestry sector, Agricultural sectors, livestock sector, non-government organizations, private enterprises, research institutes and farmers need for an outstanding re-consideration to enhance a household's decision to adopt biogas technology and get multiple benefits of the technology. Furthermore, training of local masons and technicians and sufficiently equip them to ensure availability of maintenance and repair services within a reasonable radius without excessive costs and delay should be considered by Stakeholders. Economics attributes of households, spatially, rural households are more sensitive to higher costs since most households have very weak financial capacity to buy relatively expensive technology accessory and may hinder them from adopting, so that, access to credit should be arranged for rural households by micro finance or other stakeholders.

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