

Biogas as an Alternative Energy Source in Rural Areas and Public Awareness: A Case Study in Jessore District

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Abstract: Bangladesh is a country of natural resources, but it is facing necessary energy supply difficulties for its low economical condition. Biogas can be used a substitute energy generating source in Bangladesh for its suitable climate. About 35°C temperatures are suitable for biogas production. In Bangladesh, the essential materials for biogas production can be arranged very easy and cheapest way depending on country temperature (4°C - 41°C) as it is an agricultural country. About 64 study data was collected from different biogas plants from three Upazila under Jessore district named Jessore sadar, Jhikargachha and Noapara paurasava. Three sizes of biogas plants have been observed in the study areas, which are based on cow dung. The constructional costs of these plants were from 36000 taka to 52000 taka. Biogas is beneficial to human health and environment assistances. Approximately 86% and 80.3% male informed that biogas has improved their mental and physical health respectively. This response has reached more than 95% for female. Maximum male and female thought that not only physical and mental health but also their financial conditions are also benefited by using biogas. About 85.4% to 97.65% male and 88.69% to 98.72% female realized that it has the capability to decrease various waste materials that may have contrary effect on environment. From this survey, it is able to be stated that Bangladesh has an amazing potentiality to adopt more plant life particularly in rural areas for easing the existing environmental degradation, gas power storage, and developing financial situations with suitable health.

Keywords: Renewable Energy, Biogas Plant, Health, Environment, Biogas Potentiality

1. Introduction

Bangladesh is a thickly populated country having approximately 166.37 million of people in total but it is blessed with an abundant supply of renewable energy sources [1]. The proved initial natural gas reserve of Bangladesh has been estimated at 27.12 Tcf where about 12.80 Tcf gas has already been produced leaving a remaining recoverable reserve of 14.32 Tcf [2, 12]. This remaining gas reserve will not be capable of meeting the increased energy demand in various sectors. At present the power demand in Bangladesh is about 6000MW, whereas the generation ranges only 4000-4600 MW and generation capacity is 5936 MW [5]. The recent Gross Domestic Product (GDP) growth rate in

Bangladesh is 7.65% [3]. However, the waning gas resources suggest that if till 2025 the GDP growth of Bangladesh remains less than 5.5 percent then about 19,000 MW of additional power must be added because of the gas demand to reach up to 4,567 mmcf/d by 2019-20 [10]. In these circumstances, there should be an effort for finding out an alternative source of energy which can lead to solve this energy deficiency. Biogas is such an alternative fuel which is a renewable energy source. Government of Bangladesh (GOB) created a policy for the effective utilization of renewable energy. The renewable energy technologies (RETs) have been introduced by different government, semi-government and non-government organizations (NGOs) throughout the country over a significant time period. In Bangladesh, only 5% of total population can be able to get

the benefits of natural gas coming through pipelines and 4 to 5% of the rural households use kerosene for cooking [9]. But maximum rural population of Bangladesh is depending on biomass, crop residues, plant debris, and animal dung and wood as the main energy sources which are directly responsible for the deforestation, flood, soil erosion etc. The significant views concerning the combined performance of the non-renewable energy and the renewable energy prospect are, 60% of the total energy expense of Bangladesh is made by renewable energy and the residual 40% being made by non-renewable energy [8]. Domestic and industrial sectors consume 60.36% and 21.57% of the total national energy consumption respectively [13]. The present study aims to assess the feasibility program on domestic biogas in the Republic of Bangladesh, find out people's reaction about biogas plant technologies and the impact assessment on public health and the environment. A generalized view of the location of the study area is described in Figure- 1.

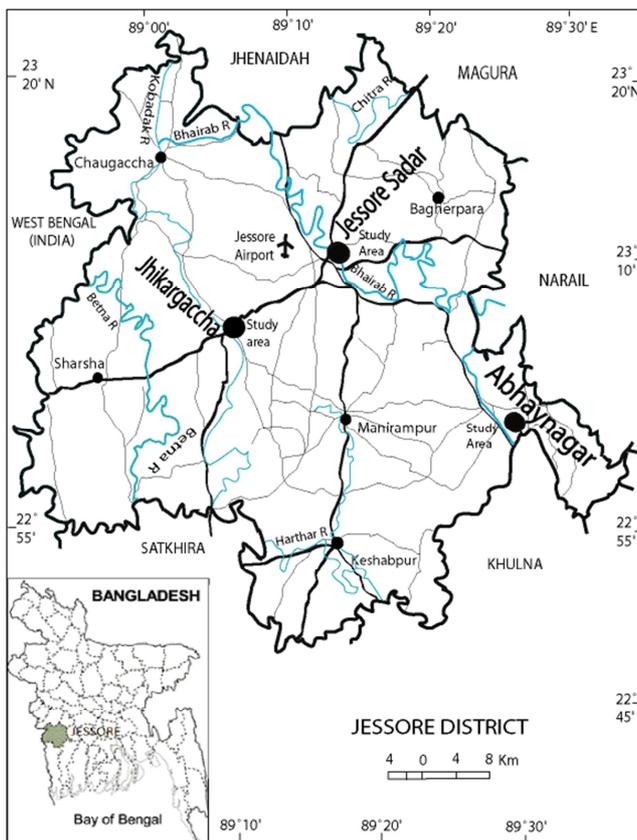


Figure 1. Generalized map showing location of the study area.

1.1. Biogas

Biogas technology is a form of biochemical conversion for generation of bio-electricity by means of decomposition or degradation of organic matter. A new biogas generation is the compact one [11]. In the absence of oxygen the natural matters are started to break down and generate biogas. When organic matters (e.g. animal and human excreta, agricultural and industrial waste, water hyacinth etc) are fermented under an anaerobic condition, those produce flammable gas named

biogas. Anaerobic bacteria can also digest raw particles in an enclosed system, or creates fermentation of biodegradable materials to produce biogas. A mixture of various quantities of different gases is found typically within biogas. Biogas is composed of mainly methane (CH_4) and carbon dioxide (CO_2) and may have a small quantity of hydrogen sulphide (H_2S) and moisture. For the production of biogas some required parameters should be properly followed such as temperature, pressure, Solid/water ratio, pH value etc.

Table 1. Typical composition of biogas [7].

Element	Amount (%)
Methane (MH_4)	55-75
Carbon dioxide (CO_2)	25-45
Hydrogen (H_2)	0-3.0
Nitrogen (N_2)	1.0-5.0
Oxygen (O_2)	0.1-0.8
Hydrogen Sulphide (H_2S)	0.1-0.5
Carbon Monoxide (CO)	0-0.3

1.2. Biogas Potential in Bangladesh

In Bangladesh biogas can be generated by applying the simplest and cheapest technology. This generation consists in perpetuating the rubbishes such as cattle dung, poultry dropping, human excreta, agricultural residues water hyacinth and trash etc out of gaseous substances surrounding the earth and collecting the gas from the uppermost point for utilize. Bangladesh presents a favourable situation in respect of the atmospheric conditions and availability of the basic materials for biogas generation. Bangladesh government has set up a plan to generate 5% of the country's total electricity from renewable sources within 2015 and 10% within 2020 [4].

Table 2. Bio-fertilizer and biogas production in Bangladesh [13].

Raw materials	Organic Fertilizer (million tons)	Yearly gas production (million cubic meter)
1. Cow/Bufalo dung	60.2	2971.1
2. Poultry droppings	2.05	191.6
3. Human excreta	32.85	1226.4
4. Garbage	1.72	115
5. Water hyacinth	10	740
6. Pressed mud	0.07	384

2. Methodology

The study is based on a feasibility survey. The survey work was carried out in three Upazila named Jhikargachha, Jessore sadar, Noapara pourasava under Jessore district, Bangladesh. The owners of the biogas plant as well as the consumers of the biogas were taken under consideration for the study. Primary data was collected from 64 biogas plants owner and users. The data collection was carried out through interview of biogas plant owners and consumers based on a prepared questionnaire. The information which was collected are respondent name and address, number of family member, biogas plant size, amount of cow dung (Kg) for charging, cow dung/water ratio, cooking duration using biogas, construction process of plant and impact on health and

environment. The study also required some secondary data. The secondary records were collected from several journals, books, and NGOs in Bangladesh. The collected data were processed further by Microsoft Word, Microsoft Excel and PowerPoint. The working procedure is shown in Figure 2.

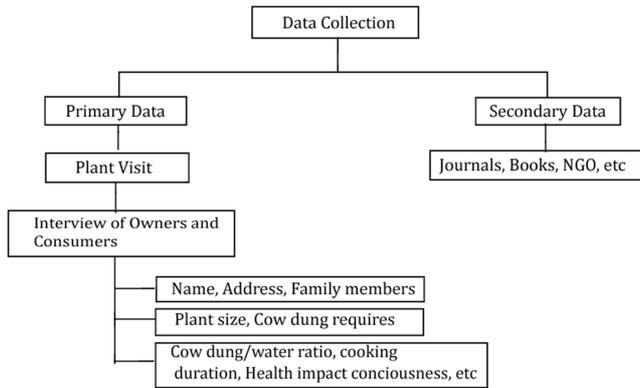


Figure 2. The working procedure for the study.

3. Results and Discussions

3.1. General Characteristics of Biogas Plant

All the assumptions of the survey data including biogas production requirements, feeding materials, usage of gas, demerits, expenses and benefits of a biogas plant are summarized in this section. The maximum data of this research is collected from field measurement and questionnaire survey in 64 biogas plants in rural areas of Jessore, Bangladesh. Three sizes of biogas plants have been observed i.e. small (2.4 m³), medium (3.2m³) and large (4.8 m³) in the study areas. The most considerable volume for biogas plant became 2.4 m³. A Schematic diagram of cow dung based biogas plant is shown in figure 2. All the plants are producing biogas from cow dung and they are used only for cooking purpose. The ratio of cow dung and water mixture is being given by a ratio of 1:1. The users delivered details information about their plant and those are summarized in Table 3.

Table 3. General information of cow dung based Biogas plant of the study area.

Volume of Biogas Plant [Biogas production / day (m ³)]	No. of biogas plant in study area (out of 64)	Required cow dung (kg)	Required cow dung / day (kg/day)	Required water / day (kg/day)	Cooking duration by stoves (hrs)
2.4	31	2900	65	65	5 - 6
3.2	30	3900	95	95	7 - 8
4.8	3	5900	150	150	- 12

3.2. Main Parts of Biogas Plant

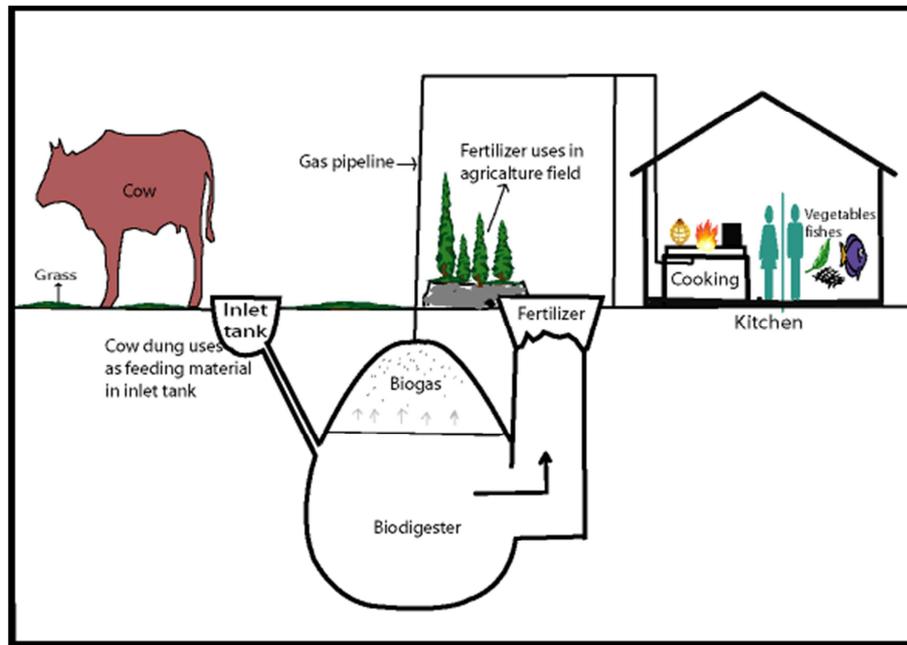


Figure 3. Schematic diagram of cow dung based biogas plant.

After the site selection, the construction of plant is carried out according to the given dimensions of each part. The biogas plants in the study areas are constructed based on the biogas plant model approved by Infrastructure Development Company Limited (IDCOL). There are six main parts of biogas plant. They are:

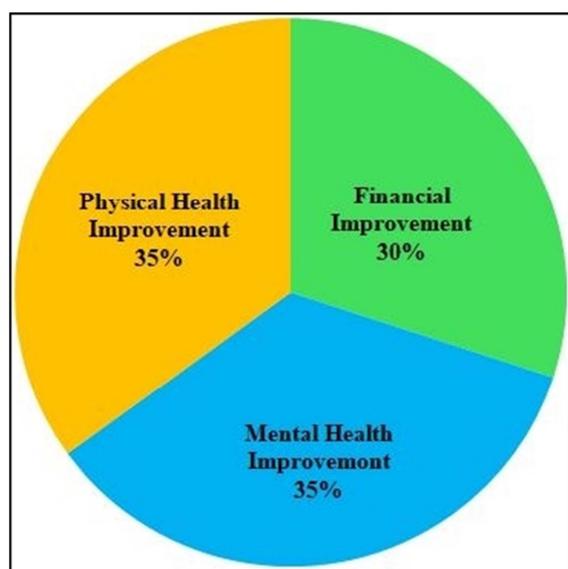
- a) Inlet tank with inlet pipe and mixing device.
- b) Digester.
- c) Dome with centre pipe and turret.
- d) Hydraulic chamber with manhole, cover and outlet.
- e) Gas supplying pipe.
- f) Fertilizer pit.

Table 4. Dimensions of IDCOL Biogas plant based on cow dung (cm).

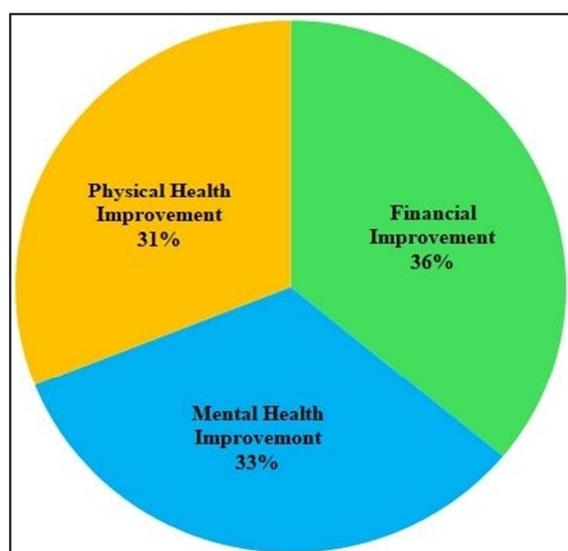
Vol. of plant	Daily demand of cow-dung	Dia. Of digester	Height of vertical wall of digester	Height of bottom dome	Size of manhole	Height of upper dome
(m ³)	(kg)	DD	HD	HB	SM	HU
2.4	65	230	120	29	60	83
3.2	87	260	130	33	60	90
4.8	130	290	150	36	60	102

Vol. of plant	Radius of upper dome	Radius of bottom dome	Height of outlet passage	Height of hydraulic chamber	Radius of hydraulic chamber	Length of slurry pit	Width of slurry pit	Depth of slurry pit
(m ³)	RU	RB	HO	HH	RH	LS	WS	DS
2.4	121	244	160+7.5	34	201	273	205	100
3.2	139	276	172+7.5	50	219	315	236	100
4.8	154	308	200+7.5	55	254	386	290	100

3.3. Impact of Biogas on Human Life



(a)



(b)

Figure 4. Respondent's opinion about the improvements of human life; (a) Male respondent (b) Female respondent.

Maximum biogas plant owner acknowledges that biogas has developed their intellectual, corporeal and economical condition. Especially women get more benefit from biogas because it reduces the physical stress in the case of fuel for collecting wood, cooking and cleaning gadgets is noticeable. Almost 86% male and 98% female said that biogas developed their mental health also. About 80.3% men and 98.5% woman informed that biogas upgrades their physical health. Indoor air pollutants is one of the maximum direct bodily fitness risks and publicity to biogas smoke will increase the hazard of respiratory sicknesses inclusive of acute lower respiration infection. But using biogas technology people gets safety from such diseases. About 92.35% male and 85.79% female told that biogas developed their financial condition. Significantly large numbers of woman provide their thoughts about improvement of their corporal and intellectual health by using biogas. After the installation of biogas plant, female and children are able to save their valuable time and can utilize the saved time for taking rest and other productive activities such as education and other social activities. On the other hand males mainly voted for financial condition, because they are using the slurry in agricultural fields instead of fertilizer and also using slurry as feed for fish. Someone sell produced slurry to other farmers and to the farm related to pisciculture. They ensure that following three factors are developing day by day using of biogas plant based on cow dung and the percentages are indicated in Figure 4.

- (a) Improvement of mental health
- (b) Improvement of physical health
- (c) Improvement of financial health

This study found biogas very economical physically favorable as raw materials are available to the owners of the plant. If a plant owner wishes to make a simple business, he can do it easily. Energy value for 1m³ of biogas is considered 17-25MJ/m³ which is very significant [14].

The calorific value of biogas is comparatively low than other fossil fuels but it has higher calorific value than traditional fire woods. The comparison of calorific value is shown in Figure 5.

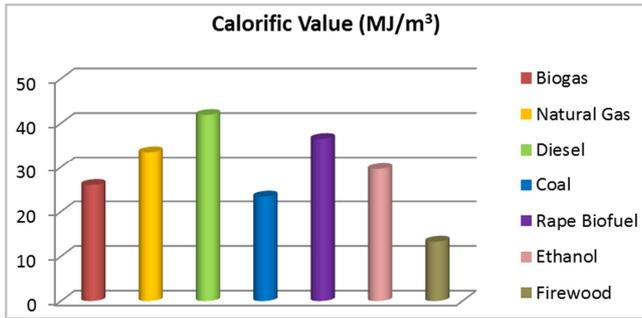


Figure 5. Calorific Value of Biogas and Traditional Fuels [15].

3.4. Impact of Biogas on Environment

After the installation of biogas plant, a remarkable higher number of man and woman hoped that unfavorable effects of traditional cooking by biomass on environment were greatly

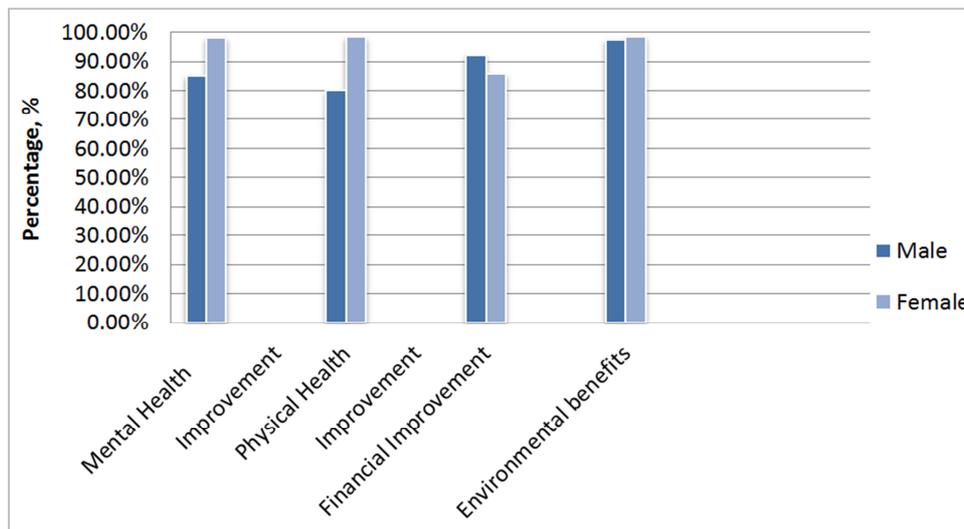


Figure 6. Respondent's opinion about the overall improvements.

4. Conclusion

In deduction, biogas could be the most effective alternative of power generation source in Bangladesh. Multiple advantages of biogas to the household, community and the country are noticed because of the uplifted socio-economical status for biogas application. It has direct positive effect on health, environment and agriculture. The prospects of biogas are very high as the biogas plant users in Bangladesh are highly aware of different advantages of biogas and they have very positive outlook about biogas plant. Females are more beneficiary from biogas because their physical and mental health both are developing day by day and they are now capable of spending their stored time in more effective works. Male respondents are also beneficial in case of improvements of financial condition. Besides, biogas is prone to protect the environment from severe pollution. Hence, if people increase their usage of biogas, it will reduce additional pressure upon natural gas, oil and coal and at the same time mitigate the scarcity of energy source in Bangladesh. In the point of view of the study revealed that

reduced. A little amount of people thought about the adverse effects of biogas on environment and the percentage was 0 to 1.13% for male and 0 to 1.95% female. On the other hand, 85.4% to 97.65% male and 88.69% to 98.72% female have the positive thinking about the reduction of environment pollution using biogas. Rising use of slurry on farm are responsible for raising the production of cereal crops, fruits and green vegetables. These reduced the use of fertilizers and pesticides those lead to soil and water pollution. Biogas does not produce smoke like traditional cooking by biomass and in such way it is barred from air pollution. Some local educated persons in the study area guess that biogas emits more carbon dioxide compared to natural gas. Overall improvement is indicated in Figure 6.

But this amount is comparatively low and random studies are being carried out to reduce this amount of carbon dioxide.

the impact of biogas on all over the environment is very positive according to both the male and female respondents.

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References

- [1] Bangladesh Population. (2018-06-04). Retrieved 2018-08-24. Available at: <http://worldpopulationreview.com/countries/bangladesh-population/>.
- [2] BDNEWS24.COM, 15 June, 2015. "Bangladesh's gas reserves 14.32 trillion cubic feet until March". Available at: <https://bdnews24.com/business/2015/06/15/bangladesh-s-gas-reserves-14.32-trillion-cubic-feet-until-march-bipu>.

- [3] The Daily Star, 4 april, 2018. "Economy marches towards record 7.65pc growth". Available at: <https://www.thedailystar.net/business/economy/gdp-growth-in-bangladesh-economy-marches-towards-record-7.65-percent-in-2018-1557706>.
- [4] Chowdhury, S and Chowdhury, M. 2018. "Renewable Energy Resources: An Over View in Bangladesh". *International Journal of Sustainable and Green Energy*, Vol. 7, No. 4, 2018, pp. 29-36. doi: 10.11648/j.ijrse.20180704.12.
- [5] Haq, ME. 2011. "Bangladesh's Power Sector: Investment Opportunities," Ministry of Power, Energy & Mineral Resources, Bangladesh, Presented in London, Mar. 2011.
- [6] Islam, AKMS; Islam, M and Rahman, T. 2006. "Effective renewable energy activities in Bangladesh". *Renewable Energy*, 31(5): 677-688.
- [7] Islam, R; Banerjee, G and Ali, F.2014. "Design and Benefit Analysis of Biogas Plant for Rural Development in Bangladesh". *International Journal of Engineering and Advanced Technology (IJEAT)*, ISSN: 2249 – 8958, Volume-3, Issue-3.
- [8] Imam, B. 2005. "Energy Resources of Bangladesh". 1st edition, University Grants Commission, Bangladesh.
- [9] Kabir, MH and Endlicher, W. 2012. "Exploitation of renewable energy in Bangladesh". A. H. Development Publishing House, Dhaka, 286p.
- [10] Khan, S. 2009. "The search for alternatives". *The Star Weekend Magazine*, vol. 8, no. 65, Apr. 2009.
- [11] Lungkhimba, HM; Karki, AB and Shrestha, JN. 2010. "Biogas Production from Anaerobic Digestion of Biodegradable Household Wastes". *Nepal Journal of Science and Technology*, 11: 167-172. DOI: 10.3126/njst.v11i0.4140.
- [12] Petrobangla Annual Report, 2014. Bangladesh Oil, Gas and Mineral Corporation, 23p.
- [13] Rouf, Dr MA and Haque, MN. 2008. "Role of Renewable Energy (Biogas and Improved Cook Stoves) for Creation of Green Jobs in Bangladesh". Workshop on "GREEN JOBS" initiative in Bangladesh.
- [14] Kasap, A; Aktas, R; Dulger, E; 2012. "Economic and Environmental Impacts of Biogas", *Journal of Agricultural Machinery Science*, Volume 8, version 3, pp 271-277.
- [15] Strzalka, K. V; Pikon, K; 2013. "Environmental impacts associated with production and utilization of agricultural biogas", *Achieves of Waste Management and Environmental Protection*, ISSN:1733-4381, Vol.15, issue 4, pp 1-12.