

## Research Article

# Contribution of biogas use on forest conservation

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Received: July 01; Accepted: September 09; Published: October 25, 2019.

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## ABSTRACT

Biogas is an eco-friendly alternative energy source which can greatly contribute to reducing greenhouse gases as they have the possibility of reducing the need to use fossil fuels. A study was conducted at Kumroj village of Khairhani municipality, of Chitwan district of Nepal to assess the sources of energy, dependency of local people on biogas, amount of fire wood substituted by biogas and people's perception towards biogas use and forest conservation. Stratified random sampling method was used for sampling design. Direct field observation, households questionnaire survey (n=44), key informant interview, and focus group discussions were used for data collection. This study showed that the main source of energy was firewood for cooking, preparation of animal feed, preparation of alcohol and water heating but now these days the dependency on firewood decreased after use of biogas. About 63.6% of the household were using biogas as an alternative source of energy. The need of biogas was always higher during winter while production of gas was lower in compare to summer season. According to gas users, it reduced the fuel wood consumption, improved the kitchen environment, saved time in fuel wood collection and cooking, and also reduced the health problems. The average reduction in fuel-wood consumption was 42.8% after the installation of biogas. All the respondents were agreed that condition of forest was improving. The reason behind this was the use of biogas which reduces the pressure on the fuel-wood collection and ultimately helps in forest conservation.

**Keywords:** Biogas, Conservation, Forest and Fuel-wood

**Correct citation:** Shrestha, I., Ghimire, P., & Bhatta, B. (2019). Contribution of biogas use on forest conservation. *Journal of Agriculture and Natural Resources*, 2(1), 75-84. DOI: <https://doi.org/10.3126/janr.v2i1.26044>

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## INTRODUCTION

Energy is a basic tool for development. Fuel wood has been and still is the major source of energy daily used by massive rural population in Nepal (BSP, 2012). This total dependence on fire wood as the source of energy for cooking has resulted in deterioration of the quality and quantity of forests and has posed a serious threat in maintaining ecological balance, thereby manifesting various problems like deforestation, flood, Global warming, soil erosion landslides, climate change and severe health problems (Sharma *et al.*, 2019). The pressure on forest resource for energy fulfillment is considerably increasing due to high population growth in rural areas causing scarcity of energy for cooking as well as other various purposes. As a consequence, many people in the rural areas are burning livestock dung and other agricultural residues as an alternative of timber (Adhikari, 2002). This has been one of the factors in deterioration of environment and soil fertility in the country. Nevertheless, the energy pattern and its utilities in rural Nepal have created a serious health problem to rural housewives. However, it is felt a bit earlier to capitalize on the alternative energy sources like biomass energy has still not into practice to the extent at which its prospects are realized in rural development (Rana *et al.*, 2014).

Kerosene and other oil based sources of fuel are scarce and costly to be easily available for small marginal and medium farmers residing in rural areas. Furthermore, frequent alarming hike in prices of imported oil and other fossil fuel have serious economic threat to the rural poor. In this context, to reach the self-sufficiency in energy and to minimize the pressure on traditional biomass fuel, biogas technology has been the best alternative energy solution, which could be achieved through the active mobilization and economic utilization of local indigenous resources available in the country ( Shrestha, 2010).

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. It is mainly composed of 50-70 percent methane, 30-40 % of carbon dioxide, and some other gases (BSP, 2012). The raw material needed is any biodegradable substances. Therefore, it is a good way to deal with biological waste such as human and animal excreta as well as kitchen and farm wastes (Hervie, 2008). Biogas plant utilizes locally available raw materials; the gas tainted from it can be cheaper and reliable. Use of biogas saves time, improves health and sanitation, maintains cleanliness and reduces user's expenses. Since biogas provides fuel for cooking, lighting and manure for the farm, it helps to conserve the environment (BSP, 2005).

Generally, the residential sector is the largest consumer sector of the total energy. The rural residential sector highly depends on firewood energy which is the major cause of deforestation. About 77 percent of the totally energy demand of the country is fulfilled by firewood (WECS, 2010). The reduction of the forest area has directly or indirectly resulted in environmental deterioration. To stop environmental and agricultural deterioration, alternative sources of energy must be introduced (Leermakers, 1992). Biogas is one of those and has become an important alternative energy source for the rural dependency on fuel-wood consumption from forest. The Government of Nepal has been promoting biogas as an

alternative energy and clean development mechanism in Nepal's Terai since the past few decades. Conservation related organizations like National Trust for Nature Conservation (NTNC) and World Wide Fund (WWF) are also promoting the use of biogas in Terai Arc Landscape (TAL) area to reduced pressure on forest resources for the last two decades. Furthermore, the main goal of the USAID funded Hariyo Ban Project is to minimize the threats to forest resources and help to conserve biodiversity. In this regards, biogas has been promoted in TAL area as a means of alternative energy to reduce pressures on forest resources. Nepal is gradually shifting towards the use of alternative energy sources to minimize the dependency forest resources ultimately contributing to forest conservation. Based upon the study of technical biogas potential of Nepal, it is estimated that a total of 1.9 million can be installed in Nepal (Rana *et al.*, 2014). In this context, biogas energy can be the appropriate option in Nepal because it is technically simple, economically viable and environment friendly. So biogas energy is emerging as the major contributor in the current renewable energy resources development.

## METHODOLOGY

### Study Area

Chitwan lies in the lowlands or Inner Terai of southern central Nepal on the international border with India. It extends between longitude  $83^{\circ} 50'$  to  $85^{\circ} 00'$  East and latitude  $27^{\circ} 40'$  North. Kumroj village of Khairhani municipality of Chitwan District of province 3, Nepal. Situated in 8 km East of Sauraha on the edge of Rapti River joining to Chitwan National Park, Kumroj village characterized by two main types of forest habitat i.e. tropical riverine forest and grass land. The climate is sub-tropical, with cold, dry winters from October to February followed by the spring which starts in May. The summer starts in June with an average temperature  $30^{\circ}\text{C}$  and a 2000 to 2100 mm rainfall it is very humid. 80% of the rainfall falls from June to September (DDC, 2016). The map of the study area was shown in Figure 1.

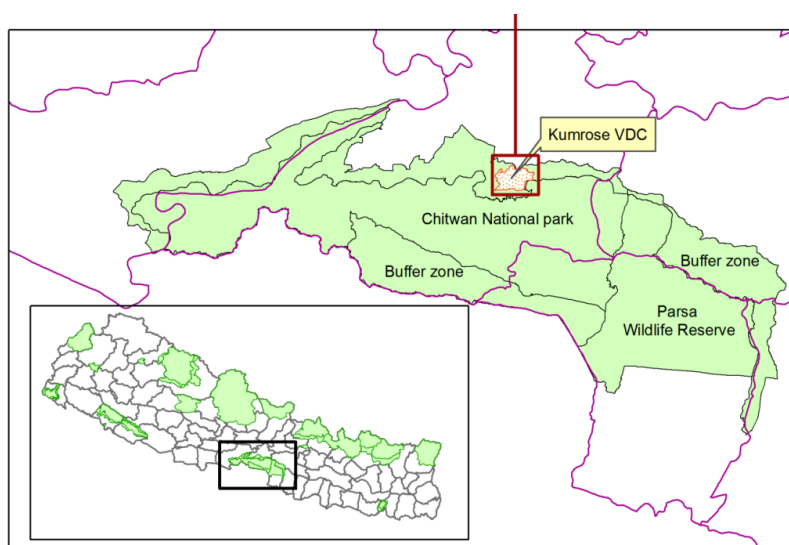


Figure 1: Map of the study area

There are currently 16,485 biogas plants installed in Chitwan (AEPC, 2011).

### ***Sampling Design***

A stratified random sampling technique was used for household survey. Both qualitative and quantitative approaches were used to inquiry for the study. Onsite field observation, questionnaire households survey (n=44), key informant interview, and focal group discussions were used for data collection. These methods were applied to extract the information such as socio-economic condition, sources of energy, dependency of local people on biogas, amount of fire wood substituted by biogas and people's perception towards biogas use and forest conservation.

### ***Sample Size***

The sample size (n) for the questionnaire survey was determined by using the following Formula given by Arkin and Colton (1963) cited in Sharma (2000) at 95% confidence level.

$$\text{Sample size (n)} = \frac{N * z^2 * P (1-P)}{N * d^2 + z^2 * P (1-P)}$$

Where,

N = Total number of households

z = value of standard variant at 95% confidence level (1.96)

P = estimated population proportion (0.05)

d = error limit of 5% (0.05)

### ***Data Analysis***

Both qualitative and quantitative analysis methods were used to analyze the data in this research. All the data collected were checked, refined and examine as per the objectives. Data were analyzed using Microsoft Excel program and Statistical Package for Social Sciences (SPSS) (Arkkelin, 2014; Shrestha & Shrestha, 2017)

## **RESULTS AND DISCUSSION**

### **Socio- Economic Characteristics of Respondents**

Of the 44 respondents surveyed during the study, 23 were male and 21 were female. To avoid gender bias, the survey was based on the availability of the household members during the field study. However, the proportion of male to female respondents represented was still male-biased (62.5% males, 37.5% females). About 77% of the respondents were literate and while remaining 23% were illiterate (Table 1). It cannot be taken as biogas effect but it can be said that mostly children and women somewhat free due to reduction of grazing LSU after installation of biogas plants. And stall feeding LSU has not increased significantly too. Agriculture is the main source of livelihood for the majority of the people in Nepal. In this study 65.9% of the HHs was dependent on agriculture related occupation, while 18.20% HHs were involved in government services and 15.90 were in business sectors (Table 1).

**Table 1:** Socioeconomic characteristics of the respondents

Category	Indicator	Number (N)	Percentage (%)
<b>Gender</b>	Male	23	53
	Female	21	47
<b>Age Group</b>	15-30 years	9	20.5
	30-45 years	28	63.6
	45-60 years	28	15.9
<b>Education</b>	Literate	34	77
	Illiterate	10	23
<b>Occupation</b>	Agriculture	29	65.90
	Government Services	8	18.20
	Private	7	15.90
	Services/Business		

### Livestock Population in Sampled Households

About 50% cattle (cow/ox, 72.7% buffaloes, 61.4% goat/sheep and 75% poultry population were surveyed in 44 households (Figure 2). Buffalo was the main livestock for biogas in the sampled households. All the respondents even having livestock not using biogas but planning to install it. Since buffaloes provide 33 % more dung than cows; buffaloes are more beneficial for biogas users. For the efficient biogas running around 20-25 kg of dung per day is needed. Joosje (2011) stated that the area with biogas as a source of energy requires more livestock population. The study found that for dung production, it is more beneficial to have buffaloes than to have cows. Buffaloes provide 33% more dung than cows. For the biogas installation it required around the 20-25 kg dung per day. The ward which has biogas as a source of energy has more livestock population (Joosje, 2011).

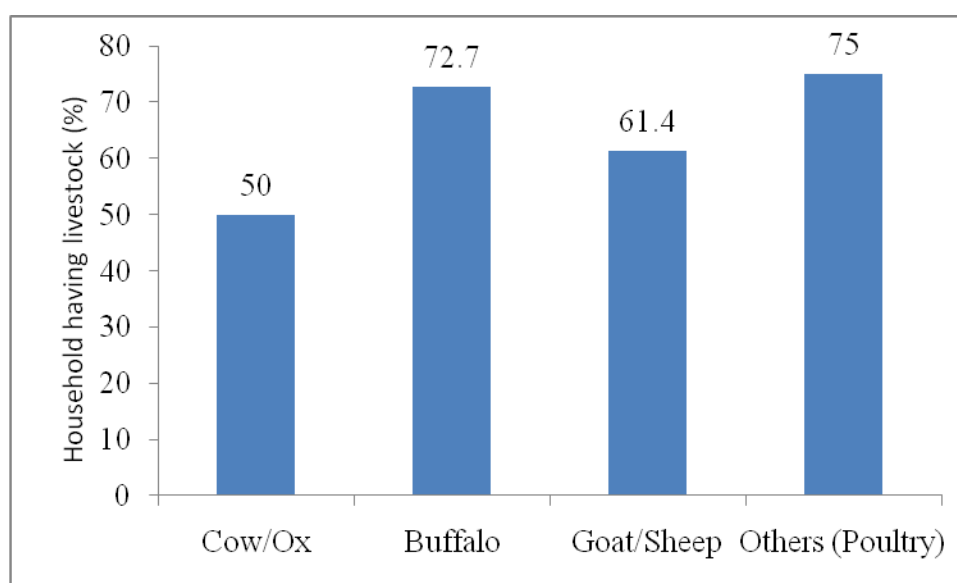


Figure 2: Status of livestock in HHS

### Source of Energy in Households

Sources of energy in the sampled household are depicted in figure 3. Result revealed that 100% of the respondents were using firewood but in less quantity as biogas is not sufficient for all seasons. 95.5% having electricity but only for light, 63.6% of respondents having biogas, 61.4% having kerosene, though 22.7% having LPG but they only used on special reasons, 9.1% having agri-residue (i.e. materials left in an agricultural field after the crop has been harvested.), 2.3% dung cake and 4.5% others i.e. candles.

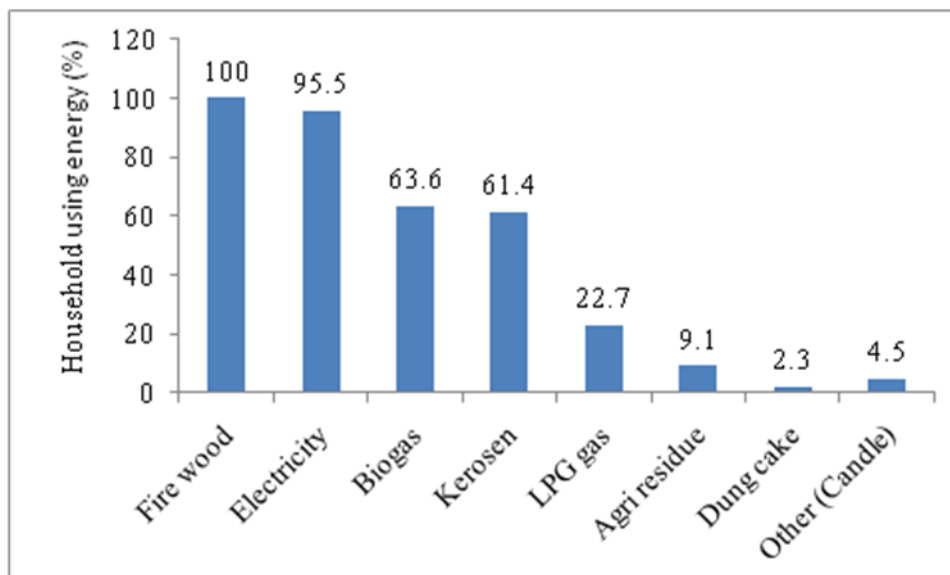


Figure 3: Source of energy in sampled HHs

Bajgain and Shakya (2005) stated biogas can also be used for lighting however in the study area use of biogas is limited only as a cooking fuel. Kerosene is imported in Nepal and the use of kerosene in rural areas is limited to relatively well-to-do families. Under such context, if use of biogas plants could be extended for lighting purpose, the benefits of biogas could be considerably increased promoting interest towards biogas plants. This would also result economic benefits to Biogas Households along with environmental benefits from replacement of imported fuel kerosene.

### Uses of Fuel wood

The users fulfil their fuelwood demand from private land and community forest. About 82% fuel wood collected from community forest and 18% fuel wood collected from private land. Maximum fuel wood was used for preparation of animal feed and alcohol i.e. 81.8%, followed by 63.6% for water heating and 45.5% for cooking (Figure 4).

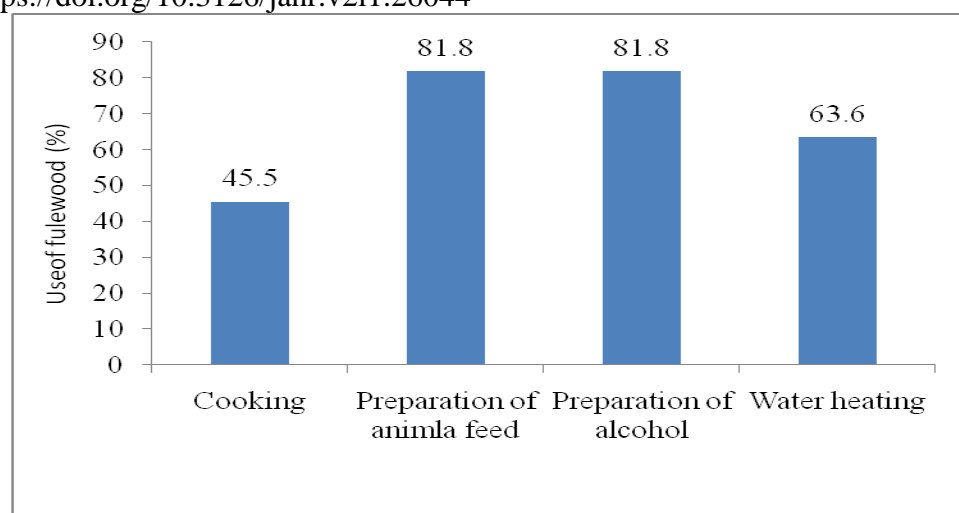


Figure 4: Uses of fuelwood

### Consumption of Biogas

The production of biogas is low in winter due to cold temperature reduction in the microbial activities but consumption of gas was high during winter. Similarly, the production of biogas is high in summer, but it was also sufficient for normal family size (4 to 5 members) not for big family size. Average family size for the respondent is 5.77.

### Amount of Firewood Substituted by Biogas

Firewood has occupied great space as energy source for heating and cooking before biogas installation. After installing biogas plants, the users have found that there has been a reduction in their fuel wood consumption. On an average 42.8% of the fuel wood was saved by the installation of biogas. Sapkota (2005) also found that 44.27% fuel wood was saved after installation of biogas in Kaski district. The result revealed that 32.1% households fuel wood consumption has reduced up to 790.5 bhari/yr, , 28.6% households fuel wood consumption has cut down up to 1581 bhari/yr., 32.1% households fuel wood consumption has decreased up to 3271 bhari/yr., 7.1% households consumption of fuel wood has reduced up to 3162 bhari/yr.. Households with maximum reduction of fuel wood consumption were highly satisfied with the biogas installation and use.

**Table 2:** Amount of firewood substituted by biogas

Firewood reduction (bhari/year)	Percentage of Household
Up to 790.5	32.1
UP to 1581	28.6
Up to 2371	32.1
Up to 3162	7.1



### Condition of Forest

The average reduction in fuel wood consumption was 42.8% after the installation of biogas. All the respondents were agreed that condition of forest is improving. Reduction in consumption of firewood by biogas users has had a direct positive effect on forest conservation as it has reduced the heavy dependency of people on forest. The reason behind this is the use of biogas which reduces the pressure on the fuel wood collection and ultimately helps in forest conservation.

### Seasonal Variation in Biogas Consumption

All the respondents said that the scarcity of the biogas was found during winter. The consumption of biogas is high during winter but the production of gas is low due to cold temperature which reduces the microbial activities. Generally biogas is sufficient during summer for the normal family size (4-5) but insufficient for big family.

### People's Perception towards Biogas Use

Perception of the respondent regarding use of biogas is shown in Table 3.

**Table 3:** People's perception towards biogas use

Statement	Highly satisfied	Satisfied	Not satisfied
Fuel wood reduction	96.4	3.6	0
Improve in kitchen environment	96.4	3.6	0
Time save in cooking	85.7	14.3	0
Time save in fuel wood collection	85.7	14.3	0
Financial benefit	7.1	92.9	0
Gas sufficient for all season	39.3	53.6	7.1
Reduce health problems	89.3	10.7	0

In case of reduction of fuel-wood, 96.4% of respondents were highly satisfied and 3.6% were satisfied. Regarding improvement in kitchen environment, 96.4% of respondents were highly satisfied and 3.6% were satisfied because it does not give out smoke while burning. In case of save in cooking time, 85.7% of respondents were highly satisfied and 14.3% were satisfied. Regarding save in time of fuel-wood collection, 85.7% of respondents were highly satisfied and 14.3% were satisfied because they can allocate their time in other activities. In respect of financial benefits only 7.1% of respondents were highly satisfied and 92.9% were satisfied because the price for the installation of biogas was expensive. In case of gas sufficient for all season, only 39.3% of respondents were highly satisfied, 53.6% were satisfied, and 7.1% were not satisfied. Regarding reduced health problems, 89.3% were highly satisfied and 10.7% were satisfied because biogas do not produced smoke and animal, human excreta and plant residues are the raw material for biogas which otherwise may create undesirable



condition.

## CONCLUSION

The production of biogas was low in winter however the demand was high compare to summer season. Biogas has positive impact on the different aspect of society like improved in kitchen environment and reduce health problem. Biogas reducing the load of fuel-wood collection as the alternative source of energy. All the respondents were agreed that condition of forest is improving day by day. The contribution of biogas to reduce the pressure on the forest and ultimately help to conserve the forest. The health of all respondents, related to the cooking, increased with 89.3% 100% after the installation of the biogas plant. In general almost every household was highly satisfied about the biogas. For the people it feels like an improvement and they advise everybody a biogas installation, because of the beneficial effects on human and environment. People's perception towards biogas use was found positive.

## ACKNOWLEDGEMENT

The authors gratefully acknowledge the Community Based Natural Forest and Tree Management in Himalayas (ComForM), Pokhara for providing financial support for this research work. We are thankful to the respondents of Kumroj village for their kind support during the study.

## Author Contributions

I. S. designed and performed experiments, analyzed data and wrote the paper; P. G. and B. B. guided the experiments and contributed this paper to this version to be published.

## Conflicts of Interest

The authors declare that there is no conflict of interest.

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