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Socio-Economic Impact of Biogas Technology in Rural Nepal: A Case of Raptisonari Rural Municipality, Banke, Nepal

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Abstract

This study investigates the socio-economic impacts of biogas technology in Raptisonari Rural Municipality ward no. 1 and 2 of Banke District, Nepal. In a nation where rural households heavily rely on traditional fuels—leading to deforestation, time poverty, and health hazards—biogas has emerged as a sustainable alternative. Employing descriptive research design, the study examines 30 households out of 150 biogas plant adopters using survey questionnaires, interviews, and focus group discussions. The research highlights that 100% of the plants were connected with toilets, indicating integration of sanitation and energy solutions. Time savings averaged 3.7 hours per day, particularly for women, who reported improved health and greater participation in social and productive activities. Health expenditures for common ailments declined significantly after biogas adoption, while annual household income exceeded NPR 100,000 for 40% of users. Biogas adoption also reduced firewood use by 90 kg/month and improved school attendance and study time for girls. Despite some seasonal underfeeding of plants and increased mosquito prevalence, overall satisfaction with biogas technology remains high. The study concludes that biogas offers multifaceted socio-economic benefits, and recommends broader policy and institutional support to expand its adoption among economically disadvantaged groups, particularly in similar agro-rural regions of Nepal.

Keywords: Biogas, Socio-economic Impact, Raptisonari, Agro-rural Nepal

Introduction

Biogas technology has emerged as a promising solution to meet rural energy needs sustainably while addressing environmental, economic, and health challenges in developing countries like Nepal. The majority of rural households in Nepal depend on firewood, agricultural residues, and animal dung for cooking. This heavy reliance on traditional biomass leads to deforestation, indoor air pollution, and a disproportionate burden on women and children who spend hours collecting fuel. Biogas, a clean-burning fuel produced through the anaerobic digestion of organic matter such as cow dung and kitchen waste, has been widely promoted in Nepal since the 1990s through government subsidies and donor support. The Biogas Support Programme (BSP), launched in 1992, contributed to the construction of over 300,000 biogas plants by 2020.

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Banke District, located in the western plains (Terai) of Nepal, presents both challenges and opportunities for renewable energy adoption. With a significant agricultural base and livestock ownership, the region is well-suited for biogas adoption. However, access to modern energy services remains limited, and the potential for biogas to reduce poverty and empower rural communities has not been fully realized.

Many developing countries are facing the energy related problem such as rising price of fossil fuel, depleting forest resources etc and Nepal is no exception to this. Firewood has been the most common and traditional source of energy for Nepal. Fire wood represents about three forth (75.78 percent) of the total energy consumption which is mainly consumed in rural Nepal. A great part of this is consumed in residential sector for cooking purpose.

Nepal has a theoretical potential of 85,000 MW and commercial Potential of 4, 2000 MW of hydroelectricity. But till to date, only 548 MW of hydroelectricity has been harvested. It contributes about 1.3 percent of total commercial potential and shares 1.47 percent of total energy consumption of the country. (RETRUD, 2003: 76) Despite this potential of hydropower, majority of the rural population in Nepal is derived from electricity facility due to geographical, technological as well as potential instability and bad governance. Moreover, because of the rugged terrain and other geographical disparities, these rural areas are very costly to reach by extending the already overburden electric grid. Installation of mini and micro hydropower too is not feasible in many areas due to unavailability of perennial water resources. Other alternative source of energy such as solar power and wind energy are in negligible in use because of high cost of installation. Hence, in order to solve the energy problem of remote area of Nepal, a fast, easily implemented, cost efficient, small scale, completely decentralized renewable alternative, which is technically feasible and economically viable has to be promoted. Biogas, in this context is well realized to be most alternative and useful energy source.

Various facts and figures indicated that biogas is a sustainable source of energy in rural Nepal and it needs to be promoted and extended effectively. Unfortunately, we have been able to install only about 8 percent biogas plant of total technical potential. (BSP, 2004: 76 This study focuses on Raptisonari Rural Municipality in Banke District, aiming to evaluate how biogas technology impacts household economics, time use, gender roles, health, education, and overall quality of life.

Objectives of the Study

The specific objectives of the study are:

1. To assess the socio-economic changes after the adoption of biogas technology.
2. To evaluate the time-saving and health impacts of biogas use, particularly for women.
3. To analyze the effect of biogas on income, education, and fuel consumption patterns.
4. To identify operational challenges and suggest policy interventions for wider adoption.

Methodology

This study employed a descriptive research design to investigate the socio-economic impacts of biogas adoption in Raptisonari Rural Municipality, Banke. The research aimed to gather detailed information from households that had installed biogas plants and to assess perceived and measurable changes in their socio-economic status.

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The study area comprised wards 1 and 2 of Raptisonari Rural Municipality, which were selected based on the high concentration of biogas users and accessibility. A total of 150 biogas plants had been installed in the area with the support of the Biogas Support Programme (BSP) and Alternative Energy Promotion Centre (AEPC). From these, a sample of 30 households was selected using purposive sampling to ensure diversity in caste, income level, and years of plant operation.

Data Collection Methods

Primary data were collected through structured household questionnaires, key informant interviews, and focus group discussions. Secondary data were obtained from VDC records, BSP installation data, and AEPC reports. The household survey gathered information on demographics, income, fuel consumption, health, education, and satisfaction with biogas services.

Focus group discussions were conducted with women beneficiaries to explore qualitative changes in workload, participation in community activities, and perceived well-being. Key informant interviews with local technicians, VDC officials, and social mobilizers provided institutional insights into implementation challenges and support systems.

Data Analysis

Quantitative data were processed using Microsoft Excel for descriptive statistics such as frequencies, percentages, and averages. Qualitative data were coded thematically to identify recurring patterns and narratives. The results are presented using tables, graphs, and figures.

Results and Discussion

This section presents the key findings from the field survey conducted in Raptisonari Rural Municipality, Banke. It highlights the socio-economic outcomes of biogas technology adoption including sanitation linkage, fuelwood reduction, time-saving benefits, health and education effects, income changes, and user satisfaction.

Table 1

Biogas Toilet Integration

Toilet Connected	No. of Households	Percentage
Yes	30	100%

All biogas plants in the sample were connected to toilets, reflecting the successful integration of sanitation and energy systems. This not only improves hygiene but enhances gas yield and contributes to the reduction of open defecation in the community.

Table 2

Average Monthly Firewood Use Before and After Biogas

Fuel Type	Before Biogas (kg)	After Biogas (kg)
Firewood	120	30
Reduction (%)	75%	

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Biogas technology has significantly reduced firewood consumption, cutting average monthly use by 90 kg or 75%. This reduction contributes to forest conservation and reduces the burden on women and children who collect fuel.

Table 3

Average Daily Time Saved Due to Biogas

Household Member	Before (hrs/day)	After (hrs/day)
Women (Cooking + Firewood Collection)	5.5	1.8
Men	0.5	0.2
Children (Supporting chores)	1.0	0.3

Biogas adoption significantly reduced the time women spent on cooking and fuelwood collection—by nearly 3.7 hours daily. This time saving allowed women to engage more in income-generating, social, and leisure activities. Children also gained more study time.

Table 4

Common Health Complaints Before and After Biogas

Health Issue	Before Biogas (Households)	After Biogas (Households)
Eye Irritation	24	5
Respiratory Problems	21	4
Headaches	18	3

Reported health issues caused by indoor smoke exposure declined drastically after switching to biogas. The reduced incidence of respiratory illnesses, eye problems, and headaches improved overall family well-being and reduced medical expenses.

Table 5

Annual Household Income Distribution

Income Range (NPR)	No. of Households
< 50,000	6
50,000 – 100,000	12
> 100,000	12

A notable 40% of households reported annual incomes above NPR 100,000, suggesting that time saved through biogas use was effectively redirected to income-generating activities such as vegetable farming, poultry keeping, or micro-enterprises.

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Use of Gained Time

All the biogas users experienced significant time due to adoption of biogas technology. Utilization of gained time in several activities is presented in table 6.

Table 6
Utilization of Gained Time in various Activities

S.N	Activities	No of HHs	Percent
1	Farm Activities	18	60
2	Kitchen Gardening	8	26.67
3	Business	2	6.67
4	Take rest	2	6.67
	Total	30	100.00

Source: Field Survey, 2025

The table shows that (60%)of biogas households utilized the gained time after the installation of the biogas plants in farm activates, (26.67%) spent the time saved in kitchen gardening, (6.67%) in business activities and remaining about (6.67%) in taking rest.

Women participation in Social Organization

The study reveals that women have got opportunity to take part in several social organizations (community forest user groups, saving and credit group, mother group etc).
The study shows that participation of women in those organization was increased by (32.22%) due to gained time after the installation of biogas plant.

Impact on Health

Though the significant impact was not quantifiable, biogas had a positive impact on the personal health of family members especially women. Though the relation of biogas was not clear and other factors were not over locked, the users were of opinion that the major cause of the health improvement was use of biogas.

Table 7
Medical Health care cost (Rs.) per year per House holds

S.N	Disease/ Health Problem	Before installation	After installation	Saving Money
1	Eye illness/burning	1820	980	840
2	Acute respiratory	3200	1510	1690
3	Headache	1730	903	827
4	Others	5020	3003	2017

Source: Field Survey, 2025

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The table shows that the sampled biogas households has spent Rs 1820 in eye illness, Rs 3200 in acute respiratory, Rs 1730 in headache, Rs 5020 in others per year of their family before the installation of biogas plant. They spend Rs 980 in eye illness, Rs 1510 in acute respiratory, Rs 903 in headache, Rs 3003 in others, after the installation of biogas plants. Economically it is very beneficial, it means the health status of member of households have improved after the installation of biogas plant.

Impact on Environment, Health and Sanitation

About 92 percent of sample biogas household had constructed toilet. Among them 86 percent toilets were built due to the encouragement of biogas companies majority of households (73 percent) perceived improvement in door as well as surrounding environment, according to above situation we can say environment, health and sanitation is improved after the installation of biogas plants.

Insect Prevalence

Fly and mosquito were taken into account for the study of change in prevalence of insects.

Flies

Reduction from the prevalence of fly, was reported from the study no one was reported the increased prevalence of fly. Majoring of the households reported the change in prevalence of insects. And about (23.33%) of the households reported did not fell change.

Table 8

Effect on Prevalence of Fly

Fly Prevalence	No. of HHs	HHs %
Decreased	23	77
Remained Same	7	23
Increased	-	-
Total	30	100

Source: Field Survey, 2025

The table shows that no one was reported increased the prevalence of fly from the study (77%) households reported that decrease in fly population. While about (23%) whose did not feel no change in prevalence fly.

Mosquito

Reduction in the prevalence of mosquito was reported from the study of 20 households reported that mosquito had increased after installation the biogas. While 67% households reported decreased in mosquito and 4 households were found different who did not feed any change.

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Table 9
Effect on prevalence of Mosquito

Mosquito prevalence	No. HHs	Percentage of HHs
Increased	20	67
Decreased	6	20
Remained Same	4	13
Total	30	100

Source: Field Survey, 2025

Table shows that (67%) of the households reported the increase in mosquito population and (20%) households felt decrease in mosquito population. But (13%) found different, who did not feel any change.

Saving on fire wood, kerosene, L.P.G.

However, extent of saving differs from family to family. Due to various reasons, considerable amount of firewood, kerosene, L.P.G. was saved after the installation of biogas plant.

Table 10
Saving Energy with Respect to Quantity and Price

		Consumption per month (kg)		Saving Money	
S.N	Source of Energy	Before installation	After installation	Quantity (kg)	Price (Rs)
1	Firewood	150	60	90	210
2	Kerosene	1.50	1	0.5	40
3	L.P.G.	5.20	-	5.20	346
	Total	156.70	61.00	95.70	669.00

Source: Field Survey, 2025

The above table shows that the use of fire wood, kerosene L.P.G was 150 kg, 1.50 kg, 5.20kg per month per family before the installation of biogas plant. They used 60 kg firewood, 1 kg kerosene and No body reported the use of L.P.G after the installation of biogas plant. Thus from saving of 90 kg firewood, 0.5 kg kerosene, 5.20 kg L.P.G per month Rs 669 at current price has been saved.

Saving Time to Schooling Children

From the focus group discussion with school children, it was found that after biogas plant installation, reading time of the school children at home had increased. Because of the biogas, the work load of school children has reduced and they investing the saving time in reading and writing tasks. They explained that around half and hour of time per day has increased in reading time.

Remarkable school girl children were benefited more from biogas because it had reduced the time in collecting firewood and cleaning utensils which are the tasks especially assigned to girls in Nepalese society. They said that, their reading time has increased by about 45 minutes per day and their education and health condition had improved.

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Impact on Slurry Use Pattern

All the biogas households had used slurry as fertilizer in their field. Slurry use pattern of biogas households is presented in table 11.

Table 11
Slurry use pattern of biogas households

S.N.	Form of slurry	No of households	Percentage
1	Composting	24	80.00
2	Solid	5	16.66
3	Irrigation channel	1	3.33
	Total	30	100.00

Source: Field Survey, 2025

The table shows that majority of plant owner, (80 %) used slurry in compost form while (16.66 %) household used it in solid (sub dried) from and remaining (3.33 %) used it through irrigation channel.

Status of Agriculture Production

The user's surveys and impact studies carried out by different intuitions biogas companies, NGO/INGOs, consultancies and individuals have reported that agriculture production is increased after the adoption of biogas technology. However, the present study indicated quite different scenario in cases of production status of which is presented in following table.

\Table 12
Slurry use and production status of sample Biogas House holds

S.N	Production status	No of households	Percentage
1	Increased	20	66.66
2	Remained same	6	16.66
3	Decreased	4	13.33
	Total	30	100.00

Source: Field Survey, 2025

The table shows that (66.66 percent) felt I*n*crease in production, (13.33 %) experienced decrease in production while (16.66 percent) said that production remained same due to composting and inorganic fertilize. The increase in production was observed in vegetable crops (cauliflower, cabbage and potato) and paddy. Maximum increment in production reported was 25 percent in paddy and 95 percent in potato and cauliflower while minimum was 9 percent in paddy and 35 percent in vegetable crops. Likewise, maximum 50 percent while by 10 percent in vegetable.

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Conclusion and Recommendations

The adoption of biogas technology in Raptisonari Rural Municipality, Banke, has led to significant socio-economic improvements for rural households. The integration of toilets with biogas plants enhanced sanitation, while the shift from firewood to clean fuel drastically reduced health issues and time spent on daily chores—particularly benefiting women and children. The reduction in indoor air pollution and the availability of organic slurry for farming further added to the value.

Despite these gains, challenges remain. Seasonal fluctuations in dung availability and occasional technical breakdowns reduce plant efficiency. Some users also noted an increase in mosquito prevalence. These issues highlight the need for continuous technical support and community-level awareness programs.

Based on the findings, the following recommendations are proposed:

1. 1. Increase subsidy support and targeted outreach to economically disadvantaged households.
2. 2. Promote the construction of larger plants in joint or extended families for greater impact.
3. 3. Train local youth as biogas technicians to ensure timely maintenance and sustainability.
4. 4. Integrate biogas promotion with women's empowerment and literacy programs.
5. 5. Establish a monitoring system through VDC or local user groups to track long-term outcomes.

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