

Factor Affecting Poultry Litter Based Captive Power Generation Using Biogas Technology in Bangladesh

Roshidul H.

Associate Professor,
Department of CSE & IT,
Bangabandhu Sheikh Mujibur
Rahman Agricultural
University,
roshidul@roshidul.com

M. N. Hasan

Assistant Professor,
Department of Statistics,
Bangabandhu Sheikh Mujibur
Rahman Agricultural
University

G. C. Saha

Lecturer,
Department of CSE & IT,
Bangabandhu Sheikh Mujibur
Rahman Agricultural
University

S. M. Shahriar

Scientific Officer,
Bangladesh Rice Research
Institute

Abstract – Energy is vital for economic and social development of any country. Energy is considered to be one of the essential inputs for overall improvement. In Bangladesh energy crisis is general phenomenon. But, there is a huge potential to use Biogas technology for producing captive power to reduce power crisis in Bangladesh. A Preliminary estimate indicates that about 6 MW electricity can be generated everyday from Gazipur district which is known as poultry zone. Around 2.7 crore poultry birds are being raised in Gazipur that excrete around 1350 metric tons of wastes every day. A study was conducted on captive power generation using biogas technology in Gazipur district of Bangladesh. The study tried to find out the factors influencing to poultry farm owners for captive power generation using biogas technology. The statistical methods; mainly chi-square test and logistic regression used to identify the factors affecting the biogas plant and its influences to produce captive power generation. The study was found very positive attitude of poultry farm owners to establish biogas plant and generate power for them.

Keyword – Captive Power, Energy, Biogas, Power Generation, Poultry.

I. INTRODUCTION

Bangladesh is one of the most densely populated countries with 79% of the population living in rural areas. Agriculture is mainstay of Bangladesh economy. In spite of its huge manpower resource and fertile land Bangladesh is one of the underdeveloped countries in the world. Environmental degradation, misuse of biomass, and drying up of water-bodies are creating constraints for the poor in the rural areas. Energy is vital for economic and social development of any country. Energy is considered to be one of the essential inputs for overall improvement. The main energy sources of Bangladesh are biomass and natural gas. Biomass energy sources are traditionally used for domestic cooking, fertilizer and in small rural industries. Harnessing these resources appears to be a promising solution for improving the quality of life of rural villagers, who are unlikely to have access to conventional electricity supply in the foreseeable future. Biogas from poultry waste for electricity could be very beneficial for increasing the productivity of household industries as well as poverty reduction. A Preliminary estimate indicates that about 6,000 kW (6 MW) electricity can be generated everyday from poultry excrement at Gazipur poultry zone, also known as the Poultry capital, experts said at a seminar at Bangabandhu Sheikh Mujibur

Rahman Agricultural University in Gazipur. Around 2.7 crore poultry birds are being raised in Gazipur that excrete around 1350 metric tons of wastes everyday, well enough to generate six megawatt electricity. So this survey was aims to assess the probability of generating electricity by Biogas technology in Gazipur district.

Energy production from poultry waste is relatively new in Bangladeshi. Most of the farms producing electricity from poultry waste have installed their electricity generation systems since 2005. However, Bogra Poultry Complex situated in Bogra district installed its system in the late 90's. This is the only poultry farm in the country which meets its electricity demand from own generation.

II. LITERATURE REVIEW

Recently, Ahmed H. and Khalid M.B. (2012) studied to find out the potential of biogas plant in Bangladesh and provide a clear picture of the existing status of biogas plant in Bangladesh. They stated that total number of biogas plants in the country is about 25000, Bangladesh Council for Scientific and Industrial Research (BCSIR) has installed about 22000 biogas plants in the country. Besides, Local Government Engineering Department (LGED) has installed about 116711, Bangladesh Rural Advancement Committee has installed about 1200 (Nes et al., 2005), Grameen Shakti (GS) has installed 50012 and Department of Environment has installed about 260 biogas plant (Ali 2005) in the country. However, the number of biogas plants in the poultry sector is not significant. The poultry farmers do not installing biogas plant due to higher cost of primary installation. 34% respondents opinion establishment cost biogas plant is cheap, whereas 66% respondent's opinion it is costly.

The Per capita energy consumption in Bangladesh is 197 kg of oil equivalent (kgoe), which is far less than the averages for low income (563 kgoe) countries¹. Around 33% (Hossain and Tamim, 2005/2006) of the total population is covered by electricity network and 4% (ibid, p. 13) are covered under natural gas network. About 40% of the total primary energy of the country comes from renewable energy, mainly biomass (Draft NEP, 2006). Biogas is one of the promising renewable energy sources in Bangladesh. It is also saving money for electricity 62% of the total poultry farmers in the study support the statement others 38% denied. It found in the study 39% deponents said biogas plant is easy to manage other 61% respondents said that it is not easy to manage.

In the last two decades the poultry industry of Bangladesh has grown from a handful of medium sized operations to a large industry. Poultry firms having bird population ranging from a few hundred to several hundred thousands are mushrooming throughout the country. Approximately 7500 MT poultry waste are being produced everyday and if not properly managed, this huge amount of poultry waste can pollute soil and water resources and create environmental hazards.

Hall & Rao (1999) and Boudri *et al* (2002) conducted research biogas technology and stated that Biomass resources are potentially the world's largest and most sustainable energy sources for power generation in the 21st century.

Goldemberg and Teixeira (2004) mentioned in their article that renewable energy is basic to reduce poverty and to allow sustainable development. However, the concept of renewable energy must be carefully established, particularly in the case of captive power generation through poultry litter.

III. METHODOLOGY

The methodology for collecting the data for the study was both qualitative and quantitative. The quantitative data were collected using structured questionnaire while qualitative information were collected from focus group discussion and semi-structured interviews with key respondents. In order to reach the poultry farmer and to administer the questionnaire a total list of poultry farmer were used. Among the 8511 poultry farmer in Gazipur district 4500 poultry farmer having birds 2000 or more in their farm was the population in the study. The sample size was determined from this group. Suppose that the target proportion of poultry farmer practicing poultry litter based captive power generation using biogas is 50% from among the total poultry farmers having 2000 or more birds in their farm. It is desired to obtain an estimate of the proportion p that is not more than 4% away from the true proportion P with 95% confidence level then sample size were determined by using the following formula

$$\text{The sample size } n = \frac{NZ^2 p(1-p)}{Nd^2 + Z^2 p(1-p)}$$

Here $N=4500$, $Z=1.96$ at 95% confidence interval, $p=0.05$, and $d=0.10$ on the basis of the above information n was approximately estimated as 100. The observations were collected from the farmers of villages Bhutulia, Goldapara, Dhonua, Nogor Haula, Faulkal, Vanua, Lagalia, Sharta, Gondia, Bolda, Harinal, Mariali, Purabari, Bagholbari, Amuna, West Chotor, Baharul, and Bormi of Gazipur district of Bangladesh.

Bivariate Analysis

In bivariate analysis we are interested in finding out if there is any association between two variables. In particular correlation analysis measures the strength of association between two intervals (at least) type data as well as regression analysis. Normally we measure this by correlation analysis. But when the data is qualitative we use measure of association for measuring the strength of

relationship. In my study most of the variable are qualitative we are working with that. In this section on the basis of the cross tabulation we test the hypothesis whether there exist any significant association between two or more variables or not.

Logistic Regression Analysis

The simple linear regression model is not appropriate when Y is a dichotomous variable because the expected value (or mean) of Y is the probability that $Y=1$ and, therefore, is limited to the range 0 through 1, inclusive. Simple linear regression model is incompatible with the reality of the situation. So the logistic regression technique was used for identifying the factors affecting the poultry litter based captive power generation using biogas technology.

If we let $p=p(Y=1)$, then the ratio $p/(1-p)$ can take on values between 0 and plus infinity. Furthermore, the logarithm (\ln) of $p/(1-p)$ can take on values between minus infinity and plus infinity. Therefore we may write

$$\ln\left[\frac{p}{1-p}\right] = \beta_0 + \beta_1 x_1 \quad (1)$$

Equation 1 is called the *logistic regression model* because the transformation of p to $\ln\left[\frac{p}{1-p}\right]$ is called the

logit transformation. Equation 1 may also be written as

$$p = \frac{\exp(\beta_0 + \beta_1 X)}{1 + \exp(\beta_0 + \beta_1 X)} \quad (2)$$

In which \exp is the inverse of the natural logarithm.

Multiple logistic model are constructed by expanding equation 1 and 2. If we begin with Equation 1 multiple logistic regressions can be represented as

$$\ln\left[\frac{p}{1-p}\right] = \beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j} + \dots + \beta_k x_{kj} \quad (3)$$

Using the logit transformation, we now have

$$p = \frac{\exp(\beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j} + \dots + \beta_k x_{kj})}{1 + \exp(\beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j} + \dots + \beta_k x_{kj})} \quad (4)$$

Computer software packages that perform the logistic regression frequently provide as part of their output estimates of β_i and the numerical value of the odds ratio.

As it runs out the odds ratio is equal to $\exp(\beta_i)$ Daniel, W.W.(2009) where $i=0,1,2, \dots k$.

IV. RESULTS AND DISCUSSION

In our study area 35% practicing captive power generation by using Biogas from poultry litter. This study found that the most of the respondents were poultry farm owner. Out of 100 respondents 95% was male and only 5% female respondent. The quantity of female respondent was less due to male ownership dominance in poultry farm. This survey divided 5 different age group of respondent from less than 25 years to above 55 years old respondent. Finally the study found **Table: 1** that 45% poultry farmers were of aged 25-35, 33% poultry farmers were of aged more than 35-45 years and least number of poultry farmers were of age group more than 55 years. The

experienced poultry farmers were replied the questionnaire, which describe in **Table: 1**. Less than one year experienced poultry farmers were the highest number of respondent 29%, both of 1-3 years and more than 3-5 Years experienced poultry farmers were 26%, and only 19% poultry farmer's experience were more than 5 years. It shows that most of the poultry owner and manager are less experience in poultry farms. Gazipur district is one of the most densely poultry populated districts in Bangladesh. The district has about 10% of the total poultry farms in the country²². In the study we found that 97% poultry farmers having farm sized 1000-5000 birds. Rest only 3% of the total farmers having farm of size more than 5000 -15000 birds.

Table 1: Percent distribution of the farmers according to different background factors

Poultry farmer practicing biogas at farm and background factors	Percent
Practicing biogas at farm	
Yes	35.0
No	65.0
Sample size (n)	100
Gender	
Male	95.0
Female	5.0
Sample size (n)	100
Age	
Less than 25 years	10.0
25-35 years	45.0
More than 35-45 years	33.0
More than 45-55 years	10.0
More than 55 years	2.0
Sample size (n)	100
Experience in poultry farming	
Less than 1 year	29.0
1-3 years	26.0
More than 3-5 years	26.0
More than 5 years	19.0
Sample size (n)	100
Farm size	
1000-5000 birds	97.0
More than 5000-15000 birds	3.0
Sample size (n)	100
Does it cheap to establish biogas plant	
Yes	34.0
No	66.0
Sample size (n)	100
Does it save money for electricity	
Yes	62.0
No	38.0
Sample size (n)	100
Does it easy to manage	
Yes	39
No	61
Sample size (n)	100
It does not need extra manpower	
Yes	4.0
No	96.0
Sample size (n)	100

Bivariate Analysis

Our aim is to find out the factors which affecting the use of poultry litter based captive power generation using biogas technology. The findings from the chi-square analysis are discussed below

Table 2: Identifying the factors on which the biogas based captive power generation depends

Name of the variables	Chi-square	Significance level
Experience in poultry farming	2.293	0.514
Satisfaction on income from poultry farm	3.846	0.0500*
Number of electric lights using at farm	19.742	0.000***
Number of electric fans using at farm	21.789	0.000***

The chi-square value shows that there is no association between uses of poultry litter based captive power generation using biogas technology and experience in poultry farming. The value of the chi-square indicates that there may have association between poultry litter based captive power generation using biogas technology and satisfaction on income from poultry farm. However, the association is not strong. If we look at the chi-square value we see that there is strong association of poultry litter based captive power generation using biogas technology with number of lights using at and number fans using at farm.

Factor Affecting Poultry Litter Based Captive Power Generation

Application and interpretation of logistic regression technique is different from usual regression technique. Fitting logistic regression requires categorization of variables. At this stage we initially categorize dependent variable use of poultry litter based captive power generation using biogas technology. Subsequently we take the influencing variables like age, gender, experience in poultry farm, number of lights using at poultry farm etc. The table 3 explains categorization of the variables under study.

Table 3: Criterion of variables used in the logistic regression

Variable	Code	Abbreviation
Using biogas technology at poultry farm for captive power generation	0=not using BGT at poultry farm for CPG 1= using BGT at poultry farm for CPG	BGT for CPG
Age
Gender	0=female, 1=male
Experience in poultry farming	1=less than one year 2=1+ to 3 years 3=3+ to 5 years 4=more than 5 years	EPF
Size of poultry farm	1=1000-5000 birds 2=more than 5000 birds	

Using electricity at farm	0=not using, 1= using	EF
Number of electric lights using at poultry farm	0=not using EL 1=less than 10 EL 2=more than 11 EL	NEL
Number of electric fans using at poultry farm	0=not using 1=less than 5 EF 2=more than 5 EF	NEF
Satisfaction on	1=not satisfied	SIPF

income from poultry farm	2=satisfied	
Need any training on biogas technology	0=no need training 1=need training	NTBGT

Searching for the influencing factors for using biogas technology at poultry farm for captive power generation through logistic model is little bit complex. The entire analysis performed through different stages.

Independent Variable	Dependent variables: Using biogas technology at poultry farm for captive power generation			
	B	Wald Statistics	Significance level (P-value)	Odds ratio Exp(B)
Age	.042	1.355	.244	1.043
Gender	.108	.003	.955	1.114
EPF		3.944	.268	
1+ to 3 years	.526	.487	.485	1.692
3+ to 5 years	-1.102	1.522	.217	.332
more than 5 years	.489	.314	.575	1.631
EF	1.526	1.145	.285	4.600
NEL		1.276	.528	
less than 10 EL	1.699	1.232	.267	5.469
more than 11 EL	1.474	.969	.325	4.368
NEF		4.149	.126	
less than 5 EF	1.019	.529	.467	2.772
more than 5 EF	2.668	3.279	.070*	14.410
SIPF	-.603	1.031	.310	.547
NTBGT	3.306	3.864	.049**	27.268
Constant	-5.960	4.460	.035	.003

Note * represents significant at 10% and ** represents significant at 5%

We have tried to bring all of the factors that seem to be apparently viable to influence using biogas technology at poultry farm for captive power generation. Here Number of electric fans using at poultry farm and Need any training on biogas technology are found significant in explaining using biogas technology at poultry farm for captive power generation.

The logistic analysis for the above model shows that poultry farmers using more than 5 electric fans at poultry farm has a significant and positive relationship with the uses of biogas technology at poultry farm for captive power generation. For the farmers using more than 5 electric fans at farm it is observed that the odds ratio is 14.41. So the farmers using more than 5 electric fans are 14 times to Using biogas technology at poultry farm for captive power generation.

Need any training on biogas technology is the next determinant where odds ratio is found 27.268. That is the farmers feels necessity of training on biogas technology is 27 times favorable to Using biogas technology at poultry farm for captive power generation than the farmers feels training not necessary. Though the factors using electricity at farm, number of electric lights at farm have no significant effect on captive power generation using biogas

technology, the farmers not using electricity at farm was around 4 times interested in using biogas at farm and the poultry farmers using less than 10 and more than 11 electric lights at farm were 5 and 4 times more favorable to use biogas at farm to generate power respectively than the farmers not using electric lights at farm. But the factors Age, Gender and Experience in poultry farming have no impact on use of biogas technology to generate captive power.

V. CONCLUSION

This study found the capital of poultry Gazipur has huge potential to use Biogas technology for producing captive power and organic fertilizer. The extracted energy from biogas technology and fertilizer can replace fossil produced fuels and chemical fertilizer. Further, the plant reduces methane emissions from the waste, therefore considerable amounts of greenhouse gases can be cut down. It can improve the soil quality and the reduction of nitrate erosion protects the ground water. The poultry farm owners those are having biogas plant are much interested to continue and those are using biogas only for cooking purpose also showed interest to establish biogas at

their premises. The study found the positive impact of captive power generation using biogas plant.

REFERENCES

- [1] Ahmed H. and Khalid M.B. (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): 313-322
- [2] Ali, Monshof, (2005). The Use and Status of Biogas Plants in Pabna District in Bangladesh. M.Sc. thesis, SESAM, Institute of International Management, University of Flensburg, Germany.
- [3] Daniel W.W. (2009): *Biostatistics Basic Concept and Methodology for the Health Sciences* (9th ed.), John Wiley & Sons, Inc.
- [4] Nes Wim J. van, Willem Boers and Khurseed-Ul-Islam (2005). Feasibility of a national programme on domestic biogas in Bangladesh, Netherland Development Organisation, Hague, Netherland
- [5] Hossain, Ijaz and M. Tamim (2005/2006): Energy and Sustainable Development in Bangladesh. In: Sustainable Energy Watch 2005/2006, HELIO International.
- [6] NEP (2006). National Energy Policy (Draft). Ministry of Power, Energy and Mineral Resources, People's Republic of Bangladesh.
- [7] Hall, D.O. and Rao, K.K.: 1999, Photosynthesis, 6th Edition, Studies in Biology, Cambridge University Press.
- [8] Boudri J.C., Hordijk L., Kroeze C. and Amann M., The potential contribution of renewable energy in air pollution abatement in China and India, *Energy Policy*, 30 (2002): pp. 409-424
- [9] José Goldemberga, , , Suani Teixeira Coelho, Renewable energy—traditional biomass vs. modern biomass, *Energy Policy*, Volume 32, Issue 6, April 2004, Pages 711-714

AUTHOR'S PROFILE



Roshidul Hasan

Md. Roshidul Hasan is sterling Associate Professor of Computer Science and Information Technology at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh. He has completed his undergraduate (B.E. in CSE) at Bangalore University, India in 1999 and Ph.D. in GIS and Geomatic Engineering from University Putra Malaysia, Malaysia. He has been on the faculty member of BSMRAU since January 2001. Currently Dr Roshidul is Head of the department of Computer Science and Information Technology and Proctor of the University.

His research has focused on ICT for development and Natural Language for Spatial representation. The results of these activities have been published on several articles in renewed international conference and journals. He has copy righted research product, SMAL (Spatial Macro Language) which is macro language for spatial representation using natural language. The SMAL is widely used in the field of GIS & Remote Sensing, and autonomous machine to represent Line-Region or Line-Polygon relationship. He has vast experienced in the field of Spatial Technology, ICT for development, and Telecenter movement.

Author is serving as editor of several scientific journals and currently serving as a Managing Editor of the American Journal Agricultural Science Engineering and Technology. He served as head of the secretariat of World Engineering Congress 2010, and The MRSS 6th International Remote Sensing & GIS Conference and Exhibition 2010. He has experienced as Lead Convener of organizing several international events including GIS Day in Malaysia.

In 2010, he was awarded GOLD MEDAL in University lever research competition (PRPi2010) Malaysia in the research and Innovation category. The title of his research was Developing Macro Language Representing Spatial Relationship in Natural Language. In 2011, he was also awarded GOLD MEDAL in international research competition ITEX 2011 at Kuala Lumpur Convention Center, Malaysia in the research and Innovation category. The title of his research was Spatial Macro Language.