Tribhuvan University Journal
Vol. 38, No. 2: 42-54, December 2023
Research Directorate, Tribhuvan University (TU),
Kathmandu, Nepal
DOI: https://doi.org/10.3126/tuj.v38i2.60747

SOCIO-ECONOMIC BENEFITS OF BIOGAS FOR WOMEN IN HOUSEHOLD COOKING IN NEPAL

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Received date: 25 Aug. 2023 - Accepted data: 30 Nov. 2023

ABSTRACT

The bio-gas is viable technology as household cooking solution to reduce smoke related diseases, accidents of burning, good source of organic fertilizer, save time for collection of fuel wood and change the kitchen environment. It is important energy source. Women empowerment is possible through bio-gas in Nepalese kitchens and promotes changes in cooking practice. The bio-gas programme is most effective and successful programme in rural Nepal. By studying and understanding the potential of biogas, the research can provide valuable insights into the potential of biogas to improve the lives of semi-urban communities and contribute to sustainable development with a specific focus on women' welfare. The researcher collected primary data and information through survey questionnaire and secondary data were gathered from relevant reports and documents published by government and bio-gas companies. The study employed both quantitative as well as qualitative techniques of data analysis. For the study, the respondents were broadly categorized in two distinct categories: households with privately owned biogas plants and the households connected to commercial biogas plant recently launched in Ghorahi Sub-Metropolitan City. For quantitative data, questionnaire was distributed among 60 randomly selected households having privately owned biogas plant, and 40 respondents were also randomly selected from among the 50 households connected to commercial biogas plant. Finally, qualitative findings from key informant interview (KII) and observation were also applied to justify and strengthen the quantitative findings. For this purpose, interviews were conducted among the Mayor of Ghorahi Sub-Metropolitan City, DE and Ward Chairman of project site. Major proportion of waste in Ghorahi is biomass that includes kitchen

waste, farm residue and livestock dung that has been utilized to produce flammable methane gas.

Bio-gas is cost effective, so, households of all income groups can afford the technology. Bio-gas as clean fuel, enhances Nepalese women's culinary practice, plays crucial role in women's welfare; which is the first step towards women empowerment. The study has shown that women and girls have greatly relieved from the drudgery of fuel wood collection and smoke related diseases.

Keywords: bio-gas, alternative energy, privately owned bio-gas plant, commercial biogas plant, socio-economic benefit

INTRODUCTION

Energy plays an important role as a global commodity and as a corner stone of socio-economic development (AEPC, 2014). Renewable energy, derived from replenishing resources, serves as an integral component of environment. It includes solar energy, wind energy, micro-hydro and bio-gas. Among these various sources of energy, biogas is a renewable energy source produced from the decomposition of organic materials, as animal waste, agricultural residues and kitchen waste in an anaerobic digester. Anaerobic digestion is a technology that converts waste into energy (Piloni & Ahamed, 2022). Bio-gas is cleaner, healthier, environment-friendly and more sustainable alternative to traditional cooking fuel. In order to promote the use of bio-gas as cooking fuel in Nepalese kitchen, Alternative Energy Promotion Centre (AEPC) was established in November 3, 1996. under the Ministry of Science and Technology which created conducive environment and formulated renewable energy subsidy policy. With growing awareness among the people, the private sectors especially, bio-gas companies and banks have played important role for dissemination of this technology. Bio-gas is a by-product of the biological breakdown under oxygen-free condition, which is called anaerobic digestion of organic waste. It is local energy source produced from degradation of plants and animal dung under controlled conditions in an air-tight container. Biogas is globally used and popular source of energy (Khadka, 2020). It is considered a feasible and sustainable option for household cooking. Interest in bio-gas as a viable energy source has spread throughout the globe. Chemical composition of bio-gas is a mixture of methane and carbon dioxide. Bio-gas is clear, odorless and combustible and is produced when bacteria react on organic materials animal dung, human waste and tender plants or residues in an air and water tight container known as bio-gas plant. The bacteria slowly digest the material and produce the gas. Bio-gas is renewable energy because its

production depends upon the supply of grass, animal dung, human waste and other bio-degradable materials (K.C., Takara, Hashimoto, & Khanal, 2014). Organic materials are digested to form bio-gas by fermentation process. Methane gas produced by fermentation having high inflammability consists of carbon and hydrogen, so, plants with high hydro carbon are suitable for bio-gas and the carbon in the organic materials is necessary for the energy supply of the anaerobic bacteria. Bio-gas burns with clear blue flame producing no smoke. Its flame temperature is around 800 degrees Celsius and it has a calorific value 5650 Kcal/ cubic meter of gas (Koirala, 2019). Biogas system helps to manage and treat organic waste materials locally, minimize environmental impact and promotes sanitation. It significantly contributes to reduce indoor air pollution and respiratory diseases. It contributes significantly to the energy supply in a sustainable manner and saves fossil fuel such as: coal, oil and natural gas. Major proportion of waste in Ghorahi is biomass that includes kitchen waste, farm residue and livestock dung that has been utilized to produce flammable methane gas.

Problem Statement

In rural areas, women are primarily responsible for household cooking. Traditional biomass fuels as wood, animal dung and charcoal are major source of household energy in rural Nepal. Such cooking practices have adverse impacts on women's health condition, socio-economic status and overall wellbeing and cause environment degradation. Biogas technology, as an alternative cooking solution, holds the potential to bring about positive changes in rural women and promotes wellbeing of rural women in a sustainable manner.

There is need of awareness about the use of bio-gas. Subsidy should be provided based on the geographical location and economic condition of the rural people in installation of bio-gas, so as to increase access. Focus should be given to aware people towards using bio-degradable household waste to generate cooking gas for environmental sustainability, sustainability of waste management and for promoting access to renewable energy sources. Ghorahi Sub-Metropolitan City has recently launched commercial biogas plant with its project name Waste to Energy with the collaboration of Alternative Energy Promotion Center and Energy Development Company under the financial support of the World Bank. After its full operation, the commercial bio-gas plant is projected to address energy need of 1600 households, signifying a significant progress in energy

sector. It not only reduces the import of other fossil fuel but also contribute to scientific management of growing solid waste in the urban area.

Literature Review

In Nepal, there are three categories energy resources: traditional, commercial, and alternative sources. Traditional sources, including firewood and bio-energy, serve as the primary energy sources for households. Commercial sources, which the country's economy is largely driven by, include such as coal, electricity, and petroleum products.

The support activities of the Government of Nepal with collaboration of Netherlands Government started formally in 1992. The activities were quite effective to promote the use of biogas tto the great extent in Nepal (Poudel, 2022).

Biogas, global source of energy, is a clean and sustainable cooking solution globally. Women viewed biogas as highly potential source of energy in rural Nepal, as there is farm based livelihood. It contributes to health and sanitation to the great extent. Bio-gas is very easy to operate. It is economic as it requires cheap and low maintenance cost and saves time. It helps to reduce household burden of women (Khadka, 2020).

Nearly 90% of the garbage in Dang's semi-urban Ghorahi is biomass that includes kitchen waste, farm residue and livestock dung that is utilized to produce flammable methane gas (Dahit, 2023).

A small biogas plant's economic and financial assessment is done in relation to a case study of a biogas plant fed with a bio-matrix that can be classified as both a product and a by-product. As the investment profitability shifted from the previous all-inclusive rate to the current incentive programme, it was declining. Small biogas production plants enable positive benefits in social, economic, and environmental aspects. It is possible to emphasise that the use of products, rather than by-products, penalises investment by reducing the incentive rate, putting the investment in a high financial risk. (Salerno *et al.,* 2017).

Biogas brings positive changes in cooking practices, defecation habit, and the role of women in social activities (Yadav, 2014). In this changing context, women not only limit themselves as the energy users but have been exploring their dignifying spaces in energy services empowering them to become energy entrepreneurs that offers multiple development benefits. (Dutta, 2015). Expansion of economic activities and opportunities

for women, their involvement in productive activities by creating new sources of wealth and income to support family, investments in education and health provide women their and identity new role to build a just society.

Domestic scale bio-gas technology remained as one of Nepal's success stories in the past three decades, offering clean cooking solutions for more than 0.3 million rural households. However, commercial scale biogas technology has been gaining popularity in recent years, it is because of growing concern about organic waste management and increasing demand for clean energy (Dulal, 2022).

Installation of bio-gas has helped to meet gender needs to some extent, as it reduces the drudgery of fuelwood collection, minimizes respiratory diseases and provides smoke free kitchen environment (Subedi, 2015).

Among many others, biogas, as an alternative energy, has been identified and promoted as a viable, renewable and sustainable cooking solution. In addition to providing low-cost sustainable energy, it offers many other benefits. However, lack of access to bank and biogas service providers are among the main obstacles to biogas adoption in Nepal (Katuwal, 2022).

Biogas has been contributing about 3 to 4 percent of cooking energy in Nepal. So, it needs to be promoted ensuring the availability and access to improved biogas technology within the country. Promotion of biogas and other renewable energy can reduce Nepal's dependency on petroleum products and help Nepal to control foreign currency depletion.

The use of biogas contributes to good health and well-being, environmental sustainability, economic efficiency and energy conservation (Gautam, Baral & Herat, 2009).

In Nepal, large size bio-gas plants are institutional and are set with commercial motive. The commercial scale institutional bio-gas plants in Nepal are: 4,200 m3 plants in Pokhara, 3,750 m3 plants in Nawalparasi, and 3,500 m3 plants in Syangja (Water and Energy Secretariate, 2023)

Water and Energy Secretariate (2023). Energy Synopsis Report 2023.

Research Gap

Various relevant literatures were found to have dealt with biogas as cooking solution. In this present study, the author has attempted to analyse

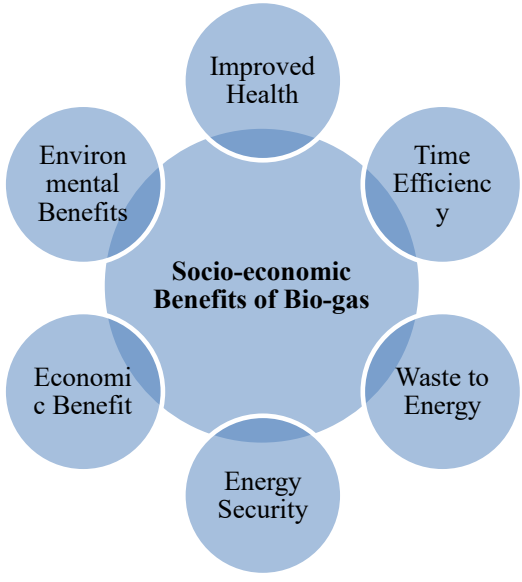
socio-economic benefits of bio-gas and compares privately owned bio-gas and commercial biogas. The promotion of commercial biogas not only reduces the import of other fossil fuel but also contributes to scientific management of growing solid waste in the urban area.

Research Objectives

The main objective of this study is to analyse socio-economic impact of bio-gas on women in rural Nepal. The specific objectives of this study are:

- To assess socio-economic benefits of bio-gas
- To analyze social impacts of bio-gas on women

Conceptual Framework



The dependent variable 'socio-economic benefits of bio-gas' provides a thorough assessment of the positive changes and advancements in the well-being and empowerment of households, particularly women, resulting from the sustainable adoption and use of bio-gas technology. By studying and understanding these socio-economic benefits, the research can provide valuable insights into the potential of bio-gas to improve the lives of rural communities and contribute to sustainable development with a specific focus on women's welfare.

The dependent variable 'Socio-economic Benefits of Bio-gas serves as a comprehensive measure of positive changes and advancements in the well-being and empowerment of households, particularly women and girls, resulting from the sustainable adoption and use of biogas technology. By studying and understanding these socio-economic benefits, the research can provide valuable insights into the potential of biogas to improve the lives of semi-urban communities and contribute to sustainable development with a specific focus on women's welfare.

METHODS AND MATERIALS

The study dealt with the socio-economic impact of bio-gas on women in Dang district. For the study purpose, the researcher collected primary data and information through survey questionnaire and secondary data were gathered from relevant reports and documents published by government and bio-gas companies, which were used as supplementary information and comparison purpose. The study employed both quantitative as well as qualitative techniques of data analysis. For the study, the respondents were broadly categorized in two distinct categories: households with privately owned biogas plants and the households connected to commercial biogas plant recently launched in Ghorahi Sub-Metropolitan City. For quantitative data, questionnaire was distributed among 60 randomly selected households having privately owned biogas plant, and the total population of 50 households connected to commercial biogas plant at its initial phase. The sample was selected so as to obtain a representative and meaningful dataset. This sampling approach provides comparative insights into potential differences or similarities between households with privately owned bio-gas plants and those connected to commercial bio-gas plant. Finally, qualitative findings from key informant interview (KII) and observation were also applied to justify and strengthen the quantitative findings. For this purpose, interviews were conducted among the Mayor, Divisional Engineer of Ghorahi Sub-Metropolitan City and Ward Chairman where the commercial level biogas plant has been installed. This study is explanatory as well as descriptive in nature. Dang district was chosen as research site for the study to make the investigation easy. Dang itself is the Head Quarter of Lumbini Province.

RESULTS AND DISCUSSION

Women and children are supposed to be the weaker part of society. The study has revealed the changes in situation of women and children by using bio-gas. And inquiry was made expecting four alternative answers

regarding the benefits of using bio-gas: economic in cooking, lighting, clean environment and others.

Table 1

Benefits of Using Bio-Gas on Women in Dang

S.N.	Particular	Percent
1	Economic in cooking	27%
2	lighting	2%
3	Clean environment and improve women health	8%
4	All of the above benefits	63%
Total		100%

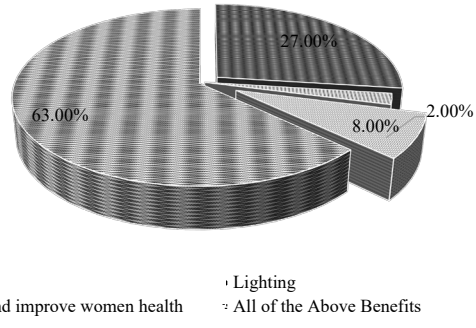
Source: Field Survey, 2022

Table 1 represents 27 percent respondents viewed that cooking in bio-gas is economic in cost as it has reduced dependency over the imported fossil fuel and has replaced fire wood and kerosene for cooking purpose, has protected women and girls from drudgery and helped in minimizing deforestation. It is convenient and produces effective heat and flame that save cooking time. Only 2 percent said that bio-gas is being used in lightening purpose and other have been using electricity for lightening.

Among the respondents, 8 percent reported that bio-gas has helped to maintain clean environment and improve women health. It has improved quality of life in household by improving rural sanitation and it reduces workload in cooking and collecting firewood, hence, has minimized deforestation. Out of total respondents, 63 percent have experienced all of the above mentioned benefits from bio-gas.

Figure 1

Benerits of Using Bio-Gas on Women in Dang.



Source: Field Survey, 2022

Project: **Waste to Energy**
Leasing Period: 20 Years.
Project Life: 35 to 40 Years.
Total Land covered by the project: Around 3 Bigah.
Model: DBOOT D: Diagram, B: Built, O: Owned, O: Operate, T: Transfer

Alternative Energy Promotion Center and Nepal Energy Development Company under the subsidy of World Bank has jointly initiated community level biogas plant in Dang. Located at Ghorahi Sub-Metropolitan City, Teraunte, the project costs Rs 22 million with a target to supply methane gas to 1500 households in the first phase with the expansion of 750 more households in the second phase. Bio-gas is technically viable project for Nepal and the energy supplied through it is sustainable and minimizes environmental degradation. At present biogas is distributed to 50 households and gas oven has been distributed to 750 households. The project can produce 2000 cubic meters of gas per day when the gas plant operates at its full capacity with the digestion of 30 tons of garbage per day but at present only 20 tons of it is collected daily from around the city area. Waste is segregated by segregating machine in the plant site as digestive and non-digestive. Similarly, metallic waste is segregated by using magnet. Army barrack and the core vegetable market at Ghorahi have been identified as the centers which produce organic waste in a large volume. These areas are provided with metal bins to systematize the process of collecting such waste. The project is in the phase of the expansion

of pipeline to the surrounding community which is around the distance of 2 .5 to 3 km in average from the Waste Energy Plant. The distance causes transmission loss.

Total investment: The total investment for the project amounts to Rs. 20.5 crore. This comprises 4.5 crore contributed by Alternative Energy Promotion Center and Rs. 16 crore in subsidies granted by the World Bank. Additionally, Ghorahi Sub-Metropolitan City allocated Rs. 50 lakhs for the construction of boundary wall around the project site. Upon reviewing the Detailed Project Report (DPR), the total cost has risen to 22.5 crore, reflecting a 2 crore increase attributed to the decision to transmit the gas through pipeline rather than bottling.

Plant cost = Rs. 20.5 crore. Out of which, Rs 4.5 crore from Alternative Energy Promotion Center and Rs. 16 crore subsidies from the World Bank. Ghorahi Sub-Metropolitan City invested Rs. 50 Lakhs for construction of Boundary wall around the project site.

The provision of affordable and sustainable energy sources is of paramount importance in the present context. In this regard, the analysis of cost dynamics between LPG, a widely utilized energy source and biogas becomes crucial.

Comparative Cost Analysis: LPG, a widely utilized energy source costs Rs. 1790 per 15 kg cylinder; on the other hand, the equivalent quantity of biogas is priced at Rs. 1500, showcasing a noticeable cost advantage

in favor of biogas. The cost difference of Rs. 200 presents an appealing prospect for consumers seeking economical energy alternatives.

LPG/ 15 kg = Rs. 1790 whereas Biogas/15 kg = Rs 1500.
Biogas through pipeline is Rs 290 cheaper than LPG.
Return to GSMC: The project pays 1% of its profit per year.

Payment System: Prepaid meter system has been introduced for optimized payment management. The system streamlines and enhances the payment system that stands to benefit the consumers to manage their energy expenses more efficiently and the providers to ensure a steady revenue system.

Human Resource: Full time staffs 3persons with one engineer, one administrator and one security.

Effectiveness: The flame is more effective and cooks faster than LPG flame distributed by Oil Corporation and saves cooking time. During survey all households were found satisfied in terms of cost effective and efficiency.

Dedicated team of three members; including one engineer, one administrator and one security; have been working full time to ensure successful operation of the project. In terms of effectiveness, it has been found that cooking on biogas flame is faster than cooking on LPG contributing to reduced cooking time.

Prospects and Challenges

Nepal, as an agro-based country, has high prospects to bio-gas. It reduces dependency on traditional fuel, hence helps to mitigate environmental challenges. It helps to minimize the import of commercial fuel, specially, fossil fuel and corrects country's balance of payment situation. Bio-gas is significant in solid waste management, and provides organic fertilizer that supports organic agro-practice.

However, people lack awareness about bio-gas. Initial investment cost is another challenge. People are not satisfied and have complain about after sale services provided by the concerned agencies. Biogas owners complain that after sale services provided are irregular and inadequate.

Coverage

Commercial bio-gas has high coverage prospects in comparison to privately owned bio-gas. A single plant, located at Ghorahi Sub Metropolitan City, has the capacity to meet the energy need of 1600 households. It

contributes to scientific and productive management of solid waste. On the other hand, privately owned bio-gas plants are in crisis due to the migration of youth members from the households. Youth drain has resulted to shifting paradigm from the occupation undertaken from generations. So, cattle rearing and agriculture, which are major source of input for bio-gas plants, are in crisis. Women and old population even lack regular effort and technical knowhow to operate the plant.

CONCLUSION

Bio-gas has brought changes in life of rural women in Nepal and so, has in Dang. Clean fuel plays crucial role in women's welfare and their empowerment (Akter & Pratap, 2022). When compared to LPG, commercial level biogas is cheaper by Rs. 200. The fact presents an appealing prospect for consumers seeking economical energy alternatives. Cooking on biogas flame is reported more effective than cooking on LPG contributing to reduced cooking time. It replaces firewood and kerosene, reduces smoke, controls deforestation and protects environment, mitigates gendered burden, saves time for cooking and improves household sanitation as well as quality of life of women. It is used for lightening through specially designed mantle. It reduces green-house gas emission. Forest is not destroyed, so, it prevents soil erosion. Cow dung is systematically collected, keeping environment clean and hygienic. Bio-gas helps to maintain kitchen clean as flame, produced by bio-gas, is clean; so, the pots remain soot free and require no thorough cleaning which prolongs their lifespan. The clean flame also reduces smoke related diseases. Commercial level bio-gas promotes integrated infrastructure development. It provides scientific, productive and sustainable solution to organic waste mass management.

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