



Impact of Community Biogas Plant Implemented by Rural Development Academy in Rural Areas of Bogura, Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author NM designed the study, managed the literature searches, conducts field survey and wrote the first draft of the manuscript. Author LB conduct field survey, managed the literature searches and performed the statistical analysis. Author SKS wrote the protocol, supervised the research, monitor field survey and finalized the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This paper determined the impact of community biogas plant implemented by rural development academy in rural areas of Bogura, Bangladesh. Data were collected by structured questionnaire having open and closed form questions. Researchers collected data with the help of BCS health care foundation trainees from the selected 68 families who were the direct beneficiaries of community biogas plant. Focus group discussion and information from union parishad were also taken into consideration. The research found that biogas plant is useful to produce a renewable, high-quality fuel i.e. biogas which is using as a alternative of biomass fuels (firewood and dried dung) for meeting energy utilization demands. In the past fuel demand was fulfilled by deforestation and land degradation which results in different health and societal problems and also cause excessive emission of greenhouse gases. Biogas is used for cooking, lighting, heating and feedstock etc while slurry of biogas increases soil fertility and taste of foods. Number of cattle also increases for biogas plants. The biogas production derives from various agricultural resources, such as manure and harvest remains enormously available. Biogas technology represents a sustainable

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way to produce energy for household, particularly in developing countries. It can be cost-effective and environment friendly technology for the people in rural areas. So, Biogas can be a best substitute of biomass fuels for use in rural areas.

Keywords: Community biogas; impact; rural area.

1. INTRODUCTION

1.1 General Background

Agriculture is an important sector in the economic development and poverty alleviation drive of Bangladesh. The role of agriculture has played in the industrial growth and development of most of the industrialized countries in the world cannot be over emphasized. Agriculture in Bangladesh is the way of life of the rural people. Despite its declining importance as a contributor to the Gross Domestic Product (GDP), agriculture still represents an important sector to the national economy and to rural livelihoods in Bangladesh [1].

Livestock's are domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, and wool. The term is sometimes used to refer solely to those that are bred for consumption, while other times it refers only to farmed ruminants, such as cattle and goats.

Animal husbandry practices have varied widely across cultures and time periods. Originally, livestock were not confined by fences or enclosures, but these practices have largely shifted to intensive animal farming, sometimes referred to as "factory farming". Now, over 99% of livestock are raised on factory farms [2]. These practices increase yield of the various commercial outputs, but have also led to negative impacts on animal welfare and the environment. Livestock production continues to play a major economic and cultural role in numerous rural communities.

1.2 Significance of the Study

Biogas refers to gas produced by fermentation of organic matter [3] which is primarily methane (CH₄) and carbon dioxide (CO₂) and may have small amounts of hydrogen sulfide (H₂S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat for cooking [3].

Biomass is the material from living, or recently living organisms and covers all kinds of organic matter from fuel wood to marine vegetation [4] and can be recycled into gas [3]. It also includes trash, animal waste/dung, cornstalk, corncobs which can be used to produce electricity and biofuels [5]. Biomass is considered as a resource that can yield valuable energy and fertilizer. Bio-residue is used in many countries; if this biodegradable waste is treated in an anaerobic digester it can produce environmentally sound energy and fertilizer, globally it is the fourth largest sources of energy in the world, providing about 14% of primary energy [6].

Developing countries get as much as 35% of their energy from biomass and in some countries it accounts for nearly 90% of the total energy used in the form of traditional fuels, e.g. fuel wood and dung [7]. The use of biogas from agricultural waste is increasing because of its environmental benefits and as an additional source of income for the farmers. The closed system cycle of nitrogen due to bio-slurry usage helps maintain soil fertility as nitrogen is held within the system. Biogas is produced as a result of metabolism of methane bacteria, when the bacterium decomposes some organic material this decomposition requires water [8].

Biogas usage gained momentum due to the solid and liquid waste treatment. In developing countries this technology appears attractive as it addresses the problem of scarcity of firewood, and indoor air health related problems due to burning of biomass. It can save a lot of time and labor for women in cleaning, washing and cooking activities [9].

Biogas plant has become common in countries like Bangladesh, China, India and Nepal. The use of biogas has helped relieve women from the drudgery of cooking with firewood, which produces hazardous smoke [5]. Biogas plant is helpful in reducing deforestation in several ways. Lower usage of firewood has had an impact but also the fact that slurry fertilizer have been returned to the fields which have raised the soil quality, giving better harvests and thereby reduced the need for exploitation of new agricultural land which also had a positive impact on deforestation rates.

1.3 Statement of the Problem

Rural Development Academy, Bogura established several biogas plant projects at different villages. From an energy point of view, sustainable development demands the access to clean, safe, reliable and affordable energy sources [10]. Renewable energy sources (RES) can help achieve energy sustainability objectives as they offer benefits for energy security, greenhouse gases (GHG) mitigation, job creation, rural development and energy access. It is estimated that RES supplied 16.7% of global final energy consumption in 2010, most of which through some form of biomass energy. In respect of that biogas plant is extensively disseminating in different parts of our country. But there is not enough data that how much extent the village peoples are benefited by this plant. So there has an urgent need of research to know the impacts of biogas plant in farming level.

1.4 Objectives of the Study

The general objective of this research is to determine the overall impact of biogas plant implemented by Rural Development Academy, Bogura in rural areas of Bogura district in Bangladesh.

The following specific objectives were taken into consideration to conduct the study:

- a. To determine and describe the socio-economic condition of the farmers' families.
- b. To assess the impact of biogas plant.
- c. To find the opportunities created through biogas plant.
- d. To know the problems faced by the farmers' using biogas plant.

2. METHODOLOGY

2.1 Area of the Study

The present study was conducted in different villages of Sherpur and Shahjahanpur upazila under Bogura District where biogas plant has been installed by Rural Development Academy, Bogura.

2.2 Population and Sample

The total beneficiary families of biogas plant from Sherpur and Shahjahanpur upazila were the population of the study. The list of populations

was collected from concerned officials of Rural Development Academy, Bogura. Among 450 beneficiary families, 68 families were selected as sample by simple random sampling method. The margin of error was set at $m=0.10$ in this study.

2.3 Research Instrument

An interview schedule was prepared mostly with close form questions. Simple questions and statements were included in the questionnaire to obtain information regarding the research topic. Scales were developed for suitable scores. The questionnaire was translated in Bengali for clarification to the respondents.

2.4 Measurement of Impact of Biogas Plant

Impact of biogas plant has been determined by making difference between data before and after implementation of the project. The upliftment of socio-economic conditions were considered as the positive impact of the study.

2.5 Data Collection Technique

Data were collected by the researcher team using structured questionnaire through face-to-face interview. During data collection desired rapport were established with the respondents before explaining the purpose of the research and collection of data. Data were collected during 15 January 2018 to 25 January 2018.

2.6 Data Management

Researcher checked, rechecked and edited all the questions of families or individuals and other entries in filling up questionnaires. Researcher also provided the necessary coding with specific code number for specific variables for completeness of the questionnaires followed by rechecking. Data were computerized with unique identifiers representing household number. Manual errors in data entry were avoided by checking frequencies of individual variables. Data were cleaned by necessary corrections and deleting outliers.

2.7 Software Used

General statistical software SPSS 22 and MS Excel were used for data analysis.

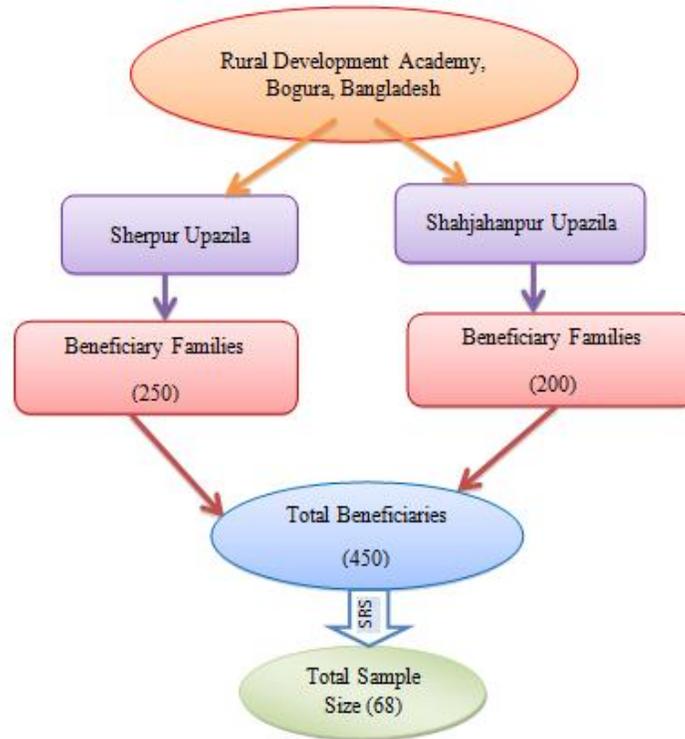


Diagram 1. Sampling procedure of the study

2.8 Data Analysis

Tabular analysis includes preparation of simple tables of proportions describing the concentration of categorical variables. *Descriptive statistics* includes computation of summary measures: means, proportions, etc. *Parametric methods* include significance test of mean differences of before and after use of biogas plant in farmers' families and other quantitative variables.

3. RESULTS AND DISCUSSION

3.1 The Socio-Economic Condition of the Farmers' Families

The research revealed that most of the respondents (32%) belongs to young age (21 to 30 years) followed by 28% belongs to 31 to 40 years old. It may be concluded that the maximum respondents are young aged who are innovative and want to take congratulate new ideas. The data has been presented in Table 1.

Receiving a technology, gender may have an influence. The research revealed that male respondents (67%) are higher than female (33%). It may indicate that females are also interested to apply biogas technology (Table 1).

The research found that most of the respondents (48%) reads up to secondary education followed by 14% can sign only, 18% passed SSC, 12% passed HSC and 8% completed graduation degree. The distribution of the respondents according to their education is shown in Table 1.

The research revealed that Main occupation of the respondents is agriculture (34%) which is the basic source of income whereas other sources also present. Besides agriculture, business (20%), service (12%), student (8%) and 26% of the respondent dependent on other occupations for their livelihood. The distribution of the respondents according to their occupation is shown in Table 1.

3.2 The Economic Benefits of Biogas Plant

3.2.1 Changes in number of livestock

The research found that the mean number of livestock of the farmers' families has been increased 50.0% after used biogas plant (Table 2).

Table 1. Distribution of socio-economic characteristics of the respondents

Variables	Categories	Respondents (%)
Age (years)	Less than 20	8.0
	20-29	32.0
	30-39	28.0
	40 and above	32.0
Gender	Male	67.0
	Female	33.0
Religion	Muslim	76.0
	Hindu	24.0
Education	Can sign only	14.0
	Read upto class 10	48.0
	SSC	18.0
	HSC	12.0
	Hon's	8.0
Main occupation	Farmer	34.0
	Service	12.0
	Business/Day labour	20.0
	Students	8.0
	Housewife	26.0
Households Size (Bigha)	Less than 1	58.0
	1-4	36.0
	5 & Above	6.0
Family Size	Small (1-4)	34.0
	Medium (5-6)	44.0
	Large (7 and above)	22.0
Earning family members	1 person	64.0
	2 and above	36.0
Monthly income (BDT)	Up to 4500	34.0
	4501 to 6500	42.0
	6501 to above	24.0
Monthly expenditure (BDT)	Less than 3000	28.0
	3000-4500	42.0
	More than 4500	30.0
Use of tubewell water	Yes	100.0
	No	0.0
Use of sanitary toilet	Yes	28.0
	No	72.0
Use of electricity	Yes	44.0
	No	56.0
Separation status of sleeping and cooking room	Yes	64.0
	No	36.0

3.2.2 Use of cowdung and poultry litre

The research revealed that about 60.0% farmers were used cowdung and poultry litre mainly to produce organic fertilizer. Besides this 32.0% farmers were used it as fuel and 8.0% were used it for selling as a poultry litre. The distribution of the respondents according to their used of cowdung and poultry litre was shown in Fig. 1.

3.2.3 Changes in cooking time

Mean cooking time of the farmers' families has been reduced 33.3% after using biogas plant compared to previous mean cooking time (Table 3). That means biogas plant saved the cooking time of housewife's of the farmers' families. The housewife got more time to do another work.

3.2.4 Changes in organic fertilizer used in the cultivating land

It was found from Table 4 that farmers' could save 37.5 % organic fertilizer through biogas plant. That means biogas plant reduced the cultivation cost and saved fertilizer. By this way, farmers' could save the money and economically benefited.

3.2.5 Increasing soil fertility

All the respondents (100.0%) opined that soil fertility has been increased by using biogas plant. The slurry of biogas was more nutritious than raw cow dung.

3.2.6 Increasing taste of vegetables

Taste of vegetables increased opined by 80.0% respondents of the study area. The result might be due to that the organic fertilizers were free from any kind of admixture. So their tastes become higher. This was shown in Fig. 2.

3.2.7 Changes in electricity line

Table 5 revealed that almost all the respondent (79.4%) used electricity from REB. Rest of them used solar (8.8%) and biogas energy (11.8%). This implied that biogas was also used for electricity. The farmers' who had not use electricity before because of high cost, they can use electricity now with lower cost or cost free.

3.2.8 Changes in crop production per bigha

After involvement with biogas plant, mean crop production scenario of the farmers' has been changed. The production capacity from same land has been increased which is presented in

Table 6. For this, farmers' were more economically benefited.

3.2.9 Changes in use of cowdung

The following Fig. 3 describes the change in use of cowdung. After involved with biogas plant, cowdung was mostly used (20.0%) for organic fertilizer preparation by the farmers', whereas before the involvement it was 15.0%.

Before the involvement, 8.0% farmers' families were used cowdung as fuel, but after involving with biogas plant it reduced to zero percent. That means nobody use cowdung as fuel, because they used biogas as fuel.

3.3 Opportunities Created through Community Biogas Plant

Biogas plant creates several opportunities for the beneficiary families which were listed by them. These were given below:

- Create opportunity to get training
- Getting loan
- Facility of cattle rearing
- Cooking gas
- Water supply
- Electricity supply
- Treatment of livestock
- Artificial insemination
- Help of ICT
- Organic fertilizer use
- Increase of productivity
- Improvement of environment
- Increase income
- Save cooking time
- Improve health
- Increase use of organic fertilizer
- Improve social status

Table 2. Change in mean number of livestock of the farmers' families after using biogas plant

Before the project	Mean number	After the project	Mean number	Increase
	16.0		24.0	50.0%

Table 3. Change in mean cooking time of farmers' families after using biogas plant

Biogas plant	Total time	Saving time
Before use	3 hrs	
After use	2 hrs	33.3 %

Table 4. Change in mean organic fertilizer used by the farmers' in the cultivating land

Biogas plant	Mean use of organic fertilizer	Saving organic fertilizer
Before used	400 Kg/Bigha	
After used	250 Kg/Bigha	37.5%

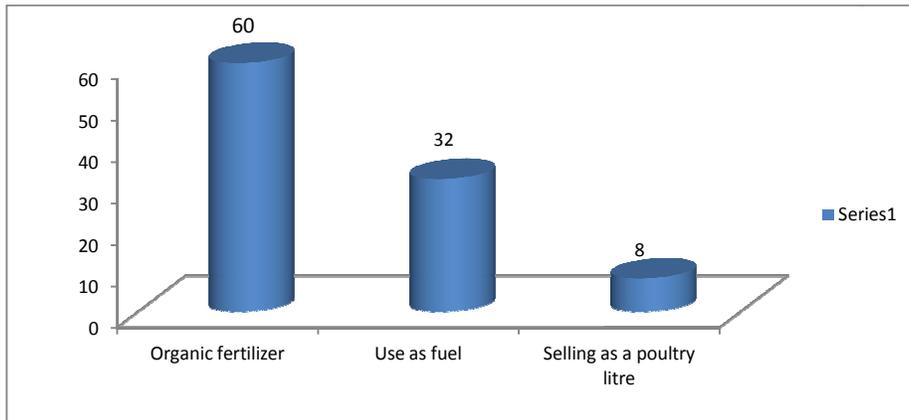


Fig. 1. Use of cowdung and poultry liter by the farmers

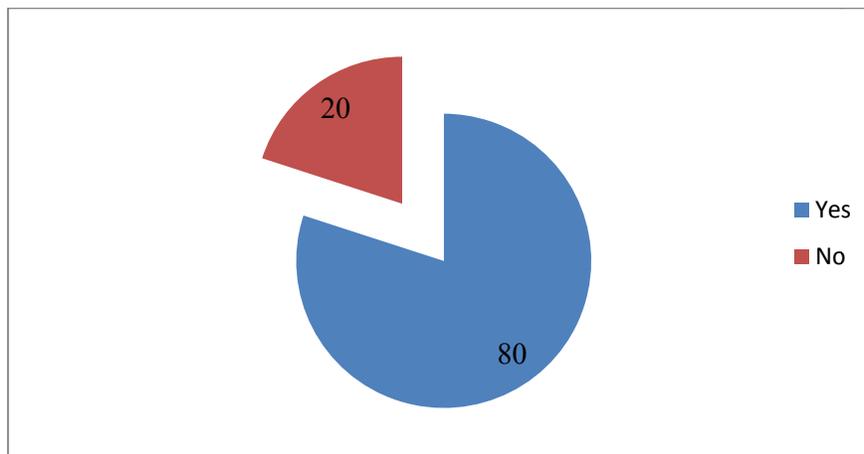


Fig. 2. Distribution of the respondents according to opinion of increasing taste of vegetables

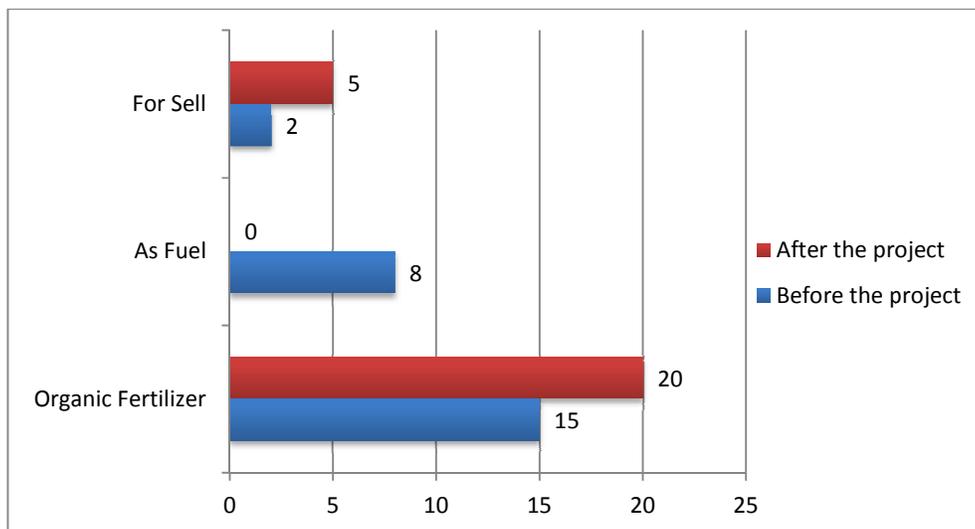


Fig. 3. Change in use of cow dung after involvement in the project

Table 5. Distribution of electricity sources used in farmers' families

Electricity	Number	Percent
REB	54	79.4
Solar	6	8.8
Biogas	8	11.8

Table 6. Change in mean crop production per bigha after using biogas plant

Crop	Previous mean production (Kg)	Recent mean production (kg)	Difference	t-Value
Rice	364.25	464.23	100.02	0.064*
Wheat	208.43	308.40	100.03	
Corn	810.12	1000.08	189.96	
Vegetable	2807.54	3215.76	408.22	

Note: $p < 0.05$

4. CONCLUSION

Biogas plant is a useful technology to produce a high-quality fuel. In rural areas people use biomass fuels (firewood and dried dung) for meeting their energy utilization demands. This demand is fulfilled by deforestation and land degradation which results in different health and societal problems and also cause excessive emission of greenhouse gases. Biogas is used for cooking, lighting, heating and feedstock etc. The slurry of biogas increases soil fertility and taste of foods. Number of cattles also increases for biogas plants. The biogas production derives from various agricultural resources, such as manure and harvest remains enormously available. Biogas technology represents a sustainable way to produce energy for household, particularly in developing countries. It can be cost-effective and environment friendly technology for the people in rural areas. So, Biogas can be a best substitute of biomass fuels for use in rural areas.

5. RECOMMENDATIONS

Recommendations that follow from this study findings are:

- Giving loan on less interest rate with easy terms and conditions.
- Improvement of gas line delivery system.
- Setting up more biogas plants.
- Ensuring higher cost-benefit ratio of production.
- Ensuring continuous cowdung supply.
- Training up human resources.
- Social awareness building regarding women education & early marriage.
- Ensuring better health facilities.

- Different motivational steps should be undertaken in the study area for popularizing and expanding biogas technology.
- Demonstration and replication of biogas technology in different areas.
- Research related to best technology for their more improvement can be conducted in the research institutional level.
- Lobbying with relevant departments of the government and policy makers at local and national levels to integrate learning from communities in the execution of large scale.

CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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