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Socio - Economic and Environmental Impact of Household Biogas Technology Built in Rural Areas of Yilmana Densa Woreda of West Gojjam in Amhara National Region state, Ethiopia

Mulugojam Wondyfraw
Lecturer, Department of Geography and Environmental Studies, Bahir Dar University, Bahir Dar, Ethiopia.

Abstract
Ethiopia has set goal to install 14,000 domestic biogas plants to achieve the growth and transformation plan. The major constraint of rural development in the country is lack of efficient and affordable energy technology and low level of crop production. Therefore, the objective of this study is assessing the socio-economic and environmental benefits of households (HHs) biogas technology and its contribution to crop production. Basic data was collected using structured and semi-structured questionnaires from HHs, extension agents and energy experts. Additionally, interview and focus group discussion were conducted with key informants and HHs for triangulation purpose. The study was carried out by surveying 50 HHs taken from 8 Kebele of Yilmana Densa woreda which is purposively selected whose biogas plant has already started production, 2 key informants and 2 energy experts. According to the result of the study 97% of the respondents revealed that biogas provides social benefits (health and sanitation, education, job opportunity, gender benefits, costs), economic benefits (reduced use of fuel wood, agricultural residue, dung cake, kerosene, chemical fertilizer, provision of organic fertilizer, opportunity of employment and income generation) are mentioned by the biogas users and participants. Moreover, biogas reduces deforestation, natural hazards and enhancing crop production using bioslurry that contributes to food security and environmental protection. 87% of HHs used slurry directly as organic fertilizer while the remaining 13% HHs used both composted slurry and slurry form. As a result, the households have saved 6838ETB per HH per year that costs for chemical fertilizers and fuel.

Key words: *Biogas technology, bioslurry, Scio-economic and Environmental benefit*

Introduction

Commenced in 2008 the National Biogas Program (NBP) in Ethiopia has set the goal to install 14,000 domestic biogas plants within a five year period to achieve the growth and transformation plan. The main objective of the NBP is to improve the quality of life and the livelihood of rural households by replacing unsustainable utilization of charcoal and wood fuel to increase agricultural output by utilizing slurry as organic fertilizer. The role of the Netherland development organization (SNV) is to support the NBP to develop the capacity of biogas sector (Boers et al. 2008). The natural resource base is very important to the survival of the people in Ethiopia. However, these resources are under intense pressure due to population growth, inappropriate farming and management practices. Small-scale farmers, who depend on these resources also face severe constraints due to continued cultivation, overgrazing and deforestation, soil erosion and soil fertility decline, and scarcity of water, livestock feed and fuel wood shortage. These factors often interact with one another and lead to food insecurity and environmental degradation (Markos, 1997).

Ethiopia has been experiencing severe land degradation problems that are originate from the demands of the growing human and livestock populations. Soil fertility loss resulting from soil degradation is widespread in Ethiopia. This situation not only undermines the agricultural production capacity but also threatens the ecological sustainability of a locality (FAO, 1986). Hence, households use a significant quantity of dung& crop residues as an important source of domestic fuel instead of using it as manure that causes a decline in soil fertility and deterioration in soil structure particularly in the northern part of the country (Mekonen& Kohlin, 2008, World Bank, 2006). For maintaining crop productivity, fertilizers play an important role and farmers in developing countries like Ethiopia are in shocking need of using it. However, many farmers continue to burn potentially valuable animal dung and crop residues which are raw materials for natural fertilizers. On the other hand the cost of chemical fertilizers is another additional problem faced the rural poor households.

In Amhara region the situation is worse since all the farmers have been used inorganic fertilizer for teffe, wheat and maize production until now. However, the available nitrogen, potassium and phosphorus in the form of organic materials is around eight times as high as the quantity of chemical fertilizers actually consumed in developing countries (UNESCAP, 2007). In the early 1984, the World Bank warned that there will be decrease in agricultural productivity in Ethiopia. This is due to the use of agricultural residues for energy purpose rather than using them as manure. In addition to the unaffordable cost of chemical fertilizer, repeated use of chemical fertilizer has also its own effect in environment and contributes to raise the global GHG emission (UNDP, 2009).

Biogas originates in the process of biodegradation of organic material under anaerobic conditions. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Methanogens (methane producing bacteria) are the last link in a chain of micro-organisms, which degrade organic material and return the decomposed products to the environment. Biogas tends to occur naturally wherever high concentrations of wet organic matter accumulate in the absence of dissolved oxygen, most commonly in the bottom sediments of lakes and ponds, in swamps, peat bogs, intestines of animals, and in the anaerobic interiors of landfill sites. The most prominent constituent of biogas is methane (55%-70%) followed by carbon dioxide (30%-45%), and trace levels of other gases such as hydrogen, carbon monoxide, nitrogen, oxygen and hydrogen sulfide. It is a Methane rich gas produced by anaerobic fermentation of organic material, is distinct from alternative renewable energy sources such as solar, wind, geothermal and hydro energy because of its importance in using waste materials (Amigun & Blottnitz, 2007). Production of biogas through anaerobic digestion (AD) is relatively simple carbon reducing technology that can be implemented at commercial, village and household levels. It allows for the controlled management of large amounts of animal dung and the safe production of gas for cooking, lighting or power generation (Amigun & Blottnitz, 2007). One of the main advantages of biogas production is its ability to transform waste material into a valuable resource using as substrate for AD (Al Seadi et al., 2008). Biogas technology is attractive because it combines cleanliness with the conversion of the animal-dung, vegetables and tree residues into high-quality organic fertilizer and clean fuel. Besides, it shows possibility to stop environmental damage resulting from deforestation caused by indiscriminate cutting of trees and burning of wood as fuel for cooking and heating (Qurashi & Hussain, 2005). The main livelihood of the population in the study area is agriculture. Agricultural productivity reduction resulting from deterioration of soil fertility is common in the study area. Despite high number of livestock and potential to adopt the biogas technology, utilization of bioslurry as best substitution for chemical fertilizer to increase crop production is given little attention and it is not well known by communities.

Energy is a means for performing activities. For the humanity, energy is a vital component for development. There are two types of energy sources in the world such as conventional energy sources and non-conventional energy sources. Conventional energy is obtained from a static storage such as fossil fuels, nuclear reactions and coal. It remains static bound in position until it is released by human actions. These are finite and non renewable. On the other hand, non-conventional energy also called renewable sources of energy is obtained from natural sources (Solar energy, wind energy, geo-thermal energy and biogas energy).They are pro-rural, decentralized, infinite, locally available and safe with environment. There are several factors that drive researchers to search alternative forms of energy. To name a few of those factors are the oil crisis of the 1970s, the depletion of fossil fuel, problems of pollution and GHG emissions. The key concerns of alternative energy sources preference were its renewability, safe, locally specific, cheap, decentralized and appropriateness. Therefore, biogas is the most promising source of alternative energy to come across the abovementioned problems.

Ethiopia has one of the lowest rates of fertilizer user and lack of efficient and affordable energy technology. Due to the same reason in the study area, more than 99.5% of HHs are traditional biomass energy users collected from cow dung cakes, wood and agricultural residues instead of using it as a manure whereas the remaining 0.5% use biogas, wood and charcoal as a domestic fuel. For maintaining crop productivity, adopting biogas technology plays an important role to provide basic energy needs in an effective manner and to use bio slurry as a substitute of chemical fertilizer for rural people where the majority of farmers are living in subsistence level. In addition to this, unaffordability cost of chemical fertilizer and repeated use of fertilizer affects the environment and increase GHG emission. Therefore, the overall objective of this study is to assess the socio-economic and environmental contribution of rural household's biogas technology in Yilmana Densa woreda of ANRS, Ethiopia. In order to achieve the aforementioned general objectives, this research was targeted to answer the following questions:

a. What are the social, economic and environmental benefits of adopting biogas technology in Yilmana Densa woreda?
b. How bio slurry used as potential source of organic fertilizer in the study area?
c. How is the farmers' perception and attitude about the use of bioslurry to substitute inorganic fertilizer in the study areas?
d. What are the challenges to adopting the biogas technology in the study area?

Materials and Methods

Methods of Data Collection

In order to acquire the best result, the researcher was used the way of triangulation. A combination of both qualitative as well as quantitative method was employed in this research. While more emphasis was given to the quantitative method, qualitative analysis was also used as supplementary to the former approach. Moreover, using both methods help to strengthen triangulation of information that in turn increases the validity of research, enhancing trustworthiness and reducing biases.

Sources of Data

The data sources for the study were both primary and secondary. Primary data was collected from the households, extension agents, key informants and woreda energy experts through questioner, interview and focus group discussion. In addition to the primary data source, secondary data was used from literature, yearly report and other sources based on its necessity.

Methods and Techniques of sampling

The National household biogas program is implemented in six zones in Amhara region. From the Amhara Region zones, Yilmana Densa woreda from west Gojjam zone was selected purposively. Yilmana Densa Woreda has 33 rural kebeles who are beneficiaries of the NBP and three kebeles in Adet town with a total of 36 kebeles. From these 33 kebeles 8 kebeles and from the 8 kebeles 50HHs were selected purposively due to their academic background. Moreover, 2 key informants and 2 woreda energy experts were selected randomly.

Methods of data analysis

Both qualitative and quantitative methods were employed to conduct the study. The qualitative data which is obtained from review of secondary data, review of internal documents and focus group discussions was analyzed by using qualitative methods. Quantitative data which is obtained from a questionnaire & interview was analyzed by using quantitative techniques. From the quantitative methods descriptive techniques was used in the study.

Results and discussion

Demographic Situation of Respondents

The number of respondents used for questionnaire, interview and focus group discussion in this study were 50 HHs who have a biogas plant, 2 key informants and 2 woreda energy expert with a total of 54 participants. The results obtained showed that 30(56%) of respondents were male and the remaining 24(44%) were female.

With respect to gender, respondents indicated that it is not a matter of being male or female to adopt the technology but it is a matter of having enough family labor force, interest, biogas focus educational training and financial capacity. Therefore, adoption of the biogas technology may not affected by sex difference as shown in the figure 1.

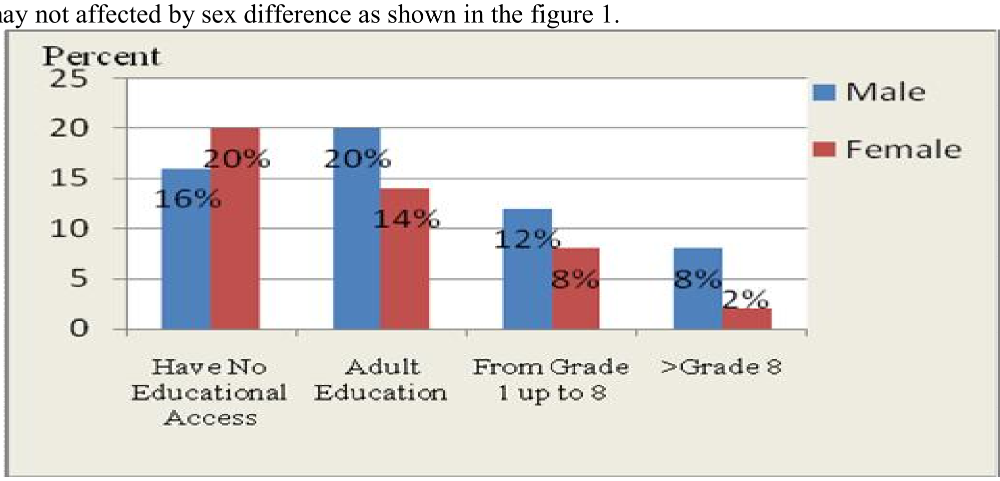

Fig. 1. Educational background of the biogas owners in number and percent

Family size

Biogas owners in the study area have enough labor force to do the activities related to biogas plants.

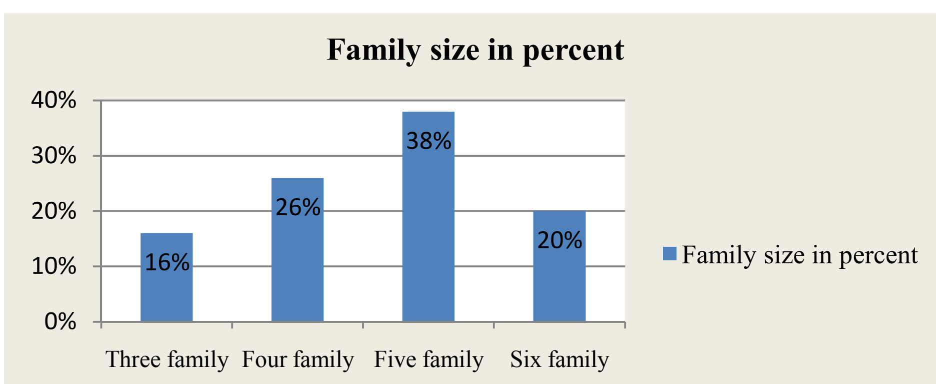

Fig 2. Family sizes of the biogas plant owners

As shown in (Figure 2), 16% of the respondents have family size of 3, 26% of the respondents have a family size of 4, 38% of the respondents have a family size of 5 and the rest of respondents (20 %) have a family size of 6. Generally, it can be understood that almost all the biogas owners have enough labor force to facilitate the activities to utilize the bioslurry and other maintenance works by considering three as minimum required family size. The results are in line with the study made by UNESCAP (2007). According to the biogas plant owners, family labor has a great contribution starting from installation up to utilization of bioslurry. Labor force for digging and other additional activities during construction of the structure is covered by family members. In addition to the above, feeding of cattle dung to the digester, transporting of the composted slurry and slurry from collection pit to the farm land is done by family members and requires huge labor force.

Environmental Benefits of Biogas Technology
Biogas technologies have contributed significantly to improve the local, national and global environment.

Locally: From a local perspective, the use of biogas has significantly improved the indoor air quality of homes employing biogas stoves in place of traditional three fire stoves. In addition, installation of biogas systems has resulted in better management and disposal of animal dung (Bajgain and Shakya, 2005). Similarly, 87% of the respondents in the study area confirmed that their home becomes free of smoke released from burning of dung cakes, fuel wood, agricultural residue and kerosene.

Nationally: From a national perspective, biogas reduces deforestation. This in turn has important implications for watershed management and soil erosion. In addition, biogas where the slurry is collected and returned to fields has enhanced soil nutrients. Similar to the above mentioned idea, biogas adoption in the study area can contribute to the national environmental protection since there is reduction in fuel wood consumption which implies reduction in forest degradation.

Globally: Biogas fuel helps to reduce greenhouse gas emissions due to consumption of fuel wood, dung cake, agricultural residue and kerosene for cooking and lighting purpose. Through biogas technology in sustainable basis assures the CO_2 associated with biogas combustion to be reabsorbed in the process of photosynthesis. All the CH_4 and CO_2 emissions that are associated with the combustion of fuel wood, dung cake, agricultural residue and kerosene can be reduced when replaced by a biogas (Bajgain and Shakya, 2005). Similarly, using biogas technology in the study area may contribute in reducing the greenhouse gas that will be emitted to the air since consumption of kerosene and fuel wood in the study area was reduced. In addition to this, the methane gas that was emitted from dung will be reduced after entering in to the biogas system.

Social Benefits of Biogas Technology
Health and sanitation benefits
Smoke is one of the major causes for acute respiratory infections among women, infants and children (Pandey, 2003). According to the respondent's response, the use of biogas significantly improves the indoor air quality. Since in Ethiopia women and female children are mostly involved in cooking purpose, they are the first beneficiaries of biogas technology to improve their health conditions. All of the respondents (100%) mentioned that since the combustion of biogas is relatively clean, it reduces eye illness, headache, cough associated with smoke from fuel wood and dung cake using traditional three fire stoves. In addition, cattle dung management using biogas digesters lead to better hygienic conditions & helps to keep the areas of HHs clean & reduces the chances for the spread of infectious and other diseases.

Educational benefits
In the study area, adoption of biogas technology has positive impact on education. According to the biogas users, key informants, woreda energy experts and focus group discussion responses, the time saved due to having biogas has enabled female children to attend school, which previously was not possible as they were involved in household daily work as well as collection of fuel wood and cattle dung cakes. The result obtained shows; the family's are motivated to send their child to school and children's have enough time to study in their home those who have biogas plant than who have not a biogas plant. According to the analysis, 95% of the students who have biogas in their home have developed better interest to come to school, reading and studying longer hours compared with those who do not have biogas plant since biogas is free of smoke. Whereas the remaining 2%& 3% of the respondents said that biogas have no advantage for education and no change whether a biogas plant is implemented or not respectively (figure 3).

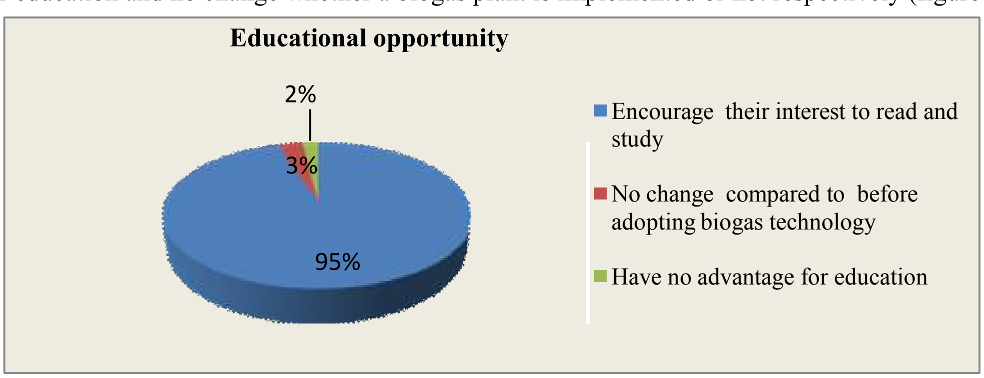

Fig 3: Educational opportunity of the respondents.

a) Biogas for lighting

b) kerosene for lighting

Fig 4. Photos that Light Comparison of biogas and kerosene lighting for educational opportunity

Job opportunity

Production of biogas from AD requires labor for manufacture of technical equipment, construction, operation and maintenance of biogas plants (Bensah and Brew-Hammond, 2010). Similarly, according to the discussion made with the focus group and information gained from key informants in the study area, some farmers got job opportunity particularly in time of construction of the biogas plant and transportation of raw material for construction. This is mostly related with plastering, transportation of cement and other necessary materials, filling concrete and biogas pipe installation. There was also additional job opportunity in time of maintenance incase the structure is damaged and the pipe stop working properly since it requires skilled manpower.

Gender benefits and costs

The biogas systems have been able to meet both practical and strategic gender needs. Women and female-children were responsible for preparing and processing of food and working in the kitchen. According to the information obtained through questionnaire and interview, 96.3% of the respondents showed that the work burden of mother and their female children's have reduced and child gets educational opportunity like their male peers. In order to confirm the reliability of information collected from respondents, discussion was made with the focus group and key informants in the study area also approved that biogas have provided a direct benefit to the women and female children by reducing the hard work and danger to personal safety related with get hold of fuel wood, agricultural residue and dung cakes. Moreover, the biogas users also mentioned that biogas technology saves time spent for cooking meals and collecting fuel wood, agricultural residue, dung cakes and chopping them into smaller sizes. As a result of friendly nature and simple to ignite biogas stoves, the male members of the family are changing the attitude and increasingly engaged in cooking activities observed in the study area. The results obtained in this study are in agreement with the study made by Britti and Kapoor (1994) who observed in lesser extent in time required for cleaning cooking utensils, saving labor and the kitchen was increasingly used as a drawing or family room because it was free from smoke exposure and was better lighted.

Economic Benefits of Biogas Technology

Reduced use of fuel wood, agricultural residues and cattle dung cakes

The use of biogas directly related to the fuel consumption of households. According to the result point of view as shown in (Table 1), 90% of fuel consumption(wood, agricultural residue, dung cake) has decreased especially for cooking "wet", and boiling of (potato, maize, peas, beans) and 100% of fuel (wood, agricultural residue, dung cake) consumption has decreased for coffee preparation. However, there is no significant change in consumption of fuel for baking "enjera" and bread. As a result, the respondents were used wood and agricultural residue for baking injera which is the most common food in Ethiopia and bread. As we have seen from table 1, 60% of HHs were used fuel wood and 40% of them were used agricultural residue for cooking injera and bread because the biogas is not used for such cooking purpose since it needs its own mitad design . Mitad is an oval shape used for baking injera and bread.

The biogas users in the study area mentioned that the decrease in fuel consumption has three principal benefits. First, it provides a financial gain for households by reducing the escalating cost of kerosene for lighting and fuel wood for cooking. Secondly, it reduces health costs by drastically improving indoor air quality since methane has smoke free fuel. Thirdly, it contributes significantly to reduce GHG emissions which are resulted from burning of less quality fuel (wood, agricultural residue, dung cake) using traditional stoves and kerosene for lighting purpose. This is because the hazardous gas methane is used as source of fuel rather than emitted to the air freely. Therefore, after adoption of biogas technology the biogas users have started using both biogas and agricultural residue as source of energy. This shows most of the biogas plant owners are shifting from using fuel wood, agricultural residues and cattle dung cakes as major source of fuel to using biogas (Table 1). Additionally, using biogas as a source of fuel has promoted financial capacity of the users. As in table 3 displayed, the biogas users have gained an annual saving of 12 bundle (300kg) of fuel wood or 2520 Birr.

Moreover, 100% of the HH stopped consuming agricultural residue as a source of fuel for preparation of coffee and tea. They are using crop residue as source of animal feed and sometimes as source of raw material for composted slurry to increase soil fertility. The findings of the study are similar with the study done by Bajgain and Shakya (2005).

Table 1: Fuel wood consumption after biogas adoption based on respondents .

Types of activities	Respondents frequency on Fuel saved									
	Biogas		Wood		Agri. residue		Dung cake		kerosene	
	No	%	No	%	No	%	No	%	No	%
For baking "enjera" & bread	0	0	30	60	20	40	0	0	0	0
For cooking "wet"& boiling of (potato, maize, peas, beans)	45	90	4	8	1	2	0	0	0	0
For tea & coffee preparation	50	100	0	0	0	0	0	0	0	0
For lighting	50	100	0	0	0	0	0	0	0	0

Similarly, changes have been observed in the use of dung in the study area. Prior to adoption of the biogas technology, the dung is dried and used as household fuel for cooking and heating. However, after introduction of the biogas, it is used to feed the biogas plant. According to the study result, 98% of the respondents revealed that dung is used as input material for biogas plant for sustainable production of methane gas and bio-slurry to substitute chemical fertilizers since the dung has not lost its fertilizer content in anaerobic digester to produce biogas. As a result, the nitrogen, phosphorus and potash content of the dung is recycled after biogas generation and will improve soil condition and agricultural output to enhance sustainability of the production system (East Consult, 2004).This has twofold benefit: preservation of forest resources and restoration of organic matter of soil using biogas waste after anaerobic fermentation. Furthermore using methane as a fuel substantially reduces the emission of GHG. However, some respondents are still using kerosene, fuel wood, agricultural residue and cattle dung cakes since the biogas is not enough to substitute the whole energy requirement of the household due to construction problems and academic background of the biogas owner to maintain the damaged parts mostly gas pipe, lamp and stove. Therefore, the Amhara national regional state Energy and mines resources development and promotion agency and the woreda energy office should provide continuous technical training for the biogas owners how to maintain and monitor their biogas plant and amend in the curriculum of adult education about the benefits and maintenance of biogas plant.

Table 2: Status of social, economic and environmental benefits gained from adopting biogas technology

Types of benefits	Respondents frequency					
	Improve		No change		Undetermined	
	No	%	No	%	No	%
Social	50	100%	0	0%	0	0%
Economic	45	90%	5	10%	0	0%
Environmental	33	66.7%	12	23.3%	5	10%

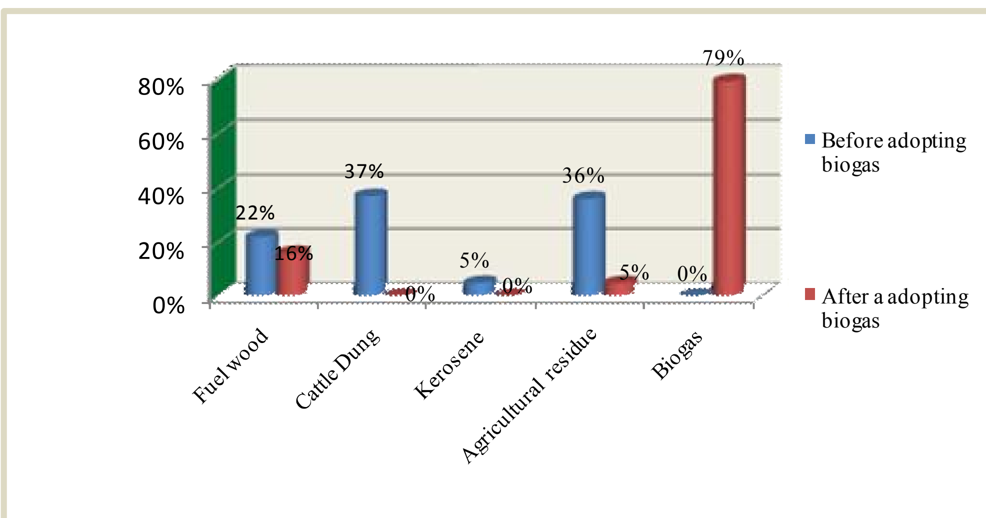

Fig 5. Comparison of the primary source of fuel before and after biogas adoption by the users.

Reduced use of Kerosene

Biogas users in the study area also reduce the consumption of kerosene as source of fuel. According to the data displayed in (Table 3) the average reduction in the use of kerosene is in the order of 4 liter (80 birr) per HH per month. Therefore, biogas plant owners are getting an annual savings of 48 liter (960 birr) of kerosene per HH per year. Consequently, the biogas user saves this expenditure and increased their living standards in terms of health, comfort and safety using green energy.

Reduced use of Chemical fertilizer

Table 3: Amount of income generated due to biogas technology

Types of fuel	Unit	Amount in month	Amount of ETB saved Per month per HH	Amount of ETB saved per year per HH
Fuel wood	Bundle	12	210 birr	2520
Kerosene	Litter	4	80 EB	960
Chemical fertilizer	Kg	150kg DAP	2250	2250
	Kg	100Kg urea	1100	1100
Total				6838

Most of the respondents (97%) agreed that chemical fertilizer is very expensive and unaffordable to cover the cost as compared to organic fertilizer produced from biogas slurry. According to the data obtained, farmers who own biogas plant obtained advantage of saving minimum of 150kg of DAP (Birr 2250) and 100 kg of Urea (Birr1100) per HH annually.

Livestock asset is the key factor for installation of biogas plant. Biogas owners of the study area have better livestock potential to prepare the raw material which is dung to feed the biogas digester from donkey, cow, oxen and sheep dropping. The results obtained revealed that 97.5% of the households who use biogas technology own more than 6 cattle and four ships and the rest 2.5 % of the households have five ships and four cattle. Therefore, the farmers who adopt biogas have enough potential to feed the digester with sufficient dung. Because as Singh (2003) mentioned 3-4 animals are sufficient for 6 cubic meter capacity biogas plant and 4-6, 5-7 animals are sufficient for 8 and 10 cubic meter capacity biogas plant, respectively.

Contribution to household income

Production of feedstock in combination with operation of biogas plants in the study area makes biogas technologies economically attractive for farmers and provides them with additional household income. The farmers also get a new and important social function as energy providers and waste treatment operators as indicated by the respondents and discussion made with key informants. The savings from purchasing fuel wood, kerosene and chemical fertilizer as estimated in (Table 3) are additional household incomes or direct monetary benefits in using the biogas. This is in line with the study done by Maharjan and Singh (2003).

Challenges in adopting Biogas Technology

Financial problems

Biogas plant is not economically attractive from conventional economic point of view, which includes the cost and the benefits from energy sells. In the other hand, biogas technology is attractive from socio-economic point of view in which environmental and agricultural impacts are included (Bensah and Brew-Hammond, 2010). Similarly, households in the study area have faced problem of finance to adopt biogas technology. Therefore, the interest of new biogas users in the future is discouraged to adopt the technology due to financial limitation. The results obtained showed that there exists financial constraint to adopt the technology which accounted 65% (Figure 8). From this, we can understand that financial resource is the limiting factor to adopt biogas technology and the users have less provision of credit service though half of the total cost for construction is covered by SNV.

Technical problem

Construction and installation of biogas plant structures requires skilled man power since the activity demands some engineering works. Some of the technical problems mentioned by the respondents included, problems related with installing the biogas vessels (pipes) and maintaining of water trapped in the pipes, damage of pipes by cattle, broken stoves and biogas lamps, and leaking gas-hoses. According to the results obtained 20% of the respondents face technical challenges (Figure 8). From the above, it is evident that technical constraint is the second limiting factor for adopting the biogas technology in the study area. In addition, less provision of spare parts for the broken, damaged vessels and florescence is also mentioned as a problem hindering wider adoption.

Biogas user training center

For adoption and proper implementation of NBP, training center arrangements are very important to provide services for farmers in biogas technology. As we have seen from (Figure 8), 15% of the respondents confirmed that the absence of biogas training center is one of the challenges to maintain the broken (unfunctional) pipes and manage the bioslurry especially in preparation of composted slurry. This problem can be alleviated by proper training and supervision by the woreda office of agriculture and rural development.

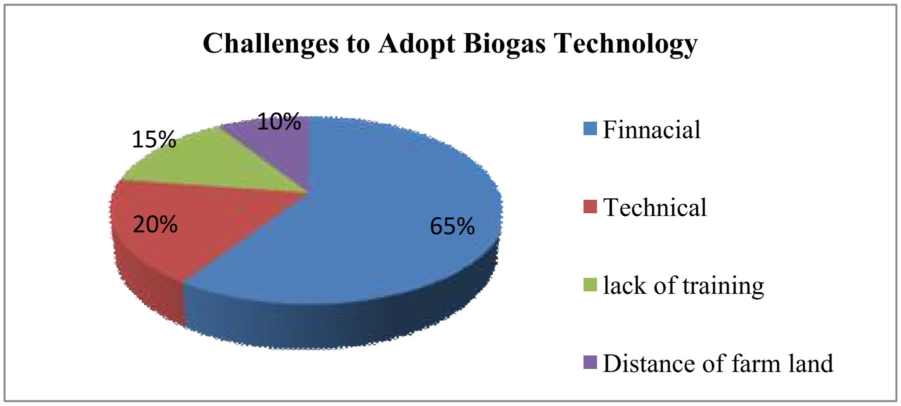

Fig 6. Challenges to adopt biogas technology

Distance of farm land
Farm distance from the biogas plants is the key factor for efficient and proper utilization of the bioslurry. According to the result obtained, 10% of the biogas plant owner's farm land has found far from the biogas plant due to having fragmented farm lands (Fig 8). According to the households whose farm land is close to the biogas plant are more advantageous, they use the bioslurry properly and efficiently. However, those biogas owners whose farm land is found at a distance greater than 0.5km are facing serious challenges in transporting the slurry to their farm. The result is in line with the study done by Islam (2006) who found out being near to the biogas structure could minimize work load of transporting the slurry and composted slurry to their farm.

Table 4: Response obtained from respondents about their farm land **size** and application of bioslurry

Farm land in hectare	Number of respondent	Percent	size of biogas(m^3)	Utilization of bioslurry
<1	7	14%	4	as fertilizer
1-1.4	30	60%	4	as fertilizer
1.5-2	10	20%	6	as fertilizer
>2	3	6%	8	as fertilizer
Total	50	100%		

As we have seen from the above table, 60% of the respondents have farm land in hectare from 1 up to 1.4 located in different area, 14% of them have <1 hectare and 20% of them have 1.5 up to 2 hectare and the remaining 6% of the household have>2 hectare. According to the information obtained, the plant size of the biogas is also limited based on the farm land size to use the bioslurry to their piece of land as fertilizers. The biogas plant owners' perception on using the bioslurry from cattle dung was positive, 100% of the users utilize bioslurry from cattle dung as a substitute of chemical fertilizer for their farm land near to the biogas plant.

Conclusion
Biogas has become a popular rural energy in Ethiopia that builds by the efforts of governmental and non-governmental sector. The involvement of non-governmental sector in promotion of biogas programme began in the early 1980s in Ethiopia. Because of severe fuel wood shortage crisis in most of high populated villages. Some of the dimensions of this crisis manifests in scarcity of fuel, water, change of micro climate and sustainability threats to the agricultural activities. This in turn jeopardizes the livelihood of the rural population. Thus 'Socio - economic and environmental impact of household Bio Gas Programme with a special reference of Yilmana Densa woreda at west Gojjam of Amhara region is conducted to assess the impact of the biogas programme in the rural areas.

In the study area energy production from biogas contributed to biogas users by supplying energy for lighting, heating, cooking and it supplies good quality slurry that can be used as quality organic fertilizer for their depleted soils. The biogas plant owners' perception on using bioslurry from cattle dung was well understood. Application of bioslurry mostly in slurry form to field crops, vegetable crops and perennial crops that are grown around the homestead is a common practice by the users especially for those cash crops such as coffee and chat in the study area. It has a positive impact in growth, development and yield of agricultural crops and total fertility of the soil. Better growth and development of plants and decrease soil erosion, increase soil retention and productivity was observed by users. Besides to this, farmers of the study area that adopt biogas technology realize the social benefits(health and sanitation, education, creation of job opportunity, gender benefits), economic benefits(reduced use of fuel wood, agricultural residue, dung cake, kerosene, chemical fertilizer and **c**ontribution to household income)are the most visible mentioned by the biogas users and different participant in this paper. In addition, availability of alternative fuel like biogas reduces the pressure on forest leading to deforestation and natural hazards and maintain environment by providing environmental benefits.

The potential of the households who adopt the technology include owning sufficient livestock heads to provide raw material for the biogas, proximity of the farmland to the biogas plant, and availability of sufficient family labor force. On the other hand common challenges in adopting biogas technology include distance of farm land for biogas plant, financial, technical and institutional aspects. These constrains have influence on development and dissemination of the technology in the study area.

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