Journal of Energy and Natural Resources
2017; 6(5): 64-68
http://www.sciencepublishinggroup.com/j/jenr
doi: 10.11648/j.jenr.20170605.12
ISSN: 2330-7366 (Print); ISSN: 2330-7404 (Online)

A Review of Potential Renewable Energy Preference in Rural Area of Bangladesh

Samrat Mitra*, Monzer Hossain Sarkar, Ahmad Kamruzzaman Majumder

Department of Environmental Science, Satmford University Bangladesh, Dhaka, Bangladesh

Email address:

smitra.env@gmail.com (S. Mitra), monzer.hsarker84@gmail.com (M. H. Sarkar), kamrul_sub@hotmail.com (A. K. Majumder)

*Corresponding author

To cite this article:

Samrat Mitra, Monzer Hossain Sarkar, Ahmad Kamruzzaman Majumder. A Review of Potential Renewable Energy Preference in Rural Area of Bangladesh. *Journal of Energy and Natural Resources*. Vol. 6, No. 5, 2017, pp. 64-68. doi: 10.11648/j.jenr.20170605.12

Received: March 22, 2017; **Accepted**: April 28, 2017; **Published**: December 19, 2017

Abstract: Khulna is located in the south western part of Bangladesh. Khulna is the third largest city of Bangladesh where the livelihood depends on mostly agricultural practices and livestock farming. Thus there might have significant potential for biogas production. From this point of view the present study has been taken into consideration. A structured questionnaire survey was conducted to investigate the plenty of livestock resources, their energy consumption pattern, biogas production, and replacement of traditional energy consumption with biogas in 80 households which is selected randomly. Study found that total manure production is 3080125.5 kg/yr and residues production is 102252.34 kg/yr. 94 percent of the households are still using mud stoves as their first priority. Useful cooking energy demand in the case of surveyed area comes out to be 77420 kWh per year. The total biogas demand of the study area to provide cooking gas and electricity is 56981.5 m^3 per year whereas the total potential biogas production is 125838.18 m^3/yr in the study area. The potential produced biogas will completely fulfill the biogas demand in the study area.

Keywords: Livestock, Manure, Agricultural Residues, Renewable Energy, Biogas Production

1. Introduction

The country's rural population faces the problem of income poverty as well as energy poverty. Around 45 percent of the rural population is income poor and 58 percent is energy poor which is the demand based measurement of energy poverty [1]. In rural areas of Bangladesh people mostly rely on biomass to meet their cooking energy need. The main biomass resources include fuel wood, agricultural waste, tree leaves and branches and cow dung [2]. The common appliances used for lighting in majority of the rural areas in the country are kerosene lamps (*hurricane and kupi*) [3]. In the line of recent energy crisis scenario in Bangladesh, the concept is being shifted from depending traditional energy to alternative or renewable energy consumption. Biogas plants have not only the advantages of improved efficiency and multidimensional use, the GHG (Green House Gas) emissions will also be reduced and organic fertilizers will be available as a by-product. The decentralized nature of some RETs (Renewable Energy Technologies) allows them to be match with the specific alternate energy like biogas [4]. At the international level, UNFCCC (United Nations Framework Convention on Climate Change) 1992, Kyoto Protocol 1997 and Copenhagen 2009 have also its main agenda for reducing GHGs (Green House Gases) emission. Bio-energy had been also discussed in IPCC (Intergovernmental Panel on Climate Change) report as a mitigating climate change can be adopted to reduce its impacts. The use of alternative energy in the form of biogas has been contributing for reducing the emission of greenhouse gases [5]. Use of biogas has been contributing for mitigating climate change by reducing greenhouse gases emission and sequestrating carbon in the form of conserving natural forest. It also offers several benefits such as health, environmental, agricultural and economic benefit through reduced deforestation and carbon trading that increase the adaptive capacity against climate change. In saved time, women potentially can spend this on education, productive

and other activities [6]. Utilization of biomass based energy resources through appropriate technological interventions has become very important for environmental conservation and sustainable rural development [7]. Energy technology like biogas is considered as feasible in rural areas and among poor people [8].

The study serves as a part of biogas based poly generation project utilizing cow dung or agricultural waste to produce biogas that would provide the services of cooking gas and electricity in rural Bangladesh. Household energy utilization patterns as well as preferences for current energy utilization patterns are studied. The study also focuses on examining the willingness of the rural households to pay for the services of cooking gas and lighting and towards the contribution for the poly generation project. Another key question that the study sheds light on is to find out the biomass potential in the surveyed area i.e. cow dung and agricultural waste to calculate the amount of biogas that could be produced from the available resources in the study area.

2. Demographic Status

The present study was accomplished to the rural area of Gangarampur Union under Batiaghata Upazila of Khulna District (Figure 1). According to Population Census 2011, the total population of Batiaghata Upazila is 171,691. Among them, 50.48% is male and 49.51% is female. In same year, 95.53% of peoples have found living in rural area followed by 4.47% of peoples in other urban area. Annual growth rate of this area is 1.99%. The average literacy rate of Batiaghata Upazila is 54.2% where literacy rate of male is 58.3% and female is 50.1%. The study also observed that the main energy consumption pattern in this region is biomass energy in terms of firewood, agricultural residues, cow dung cake, dry leaves, twigs and branches of plants for household cooking and kerosene for lighting. Another interesting situation was observed that the some areas of the Upazila are still lack of electricity.

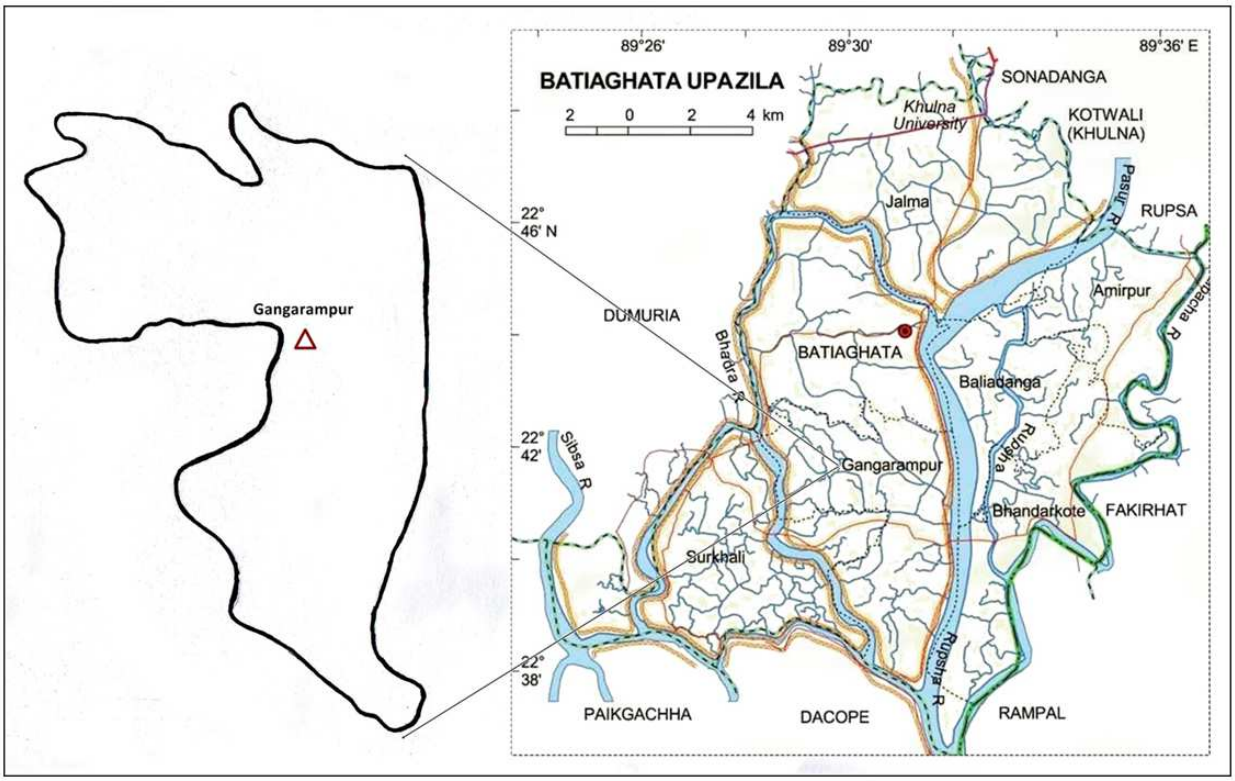

Figure 1. *Map of Batiaghata Upazila showing Gangarampur Union.*

3. Materials and Methods

3.1. Survey Procedure

For the present study Gangarampur Union was selected. Total 80 households from Gangarampur Union were selected randomly. A structured questionnaire survey was conducted to investigate the plenty of livestock resources, their energy consumption pattern, biogas production, and replacement of traditional energy consumption with biogas. The survey was conducted to the owner of the households. In some cases the comments from the housewife was also investigated.

3.2. Biogas Calculation

In order to estimate the biogas production, the biogas production rate from various sources developed by Ahmed and Bahauddin [9] has been used. Report showed that manure production rate respectively for cow/buffalo, goat/sheep/pork and hen/duck is 20 kg/d.c, 3 kg/d.c and 0.1 kg/d.c and human excreta production rate is 0.4 kg/d.c whereas biogas production rate is 0.037 m^3, 0.052 m^3, 0.074

m^3, 0.074 m^3 and 0.072 m^3 per kg of manure from cow/buffalo, goat/sheep/pork, hen/duck, human excreta and organic waste respectively. The manure and biogas production rate from different sources is given in Table 1.

Table 1. *Biogas production from man and animal litter.*

Sources	Manure Production rate (kg/d.c)	Biogas Production rate (m^3/kg)
Livestock_CB	20	0.037
Livestock_GSP	3	0.052
Livestock_HD	0.1	0.074
Human	0.4	0.074
Organic waste		0.072

(Source: Ahmed and Bahauddin [9])

4. Result and Discussion

4.1. Fiscal Status

4.1.1. Income

The respondents were divided in three types income group which are (a) Low Income (below 10,000 BDT), (b) Middle Income (10,000 BDT-20,000 BDT), (c) High Income (above 20,000 BDT). Figure 2 demonstrated that maximum 46.25% respondents were in low income group followed by 32.50% respondents was in middle income group and 21.25% respondents were in high income group.

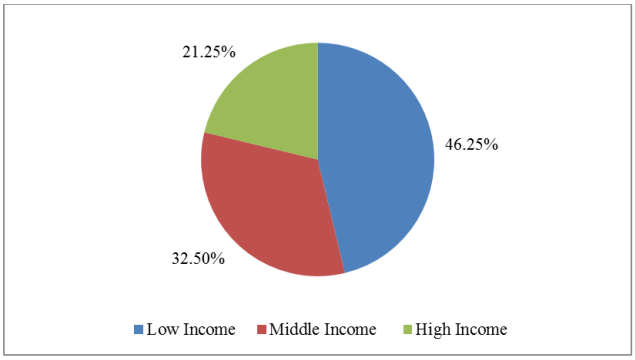

Figure 2. *Group wise monthly average income of the studied households.*

4.1.2. Livestock Ownership

There was plenty of livestock in the study area. Table 2 demonstrated that 389 of cows and buffalos were found in the study area. The total households owned 389 cows and buffalos at an average of 4.86 per household which is higher than the national average of 2.64.

Table 2. *Livestock resources in the study area.*

Livestock	Frequency
Cow & Buffalo	389
Goat, Sheep & Pork	182
Hen & Duck	1127

As well as 182 of goat, sheep and pork and 1127 of hen and duck were found in the study area. A study conducted by Ahmed and Bahauddin [9] mentioned that overall growth of livestock in national economy in 2006 to 2007 was 5.85%. The following table shows the number of cattle owned by household during the time of survey.

4.2. Biomass Resource Calculation and Biogas Production

4.2.1. Manure and Biogas Production

As we can see from table 3, the number of livestock in the study area is quite impressive. Total number of the cows available in the study area is 389. Dung potential in the study area is 2839700 kg/yr. As well as manure from goat, sheep and pork is 199290 kg/yr and hen and duck is 41135.5 kg/yr. Total manure production is 3080125.5 kg/yr. Besides total biogas production potentiality is 118476.01 m^3/yr. So the other resource that is scrutinized is the available agricultural waste produced in the surveyed area to examine the possibility of co-digestion of manure and agricultural residue for production of biogas [9].

Table 3. *Manure production in the study area.*

Sources	Manure Production rate (kg/d.c)	Values	Manure (kg/yr)	Potential Biogas Production (m^3/yr)
No. of Cow & Buffalo	20	389	2839700	105068.9
No. of Goat, Sheep & Pork	3	182	199290	10363.08
No. of Hen & Duck	0.1	1127	41135.5	3044.03
Total			3080125.5	118476.01

4.2.2. Agricultural Residues and Biogas Production

The main crops cultivated in this area are rice, jute, mustard, sunflower, water melon, sesame, betel nut and vegetables. Mustard, jute, sunflower and rice are extensively cultivated crops and hold the major share in the total growth followed by vegetables. For the purpose of biogas production the crops residue that are considered to be used are rice, jute and vegetables. In the case of vegetables only 10 percent of the total amount produced is considered for residue. Out of the total residue that could be obtained from the jute crops only 90 percent is considered to be used and in case of rice all the waste is considered. The total amount of crop residue calculated from the crops cultivated in the study area is 102252.34 kg/yr and total potential biogas production is 7362.17 m^3/yr (Table 4). The total biogas production

potentiality from manure and agricultural residues is 125838.18 m^3/yr, which is enough for meeting the cooking energy and electricity demand of the Study area.

Table 4. *Agriculture residue production in the study area.*

Crops	Residue to product ratio	Amount (kg/yr)	Potential Biogas Production (m^3/yr)
Rice	1.8	147492	7362.17
Jute (90% of total waste)	1.6	98409.6	
Vegetables (10% of total production)	-	3828	
Total		102252.34	

4.3. Biogas from Poly-generation Plant

The biogas poly generation focuses on the utilization of the available biomass resources in the study area to produce biogas. The biogas can be used as the cooking gas for sufficing cooking energy demand for the dwellers. To check the feasibility of biogas poly generation, it is necessary to calculate the amount of biogas potential in the study area. By the data gathered in the survey, biomass resource in the surveyed area is estimated. This estimated resource potential is used to calculate the biogas potential in the area. Amount of biogas needed for the poly generation unit to provide cooking gas and electricity for certain number of households was calculated using Khan et al, [10] estimation. So in this part only the biogas potential is estimated to see if the available resources would be sufficient to produce enough biogas to meet the combined demand of cooking gas and electricity for the households in the study area.

The calculation results regarding the total cooking demand of the surveyed study area is given in table 5. The total cooking energy demand of the different types of biomass is calculated in kWh per year using the energy values of each type of biomass. It is important to know the efficient or useful cooking energy as the efficiency of the cooking stoves used is quite low.

94 percent of the households are still using mud stoves as their first priority, which means that cooking fuel efficiency in the study area is quite low. Useful cooking energy consumed by the rural households gives a precise picture of the utilization of cooking energy at user end. Useful cooking energy demand in the case of surveyed area comes out to be 77420 kWh per year. Based on this useful cooking energy demand total cooking gas demand in the area is calculated. The estimation is based on the assumption that households cook two meals a day throughout the year, which is also the case for most of the surveyed households.

Table 5. *Cooking energy demand of the study area.*

Biomass	Total Energy Demand (kWh/yr)	Efficient cooking Energy Demand (kWh/yr)
Dung	226900.39	27228.04
Fuel Wood	122894.86	18434.23
Crop Residue and Leaves	204018.75	24482.25
Biogas	12126.11	7275.66
Total	565940.12	77420.19

* Source: Calculation was based on Ahmed and Bahauddin [9].

Total biogas required for cooking for the whole area comes out to be 20481 m^3 per year. Average electricity demand which is used here is 27 kWh per household per month calculated by Khan et al [10]. For producing 27kWh of electricity for each household per month and the biogas requirement for the whole area is 100 m^3 per day [10]. So finally the total biogas demand of the study area to provide cooking gas and electricity is 56981.5 m^3 per year whereas the total potential biogas production is 125838.18 m^3/yr in the study area. The potential produced biogas will completely fulfill the biogas demand in the study area. The calculation results regarding the total biogas demand of the surveyed area is given in the table 6.

Table 6. *Calculation of total biogas demand of the study area.*

Description	Values
Total cooking energy demand (kWh/yr)*	565940.12
Total useful cooking energy demand (kWh/yr)**	77420.19
Useful cooking energy demand(kWh/person/2meals)*	0.406
Secondary cooking energy demand (kWh/person/2meals)**	0.677
Biogas demand for cooking(m^3/person/2meals)*	0.1074
Biogas demand for cooking (m3/yr)*	20481.53
Biogas for electricity for lightning (m3/yr)***	36500
Total Biogas production potentiality (m3/yr)	125838.18
Total Biogas demand (m3/yr)	56981.53

* Surveyed Data, ** World Bank report conversions, ***Mainali [8]

4.4. Willingness to Biogas Production and Adaptation

As the poly generation project deals with the production of biogas with cow dung or in case of lack of resources, would utilize the agricultural resource. At this stage it is of prime importance to know the point of view of the local people regarding poly generation project, biogas and possibility of their contribution in the success of such a project in future. So the respondents were asked about their awareness of the biogas technology in the first place, to know if the local people do have an idea about the technology and how many of them have seen or heard about such a technology of gas production using animal waste, which can be used for cooking and other purposes.

Figure 3 illustrates the awareness of the respondents regarding the biogas technology in groups with three different income levels. Households are divided in three groups with low income, middle income and high income.

The figure implies that awareness about the biogas is increasing from the middle income group.

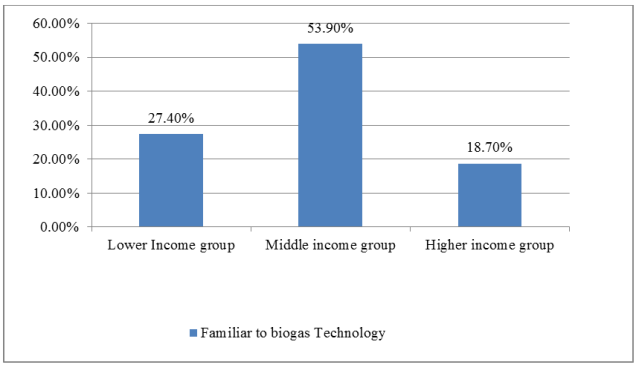

Figure 3. *Percentage distribution of the respondents familiar to biogas with income level.*

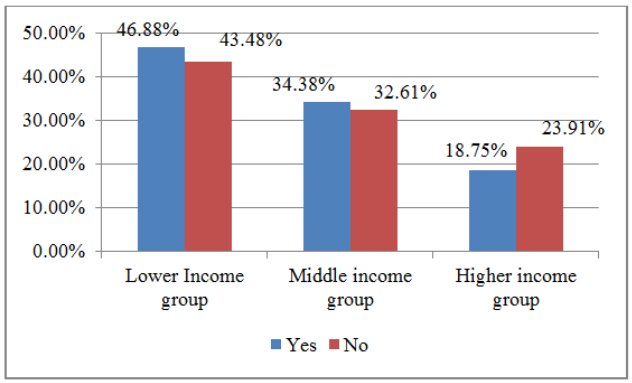

Figure 4. *Percentage distribution of the respondent's willingness to contribute to biogas use.*

In the above figure 4 showed the willingness of the households for their contribution to provide dung in the plant is analyzed with the income level. Every income group answered between two options: i) Yes or ii) No. The figure implies that willingness about the contribution is increasing from the lower income group.

5. Conclusion

The study and its findings are based on a household survey in the rural village of Bangladesh. The main purpose of the survey was to find out the cooking and lighting energy demand of the study area. These findings are also meant to be used as baseline information for biogas poly generation project. The study shows that among the total energy demand (cooking and lighting), cooking energy has the major share and lighting energy consumption is quite nominal in comparison, reason of which is the limited use of kerosene by majority of households. Cooking energy consumption of households is observed to increase with an increase in income of households.

References

[1] Barnes, D., Khandker, S. R. & Samad, H. A., 2010. Energy poverty in rural Bangladesh. Elsevier, pp. 894-904.

[2] Jashimuddin, M., Masum, K. & Salam, M., 2006. Preference and consumption pattern of biomass fuel in some disregarded villages of Bangladesh. pp. 446-451.

[3] Asaduzzaman, M., Barnes, D. F. & Khandker, S. R., 2010. Restoring Balance Bangladesh's Rural Energy Realities, s.l.: World Bank.

[4] CBS. (2001). Population Census of Nepal. Central Bureau of Statistics, Government of Nepal.

[5] MoE. (2011). Status of Climate Change in Nepal. Government of Nepal, Ministry of Environment, Singha Durbar, Kathmandu, Nepal.

[6] Ahlborg, H. & Hammar, L., 2012. Drivers and barriers to rural electrification in Tanzania and Mozambique e Grid extension, off-grid, and renewable energy technologies. Elsevier, pp. 1-8.

[7] Kaygusuz, K., 2011. Energy for sustainable development: A case of developing countries. Elsevier, pp. 1116-1126.

[8] Mainali, B., 2012. Report on One to One consultation with Stakeholders, Stockholm: Unpublished.

[9] Ahmed, H. and Bahauddin, K. M. (2012). Prospect and Potential of Biogas Energy and Its Technology: A Sustainable Clean Energy Future of Bangladesh. International Journal of Advanced Renewable Energy Research. 1: 6 pp. 313-322.

[10] Khan, E. U., Mainali, B., Martin, A. &Silveira, S., 2012. Techno-Economic Analysis of Small Scale Biogas Based Poly generation Syatem in Bangladesh. Unpublished, p. 9.