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Biogas Plants and Its Impact on Rural Life in Nepalese Communities

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Abstract

The main components of development are energy. The manufacturing of biogas is an established technology that is largely used to produce sustainable energy as well as to monetize organic waste. The potentiality of the development of biogas energy is very high in rural Nepalese community and the mainly used for cooking. This article aims to know the impact of biogas plant installation on the community people in their lifestyle including the study area of Lekbesi Municipality - 4 Dasharathpur, Surkhet. Quantitative research design was adopted to meet the objectives and extent of activity as well as the descriptive. Data were collecting through the questionnaire method. The purposive sampling of 72 HHs was taken to gathering the necessary information. The study found that, Biogas plant is a reliable source of renewable energy for limiting deforestation rates, increasing productivity, and protecting the environment from human population increase. The workloads of people, particularly women, have decreased in everyday activities since the installation of the biogas plant, which has had a good impact on the family members' workload schedules. The current study shows that there is a rising tendency toward reliance on biogas plants, which appears to be solid evidence for the preservation of forest resources. The findings of this article have been helpful for government, non-government, as well as social groups to

develop better plans, policies, and practical tactics for providing biogas energy to the poorer sector of rural residents.

Keywords: Biogas, Biogas Plant, Renewable energy, Gobar gas, Environment

Background

Biogas is a composition of gas released by methane-based bacteria operating on biodegradable materials such as cattle dung, human excreta, and other organic wastes in an anaerobic environment between 26° and 35° for a specified period of time (Jain et al., 2015). B.R Saubolle, a teacher at St. Xavier's school in Godavari, was the first to introduce the biogas plant to Nepal in 1965. In 1968, India's Khadi Village Industries Commission (KVIC) constructed a facility in Kathmandu for an exhibition (Gewali & Bhandari, 2005). In 1977, Gobar Gas Corporation and Agricultural Equipment Development Company Pvt. Ltd. were established as a private company for the purpose of conducting research, developing, and disseminating biogas technology throughout the nation. Since then, Nepal has steadily advanced its biogas technology. Floating drum, concrete fixed dome, precast tunnel, plastic bio digester, Ferro-cement gas holder, and brick mortar dome were among the biogas plant designs investigated and tested. The fixed dome design (GGC model 1990) has gained popularity in Nepal among the many designs (Devkota, 2001).

Biogas is a clean, efficient, and renewable energy source made from organic materials that can be utilized in a wide range of applications, including as an alternative fuel (Mohanty et al., n.d.). Although conversion of waste to biogas is an established technology (Kougias & Angelidaki, 2018). Biogas is a renewable energy carrier that can be used for a variety of purposes, including heating, combined heat and power (CHP) generation, transportation fuel (after being upgraded to bio methane), and upgrading to natural gas quality for a variety of uses (Koirala, 2020). Anyway, it has been under-used in the community of Nepal. However, the increase in both the demand for, and the cost of, electricity and climate change has prompted to revive their interest in rolling out biogas technology in Nepalese communities (Sovacool et al., 2013).

Biogas can be effectively used In rural regions, by utilizing to power modest gas burners for cooking and lighting that can be used instead of wood, charcoal, or kerosene as a source of energy (Zerihun, 2015). Despite the prevalence of organic matter in developing countries, creating household-scale biogas production systems is an appealing option (Bößner et al., 2019).It is considered the conditions on the scarcity of fuel wood or lack of access to fossil fuel in these communities. However, in underdeveloped nations where biogas is predominantly produced on a household scale, the end use of biogas is primarily limited to cooking and lighting (Surendra et al., 2014). It should be emphasized; however, that biogas produced at large-scale institutional plants in some developing nations is used to generate electricity via fuel cells or combined heat and power engines, which are similar to technologies employed in advanced nations (Sovacool et al., 2013).

Biogas development has substantial role in forest conservation. The decline in forest firewood consumption can be traced back to a direct influence. Biogas saves about 250 kg of firewood per day and about 65% reduction of firewood demand after installation of biogas plant (Meeks et al., 2018). Because of the switch from a traditional stove to a biogas burner, several households have completely stopped collecting firewood from the forest (Gautam, 2003). Biogas has a number of key advantages, including improved health, increased crop yield, and time savings for women. Reduced deforestation and carbon trading give economic benefits to the country. Furthermore, the technique aids in the mitigation of global warming and climate change by reducing greenhouse gas emissions (Katuwal & Bohara, 2009). The installation of a biogas system modifies the way cattle are raised. People are switching to stall-feeding instead of free grazing on public areas, such as forests (Sati & Singh, 2010). As the forests in developing country, like Nepal, are affected by grazing, biogas development may reduce the grazing pressure and eventually supporting forest regeneration. Based on RGG's over a decade of expertise, biogas production could be a useful way for the private sector to get involved in forest conservation (Bajgain & Mendis, 2005). Biogas is also presented as an alternative for coal, oil, biomass, wind, solar and natural gas sources in heat and electricity generation.

Biogas Technology has been gaining the popularity now a day as a good alternative source of domestic energy. Biogas industrial developments have significant ramifications for chemical industries, equipment manufacturers, renewable energy providers, oil and gas companies, and agriculture entrepreneurship (Martinot et al., 2002). During the period of 1981 to 1986, Gobar Gas Company developed and tested various designs of biogas plants such as floating drum design, fixed dome design, tunnel design, and plastic bag design (Shakya, 2002). Furthermore, Gas pipelines, mixing machines, gas taps, lamps, water drains, gas meters, agitators, manometers, and other biogas appliances were designed, modified, and tested. Covered sewage tanks are mentioned in macro polo. It is thought to have originated in ancient Chinese literature between 2000 and 3000 years ago. H. Davy experimented with straw manure in a vacuum retort and collected biogas in 1808. He was more interested in rotten or not rotten manure than in the gas. He did, however, discover methane in the gases created during the anaerobic digestion of cattle manure (Biogas Programme - Nepal | SNV World, n.d.) .

As a result of government initiatives, the installation of biogas plants has increased over time. The government is assisting a variety of organizations and agencies in their development. Through the distribution of land ownership certificates through ADB/N, the government has encouraged credit facilities to the people. The energy consumption in Nepal is very low (14.6) and most of the energy is being used for domestic purpose (Liu et al., 2008). Energy sources are largely common in Nepal. In 2002, 75.78 percent of energy was consumed in the form of fuel wood, 9.23 percent in the form of petroleum products, 1.47 percent in the form of electricity, 5.74 percent in the form of animal waste, 3.75 percent in the form of agricultural residue, 3.53 percent in the form of coal, and 0.48 percent in the form of renewable energy (WECS, 2010) . This shows that Nepal's dependence on its woods for energy is very high, and that the country's forests are being used to the point of deforestation and environmental deterioration. A suitable environment for utilizing the great potential of the water resource has not been successfully created by the nation due to several technological, financial, political, and other obstacles. The biogas industry is booming these days, and new breakthroughs are laying

the groundwork for biogas facilities to become modern bioenergy manufacturers. Biogas plants, in this sense, are the foundation of a circular economy model aimed towards nutrient recycling, greenhouse gas reduction, and bio refinery objectives. In these contexts, this article tries to find the impact of biogas plant installation on the community people in their lifestyle. Hence, the current study focused to find the answer to following research questions.

1. What are the changes in socio - economic conditions of biogas users after biogas installation in the Dasharathpur - 5, Surkhet?
2. What are the difficulties faced by biogas users in the study area?
3. How can access the problems and prospects regarding the bio-gas energy?

Methodology

This study was carried out based on a quantitative research design; the study focused on the impact of biogas plant installation and gains the opportunities for its users in the community. The primary data was gathered from the field visit by using the questionnaire, interview, and key information from observation. The sampling population was taken from Lekbesi Municipality - 4 Dasharathpur, Surkhet. A quantitative research design was adopted to meet the objectives and extent of activity as well as the descriptive. In this study, the selected field was one-third of households' installation of Biogas plant own of the kitchen. The total number of households is 708 and the total population is 3,064 this study area among those households is the installation of the biogas plant. The data were analyzed by using descriptive statistics. Mean and percentage were used under descriptive statistics.

Participant information

Lekbesi Municipality - 4 Dasharathpur, Surkhet was selected to achieve the objective for the study. The center (headquarters) of the municipality is situated at Kalyan. It lies at a distance of Lekbesi Municipality territory distances from one to ten Kosh from the district headquarter of Surkhet. The socio-cultural condition of Lekbesi Municipality is the area of different castes and communities inhabitants were the total population of the Municipality as of the 2011 Nepal census is 30,295

(Males 14,122 & Females 16,173) individuals. The Dalit community population is 6,357, the Janajati community population is 11, 246 and others (Brahaman, Chhetri & Thakuri) 12692. The municipality is divided into a total of 10 wards. The total number of households is 708 and the total population is 3,064 this study area among those households is the installation of the biogas plant. Whole the universe 72 households are in research & taken as the respondents for the interview to materialize the techniques of using the data collection. Total surveyed 72 households have 497 population among them Female are 259 and male are 238 people, out of total surveyed households, Cherty 34.43%, Brahmin 29.31%, Janjati 27.23% and Dalit 9.03% are habitant.

Results and Discussion

The majority of households indicated that since the biogas plant was installed, they had much time to spend on socializing, other things than cooking and cleaning, and collecting firewood. After installation, the majority of homes utilize biogas to reduce smoke, eye issues, and provide a clean, healthy environment. After the building of the biogas plant and its use in their homes, the majority of users reported a decrease in their respiratory, cough, headache, burning instances, and chest pain (Singh et al., 2011). The majority of homes used agricultural waste and firewood for cooking before to the installation of the biogas plant; however this usage has significantly decreased since the biogas plant's construction. It is interesting to note that after the installation of the biogas plant, homes reported a significant drop in smoke, which resulted in a degree of reduction in indoor air pollution. Some of the negative effects of biogas plant owners have also been researched; some individuals have believed that collecting dung, mixing dung, using manure, etc., is dirty activity that produces unpleasant odors and mosquitoes. People have felt the effects of the economy because installation requires a significant sum of money. These are the few issues that can occur as a result of the installation of biogas plants, but they are minor when appropriate management practices are used.

Impact of Biogas Installation

Almost all households felt that their economic conditions are uplifted by these the biogas plant although it failed to fetch direct earning for them. In the beginning, the biogas plant users have to spend more money to install the biogas but after the installation of the biogas, they did not have to spend more money.

Impact of Biogas on Health and Sanitation

The Study shows that the respondents' health and sanitation have been improved as a result of the biogas plant. The usage of biogas plant has changed the population pattern of fly and mosquito due to technology.

Reduction in different Diseases

The installation of the biogas plant has resulted in a significant improvement in smoke burn diseases such as eye illness, coughing, burning cases, and headaches. About 100 percent of respondents said they built a toilet to connect to the plant, which aided personal health and environmental sanitation, that the household population has been covered by firewood smoke has been reduced, and that the biogas facility enables them to reduce the number of burning cases and eye illness.

The reduction of Workloads and time saving

After the installation of the biogas plant, the workloads of people especially the female have reduced their daily life activities. Therefore, the respondents are given the answers the introduction of biogas has a positive effect on the workload of the family members. The time-saving in firewood collection and cooking activities due to smokeless stoves is a direct benefit to the female members, which is clearly shown in the table given below.

Table 1

Reduction in Workloads and Time Saving in Owners

S.N.	Activity	Before Biogas (In minutes)	After Biogas (In minutes)	Different (minutes per day)

1.	Firewood collection from Jungle	180	60	120
2.	Cooking activities	90	60	30
3.	Washing the utensils	40	25	15
Total		310	145	165

Source: Field Survey, 2020

The above table shows that saving time is considerable. It shows that the biogas user families used to spend more time collecting the firewood from the jungle. Allmost all households have used the collection of firewood from the jungle because the firewood is easy to access for them. The villagers spend 180 minutes per day for firewood collection before the installation whereas, on average, 120 minutes have been saved after the installation of biogas. After the installation biogas plant, average the time spent on the firewood collection has been decreased by 2 hours per day. All biogas users who collect the firewood from their land and market have not been dealt with in this analysis. On the average, 30 minutes have been saved after the installation of the biogas plant on the cooking activities. It has decreased the 1/2 hours per day, as well as the washing the utensils activities 15 minutes has been saved after the installation of biogas plant average the time spending for the Washing the utensils has been the decreased the 15 minutes per day. This data shows that after the installation of the biogas plant workload of women had reduced. It helps to take responsibility of household work both men and women. It helps to reduce gender differences to some extent.

Specific Benefits from the Saving

The respondents reported that specific achievements which are made by investing the money from the saving of firewood, which is shown as below.

Table 2

Specific Benefits from Saving

S.N.	Specific Benefits	Number of HHs	Percentages
1.	Income generation activity	31	43.05
2.	To support the children Education	17	23.61
3.	Support the Health problems	11	15.28
4.	General expenses	8	11.11
5.	Invest in agriculture activities	5	6.95
6.	To support the Household expenses	-	-
Total		72	100.00

Source: Field Survey, 2020

Above table shows that biogas has been the contribution towards the field of income generation activity 43.05 percent, to support the children in education field 23.61, support the health problems 15.28, General expenses 11.11 as well as the 6.95 percent invests in agriculture activities.

Use of Toilet

After installation of biogas, villagers are dramatically changed and they have made latrine in their home which shows the data below.

Table 3

Use of Latrine

S.N.	Have a Latrine	Number of HHs	Percentage
1.	Yes	72	100.00
2.	No	0	0
Total		72	100

Source: Field Survey, 2020

Table shows that, all 72 households have latrine with the installation of

biogas plant. This indicates that after the installation of biogas plant the people were encouraged the use of latrine for the better sanitation practices.

Connection of Latrine to Biogas Plant

After connected the latrine, people have used the human excreta to produce the biogas. So people added the quantity of biogas as well as the better slurry production to the agriculture farm and no tension for the managing the safety plant.

Table 4

Latrine Connected to the Biogas Plant

S.N.	Connection of Latrine to Biogas Plant	Number of HHs	Percentage
1.	Latrine Connected	72	100
2.	Not Connected	-	-
Total		72	100.00

Source: Field Survey, 2020

The above table shows that, out of 72 households, 100 percent of the households have connected their latrines to the biogas plants. They reported the reasons for connecting latrine to the biogas plant because of it helps to keep environment clean and sustainable sanitation .Human excreta can be utilized as fertilizer and sufficient gas production.

Improve in the Health condition of Women and Children

Biogas plant has a positive impact on personal health of family members specially the women and children, while using the biogas plant for household's purpose. It does not produce the smoke which is harmful for human being. The biogas plant has played the vital role to maintain the proper health condition for them. Generally, the women and children are engaging in kitchen based works and suffered by the eye illness, headache, coughing and respiratory problems. But biogas plant has reduced those kinds of problems. So biogas plants are beneficial for women and children.

Table 5

Improve in Health Conditions of Women and Children

S.N.	Diseases	Number of HHs	Percentage
1.	Eye Illness	41	56.96
2.	Respiratory	21	29.16
3	Headache	7	9.72
4.	Coughing	3	4.16
Total		72	100.00

Source: Field Survey, 2020

Table shows that improvement of health condition of women and children are considerable, from this study it has been observed that about the 56.96 percent households are eye illness problems have improved after the installation of the biogas plants. Similarly 29.16 percent of the sampled households have respiratory problems, 9.72 percent of the sampled households have headache problems and 4.16 percent of the sampled households coughing problems have improved after the installation of the biogas plants.

Respiratory Diseases Problem

The respondents of the respiratory disease of the household's members are under the examination with the biogas plant.

Table 6

Respiratory Diseases Problem

S.N.	Status of Infection	Number of HHs	Percentage
1.	Presence of Respiratory	9	12.5
2.	Absence of Respiratory	63	87.5

Total		72	100.00

Source: Field Survey, 2020

Table shows that 87.5 percent of the respondents haven't reported the respiratory problem and 12.5 percent of the respondents have reported respiratory problem. This is one of them the positive impact of biogas installation. Households reporting the presence of respiratory problems may be attributed to the use of firewood even after the biogas plant to prepare the khole (buffalo & cows feed); heat milk and Celebrate the fest & festivals prepare the ring bread as well as the other activities which use the firewood that emits smoke in the kitchen.

Impacts of Slurry in Agriculture production

The ability to create slurry, highly valuable organic manure for crop cultivation, is one of the most appealing reasons to build a biogas plant. The biogas slurry's several advantages. Due to the high concentration of soil nutrients, boosts agricultural yield. It results in an appropriate increase in shape when the digested slurry is added to the food chains of plants and animals. According to Gobar Gas Company standards, the slurry from the biogas plant contains 1.6 percent nitrogen, 1.2 percent phosphorous, and 1.0 percent potash, compared to 0.05 percent phosphorous and 0.6 percent potash in livestock manure. (*DSpace at Tribhuvan University Central Library (TUCL): Socio-Economic Impact of Household Biogas System (A Household Biogas Study of Belbari Municipality, Morang District)*, n.d.). The higher percent of nutrients in slurry is due to saving of nutrient from getting lost. The biogas slurry is regarded as premium organic manure. The soil texture is enhanced, the humidity level is stabilized, the pace of nutrient depot building is accelerated, and the soil's water-holding capacity is raised due to the digested slurry's organic content.

Methods of Using Slurry on Form

Information on the application of the bio-slurry in different form as reported by the respondents is presented as below :

Table 7

Method of Bio-Slurry Applied

S.N.	Methods of Application	Number of HHs	Percentage
1.	In liquid Form	6	8.33
2.	In dried Form	14	19.45
3	In composted Form	52	72.22
Total		72	100.00

Source: Field Survey, 2020

Approximately 72.22 percent of biogas formers employed composted forms of the slurry, according to the data in the above table, while 19.45 percent used it in dried form. Few responders (8.33%) said they directly fertilized their crops with the liquid slurry. The best method for preserving plant nutrients, it should be noted, is to use liquid slurry; however, this method is limited in its applicability due to the difficulty of transporting it to the fields. Extension agents and biogas companies have urged farmers to use plant nutrients sparingly for better result. There by augmenting the quality of organic fertilizer which the application of slurry in dried form is not normally recommended as the nutrients especially the nitrogen contained in it are lost when dried in the sun.

Production Increment after using the Slurry

Every household has utilized slurry as fertilizer to increase crop production, and the digested slurry can be used as manure in the fields. The usage of slurry has undoubtedly saved money that may have been spent on chemical fertilizer even though accurate collections are not attainable. Regarding the production increment 58 households reported that there is an increase in their agricultural production, 10 households have not felt any change in production and 4 households have felt the decrease in the production even after the application of bio-slurry on the form.

Table 8

Production Increment after Using the Slurry

S.N.	Agricultural production	Number of HHs	Percentage
1.	Production Increased	58	80.55
2.	Remained the Same	10	13.89
3.	Production Decreased	4	5.56
Total		72	100.00

Source: Field Survey, 2020

The data presented in table shows that about, the slurry is mainly used in maize, paddy, mustard, wheat, and vegetable production, which the production relationship of using and not using slurry is very significant. The data analysis recommends that the production of these crops has increased after the use of slurry, so there is positive relationship between using slurry and agriculture productivity. Thus the slurry is better than chemical fertilizer in agricultural farming.

Social Impact

Social impact of biogas plants are mostly intangible and need to be observed. The outcome of the study shows that the installation of biogas plant has a matter of social prestige in the community. It helps quick services for kitchen activities to daily activities. All most of the plant owner under the study felt a rise in their social status in the community after the installation of biogas plants. Firewood collection time and working load of women and children decreased due to this reason children got free time to study where as women were found more active in social, economic and political activities. Owners especially women are engaged the economic activities like mother group (Aama Samuha), self-eco-help group & community level cooperative organization and men owners are engaged the social organization as well as the political activities.

Environmental Impact

Biogas plants help the reduction of emission of carbon dioxide. It easily substitutes the traditional sources which allow the forests to remain the dung used for two purposes: - as a gas for cooking and slurry a replacement them in organic

fertilizer in agricultural production. After the biogas plant installation, it saves the firewood, dung cakes, kerosene, LPG gas and agricultural wastes. The Organic matter and nutrients of agricultural wastes and the dug cakes are helpful to sustain the fertility of soil.

Conservation of Forest

The information regarding the conservation of forest has also been obtained from the community level discussion. In the community, when the biogas is used by maximum level, they do not go for cutting trees in the forest. This task helps to preserve and increase the area of the forests in the community. The biogas is the complementary of the firewood, when the biogas is used then the forests are automatically protected and increased. In the case of the arrangement of the forest, the considerable amount of the firewood has been saved after the installation of biogas plant. In this study area, average amount of firewood saved per households 7 bhari per month. One bhari, is approximately equivalent to 40 kg. After the installation of biogas plant, the majority of the plant owners have failed the reduction of use of firewood.

Different problems faced the Biogas Users

Even though there are several advantages to the biogas plant, the researcher discovers a variety of concerns from the respondents. Biogas users have listed the different problems that have observed the field survey, which are mention below.

Destroyed of Wooden Ceiling

The ceiling of the room in traditional rural homes is constructed from woods that are impervious to insects due to soot buildup from firewood burning. The hardwood ceiling is susceptible to damage from termites and other insects like ants since biogas creates smoke-free flame.

More water to collect for the Biogas Plant

In order to feed the biogas, dung and water must be mixed in an equal proportion; the largest biogas plant, more dung and water are needed. The biggest issue is collecting water. Since there are no adjacent water sources, there are no

readily accessible water sources.

No direct Income

Although biogas has several benefits, it does not generate cash income. Farmers perfect the direct income to enable them to pay back the principal and the interest on the loan. They have less income-generating opportunity to utilize the time saved from the installation of biogas and therefore hesitate to invest the loan money.

Unnecessary Tension

The biogas plant owners reported that the loan for the installation of biogas plant creates the unnecessary tensions as they did nither have such the practice of taking loan before. As the biogas plant did not fetch the direct cash income and able to express the saved time and efforts.

Higher Maintenance and Repair Cost

According to users of biogas plants, the biggest benefits of a biogas plant are considered to be its inefficiency for space heating. A biogas plant's claimed drawbacks include its high startup costs, high borrowing rates, high repair costs, tough maintenance requirements, and lack of GGC staff.

Less taste food

Few respondents claimed that food produced in the kitchen using biogas was less flavorful than food prepared using firewood.

Conclusion

The potential for renewable energy development is stronger in rural area of Nepal, where there are more resources available. The environment won't be harmed throughout development. As more renewable energy resources are developed, biogas energy is becoming a significant contributor. The biogas plant is best alternatives for the fuel in rural as well as urban area, which is the most popular, now a day in our country. The installation of biogas plant has been increasing rapidly and realizing

the existing of different problems of energy the Government of Nepal, different companies as well as I/NGOs have been the incorporating in the installation the biogas plant. Biogas plant technology has been felt successful in the study area. The study found that it is one of the effective renewable energy sources for the purpose of production growth, protecting the environment from the population, controlling the rate of deforestation and easy for housewives for the kitchen. The present study has shown that there is an increasing trend to depend on biogas plant which seems to be good indicator for the conservation of forest resources conservation.

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