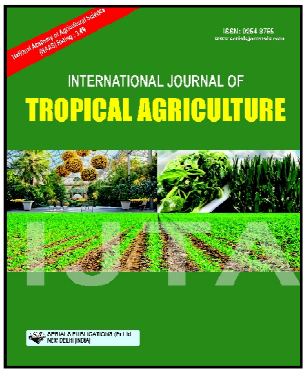

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Environmental and Economic Assessment of Household Biogas Plants for Indian Villages

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Abstract: The study was carried out in Hassan district of Karnataka state and data were collected with personal interview and visit to the villages. The study was taken up to evaluate the impact of biogas technology on economic and environment assessment of biogas users. The study revealed that, biogas constructed with motivation from biofuel park Hassan and agreed that biogas was easy for cooking, saves time and energy. Annual income of majority (61.67%) biogas plant owners were in medium level (0.51-1.00 lakh), it is also found that each biogas plant owner could save 205.50 kg of urea after stated using of biogas slurry and save time about 5.17 hours per day in performing different activities. In the point of health and hygiene, all the respondents accepted that after biogas plant installation smoke born related hazards reduced, presence of black soot in kitchen reduces and dishes are clearly observable while cooking. 97% biogas users expressed that biogas helps in eliminating environmental pollution, reduces fuel wood collection, reduces deforestation and maintains ecological balance of the village ecosystem. The research findings indicated that biogas helps in improving socioeconomic, condition, save time, energy, urea and helps in better sanitation, relief from smoke, reduces human exposure to health damaging pollutant air and reduced emissions of greenhouse gases that are thought to increase the probability of global climate change.

Keywords: *Biogas, economy, environment & health,*

INTRODUCTION

The economic and environmental prosperity of life of a country is closely linked to the level of its per capita energy consumption (Jatinder & Sarbjit, 2004). Energy is the ability to do work and is broadly classified into renewable and non-renewable sources

or that can never be exhausted. Non-renewable energy is obtained from natural static storages such as fossil fuels like petroleum products coal and nuclear energy derived from rare minerals. These natural resources will be exhausted over a period of time. On the other hand, non-renewable energy is obtained from natural sources, which continuously exploited from the environment on the earth's crust. The renewable energy can be obtained from the sun (solar energy), water (hydropower), wind (windmills), hot dry rocks, magma, hot water springs (geothermal), firewood, animal manure, crop residues and farm waste (biomass) (Tulasidas *et al*, 2007).

Renewable energy is considered as one of the most promising alternatives. Recognizing this potential, India has been implementing one or the other renewable energy programmes at different states. Among the renewable energy technologies, bioenergy has a large diverse portfolio including efficient biomass stoves, biogas, biomass combustion and gasification and liquid fuels. India has also formulated and implemented a number of innovative policies and programmes to promote bioenergy technologies (Ravindranath & Balachandra, 2009).

Biogas is the best renewable energy source produced by anaerobic digestion of organic wastes. Biogas originates from the biogenic material; it is a type of bio-fuel which primarily consists of methane and carbon dioxide. Biogas can be used as a low-cost fuel for heating, cooking and power generation. Biogas can also be compressed like natural gas, and we can also use it to run motor vehicles (Khurshid, 2009).

Normally, biogas digesters have an approach to indicate access to new forms of alternate energy services in rural areas and significantly improve health, environment, reduce greenhouse gases emission and provide direct & indirect benefits to the society.

Considering the above facts concerning the importance of renewable energies, present study on "Economic and environmental assessment of household biogas plants for Indian villages" were undertaken.

MATERIAL AND METHODS

The present investigation was carried out in three village viz., Muddanahalli, Huvinahalli and Kalenahalli, Hassan district of Karnataka state, India. A semi-structured questionnaire was administered to 60 respondents belonging to Muddanahalli, Huvinahalli and Kalenahalli villages and more than one response was obtained.

The household survey was conducted to assess the health, the environmental and economic benefit of the household biogas plant resources use for their energy needs before and after utilization of biogas plant. The questionnaires were administered to households to collect various information about the family like reasons for installation of biogas plant, the annual income of the respondent, income source, time-saving against different activities, urea utilization before and after installing biogas plant and greenhouse gas emission.

RESULTS AND DISCUSSION

The main purpose of the present investigation was to study the impact of adoption of biogas plant on the economic and environmental status of the biogas user in Hassan district of Karnataka. This chapter presents the results of the study in tabular and graphical form along with the discussion to interpret the outcome of the study. Results of the above details are explained below.

Installation of biogas plant

According to the survey conducted and response from all respondent, the question was made to know the reasons behind for installing of biogas plant for their household. In figure 5 presents answer form all respondent and it categorized into five factors where more than one response was obtained.

From sixty biogas plant owners, seven of them mentioned non-available of other fuel sources, fife of them said they motivated from existing plant owners, fifty-eight from sixty owners said motivated from Hassan Biofuel Park and all of them mentioned it saves times, energy and easy for cooking. Shrestha, A. (2010) found more or less uniformity in the diversified reasons for the installation of biogas plant installation.

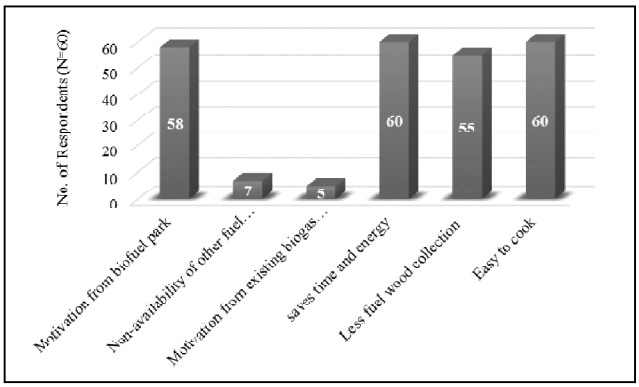

Figure 1: Analysis the Reasons for biogas installation (N=60)

Source: field survey, 2018

Annual income

The annual income of farm family refers to the total sum amount received by all the sources in the year. It describes the economic condition of farmers during the phases of learning cycle. In Table 1 the annual income is categorized as low, medium and high and result were presented as follows.

Table 1
Distribution of respondents according to their annual income (N=60)

Sl. No.	*Annual income*	*Frequency*	*Percentage*
1.	Low (below 0.50 lakh)	10	16.67
2.	Medium (0.51-1.00 lakh)	37	61.67
3.	High (above 1.00 lakh)	13	21.67

Source: field survey, 2018

Table 1 inferred that an individual possessing higher annual income is more oriented to possess higher knowledge of biogas plant as access to knowledge about biogas and its construction becomes easier as compared to individuals with the low-income group.

Income source for respondents

As per the survey the source of income for respondents was considered and divide into four categories and presented in the figure 2, as agriculture only, agriculture & industry, agriculture & government job and agriculture & business.

Figure 2 explains the Income source of biogas plants owners. Majority of owners around 68.33% depends on agriculture only, 11.67% of the owners doing both agriculture & government job, while 10.0% of sixty biogas plant owners have running small industry along with agriculture and 10.0% of the respondents earning income from agriculture along with other business.

Income was an important factor determining the choice of fuel for cooking, but there were some socio-cultural and technical factors which were equally important in making fuel preferences at the household level. Vinod *et al.* (2009).

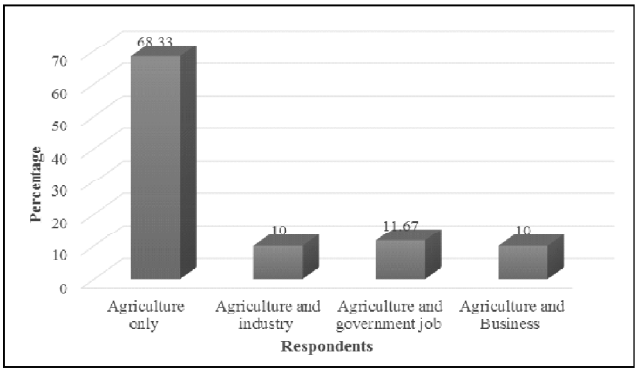

Figure 2: Income source for respondents

Source: field survey, 2018

Urea utilization before and after installing the biogas plant

Urea is one of the chemical fertilizers used to enrich the soil nutrient. The utilization of urea varies from

household to household. The data were collected with a direct interview for to know the consumption of urea from all respondent at before and after biogas installation of biogas plant. Average utilization of urea for household mentioned in bag and kg per year (each bag contains 50 kg).

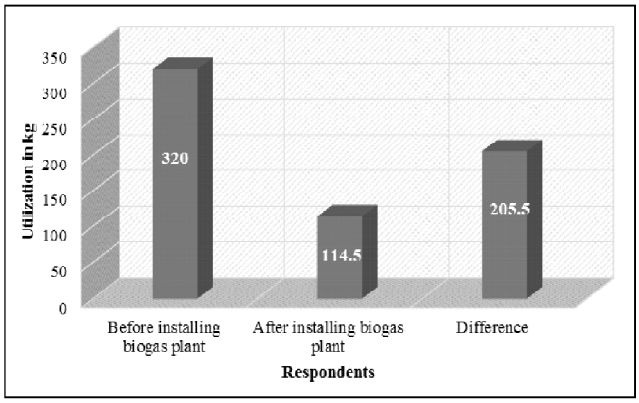

Figure 3: Urea utilization before and after installing biogas plant (N=60)

Source: field survey, 2018

The Figure 3 presents the total urea consumption by the household from the respondents. With the figure, it clearly highlights the average quantity of urea saved from a household in bags and kg per household per year. The difference in urea consumption per household decreased from 6.40 to 2.29 bags per household by installing biogas plant. It can save 4.11 bag per household or 205.50 kg per household per year of urea consumption.

The findings Sharma and Nema (2013) reported that among the respondents 96% of them are using digested biogas slurry as fertilizer and 90% of the farmers were able to reduce the use of chemical fertilizer. All of them stated that it is very helpful in improving soil structure and yield and Viresh Kumargoud *et al.* (2006) worked on the impact of biogas technology on rural women at villages of Shimoga district, Karnataka and they reported that after adoption of biogas reduces 93.50% on spending of petroleum fuel and of petroleum and chemical fertilizers.

Time saving against different activities by installing a biogas plant

This study was carried and discuss with respondents to know the time saved by using biogas against cooking and other activities. Time spend for the following activities before and after biogas plant installation mentioned and overall time saved per households by using biogas plant represented below.

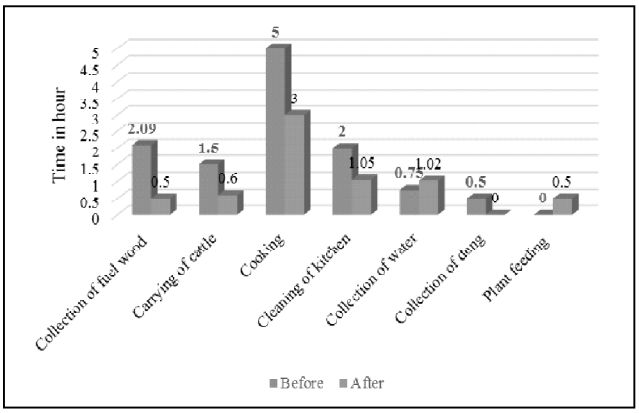

Figure 4: Time-saving against different activities by installing biogas plant in a day

Source: field survey, 2018

The same was reported by NGO Promotion Center (2003) in Bhaktapur District and found that 30% have been involved in the income generating activities from the saved time. Sharma and Nema (2013) worked on applicability of biogas technology in rural development and greenhouse gas mitigation and he reported, based on Survey included 22 families which were using biogas for cooking purposes and slurry as fertilizer, 100% families experienced less time consuming and convenient cooking with biogas and all of them noticed health improvement.

Health and hygiene benefits of biogas plant

During the data collection, health and hygiene benefits of biogas plants were asked to respondents with direct interaction by considering four factors viz., smoke born disease, burn cases, black soot in kitchen/house and expenses related to health and hygiene, where more than one response is obtained.

Figure 5 represents the number of respondents and percentage according to sixty biogas plant owners towards health and hygiene benefits of biogas plant. It clearly shows that 100% of the respondents agreed about biogas plants benefits in decreases smoke born disease and black soot in kitchen, 95% among them agreed in the reduction of burning cases and 83.33% of respondents satisfied in the reduction of expenses related to health and hygiene.

Li *et al.* (2005) worked on green rural energy in Yunnan, China and reported that 67% of the households expressed in improved health due to reduced indoor smoke and indirectly it reduces health-related expenses. Indoor climate dramatically improved as a result of using clean biogas stoves instead of burning fuelwood, straw and dung cakes would mean that a lot of problems with hazardous smoke particles would be avoided.

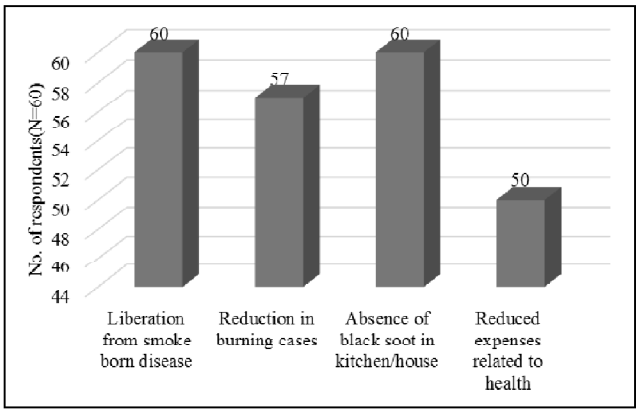

Figure 5: Health and hygiene benefits of biogas plant (N=60)

Source: field survey, 2018

Greenhouse Gas Emission (GHG)

Most of the greenhouse gas emissions causes the world's current climate change and it can be traced by human activities particularly in industrialized countries resulted in the high concentration of some of these gases specifically CO_2, CH_4, and N_2O. The major source of greenhouse gas emission is through the unsustainable use of traditional biomass resources like fuel wood, agricultural residues, animal dung etc. Through the data collection, the average fuel wood consumption was calculated and found that average fuel wood consumption per household as 4705 kg/household and 2008 kg/household at before and after adoption not using biogas plant.

Table 2 represents Greenhouse Gas (GHG) emission from fuelwood burning per household and total CO_2 Emission in kg per household per year by considering the total fuelwood consumption per household. It shows that before using biogas plant the total amount in kg of CO_2 emission per household per year was found that 7140.84 and it has reduced to 3047.52 emissions per household per year by installing and using biogas plant.

Shrestha, A. (2010) reported that by installation of biogas and replacement of fuel wood reduced the annual GHG emission from total of 6,025.538 kg of CO_2 emission/year GHG for a Non- Biogas Household to 3,656.6519 kg of CO_2 emission/year GHG (including 853.209 kg of CO_2 emission/year/plant from slurry tank) for a biogas household.

Typical animal waste management systems utilize anaerobic or facultative lagoons for treatment of liquid waste streams, such as flush water and runoff and land application to dispose of solids. Enclosed anaerobic digestion systems for biogas production are not subject to pronounced influences of the weather, making effluents from digesters more stable and uniform than effluents from anaerobic lagoons. Additionally, odors are controlled since all the gas is burned prior to release into the atmosphere. Anaerobic digestion processes result in source strength reduction by converting incoming organic matter to methane, carbon dioxide and small amounts of microbial biomass, pathogens and weed seeds are destroyed and odors are reduced.

The environmental benefit from using biogas as an energy resource is that there is no net production of greenhouse gases. The carbon dioxide released during biogas combustion originally was

Table 2
Greenhouse Gas (GHG) Emission from Fuelwood per Household (N=60)

Sl. No.	*Respondent*	*Average Fuelwood consumption (kg/ household/ month)*	*GHG*	*Emission in kg/ month / household*	*Emission in Kg/ year/ household*	*Total Emission of CO_2 in kg / Household/ year*
1.	Before installing the biogas plant	392.01	CO_2	551.16	6613.99	7140.84
			CH_4	32.92	395.14	
			N_2O	10.98	131.71	
2.	After installing a biogas plant	167.30	CO_2	235.22	2822.68	3047.52
			CH_4	14.05	168.63	
			N_2O	4.68	56.21	

organic plant material and so is just completing a cycle from the atmosphere to plant to animal and back to the atmosphere.

CONCLUSION

Biogas can provide clean and non-polluting energy in rural areas. Enclosed anaerobic digestion systems for biogas production are not subject to pronounced influences of the weather, making effluents from digesters more stable and uniform than effluents from anaerobic lagoons. It was also expected to generate employment, economic improvement, environmental stability and energy self-reliance. Biogas could meet the ever growing energy demand and reduces India's dependency on oil imports.

The economic situation of families closely related to kinds of fuels, that they are chosen. It has been proved that advanced bioenergy technologies have the potential to produce sufficient quantum of modern energy carriers to meet the heating, lighting, shaft power and motive power needs, particularly of the rural population. Further, bioenergy technologies are the prime possibilities aimed at mitigation of climate change apart from land reclamation through growing energy plantations and reduction in domestic indoor pollution.

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