

Biogas Plant Owner's Opinion about the Impact of Biogas on Health and Environment in Bangladesh

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ABSTRACT: The present study was designed to know the opinion of biogas plant owners about the impact of biogas on health and environment. Most of the respondent (86.14%) does not pay any money for cooking. Hundred percent male and female ranked cooking as the number one cause of biogas plant installation. Eighty percent male and 90% female said that biogas improved their mental health, 70.30% male and 80.39% female agreed that biogas improved their physical health and 90.3% male and 69.6% female agreed that biogas improved their financial condition. A significantly higher number of male and female thought that various diseases were either decreased or no change was observed after installation of biogas plant. A significantly higher number of male and female thought that adverse effects of traditional cooking through biomass was greatly decreased after biogas plant installation. Around 84 to 95% male and 89 to 94% female thought biogas could have decreased various pollutants that may have adverse effect on environment. Biogas could be the most successful models of renewable energy in Bangladesh.

KEYWORDS: Biogas, Impact, Health, Environment, Diseases.

I. INTRODUCTION

Biogas is produced by methanogenic bacteria while acting upon the biodegradable materials in an anaerobic condition [1]. It is composed of 50 to 70% methane (CH₄), 30 to 40% carbon dioxide (CO₂), and some trace gasses like Hydrogen, Nitrogen, Hydrogen Sulphide [2, 3]. As biogas has 70% methane, it could be used as a source of energy. Energy content of biogas can also be transformed into various other forms such as mechanical energy (for running machines) and heat energy (for cooking and lighting) through combustion [4]. Furthermore, the slurry produced in the process of biogas production also used in agriculture as bio-fertilizer to increase crop production and to decrease fertilizer cost. Biogas can contribute to the reduction of greenhouse gas emissions by substituting fossil energy sources [5]. As a result, production of biogas has got tremendous attention for mitigation harmful effects of carbon on environment.

Despite its multiple benefits for the empowerment of rural households, there is dearth of studies which assess the plant owners' opinion about the impact of biogas on health and environment in Bangladesh. The main purpose of this study was to provide some empirical information about biogas plant owners' views on the effects of biogas on health and environment.

II. RELATED WORK

Any plant or animal based material deliberately burned by humans is known as biomass fuel. The most common bio-fuel is wood; however the use of animal dung and crop residues is also widespread in all most all developing and underdeveloped countries [6]. The combustion of solid biomass fuels constitute the primary source for domestic energy needs, such as

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cooking, light, and warmth for more than 50% of the world's population [7]. In Bangladesh, the dependency on biomass for cooking is even higher. Khan [8] reported that majority of rural people uses traditional energy sources-nearly 70% of total energy consumption comes from traditional biomass sources. Some early study revealed that only 3% citizen has grid connection of gas for cooking [9]. Extension of grid line for gas supply is not easy for a country like Bangladesh [10]. Installation of biogas plant for individual family or community based biogas plant for a group of families could solve the necessity of grid line extension and improve the energy utilization by rural people.

Bangladesh has many favorable features for biogas production. The climate is close to ideal with modest seasonal variations in temperature, and mostly warm temperatures throughout the year due to the prevailing tropical/subtropical climate [11]. Furthermore, Bangladesh has huge number of poultry and dairy farms which produce approximately 186,000 tons of dung per day [12]. Therefore, raw materials in the form of cow dung are widely and cheaply available throughout the country. On the other hand, the uncontrolled decomposition of organic solid waste can result in large-scale contamination of soil, water, and air [13]. If the organic component of the solid waste is converted into energy through anaerobic digestion, it will reduce the adverse impact on the environment and contribute to reduce the consumption of fossil fuel [11].

In Bangladesh, the energy required for cooking constitutes the biggest share of the total national energy consumption and is normally met by biomass [14]. According to Ghimire [15] traditional biomass-fired cooking stoves have two major drawbacks like low efficiency and indoor air pollution created by pollutants released inside the kitchen. Women are often obliged to breathe this polluted air as they remain in the kitchen. Young children who accompany their mothers during cooking and other household's activities are also prone to adverse effect of air pollution [16]. Air pollution in general and indoor air pollution in particular have been associated with various diseases like ocular and respiratory diseases. Numerous studies reported that exposure to biomass smoke is a significant cause of health problems such as acute respiratory infections (ARI) in children, chronic obstructive lung diseases (such as chronic bronchitis and asthma), lung cancer and pregnancy-related outcomes [17-19]. However, proper utilization of biomass for energy production through biogas is much less harmful than traditional use of biomass.

Potential of scientific utilization of biomass energy as an alternative source of energy, and the ecological, social, cultural and economic impacts of biogas technology was studied by some authors like Omer and Fadalla [20], Prasertsan and Sajjakulnukit [21], and Yu et al. [22]. Some reports also available in Bangladesh context [11, 23-25]. According to Gautam et al. [26], the biogas could help any nation in many ways through income generation, life style improvements and cost saving. The authors also discuss different types of benefits of biogas such as health, education, employment generation, reduction in fuel consumption.

III. MATERIAL AND METHODS

3.1 Selection of study area and participant

The study was conducted in three districts of Bangladesh namely Pabna, Tangail and Mymensingh. Twenty five villages were purposively selected to attain the objective of the present study. Dairy farm activities were considered during this study. Farmers earning at least 25% of their total income from dairy were considered as dairy farmers. Two hundred and sixty seven respondents were included in this study.

3.2 Development of the questionnaires

The questionnaires were developed with both open and closed form of questions. However, the first part of questionnaire has some short answer type of questions about respondent personal and livestock farming information like name and address, family size, biogas plant size, monthly income, expenditure on cooking energy; those were measured through ordinary methods. There were seven choices for causes of biogas plant installation. The respondent could choice one or more causes. Three dichotomous types of questions were used to judge the impact of biogas on family life. The

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respondent’s opinions about the impact of biogas on occurrence of diseases and on environment were collected by asking five and four questions, respectively. Each question had three answer options like increased, decreased and no change.

3.3 Data collection

All the survey was conducted by the researchers themselves during September 2013 to March 2014. The researchers visited the farm and collected data directly talking with the biogas plant owners or their wives.

3.4 Data analysis

SPSS 18 was utilized to analyze the data. General descriptive statistics, frequency, frequency percentage were used to present the data. Pearson chi-square test was used to analyses the relationship of farm size to family size of the respondents. Chi-square test (test for goodness of fit) was used to judge the equality in four expenditure category. The differences in opinion of male and female about the causes of biogas plant installation, impact of biogas on family life, incidence of diseases after biogas plant installation and impact of biogas plant installation on environment were analyzed by Pearson chi-square test. The relationships were considered significant at 5% level of probability.

IV. RESULT

4.1 Selected characteristics of the biogas plant owner:

The basic information of the respondents regarding their family size, farm size, biogas plant size and monthly income level are presented in Table-1.a. Most of the biogas plant owners have small family size (39.7%) and 22.8% plant owner has large family size having more than 8 members. Around 71.2, 19.9, and 9% farm size was small, medium and large, respectively. The most popular size for biogas plant was 2.4 cubic meters followed by 4.8, 3.2, and 2.0 cubic meters. Most of the respondents were in high income group (61.40%) compared to upper medium (26.6%), medium (9.4%) and low (2.6%) income group. The frequencies of farm size to family size were presented in Table 1.b. Pearson chi-square test shows that there was highly significant relationship among the family size to farm size; whereas the frequencies number is decreasing with increasing the family size and farm size of the respondents.

Table 1.a Socio-demographic study of respondent family

Selected Characteristics		Respondents N=267	
		Number	Percent
Family Size	Small (below 5)	106	39.70
	Medium (5-8)	100	37.50
	Large (above 8)	61	22.80
Farm Size	Small (below 7)	190	71.20
	Medium (7 – 15)	53	19.90
	Large (above 15)	24	9.00
Biogas plant size	4.8 Cubic meter	86	32.21
	3.2 Cubic meter	48	17.98
	2.4 Cubic meter	117	43.82
	2.0 Cubic meter	16	5.99
Income Level (monthly in taka)	Low (below 5,000)	7	2.60
	Medium (5,001-12,500)	25	9.40
	Upper medium (12,501-20,500)	71	26.60
	High (above 20,500)	164	61.40

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Table 1.b Frequencies and Chi-Square results of family size and farm size of the respondents

Cross tabulation of family size vs farm size		Farm size			Pearson Chi-Square Asymp. Sig. (2-sided)
		Small	Medium	Large	Family size vs. Farm size
Family size	Small	94	6	6	0.000
	Medium	53	35	12	
	Large	43	12	6	

4.2 Respondents monthly expenditure on cooking

The frequency distribution of respondent’s monthly expenditure on cooking is presented in Table 2. Most of the respondent (86.14%) do not pay any money for cooking while only 1.1% respondent expense above 500 taka for cooking (1 USD = 78 Taka). There were highly significant differences among the expenditure categories at 5% level of probability.

Table 2. Frequency distribution of respondents for monthly expenditure on cooking

Expenditure in taka*	Number of house hold	Percentage	X ² -test (Testing Goodness of Fit)
No cost	230	86.14	0.000
below 250	29	10.86	
250-500	5	1.87	
above 500	3	1.12	

*(1 USD = 78 Taka)

4.3. Causes of biogas plant installation

The percentage frequency of causes of biogas plant installation is presented in Table 3. Data shows that differences exist in some areas of causes of biogas plant installation in male and female and in some areas they have similar thinking. Hundred percent male and female ranked cooking as the number one cause for biogas plant installation. In case of male, the second priority was bio-fertilizer (80%), followed by save time (70.3%) and least important was reduction of diseases (6.1%) followed by improvement of house hold environment (10.3%). In case of female, the second priority was save time (100%), followed by improvement of household environment (67.7%), and least important was production of electricity (9.8%) followed by reduction of disease (17.75%). There were significant differences in male and female opinion about save time, use of bio-fertilizer, reduce disease and improve house hold environment while in differences was observed in cooking, use of electricity and save energy cost.

Table 3. Percentage frequency of respondents due to causes of biogas plant installation

Causes of biogas plant installation	Male (n=165)		Female (n=102)		Pearson Chi-Square Asymp. Sig. (2-sided)
	Number	Percentage	Number	Percentage	Gender
Cooking	165	100	102	100	NS
Electricity	28	16.97	10	9.80	NS
Save energy cost	41	24.85	20	19.61	NS
Save time	116	70.30	102	100	0.000
Bio-fertilizer	132	80.00	20	19.61	0.000
Reduce diseases	10	6.06	18	17.65	0.003
Improve house hold environment	17	10.30	69	67.65	0.000

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4.4. Impact of biogas on family life

The impact of biogas on family life was determined by asking three questions and presented in Table 4. Most of the respondent agrees that biogas improved their mental, physical and financial condition. Eighty percent male and 90% female said that biogas improved their mental health, 70.30% male and 80.39% female agreed that biogas improved their physical health and 90.3% male and 69.6% female agreed that biogas improved their financial condition. However, significant differences exist in male and female respondents' opinion for improvement of mental and financial condition at 5% level of probability.

Table 4. Frequency distribution of respondents due to impact of biogas on family life

Impact of biogas on family life	Male (n=165)		Female (n=102)		Pearson Chi-Square Asymp. Sig. (2-sided) Gender
	Number	percentage	Number	percentage	
Improvement of mental health	132	80.00	92	90.20	0.028
Improvement of physical health	116	70.30	82	80.39	NS
Improvement of financial health	149	90.30	71	69.61	0.000

4.5 Impact of biogas on incidence of diseases

The frequency distribution of incidence of diseases after biogas plant installation is presented in Table 5. A significantly higher number of male and female thought that various diseases were either decreased or no change was observed after installation of biogas plant. Only 0.61 to 3.03 % male and 0.98 to 3.92% female thought that diseases increased after biogas installation while 44.85 to 58.79% male and 50 to 65.69% female thought diseases decreased after biogas installation. Among the various diseases, 58.79% male thought respiratory diseases were reduced the most while 65.69% female thought eye infections were reduced the most. There were no significant relationships of gender to different diseases.

Table 5. Frequency distribution of incidence for diseases after biogas plant installation

Disease	Male (n=165)			Female (n=102)			Pearson Chi-Square Asymp. Sig. (2-sided) Gender
	Increased	Decreased	No change	Increased	Decreased	No change	
Eye Infection	2(1.21)	92(55.76)	71(43.03)	2(1.96)	67(65.69)	33(32.35)	NS
Respiratory Disease	2(1.21)	97(58.79)	66(40.00)	1(0.98)	62(60.78)	39(38.24)	NS
Antemithiasis	1(0.61)	74(44.85)	90(54.55)	1(0.98)	51(50.00)	50(49.02)	NS
Diarrhoea	1(0.61)	95(57.58)	69(41.81)	1(0.98)	53(51.96)	48(47.06)	NS
Headache	5(3.03)	81(49.09)	79(47.88)	4(3.92)	59(57.84)	39(38.24)	NS

Values in the parenthesis indicates percentage

4.6 Impact of biogas on environment

The frequency distribution of the impact of biogas plant installation on environment is presented in Table 6. A significantly higher number of male and female thought that adverse effects of traditional cooking by biomass was greatly decreased after biogas plant installation. Only 0 to 1.82 % male and 0 to 0.98% female thought that biogas could have adverse effect on environment while 84.24 to 95.15% male and 89.22 to 94.12% female thought biogas could have decreased various pollutant that may have adverse effect on environment. There were insignificant relationships of gender to different environmental impact.

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Table 6. Frequency distribution of incidence for environmental impact after biogas plant installation

Environmental impact	Male (n=165)			Female (n=102)			Pearson Chi-Square Asymp. Sig. (2-sided)
	Increased	Decreased	No change	Increased	Decreased	No change	
Bad smell in household area	1(0.61)	139(84.24)	25(15.15)	1(0.98)	94(92.16)	7(6.86)	NS
Smoke in kitchen	3(1.82)	142(86.06)	20(12.12)	1(0.98)	93(91.18)	8(7.84)	NS
Dirt in surrounding	2(1.21)	142(86.06)	21(12.73)	1(0.98)	91(89.22)	10(9.80)	NS
Destruction of fire wood	0(0.00)	157(95.15)	8(4.85)	0(0.00)	96(94.12)	6(5.88)	NS

Values in the parenthesis indicates percentage

V. DISCUSSION

Biogas is the most reliable, easily available and economically feasible source of alternative and renewable energy which can be managed by locally available sources and simple technology in the rural villages of Bangladesh. However, adoption of any technology largely depends on the realization of the benefits of that technology by the target group of people. In the present study, we have analyzed the effects of biogas plant operation on health and environment by household opinion survey through direct interviewing the plant owners. Our results revealed that plant owners have positive thinking about biogas and they thought biogas improve their living condition, reduced the disease incidence caused by smoke and orofecal contamination.

Biogas technology has been introduced and developed quite a long time in Bangladesh .The first biogas plant in Bangladesh was established in 1972 at Bangladesh Agricultural University, Mymensingh campus [11]. Lately, Bangladesh has 55,000 biogas plants all over the country [4]. However, the potential is much more than the installed biogas plants. As an agricultural country, Bangladesh has 24.48 million cattle and buffalo, 21.6 million Goats, 2.8 million sheep, 212.5 million chicken and 39.8 million ducks [27]. As a result, huge amount of livestock wastes generated daily. These renewable waste materials from livestock sources alone or together with other agricultural, industrial or domestic wastes could be converted to useful energy forms like biogas for sustainable growth of Bangladesh [13, 28-30].

The socioeconomic data of the present study revealed that monthly income of most of the biogas plant owner is quite high. The average monthly income in Bangladesh is USD 98 while more than 80% of dairy farmers make USD 162 per month. An earlier study by Shamsuddin et al. [31] reported that dairy and poultry farmers are more solvent group of people in Bangladesh. Our result showed that dairy farmers are making much money still they spend very less in cooking fuel. Eighty six percent respondents spend no money for cooking. Cooking fuels in the rural areas of Bangladesh are predominantly unprocessed bio-fuels, such as fuel-wood, crop residues and animal dung [4]. Females and children usually collect these for cooking. Time spends and physical labor for collection of these bio-fuels is greatly overlooked by the society. There is no data for Bangladesh about how much time female and/ or children spend for collection of fire fuel. Some study from Nepal revealed that females and/ or children could save average 50 to 93 minutes per day after biogas plant installation [32, 33].

Biogas has a number of benefits to rural households along with reducing greenhouse gas emissions. Beside carbon revenue, other tangible benefits associated with this technology are availability of clean energy, availability of organic fertilizer, time saving on daily household works, improvement in sanitation and health, cleanliness in and around the house, environmental protection and employment generation [34, 35]. Our data revealed that the causes of biogas plant installation have some differences among male and female. All the respondents of present study said that cooking was the main cause for biogas

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plant installation. However, significant differences exist among male and female's thinking about other causes of biogas plant installation. Significantly higher number of females voted for time saving, reduced diseases and improved house hold environment while male voted for bio-fertilizer as a cause of biogas plant installation. This variation may result from respondents experience and usage of biogas like males use bio-fertilizer for cultivation and traditionally females do house hold activities.

Females are more beneficiary from biogas because the reduction in the physical stress in terms of fuel wood collection, cooking and cleaning utensils is remarkable. Biogas burns with blue flame without emitting smoke and it is CO₂ neutral. Katuwal and Bohara [32] reported that biogas has brought households and kitchen smoke and ash free and made cooking easier, faster and healthier. Similarly, in our study this has got reflection on respondent's opinion like significantly higher number of female give their opinion that biogas improved their physical and mental health while males voted for financial condition. As women and children could have saved time after the biogas plant installation, they get more rest and recreation even they have been able to spend their saved time in more productive works such as education and other social activities. Increased use of slurry on farm as manure would likely to increase the production of cereal crops, fruits and green vegetables. Moreover, tendency towards raising stall fed milking cow and buffalo to meet slurry requirement for the biogas plant would increase supply of milk and milk products in the households.

Obnoxious smokes are usually produced as a result of cooking by firewood and dung cakes. Indoor air pollution is one of the most direct physical health risks and exposure to biomass smoke increases the risk of respiratory diseases such as acute lower respiratory infection. It also increases the risk of bronchitis, asthma, lung cancer, ear infection etc [34]. Utilization of biogas for cooking reduced smoke in the kitchen. Therefore, it could reduce eye or respiratory diseases. On the other hand, proper disposal of cow manure and other farm house dirt could improve general hygiene and could reduce gastrointestinal diseases caused by oro-fecal contamination. The results of the present study are also in consensus with this. However, some differences in opinion of male and female were observed like 65.69% female said biogas reduced eye diseases while 55.76% male gave the same answer. Similarly, for reduction of every disease females were more positive than males. This may be due to direct utilization of biogas by females.

The result of present study revealed that both the male and female respondents are well aware about the impact of biogas on house hold environment as well as the general environment. During survey, more visible questions about environmental benefits of biogas were asked rather than indirect benefits like reduction of carbon, global warming, or green house effects. Katuwal and Bohara [32] reported that utilization of biogas reduced the consumption of firewood and thus slows the process of deforestation.

VI. CONCLUSION

In conclusion, biogas could be the most successful models of renewable energy in Bangladesh. Biogas could uplift the socio-economic status of its users because of its multiple benefits to the households, community and the country. It has direct impact on health, environmental and agriculture. The prospects of biogas are very high as the biogas plant owners in Bangladesh are well aware of various benefits of biogas and they have very positive views about biogas plant.

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