CHAPTER - I

INTRODUCTION

1.1 Background of the Study

Biogas is usually known as methane which is collected from animal manure and other organic material that gives methane as it decomposes an aerobically (i. e. without air). Methane, Carbon Dioxide, Water Oxygen, Traces of Sulphur and Hydrogen Sulphide are main component of biogas. If this gas is collected in a centralized plant, it can be used to create energy for variation profession. Any residue is available as an organic fertilizer which is less harmful than chemical fertilizers. Biogas consists of methane which is the same kind of natural gas. The difference is that how it is formed. Natural gas is stored in the earth's crust as oil, while biogas is renewable and is made of organic material. The material (i.e. sewage sludge, manure, meat and catering waste) rots in an oxygen-free environment and in the process forms a gas composed of methane and carbon dioxide. The gas is purified from carbon dioxide and the remaining is a gas consisting of 97 percent methane that can be used as fuel for vehicle or to generate electricity. Biogas is a renewable bio-fuel and is classified as one of our cleanest fuels. If biogas is used as vehicle fuel instead of gasoline, it reduces emissions and the use of fossil oil. Biogas is formed in a natural degradation process of biological material, and unlike petrol and diesel, is a renewable energy source that is part of nature's cycle.(https://www.quora.com)

Nepal is a small country with an area of 1, 47,181 sq. km. inhabited by 2, 64, 94,504 people. The land area can be roughly divided into three physiographic regions like: the hills, the mountains and the plains. Out of total population 83 percent live in ruler areas as well as 14 percent live in urban areas (CBS, 2012). It is no doubt to say that Nepal is a beautiful landlocked Country lies in between India and china. Nepal is mountain country situated in the foothill of the Himalayas. The economy of Nepal is primarily based on agriculture and the share of agriculture to total GDP was 32.35 percent (MoF, 2012), most of the rural population has the tradition of raising cattle as an integral part of their farm people are depended mainly on firewood for their energy requirement. The per capita consumption of fire wood in Nepal is 332 kilograms per year

which is the main cause of deforestation. They use it for cooking space heating and other purposes

Biogas as an alternative energy is essential in these days. There are so many alternative energy such as hydro power, solar power, wind energy, biogas and so on. Thus, biogas remains the best alternative source of energy that stands technically, socially, economically, biologically and environmentally feasible. The cost of wind and solar power and expensive for the rural people than biogas this technology increasingly accepted by all ethnic group in both the Hills and the Tarai. There is not any significant social barrier to the technology especially when cows and buffaloes dung is used as surly. Since combustion of biogas does not produce toxic fame and carbon residues on the bottom of pots and pans, health conscious rural people (especially women) favor this technology the plant owner on the Tarai reported that the land of gas production decreased by about 25 percent during winter.

Benefits of biogas is not only cooking and lighting, because it has other indirect advantages also. After using the cattle's dung in the biogas plant, the digested slurry can be used for compost fertilizer. This helps to increases the productivity of land which helps to minimize the food shortage. Moreover this, as the cattle (i.e.cows, buffalos etc.) have to keep in sheds for the use of their dung in the gas plant, the problem of overgrazing is minimized or reduced.

In Nepal, biogas is mainly used for cooking and lighting. But benefits of biogas do not end there. It has other indirect advantages too. After using cattle's dung in the biogas plant, the digested slurry can be used for compost fertilizer. This helps to increase the productivity of land that helps to minimize to food shortage. Moreover, as the cattle (i.e. cows, buffalo etc.) have to be kept in sheds for the use of their dung in the gas plant, the problem of overgrazing is minimized. After using the biogas for cooking, the kitchen remains smoke free and hence the chance of smoke borne diseases is eliminated, which helps to reduce the medical expenses. Biogas also saves time and money which can be used for different income generating actives. Use of biogas helps to reduce deforestation, which is another positive impact of biogas plant installation. Biogas plant installation also helps in creating job opportunities for skilled human resource.

This study concentrates on the use of biogas plant as an alternative source of energy, and the same time tries to explore the various benefits of adopting biogas such as economic, environmental, social, health, and sanitation in Pathari Shanischare municipally of Morang District, Nepal.

1.2 Statement of the Problem

Biogas is really less dangerous then other fuels such as these fuels have their way of being dangerous. Certain precautions should be observed in the operation of biogas systems. Biogas can be explosive when mixed with air in the proportion of one part biogas to 8-20 parts air in an enclosed space. This situation can occur when a dig ester is opened for cleaning when biogas is released to repair a gas storage tank, or when there is a gas leak in a poorly ventilated room. In such case avoid sparks, smoking and open flames. A biogas leak can be smelled if the hydrogen sulfide has not been removed from the biogas. It smelled liked rotten eggs. No one should go inside large dig esters unless they have a companion on the outside. Although the methane and carbon dioxide of biogas are not poisonous, a person may stop breathing if there is too much biogas and not enough oxygen in the air they are trying to breath.

It is the very important that if a digester is built underground, that it is built in place that never floods. If an above ground digester is built in an area that sometimes floods, make sure that the opening into the digester are above the high water mark. If a digester is built in an area that does have floods, safety measures should be taken in advance so that the gas can escape in case the digester and or the gas storage tank are flooded failure to do so could result in dangerous, uncontrolled release of biogas and if the digester is a plastic bag, it could float up and away. An upside – down "T" pipe should be placed at the highest vertical point in the gas pipe line above the gas outlet from the digester.

In Nepal, more than 85 percent of total energy is used from the forest which means the high rate of deforestation. It leads to natural calamities such as landside, flood, soil erosion etc. on one hand. And on the other hand, collations of firewood consume more time and ultimately result in ill health of the people. So, people are bound to live

always in poor condition economically and socially. However, the main research questions of the study are as given.

a) What are the socio-economic features of sample households?
b) How do people use biogas in the study area?
c) What are the benefits of using biogas in the study area?
d) Is it feasible for each and every individual in the society? As we know most of people are under poverty line, can they afford it?
e) Biogas has a lot of advantages over the primitive firewood. How the techniques of biogas do stands to the people of rural area?

1.3 Objectives of the study

The general objective of the study is to analyze the contribution of using biogas to the people of Pathari Shanischare Municipality of Morang District. However, the special objectives of the study are: -

a) To explore the socio-economic features of sample households.
b) To assess the uses of biogas in the study area.
c) To analysis the benefits of using biogas in the study area.

1.4 Signification of the Study

Biogas plant installation is an appropriate alternative and renewable source of energy in rural areas. It has gained momentum contribution now-a-days in the absence of adequate development of energy source such as hydropower, solar power and wind energy which require more capital for installation and operation. Biogas technology simply reduces the workload of woman and children of household family members for collecting firewood and washing utensils. Time and money saved after the installation of biogas plant can be utilized on income generating activities. Biogas technology also helps to improve the health and sanitation of rural people and creates smokeless and healthy environment in the kitchen. Biogas also reduces the prevalence of insects in higher rate than that of earlier due to the neat and clean environment. Biogas directly helps to reduce the rate of forest depletion. The consumption of firewood is curtailed after the installation of biogas plant. Reduction in the rate of forest depletion ultimately reduces the range of natural disaster such as flood, landside, soil erosion, and desertification.

As Nepal has virtually no proven reserves of coal, oil and gas so these fuels are imported from aboard by paying large amount of money. To outcome from such situation, uses of renewable energy are the only option. Hydro power is the most obvious sources, biogas is the most appropriate and viable sources of energy in Nepal. Where large majority of the people are living in rural areas and have the tradition of the raising cattle and buffaloes as a integral part of their everyday life. They where hesitating to adopt biogas in their houses. So, it is imperative to study the socio – economic impact of biogas in everyday activities. There four, the study will be helpful to the government, national planner, policy maker, researchers, teachers, students who are interested to know about the contribution of using biogas in rural area in Nepal.

1.5 Limitations of the Study

The study has few limitations as given below.

a) The study is related to only the Ward No.15 of Pathari Shanischare Municipality of Morang district of Nepal.
b) The study used only 60 households (16.67 percent) of total size of population (360 biogas user households)..
c) The study does not concern about the technical part (issues) of using biogas.
d) The results of the study can't be generalized in other areas of the nation where biogas is used.

1.6 Organization of the Study

This study has organized into five chapters. The first chapter of the study is the introduction that includes background of the study, statement of the problems, objectives, signification, limitations, and organization of the study. Besides, introduction of the study area is also included in the first chapter. In the second chapter, literature review is presented that is divided into international context and national context. Besides, the research gap is also added. The third chapter is the research methodology that deals with research design, nature and sources of data, selection of the study area, population, sample and sampling procedure, tools of primary data collection, data organization and processing, tools and method of data analysis. The fourth chapter is the body part of the study that is provides the answers of the given research questions and also justifies objectives of the study. The last chapter is the major findings, conclusion and recommendations of the study.

CHAPTER – II

REVIEW OF LITERATURE

Review of literature is an integral part of any kind of research work. The review of literature serves to enhance and consolidate knowledge of the given subject matters. Review of literature basically provides a theoretical background and present status of the study on given subject matters undertaken by various researchers in the past. It also established the linkage between the past studies and proposed study on the given subject matter. The literature is reviewed from various sources such as books, booklets, and articles published in various bulletins, journals and newspapers, reports and papers presented at seminars, information published by concerned agencies and dissertation presented by former students, It is divided into international context and national context.

2.1 International Context

GoI (2002) has stated that biogas is produced and utilized as a cooking fuel by many villagers in India. The study used two models that were the Community Biogas plant established by SUMUL Dairy at Bhintbudrak, Gujrat and the Individual Biogas plants established by a NGO namely Bhagirath Pratisthan in south Konkan region of Maharashtra. The study discribed various aspects including design of biogas, its operation, vision, performance, economics and benefits to the stakeholders. The report ends with a comparison of the two models in the study area.

Madlenera, Antunesb, and Diasc (2006) compared multi-criteria decision aiding (MCDA) and data envelopment analysis (DEA) approaches for assessing renewable energy plants, in order to determine their performance in terms of economic, environmental, and social criteria and indicators. The case is for a dataset of 41 agricultural biogas plants in Austria using anaerobic digestion. The results indicate that MCDA constitutes an insightful approach, to be used alternatively or in a complementary way to DEA, namely in situations requiring a meaningful expression of managerial preferences regarding the relative importance of evaluation aspects to be considered in performance assessment.

Sagagi, Garba, and Usman (2009) presented the results of the study on biogas production from fruits and vegetables waste materials and their effects on plants when used as fertilizer (Using digested and undigested sludge). It has been observed that the highest weekly individual production rate is recorded for the cow dung (control) slurry with average production of 1554 cm3, followed by pineapple waste which had 965 cm3 of biogas, then by orange waste which had 612 c.m. 3 of biogas, lastly, pumpkin and spinach wastes had 373 cm3 and 269 cm3 respectively. The results obtained shows that difference in the production of biogas to a large extent depends on the nature of the substrate. All the substrates used appeared to be good materials for biogas production and their spent slurries can be used as a source of plant nutrients.

Choragudi (2011) assessed diffusion of one of the earliest renewable energy technology initiated in India i.e. domestic biogas plants (BPs). In this paper they examine the trends and patterns of the diffusion of biogas plants over time across states; analyses the performance of the states vis-à-vis funds invested in the development of the technology. Since the initiation of the programme, it took twenty-eight years for us to achieve 34 per cent of the estimated potential in terms of installation of domestic BPs. Performance of BP though showed an encouraging picture in the initial years, it weakened in the later years and it remained almost stagnant in the past six years. Compared to other primary sources of energy, BPs are sparsely opted energy source. Variation in the performance among the states is observed. Disparities were found between states 'received funds and their performance levels. In order to account for the above observed trend, we sought to household level econometric analysis by taking state level characteristics into account. In order to examine the factors that explain the differences between adopters and non-adopters of biogas plants, they employed a logic model on the household energy consumption data provided by 61st NSSO round.

Gebrezgabher (2009) presented one of the key concerns of biogas plants is the disposal of comparatively large amounts of dig estates in an economically and environmentally sustainable manner. This paper analyses the economic performance of anaerobic digestion of a given biogas plant. A scenario analysis is carried out based on a linear programming model to identify feed stocks that optimize electricity production and to determine the optimal application of dig estate. The economic analysis is also based on

NPV and IRR concepts, to assess the cost-effectiveness of the biogas system. In addition to a default scenario, management and policy scenarios were investigated. Findings show that treating RO as green fertilizer as opposed to manure (default scenario) is not only lucrative for the plant but also lessens the environmental burden of long distance transportation of concentrates. This paper also concludes that given the uncertainty of regulations concerning RO and the currently low values of dig estate and heat, high investment and operating costs limit 6 the feasibility of anaerobic digestion of wastes of farm origin and other co-substrates unless subsidies are provided.

Bond and Templeton (2011) studied technologies which recover biogas do so by harnessing anaerobic degradation pathways controlled by a suite of microorganisms. The biogas released acts as an environmentally sustainable energy source, while providing a method for disposal of various wastes. Biogas contains 50–70% methane and 30–50% carbon dioxide, as well as small amounts of other gases and typically has a calorific value of 21–24 MJ/m3. Various appliances can be fueled by biogas, with stoves offering an application appropriate for deployment in developing countries. Widespread dissemination of biogas digesters in developing countries stems from the 1970s and there are now around four and 27 million biogas plants in India and China respectively. These are typically small systems in rural areas fed by animal manure. However, in many other countries technology spread has foundered and/or up to 50% of plants are non-functional. This is linked to inadequate emphasis on maintenance and repair of existing facilities. Hence for biogas recovery technology to thrive in the future, operational support networks need to be established. There appear to be opportunities for biogas stoves to contribute to projects introducing cleaner cook stoves, such as the Global Alliance for Clean Cook stoves. Beyond this, there remains potential for domestic plants to utilize currently under exploited biogas substrates such as kitchen waste, weeds and crop residues. Thus there is a need for research into reactors and processes which enable efficient anaerobic bio degradation of these resources.

Vaibhav (2011) has written is the center of a large agriculture region in Oyo State The Ibadan digester will take advantage of the city's Bodija Municipal Abattoir, where nearly two-thirds of the animals in Oyo State are slaughtered , according to a study in the

January 2002 African Journal of Environmental Assessment and Management. The waste from the slaughtering process is rinsed into open drains that connect to surface water; they also percolate into groundwater. About 60% of get water from hand – dug wells vulnerable to contamination from surface sources, and about 15% have private wells tapping a deep aquifer, according to Tijani Moshood, a geologist at the University of Ibadan.

Abattoir waste carries high levels of microorganisms that cause disease in humans and animals, such as Salmonella and Escherichia coli bacteria, Rift Valley fever virus, and parasites that cause toxoplasmosis and trichinellosis. Pesticides, antibiotics, metals, industrial chemicals, and the agents responsible for bovine spongy- form encephalopathy (BSE) May also enter the human food chain at an abattoir if they are present in the animals. Furthermore, decomposing organic material releases methane is even worse – 23 times more potent than co2, according to the Intergovernmental Panel on Climate change report Climate change 2001: The Scientific Basis.

Weisman (2011) has written energy has heard of biogas by now, yet the origins and uses of biogas remain mysterious to Home Biogas, has from the past: Biogas 101. Most people who follow renewable biogas are unusual in that its use predates the use of fossil fuels. In fact, it is older than fossil fuels completely. The microorganisms that create biogas are among the oldest life forms on earth, over three billion years older than the plants and animals that became today's fossil fuels. Biogas not only provides excellent, clean – burning energy that can replace fossil fuels in the future, but in many place it already is.

International workshop on domestic biogas held in Indonesia, (2010)the convener of the domestic biogas working group of the energy for all partnership, together with HIVOS and Indonesia domestic Biogas Program organized a three- day international workshop entitled "domestic biogas program in Asia: transformation towards commercial sectors and development of effective financing facilities" on 22-24 November 2011 in Bandung, Indonesia. More than 60 participants from 17 countries joined the event, representing government institutions, private and civil society organization, knowledge center, development agencies, multilateral banks, and international donors.

Chanakya (2012) presented this paper the quest for a simple technology to realize the goal of sustainable energy for all. The conversion of non-lignified non-woody biomass to biogas in modern anaerobic digesters is an important component. Firstly, agro-residues, agro-industrial wastes, terrestrial/ aquatic weeds form a major source of sustainably raised bio resources. An aerobically converting them to biogas provides a sustainable energy source to a large number of users and simultaneously facilitates nutrient recycling (nutrient-rich compost) permitting nutrient-starved agricultural systems in India to become more sustainable. When processed through biogas plants, over 95% of all plant nutrients within can be recycled making India‘s fragile agricultural soils more sustainable while also producing an energy source, biogas. This potential has been inadequately tapped. In this paper, an attempt is made to review the microbiology of anaerobic digestion of various biomass residues, the conversion processes that are being developed/in use and finally to examine methods to make them attractive, provide multiple outputs and services than what was possible through animal dung biogas plants. The micro-organisms responsible, physio-chemical environment process and therefore the technology of digestion of biomass residues are not similar or as simple as that found for animal dung or food wastes.

Therefore, novel fermentation concepts and modern digesters being developed for biomass residues are required to make this concept feasible and viable. Many more end-products, other than compost and biogas, as was done in the past, are required if the digesters have to be economically attractive to use and socially justifiable as well as sustainable in the long run. The sustainability issues that have and will shape this field are discussed. In this paper we show that simultaneous anaerobic digestion of biomass residues to biogas and multiple by-products could be an answer to the search for alternatives to achieve sustainable energy for all in this decade.

2.2 National Context

Shrestha (1990) studied clearly shows that the biogas technology is economically a non-viable technology that is beset with many social problems of re-adjustment during the transition period of moving from one technology to another. For instance, it is incorrect to assume that Dung the row material in the production of biogas is a waste

product. It is used almost to the fullest possible extent, though the efficiency of such use may be questioned. Existing consumption pattern will most definitely be disrupted and as Ashok Kumar argues to the detriment of a large section of the population. Though he has not mentioned it anywhere in his monograph his results suggest that expenditure of public money in such cases is better spent on Further technological work rather than on any large scale application as it is presently being aimed.

ADB/N (1996) has elaborated that in biogas technology, an anaerobic fermentation of organic waste takes place causing its decomposition and a mixture of gases containing methane 60-70 percent evolves after the fermentation of sledge like residue which is left behind can be used as an organic fertilizer (New ERA, 1999). The gas is colorless, odorless but also certain more nutrients like nitrogen, phosphorous and potash than in reading. The volume of gas produced from the plants of both types totally depends upon the temperature, higher the temperature, higher is the level of daily gas production. Temperature between 30-39oc is taken as suitable one for fermentation likewise PH of 7 to 8 considered as the best.

Dhakal (2002) studied microbiological method of producing biogas by using vegetable and kitchen waste with or without cow dung. The study found that biogas production through anaerobic digestion of the biodegradable portion of waste is continuous and self- sustained process which once established has array of advantages. It becomes cost-effective in the end because it is continuously a clean burning fuel and high quality fertilizer from low-value waste. The study concluded that the equivoque mixture of cow dung and vegetable and kitchen waste is an effective feed material compared to kitchen waste only for increased yield of biogas, which is beneficial especially for marginal farmers. If the ambient temperature is suitable, biogas can be produced easily even at outdoor environment .Alternatively, vegetable and kitchen waste can replace the use of animal and human excreta for biogas production. The use of such feed materials can initiate the management of biodegradable solid waste in urban areas. At the same time, along with alternative energy production, high quality fertilizer also comes to be available.

Bajgain and Shakya (2005) have written that the Nepal is a non-annex I country recognized by United Nation Framework Convention on Climate Change (UNFCCC). The avoided GHGs emissions from CDM projects will generate Certified Emission Reductions (CERs) that can have brought by Annex I countries. This can help financing biogas growth in developing countries. The economic analysis for the biogas system carried out by Bajgain and Shakya (2005) with capital cost of NRs 23, 113(US $ 312) in the Hills assuming a life span of 20 years. The base analysis, which included only the saving of fuel like fuel wood and kerosene gives a Financial Internal Rate of Return (FIRR)of 21%. This study also reveals that the actual FIRR realized by the farmer is largely dependent on the local cost of fuel wood. Adding to this the benefits due to subsidy, NRs 9500 (US $ 128) in the Hills the FIRR increase to 37%. A sensitivity analysis on the amount of the subsidy provided shows that, while doubling the subsidy per biogas unit the Hills to US $ 256, the FIRR is nearly 160%. This indicates that the resulting FIRR is extremely sensitive to the subsidy.

BSP (Biogas Support Program) (2008) stated that there was significant positive contribution to the biogas user households. It has been the first CDM project in Nepal with registration of two CDM project on December, 2005 of 19,396 plants constructed under BSP phase – IV. It has been registered with and approved by the CDM Executive Board. An Emission Reduction Purchase Agreement (ERPA) for the two projects has been signed with the word bank for trading of the Emission Reductions from the two projects for first seven years starting 2004/2005 as the first crediting years 2004/2005 has been completed and payment has been made too.

GGC (Gober Gas Company) (2009) reported that while preparing hoer has company profile further expresses the view that biogas the clean energy technology has also improved sanitation of local environment however poorest of poor could not be benefited from the program directly after installation raising, poultry farming gain time was utilized in goat raising. Poultry farming other income generating activities, child care agriculture production. Thus it has improved the living condition of the rural people it is believed that proper use of slurry biogas is about 20% lighter than air. The main component of biogas is methane which is colorless, odorless and tasteless. But due to the presence of other gases it gives smell similar to that of garlic or rotten eggs.

Aryal (2010) has written that biogas is the reliable alternative source of energy. Nepal has the potential of installing 1.3 million biogas plants. However, the actual number of plants installed is only about 150000, which has reduced the consumption of firewood by 250000 tons and that of kerosene by 4 million liters. In general, a household with two livestock can install a biogas plant. Although the plant installation cost is high, the government has provisioned a subsidy program for the ultra-poor to ease the problem. Biogas can be very handy while cooking, lighting, as well as providing agro- fertilizer through bio-slurry. In Nepal, if biogas potential is fully realized, it can support 10 percent of total energy consumption of the country.

CMF (Center for Micro Finance) (2013) conducted a study with objectives to assess different biogas financing modalities, assess lending policies and strategies of MFIs for RETs, find the current status of biogas financing and assess different source of user's contribution in biogas plant installation. The study has found that the users and local financial institution are benefitted and motivated with biogas and financing services. The biogas users have benefitted mainly by cooking fuel cost saving, improve health and sanitation. The users have got easy and cheaper financial access form financial institutions in their locality and repaid loan in installment. Similarly, the MFLs have benefitted from spread income, provided service to the clients and satisfied to fulfill corporate social responsibility to improve health and environment. Despite these benefit, the users are worried mainly on maintenance of the biogas plants and not clear on the terms and conditions of biogas, biogas loan and amount of subsidy.

Ghimire (2014) studied on the potentiality of biogas plants and their role for the conservation of environment. This study found that there were more than 95% of the people residing in the VDCs were using firewood as a main source of energy. The total amount of firewood consumed was 510.570 tone/year which emits 775.052 tones CO_{2e}/ year. The study showed that biogas technology could save 34.40% of firewood which conserves 5.415 ha of forests area. There is a potentiality of 58 biogas plant of size 6 m^3 which will reduce 440.800 tones CO_{2e}/year.

Thapa and Lamichhane (2014) revealed that biogas plant were able to reduce fuel wood consumption by 54.50% (from 3672 Kg / year / HH to 1670 Kg / year / HH). Thus,

3038.4288 Kg CO_2e / HH /year of GHGs emission were reduced annually due to the installation of biogas plant. Based on the study, each biogas plant was likely to bring annual carbon abatement revenue of around US $ 20.272 per plant per annum and US $ 1094.688 if climate change by reducing greenhouse gases emission and sequestrating carbon in the form of conserving natural forest.

The GHGs inventory finds that about 71% of the total CO_2 equivalent emission from the energy sector in 2000/01 is from the fuel combusted in the residential sector for heating and lighting purposes. According to the GHG inventory, in the base year 2000/01, the energy sector in Nepal emitted 6894.64 Gg of CO_2 equivalents. Out of this, 2763.28Gg was emitted as CO_2, 163.96 Gg as CH_4 and 2.22 Gg as N_2O (SNC, 2014)

Shrestha (2014) found that there was a saving of 53.83% of fuel wood per year among the biogas holding households compared to non holding households and each biogas plant saved over 2 tonnes of fuel wood annually. Installation of biogas plants provided each biogas households an equivalent saving of NRs. 2653.2 per year through reduced fuel wood consumption. The total annual GHGs emission was 3656.6519 kg CO_2e/year/HH for Biogas households and 6025.53762 kg CO_2e/ year/HH for Non-Biogas households. The methane leakage from slurry tank was 3656.65 kg co_2e/year/HH. Thus the net annual GHGs emission substitution of fuel wood by biogas energy was 2368.836 kg CO_2e/plant/year.

Guragain (2017) carried out the study on Economic Impact of Biogas Plant in Budhabare VDC, Jhapa. This study was undertaken to analyze the economic impact of Biogas plants. Descriptive method was used for the study. Information was collected from field survey where as 40 samples of biogas households were taken from whole population. Questionnaire interview and observation were used as main tools for the study. The main findings of the research are as follows:

a) There is a considerable reduction in the workload of the family members especially women.
b) A significant amount of time has been saved and the saved time (40%) has been used mostly in agricultural activities.

c) Most of the households have latrine facility (95%) .
d) Most of the people (95%) realized the reduction in the effect of diseases like respiratory problems, headache, burning coughing, eye problem etc.
e) About 9 bharis of firewood per home was found to be saved per month after the installation of biogas, where 1 bhari costs 100 rupees. Similarly an average hour of 4.57 per day per household was noted to be saved.

Dumre (2018) concluded that housewives or women of the study area are the main beneficiaries from the installation of biogas plant that helped for cooking and lighting purposes. They were also found to be quite content and enjoyed as it made their work lot easier. The installation of biogas has also emphasized people to construct toilet along with it which is a great achievement in keeping up with good health and anitation. Besides, biogas helped a great deal to keep the interior parts of the houses clean with contrast to firewood from which the emitted smoke used to make the house dirty. Similarly, the study found that surrounding environment condition of home was also found better as the emission of smoke was controlled and help of firewood collection. So, it reduces the exploitation of forest and forest vegetations to a large extent.

2.3 Research Gap

All above mentioned studies have mainly indicated that installation of biogas has positive contribution on users. However, it has also been found that some of the users have experienced negative impacts as well. In order to encourage the installation of biogas plants the government has also provided subsidy to the farmers. This study has aimed at addressing positive contribution of the biogas as an alternative source of energy.

CHAPTER – III

RESEARCH METHODOLOGY

Research is a systematic and organized effort to find out answers of specific research questions that provide solution of the given specific problems. Similarly, methodology refers to the various steps that are generally adopted by a researcher in order to find out the answers of the given research questions and fulfill the given objectives of the study. So, research methodology is an organized, systematic and sequential steps adopted by the researcher for the study. So, research methodology is one of the most important parts of any good research work. The chapter is mainly devoted to a suitable research methodology based on the nature and the subject matter of the study. So, a detailed explanation of the methods of research used in the study has been presented like research design, nature and sources of data, selection of the study area, population, sample and sampling procedure, tools and method of primary data collection, data organization and processing, and tools and method of data analysis.

3.1 Introduction of the Study Area

Morang district is one of the 77 districts of Nepal that lies in Province No.1 of eastern region of Nepal. It lies in Koshi zone. Morang district is situated at latitude 26 N and longitude 86 E. It borders on Jhapa and Ilam in the east and Sunsari district in the west and Dhankuta and Panchathar district in the North and the border is India to the south. Its total geographical area is 1855 km^2. It's total population is 9,65,370 and population density is 81.4 km^2 (CBS, 2012). There are 9 municipalities and 8 village councils in Morang district (CBS, 2012). The Headquarter of the district is Biratnagar.

Pathari Sanischare Municipality is one of the 9 municipalities of Morang district. The total geographical area of the Municipalty is 79.81 km^2. It has total population of 99,680 with 17,100 total households (CBS. 2012).

Pathari Sanischare Municipality Ward No. 15 as the study area (It was Shanischare VDC in the Past) is divided into 15 wards. (Appendix – I) in which the total population is 10,245 (4895 Male and 5350 Female) with total households is 1,973. In the

study area of Ward No. 15 of the municipality, 360 households are biogas users (Municipality Record, 2074).

There are 9 primary schools, 7 lower secondary schools and 5 higher secondary schools and one Pathari Multiple Campus. There is one health post, one post office, one police station and 7 saving and co-operatives. Economic activities in the surveyed municipality were quite diverse. Agriculture in the municipality was subsistence oriented and majority of the households were involved in at least one activity such as government service, poultry farming , bus driving shop keeping etc. a significant percentage was dependent upon pension from government service, British army, and Indian army. Likewise, the trends of foreign employment in Gulf Countries like Qatar and Arab area also highly increasing.

3.2 Research Design

The study is designed in accordance with the given research questions, objectives and subject matter of the study. It is exploratory type of study. It followed a descriptive method and analysis is made with inductive as well as individual approaches. It helps to fact finding process of investigation. The study is fully based on primary data. The required data and information were collected from the field survey through a structured questionnaire, informal discussion, formal focus group discussion and participatory observation. The data that are not quantifiable have been explained in descriptive way. Analysis of data has been made from the average and percentages.

3.3 Nature and Source of Data

The study is mainly based on primary data and information obtained from field survey. The primary data have been collected from the field survey. The responses of biogas plant users in the study area are regarded as the major sources of data and information of the study. In addition to primary data, secondary data have also been used for basic concept and conceptual matter of the study wherever relevant to use in the study. Such secondary data have been collected from books, booklets, research reports, journals, magazine, and dissertations etc. published by various institutions like CBS

(Central Bureau of Statistic), Ministry of Finance, Central Library of Tribhuvan University, Central Office of Biogas Company, Biogas Support Program (BSP) etc.

3.4 Selection of the Study Area

The Ward Number 15 (It was the Shanischare VDC) of Pathari Shanischare Municipality of Morang district is selected as the study area of the study. It is because that the researcher is a local residence of the study area who is seeking for getting more knowledge of using biogas by the local people and biogas installation in the study area. Therefore, by selecting the study area, it is believed that the study could provide more reliable findings about the given subject matter.

3.5 Population, Sample and Sampling Procedure

All biogas user households in the study area are the size of population of the study. There were 360 households who use biogas in the study area till the end of 2074 as per the records of the Ward No. 15 of the municipality. So, it is not an easy task to collect information from all of them for the study with in limited time period. Therefore, only 60 biogas user households (i.e. 16.67% of total biogas users in the study area) have been taken as sample units of the study. It is believed that all sample households could represent for of all biogas users (size of population) in the study area. A simple random sampling procedure with a lottery method without replacement was used for the collection of sample households.

3.6 Tools and Method of Primary Data Collection

As the study is fully based on primary data, the required data and information were collected from a field survey in the study area. The survey is conducted through four tools of collecting primary data and information as given below.

a) **Household Survey:-** Before conducting the field survey, a structured questionnaire (Appendix – II) was used and it was pretested in the nearby study area (ward no. 14 and 16 of the municipality). A household survey was conducted through a pretested structured questionnaire visiting door to door of sampled households by the researcher herself. If the sampled households were not present during the time period of field survey, the closed biogas household was interviewed. The survey was basically focused

on socio economic features of the biogas users, sources of household income, pattern of consumption expenditure, and information on uses of biogas and plant installation, amount of energy substitution etc. Different methods were used to check out the validity of data.

b) **Informal Discussion:-**The household survey was supplemented by the informal discussion among the biogas user households which was conducted at open place of the study area during the period of field visit covering different aspects and multi dymential way of the subject matters of the study.

c) Formal Focus Group Discussion:- A formal focus group discussion was also conducted at the office of ward no. 15 of the municipality with the key informants of the study area during the field visit in order to cross check the collected data and information related to the given subject matter. The major key informants were both of biogas user and non-user households, ward level representatives, political leaders, social workers, teachers, senior citizens, and other knowledgeable persons of the study area.

d) Participatory Observations:- In other to understand existing situation of using biogas, the researcher visited all biogas user sampled household in the study area. The researcher also closely observed and took photographs that include the following.

i) General life style of the biogas users,
ii) Socio-economic characteristics,
iii) Economic activities of biogas users,
iv) Biogas plants under construction.
v) Condition of biogas plant.
vi) Working condition of cooking gas stoves.
vii) Sanitary condition around the households.
viii) Cleanliness of kitchen.
ix) Biogas companies of the study area etc.

3.7 Date Organization and Processing

The collected data and information were in raw form by nature which is not possible to directly analyze. Hence, it is necessary to process the raw data and convert it into required forms. The collected data and information were edited, organized, grouped, sub-grouped, classified, and transformed into a master sheet. Then, obtained various tables and graphs from the master sheet and computed in accordance with the nature of available data and information that could help to find the answers of the given research questions and justify the objectives of the study.

3.8 Tools and Method of Data Analysis

The major tools and methods of data analysis were various tables and graphic presentation. Apart from it, simple methodical tools have been used to analyze and interpretation the collected data and information like percentage and average. The computer software of 'Excel' has been used for data processing and analysis.

CHAPTER - IV

DATA PRESENTATION AND ANALYSIS

4.1 Socio – economic Features of Sample Households

This chapter describes major features of the biogas users sample households, use of biogas and benefits of using biogas in the study area. This chapter deals with the main finding related to the economic condition of biogas users.

4.1.1 Age Group Distribution

Age group distribution refers to the share of given family members that go to the given different age groups. It means that how many households fall in different categories of given age group of population. The study made nine different age groups from 0-10 to 80 - 90 years as shown in given table 4.1.

Table: 4.1
Age Group Distribution of Family Members in Sample Households

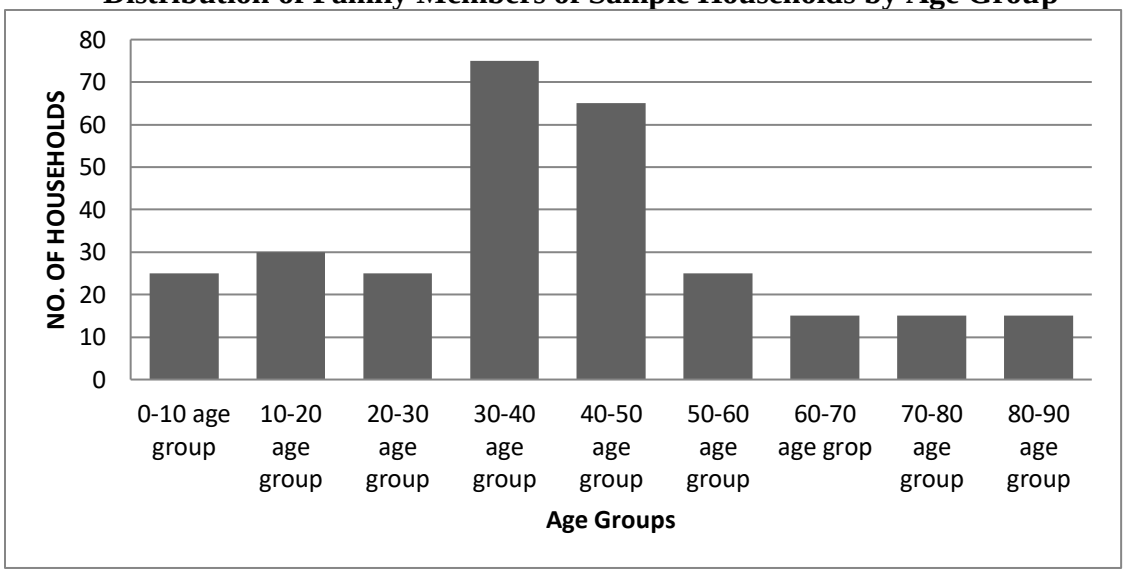
S. N.	Age Groups	Family Members of Sample Households	Percentage
1.	0-10	25	8.62
2.	10-20	30	10.34
3.	20-30	25	8.62
4.	30-40	75	25.86
5.	40-50	65	22.41
6.	50-60	25	8.62
7.	60-70	15	5.17
8.	70-80	15	5.17
9.	80-90	15	5.17
	Total	290	100

Source: Field survey, 2017.

The table 4.1 shows that the higher percentage of the biogas users is age group in (30-40). About 25.86 percent of the plant owners are 30-40 age groups. 22.41 percent in 40-50 age group, 10.34 percent in 10-20 age group, 8.62 percent is 0-10, 20-30 and 50-60 age group are biogas users. 5.17 percent also involved in 60-70, 70-80 and 80-90 age

group in sampled households. The table can also be explained with the help of given figure.

Figure: 4.1
Distribution of Family Members of Sample Households by Age Group



Source: Field survey, 2017.

The figure 4.1 shows that the higher percentage of the biogas users is age group in (30-40). About 25.86 percent of the plant owners are 30-40. Lower percentage of the biogas users is age group in 60-90, 70-80 and 80-90.

4.1.2 Family Size

The family size reveals to the number of heads belongs to the individual sample household. The result of the survey reveals that average family size of the sampled biogas user household is table 4.2 shows that distribution of households by family size.

Table: 4.2
Distribution of Sampled Households by Family Size

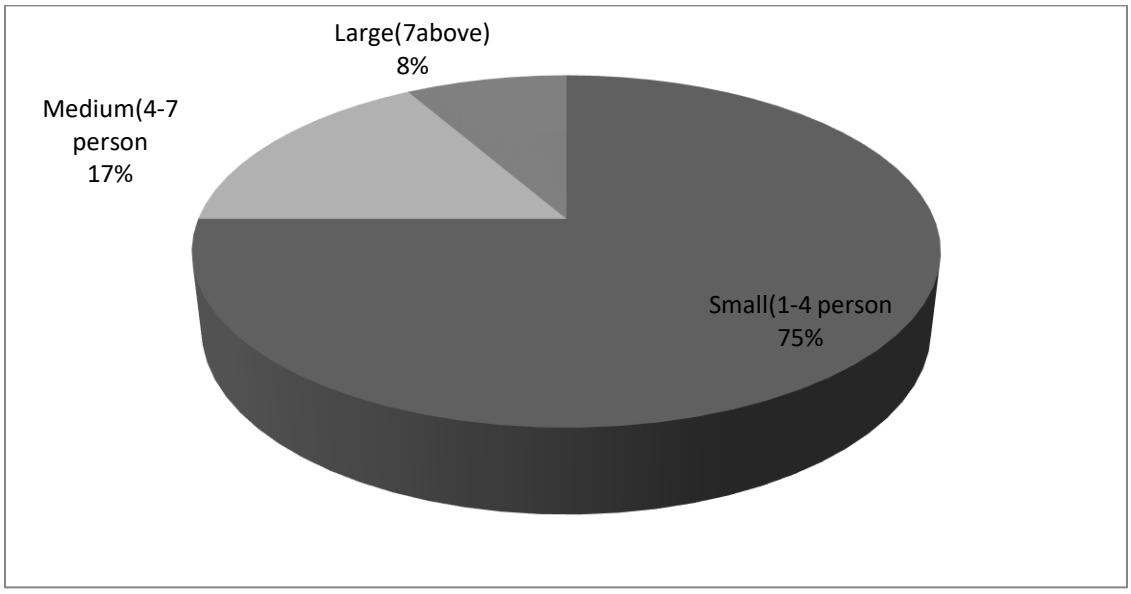
S. N.	Family Size	No. of Households	Percentage
1.	Small (1- 4 persons)	45	75
2.	Medium (5 -7 persons)	10	16.67
3.	Large (7 person and above)	5	8.33
	Total	60	100

Source: Field survey, 2017.

The table 4.2 shows that among 60 biogas users, 45 households (75 percent) have 1 - 4 family members, 10 households (16.67 percent) have 4 - 7 family members and 5 households have (8.33 percent) seven and above family members. The average size of family members becomes 4.83. It can also be shown with the help of given figure.

Figure: 4.2

Distribution of Households by Family Size



Source: Field survey, 2017.

The figure 4.2 show that 75 percent have small (1-4 persons) family member, 16.67 percent have medium (4-7 persons) family member and 8 percent have large (7 person and above) family members. The average size of family members becomes 4.83 percent in sample households.

4.1.3 Types of Family

Traditionally, there was mostly a joint family in the study area. But in the modern age, nuclear family is also increasingly takes place. In this regard, the sample households can be divided into joint family and nuclear family as shown in given table and figure. The table 4.3 shows the division of total sample households into joint and nuclear families in the study area.

Table: 4.3
Types of Family

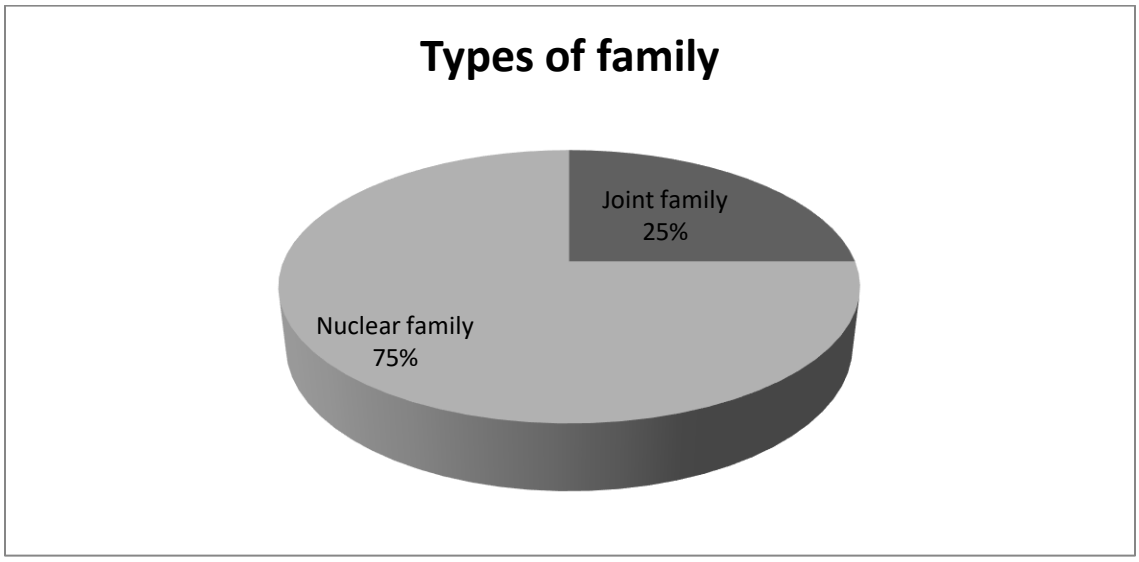
S. N.	Types of Family	No. of Sample Households	Percentage
1.	Nuclear	45	75
2.	Joint	15	25
	Total	60	100

Source: Field survey, 2017.

The table 4.3 shows that among all 60 biogas users, 45 households (75 percent) have nuclear family and rest 15 households (25 percent) have joint family members. It can also be shown with the help of given figure.

Figure: 4.3

Types of Family



Source: Field survey, 2017.

The figure shows that 75 percent have nuclear family and rest 15 households (25 percent) have joint family members.

4.1.4 Caste / Ethnic Composition

The study area is being a multi-ethnic and multi-cultural society. The data on ethnicity of the sampled biogas user households have also been different caste and ethnic community. The given table 4.4 reveals that the majority of the sample households of the study area fall to the Chhetry followed by Brahmine and Magar. The reason behind the

higher percentage of biogas users (Chhetri) is that they are socially and economically forward in each and every sector. The lowest group is dalit families.

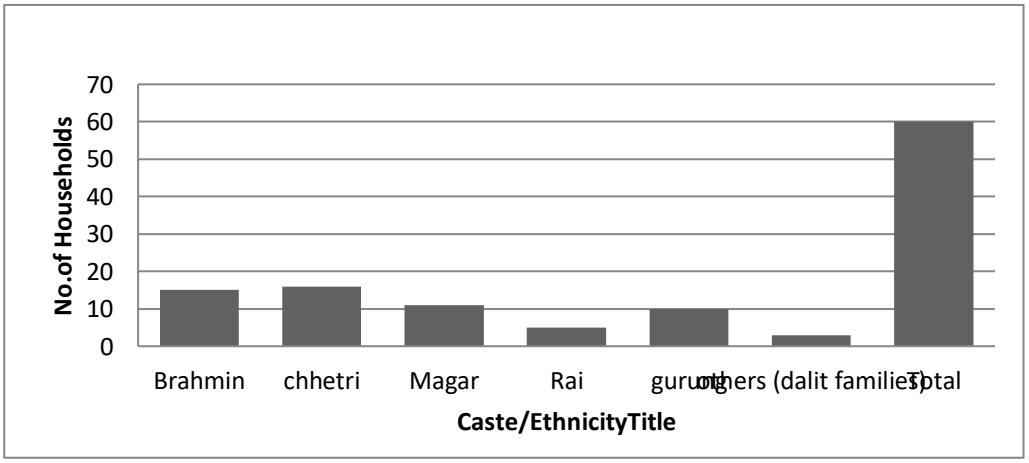
Table 4.4
Cast / Ethnic Composition of Sample Households

S. N.	Ethnical Groups	Biogas User Households	
		Frequency	Percentage
1.	Brahamin	15	25
2.	Chhetri	16	26.67
3.	Magar	11	18.33
4.	Rai	5	8.33
5.	Gurung and Tamang	10	16.67
6.	Others (Dalit Families)	3	5
7.	Total	60	100

Source: Field survey, 2017.

From the table 4.4, the study came to know that the majority of household are Brahaman (25 percent), Chhetri (26.67 percent), Magar (18.33 percent), Rai (8.33 percent) Gurung and Tamang (16.67 percent) and others (5 percent). It can also be shown with the help of given figure.

Figure: 4.4
Caste / Ethnic Composition of Sample Households



Source: Field survey, 2017.

The figure 4.4 show that the majority of household are Brahaman (25 percent), Chhetri (26.67 percent), Magar (18.33 percent), Rai (8.33 percent) Gurung and Tamang (16.67 percent) and others (5 percent).

4.1.5 Occupational Distribution

Agricultural is regarded as the backbone occupation among all biogas user sample households in the study area. As shown in given table 4.5, agriculture provides major occupation as a major source of income in the study area followed by agriculture and foreign employment. Beside, service, pension and business are also playing main role in occupational distribution of the biogas users. Major occupational distribution of sampled households is given in the table 4.5.

Table: 4.5

Occupational Distribution of Sample Households

S. N.	Occupation	Biogas Users Households	
		Frequency	Percentage
1.	Agriculture only	30	50
2.	Agriculture and Foreign Employment	12	20
3	Agriculture and Business	7	11.67
4.	Agriculture and Service	5	8.33
5.	Agriculture and Pension	3	5
7.	Others	3	5
	Total	60	100

Source: Field survey, 2017.

The table 4.5 reveals that 50 percent of the biogas user's sampled households are engaged in agriculture only where as 20 percent of the plant owners engaged in agriculture and foreign employment. Similarly, sample households engaged in agriculture and business is 11.67 percent, agriculture and service is 8.33 percent, agriculture and pension is 5 percent of the biogas users and rest belong to other occupation. It is found that occupation does not play vital role for making biogas in their houses although there

is difference in the quantity of biogas due to occupation of biogas households. The farmers have more land and animals for the dung needed for biogas in comparison to the serviceman and businessman. Besides agriculture, most of the households has secondary source of income as well. They are government service pensions and other business. It supports them economically to fulfill basic requirements. It can also be shown with the help of given figure.

Figure: 4.5

Occupational Distribution of Sample Households

Source: Field survey, 2017.

The figure shows that 50 percent of the biogas user's sampled households are engaged in agriculture only where as 20 percent of the plant owners engaged in agriculture and foreign employment. Similarly, sample households engaged in agriculture and business is 11.67 percent, agriculture and service is 8.33 percent, agriculture and pension is 5 percent of the biogas users and rest belong to other occupation.

4.1.6 Size of Land Holding

As major occupation of all sample biogas users is being agriculture, all of them have their own land to cultivate. While calculating the land holding, only operational land holding has been taken into account. In most of the cases, it is found that the land is cultivated by owners themselves. The table 4.6 and figure 4.6 shows the distribution of land holding of the biogas user sample households.

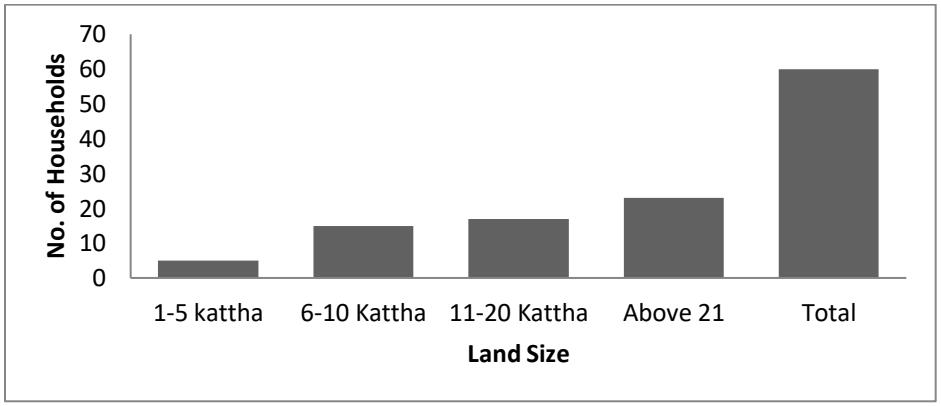
Table: 4.6
Distribution of Land Holding Among Sample Households

S. N.	Land Holding in Kattha	No. of Households.	Percentage
1.	Below 5	5	8.33
2.	6-10	15	25
3.	11-20	17	28.33
4.	Above 21	23	38.33
	Total	60	100

Source: Field survey, 2017.

The table 4.7 show that 8.33 percent of house with land below 5 Kattha, 25 percent of household with land 6-10 kattha, 33.33 percent of households with land 11-20 Kattha and 33.33 percent above 21 Kattha respectively. So the highest and lowest responses are recorded in respondent having land of above 21 Kattha and 1-5 Kattha.

Figure: 4.6
Distribution of Land Holding Among Sample Households



Source: Field survey, 2017.

The figure 4.6 reveals that 8.33 percent of house with land below 5 Kattha, 25 percent of household with land 6-10 kattha, 33.33 percent of households with land 11-20 Kattha and 33.33 percent above 21 Kattha respectively. So the highest and lowest responses are recorded in respondent having land of above 21 Kattha and 1-5 Kattha.

4.1.7 Size of Livestock Keeping

Livestock keeping is an integral part of agro-economy of Nepal. It becomes common practices and also considered as a part of wealth. So, the households own livestock having more with the rich households and vice versa. Livestock are used in plowing land, threshing food crops like paddy, wheat and mustered. Cattle and buffaloes are also kept to obtain manure for biogas. Small animal like goats and pig are kept mostly for fattening purpose only reliable source of cash income. The rural people can earn money through the sale of live livestock, livestock products like milk, curd and ghee etc. It is found that a significant part of the cash income in rural Nepal comes from livestock. All sample households in the study area are found keeping various types of livestock like cows, buffaloes, ox, goats, and pig. Most of them are local breed. Livestock dung is the main part for installing biogas plant. The size and composition of livestock keeping in the sampled households in the study area is shown in the given table 4.7 and figure 4.7.

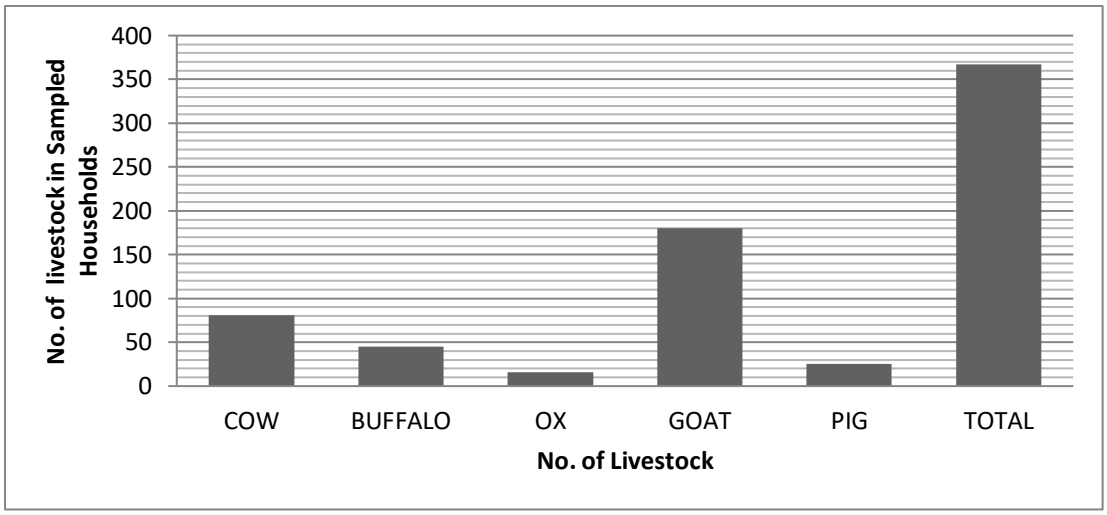
Table: 4.7
Size and Composition of Livestock Keeping

S.N.	No. of Livestock	No. of Livestock in Sampled Households	Percentage
1.	Cow	81	22.07
2.	Buffalo	45	12.26
3.	Ox	16	4.35
4.	Goat	180	49.04
5.	Pig	25	6.81
	Total	367	100

Source: Field survey, 2017.

Regarding the livestock population, it was found that biogas household had 22.07 percent heads of cow, 12.26 percent heads of buffalo, 4.35 percent heads of ox, 49.04 percent heads of goat and 6.81 percent heads of pig in sampled households.

Figure: 4.7
Size and Composition of Livestock Keeping



Source: Field survey 2017

The figure show that 22.07 percent heads of cow, 12.26 percent heads of buffalo, 4.35 percent heads of ox, 49.04 percent heads of goat and 6.81 percent heads of pig in sampled households.

4.1.8 Livestock Distribution of Sample Households

All sample biogas users in the study area are keeping a certain size of livestock's especially for dung or manure which is the vital part of producing biogas. In fact, in the study area, animal manure is not available to purchase in the market. So, whatever the amount of animal manure is required, every sample household has to prepare by them. The sizes of livestock keeping by sample households can be explained by the table 4.8 and also figure 4.8.

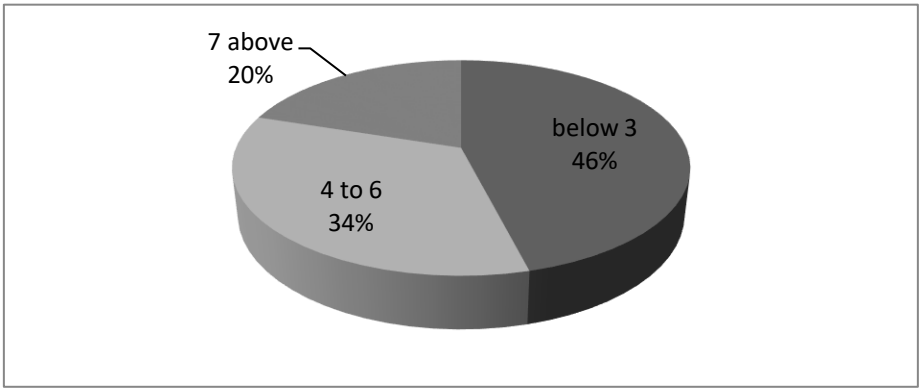
Table: 4.8
Livestock Distribution of Sample Households

S.N.	Size of Livestock	No. of Households	Percentage
1.	1 – 3	27	46
2.	4 - 6	21	34
3	7 and above	12	20
	Total	60	100

Source: Field survey, 2017.

The table 4.8 shows that 46 percent household has 1-3 livestock, and 34 percent has 4-6 livestock and rest 20 percent has 7 and more than 7 livestock keeping. It can be shown with the help of given figure 4.8.

Figure: 4.8
Distribution of Livestock



Source: Field survey 2017

The figure 4.8 show that 46 percent household has 1-3 livestock, and 34 percent has 4-6 livestock and rest 20 percent has 7 and more than 7 livestock keeping.

4.1.9 Income Distribution of the Sample Households

Agricultural and livestock keeping are the main sources of income of the sample households in the study area. However, income distribution of the biogas user sample households is observed by adding income received from all possible sources of income per year as shown in given table.

Table 4.9
Income Distribution of Sample Households

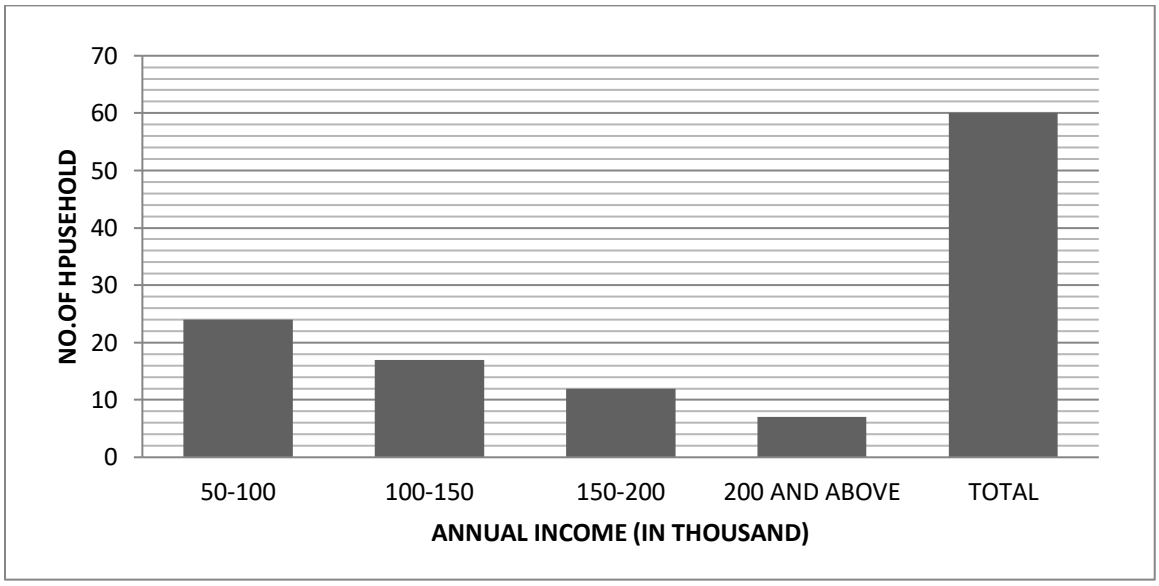
S. N.	Annual Income	Biogas User Sample Households	
		No. of Respondents	Percent
1.	50000 -100000	24	40
2.	100000-150000	17	28.33
3.	150000-200000	12	20
4.	200000 and above	7	11.67
	Total	60	100

Source: Field survey, 2017.

The table shows that there is a high (40 percent) proportion of less income group of sample household using biogas and very less (11.67 percent) proportion of high income sample households.

Figure 4.9

Income Distribution of Sample Households



Source: Field survey, 2017.

The figure shows that there is high income source 40 percent of sample household. Less income group of sample household using biogas 11.67 percent.

4.1.10 Educational Status

The study area is facilitated with primary, lower secondary, secondary, higher secondary schools and bachelor degree that provides a good educational atmostfear among younger group of the study area. So, most of the biogas users are educated. The data presented in table 4.6 reveals that majority (250 family members) of the family members of biogas users are literate 86.20 percent. This result shows that only 40 people (13.8 percent) are illiterate.

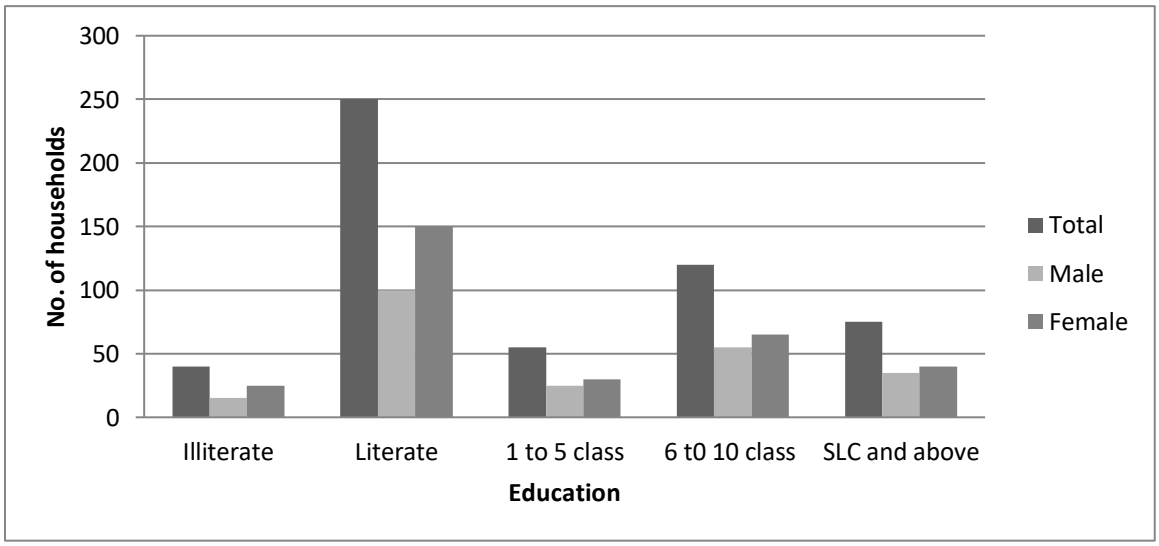
Table: 4.10
Educational Status of Family Members of Biogas User Households

S.N	Level of Education	Male	Percent	Female	Percent	Total	Percent
1.	Illiterate	15	5.17	25	8.62	40	13.8
2	Literate	100	34.48	150	51.72	250	86.20
	a) 1 to 5 class	*25*	*10*	*30*	*12*	*55*	*22*
	b) 6 to 10	*55*	*22*	*65*	*26*	*120*	*48*
	c) SLC and above	*35*	*14*	*40*	*16*	*75*	*30*
	Total	115	46	135	54	290	100

Source: Field survey, 2017.

The data presented in table 4.10 reveals that majority of the biogas users are literate 86.20 percent. They have admitted their children to school about 22 percent owners out of total interviewed completed class 1 to 5. 48 percent have completed grade 6 to10 and remaining 30 percent of total plant owners have completed grade SLC and above. Table 4.10 shows educational status of the sampled households. It can also be shown with the help of given figure.

Figure: 4.10
Educational Distribution of Family Members of Biogas Users Households



Source: Field survey, 2017.

The figure shows that majority of the biogas users are literate 86.20 percent. They have admitted their children to school about 22 percent owners out of total interviewed completed class 1 to 5. 48 percent have completed grade 6 to10 and remaining 30 percent of total plant owners have completed grade SLC and above.

4.2 Use of Biogas in the Study Area

This section is a complete suggestive about the use of biogas plant based on the respondent of biogas user sample households of the study area.

4.2.1 Reasons for Installing Biogas

Most of the households have installed biogas plant in the study area because of various reasons. The main cause of them is the scarcity of firewood nearby the settlement area. They use of dung mainly from cows, ox and buffaloes as raw materials to generate gas for cooking and lighting. Before installation of biogas, they basically used fuel wood for cooking purpose and kerosene for lighting purpose. Many of the biogas owners said that they installed biogas because of shortage of firewood that can be shown with the help of give table and figure.

Table: 4.11
Reasons for Installation of Biogas.

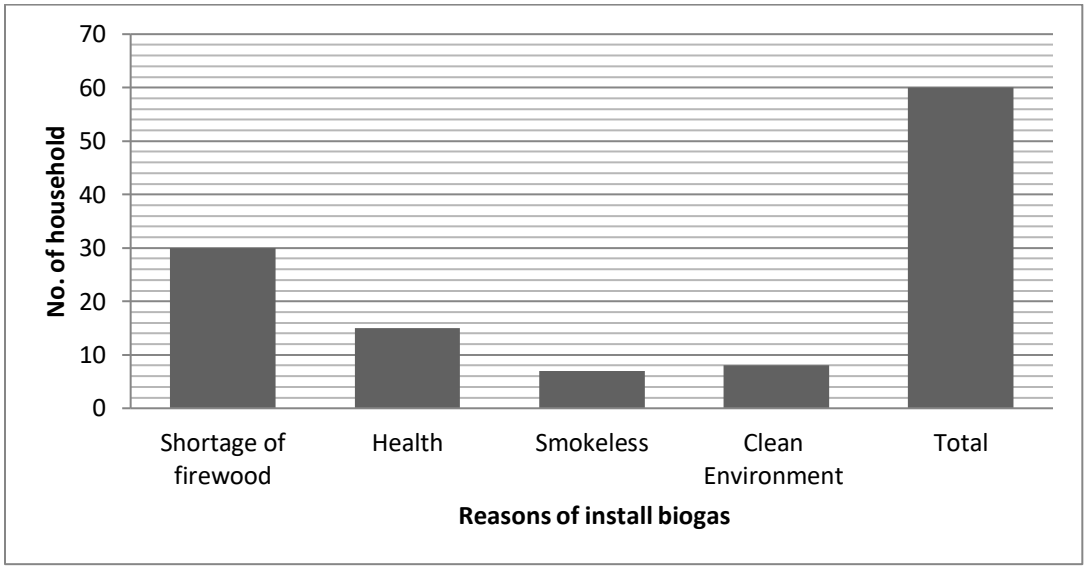
Reasons of Install Biogas	No. of Sample Households	Percentage
Shortage of firewood	30	50
Health	15	25
Smokeless	7	11.67
Clean Environment	8	13.33
Total	60	100

Source: Field survey, 2017.

Table 4.11 reveals that 50 percent biogas plant owners said that the main reason for install biogas is shortage of firewood. Nearly 11.67 percent of the plant owner said biogas is a smokeless technology. So, they install biogas plant 25 percent of the plant owners said that they install biogas for health reasons because health is the major factor of life and the rest of 13.33 percent of the plant owners said that using biogas for cooking

purpose which helps to reduce the environment degradation and kept surrounding neat and clean. It can be shown with the help of given figure 4.11.

Figure: 4.11
Reasons for Installation of Biogas



Source: Field survey, 2017.

The figure reveals that 50 percent biogas plant owners said that the main reason for install biogas is shortage of firewood. Nearly 11.67 percent of the plant owner said biogas is a smokeless technology. So, they install biogas plant 25 percent of the plant owners said that they install biogas for health reasons because health is the major factor of life and the rest of 13.33 percent of the plant owners said that using biogas for cooking purpose which helps to reduce the environment degradation and kept surrounding neat and clean.

4.2.2 Motivating Factors for Installation of Biogas Plant

Using biogas is much more beneficial than using other alternative energy like firewood, kerosene, and electricity. Due to this fact, most of the plant owners themselves motivated to install the biogas plant in their houses. On the other hand, they have been motivated to install the biogas plant by different motivating factors like as staff's members of the biogas company, government agencies/office, ADB/N, NGO's, INGO's and so on. It is shown by following table.

Table: 4.12

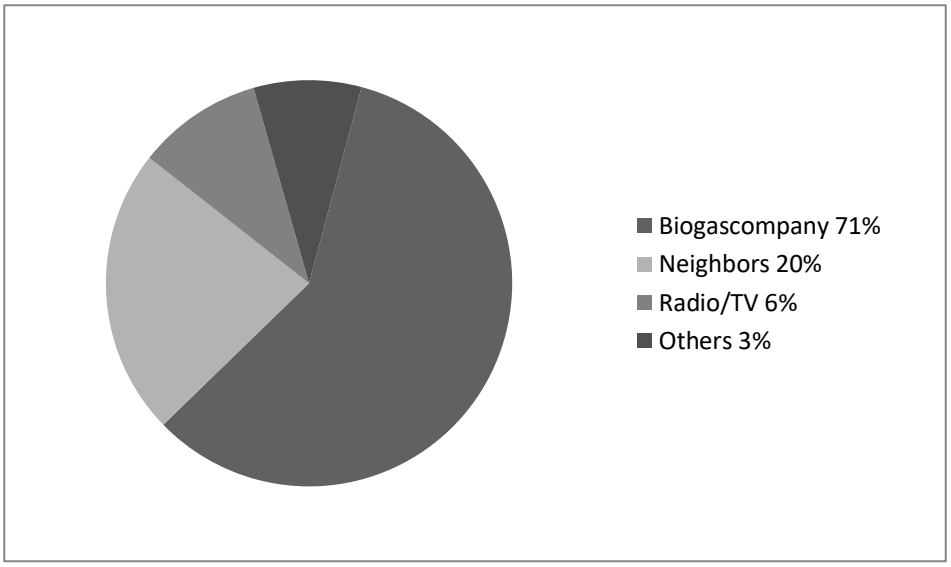
Motivating Factors for the Biogas Plant Installation

S.No.	Motivating Factors	Sample Households	Percentage
1.	Biogas company	42	71
2.	Neighbors	12	20
3.	Radio/TV	4	6
4.	Others	2	3

Source: Field survey, 2017.

The table 4.12 revels that 71 percent motivated to Biogas Company in sample household. 20 percent motivated to neighbors and 6 percent motivated to install the biogas plant by Radio/TV and 3 percent motivated the others persons install the biogas plant. It can be shown with the help of given figure 4.12.

Figure: 4.12
Motivating Factors for the Biogas Plant Installation



Source: Field survey, 2017.

The figure show that different motivating factors install the biogas plant staff's member's 71 percent and 20 percent motivated neighbors. Likewise, 6 percent motivated to radio/TV and 3 percent others member motivated to install the biogas plant.

4.2.3 Size of Biogas Plant

All sample households have adopted biogas plant of Gobar Gas Company Model (GGC Model) using cow dung as approved by Purnima Bio Gas Plant (PBSP). There are only two types of biogas plants. The size of plant used by sample households depends upon the family size of sample household and the number of cattle (cows, ox and buffaloes) they have. Because, cattle dung is the main determining factor of the size of biogas plant that can be explain with the help of given table.

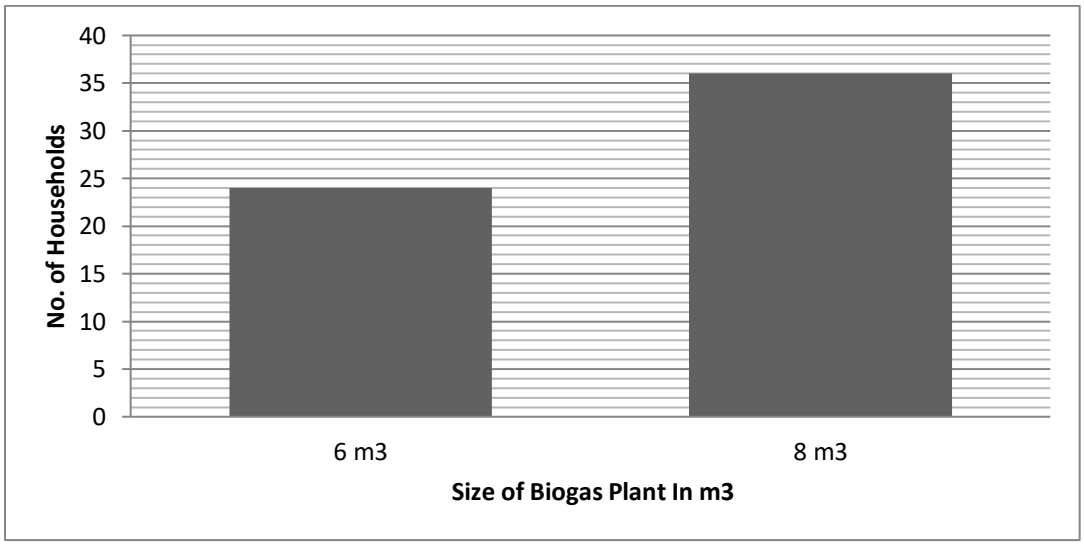
Table: 4.13
Size of Biogas Plant Used

S. N.	Size of Plant In m^3	No. of Households	Percentage	Approximate Expense from Biogas Households Per Plant (NRs.)
1	6 m^3	24	40	22900
2	8 m^3	36	60	27435
	Total	60	100	50335

Source: Field survey, 2017.

The table 4.13 shows that 40 percent plant owners have installed $6m^3$ of plant. Likewise, 60 percent have installed $8m^3$. The possible reason for this is that for plant size greater then $8m^3$, the dung produced by the livestock per household is insufficient.

Figure: 4.13
Distribution of Size of Biogas Plant



Source: Field survey, 2017.

The figure 4.13 shows that 24 household plant owners have installed $6m^3$ of plant. Likewise 36 household have installed $8m^3$.

4.2.4 Use of Biogas

In the study area, basically households used biogas for cooking purpose and very small number of the plant owner have used biogas for lighting purposes although the electricity has been provided to them. But where electricity from national grid isn't available they used it a lighting and cooking purposes. The using pattern of biogas in the study area can be shown with the help of given table.

Table: 4.14
Distribution of Use of Biogas

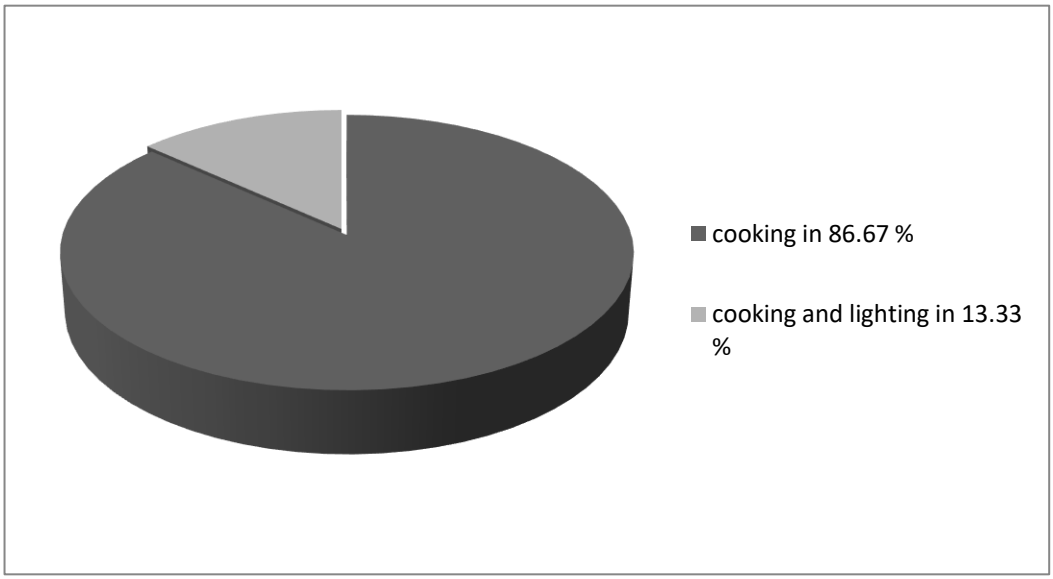
Purposes	Frequency	Percentage (%)
Cooking	52	86.67
Cooking and Lighting	8	13.33
Total	60	100.0

Source: Field survey, 2017.

The table 4.14 reveals that 86.6 percent of the household have used biogas only for cooking purpose .13.33 percent households have used biogas for cooking and lighting purpose.

Figure: 4.14

Distribution of Use of Biogas



Source : Field survey 2017

The figure shows that 86.6 percent of the household have used biogas only for cooking purpose .13.33 percent households have used biogas for cooking and lighting purpose.

4.2.5 Operation of Biogas Plant

After installation of biogas plant, the households of the plant have to do their regular duties for production of gas, i.e. collection of cow dung, mixed water and poured into the inlet of biogas etc. (Appendix - II). In some cases, plant owners may have technical problems. But they are unable to solve these problems themselves. On the other hand, they cannot get the service of trained technician on time to solve the problem. But occasionally biogas companies had conduct two days training for biogas users with support from BSP. By such training, users of biogas plant owner were highly benefited. All users reported that the operation of biogas plant was easy. Once they feed the digester with the mixture of dung and water each day, the gas started producing due to anaerobic digestion process. So, the success of biogas programs highly influenced by the flawless construction and prolonged operation of biogas plant with satisfactory results to the users.

4.2.6 Cleaning of Vessels (Filter of biogas plant)

In majority of the cases, cleaning vessels are done by female members. In the few cases, children are responsible for the job and women reported that they used to spend about average 45 minute for cleaning vessels in a day before installation of biogas. But after installation of biogas, they used to spend about average 27 minute for cleaning vessels (Appendix – II). They feel much more relaxed and needed less effort during cleaning vessels because of the absence of black soot. The outcome of the study suggested that there was a average time is 28 minute per day per family after installation of biogas.

4.2.7 Toilet Attached to Biogas Plant

Toilet waist is also a big source of biogas production. But in the study area, majority of sample households have not attached toilet to the biogas plant due to availability of enough of cow dung in the study area. The table 4.15 shows the distribution of sample households using toilet to biogas plant.

Table: 4.15
Toilet Attached with Biogas Plant

S. No.	Toilet Attached	No. of Households	Percentage
1.	Attached	13	21.67
2.	Not attached	47	78.33
	Total	60	100

Source: Field survey, 2017.

The table 4.15 shows that majority of the sample households reported that they have attached toilet to biogas plant only 21.67 percent and 78.33 percent reported that they have not attached toilet with biogas plants.

4.3 Benefits of Using Biogas Plant

There are a lot of direct and indirect benefits of using biogas plant to the biogas users as given below.

4.3.1 Saving of Firewood

Before installation of biogas plant, the sample households in the study area basically collect firewood either from nearby forests or their own farm land or from the market. But there is a significant saving of firewood use in the kitchen which is the one of the biggest benefits of using biogas plant. The use of firewood on average per year before and after installation of biogas and saving of firewood can be shown in given table.

Table: 4. 16
Use of Firewood before and after Installation of Biogas Plant

S. N.	Sample Households	Before Installation		After Installation		Saving
		Firewood (Bhari)	Total	Firewood (in Bhari)	Total	
1	6	30	180	5	30	150
2	10	35	350	8	80	270
3	18	40	720	10	180	540
4	7	45	315	13	91	224
5	14	50	700	15	210	490
6	5	60	300	18	90	210
Total	60		2565		681	1884
Average			42.75		11.35	

Source: Field survey, 2017.

The table 4.16 shows that the sample households used maximum of 60 ***Bhari*** and minimum of 30 ***Bhari*** of firewood per year that makes total use of firewood is 2565 ***Bhari*** before installation of biogas. The average use of firewood per sample household per year is 42.75 ***Bhari***. On the other hand, the sample household used minimum of 18 ***Bhari*** and minimum of 5 ***Bhari*** of firewood per year that makes total use of firewood is 681 ***Bhari*** after installation of biogas. The average use of firewood per sample household per year is 42.75 ***Bhari***. The table further shows total less used of firewood is 1884 Bhari per year which is the saving of firewood used after installation of biogas plant. The average saving of firewood per sample household per year is 11.35 ***Bhari*** which is the biggest achievement of the installation of biogas plant in the study area.

4.3.2 Saving of Kerosene after Installation of Biogas

The use of kerosene by the sample households has been found negligible. All sample households reported that they had stopped using kerosene since the year 2060 when the price of kerosene was abnormally hiked and due to the frequent disruption in the smooth supply of kerosene.

4.3.3 Cooking Time

The use of biogas also helps to save cooking time to the sample households and the saving time is used to various other works as shown in given figure.

Table: 4.17
Required Times for Cooking before and after Using Biogas

No. of Households	Required Time per day before using Biogas (in hours)	Required Time per day after using Biogas (in Hours)	Time Saving
25	4	3	1
23	5	3.5	1.5
12	6	4	2
60	5	3.5	1.5

Source: Field survey, 2017.

The table 4.17 reveals that the daily time saving per sample household is 1.5 hours per day. The saving time is to be used by the each sample household for various productive activities for additional income generation.

4.3.4 Benefit of Slurry in Agriculture Production

One of the most encouraging factors of using biogas plant is the production of slurry, which is very valuable organic manure for crop farming. It has multiple advantages with these of biogas slurry. It increases agriculture production because of its high content of soil nutrients. When the digested slurry is placed into the food chain of crops and animals it leads to a sustainable increase in from income.

As per norms established by the Gobar Gas Company (GGC), the slurry produced from the biogas plant contains 1.6 percent nitrogen, 1.2 percent phosphorous and 1.0 percent potash against 0.05 percent phosphorous and 0.6 percent potash in livestock dung (GGC, 2001). The higher percent of nutrients in slurry is due to saving of nutrient from getting lost biogas slurry is considered to be high quality organic manure. The organic

contain of the digested slurry improves the soil texture, stabilizes its humid content, intensifies its rate of nutrient depot formation and increase its water hording capacity. Company to from yard manure (FYM) biogas slurry has more nutrients than FYM because in FYM , nutrients are loss by volatilization (especially nitrogen) due to exposure to sun head and as well as by teaching.

4.3.5 Methods of Using Slurry on Farm Land

Slurry is the waist product of biogas plant that can be used in three different forms as reported by the sample households that is presented in the given table 4.17.

Table 4.18

Methods of Using Slurry

S. N.	Methods of Using Slurry	No. of Sample Households	Percentage
1.	In liquid form	6	11
2.	In solid form	10	16.67
3.	In composted form	44	73.33
	Total	60	100

Source: Field survey, 2017.

The table 4.18 clearly shows that about 73.33 percent of the biogas formers have performed using the slurry in composted forms while 16.67 percent used it in dried form. Only 11 percent of the respondents reported using liquid slurry directly to fertilizer their crops. It is worth nothing that using the slurry in liquid form is the best practice form the point of view of conservation of plant nutrients. But this practice has a limitation for wider adaptability due to the difficulty of transporting it to the fields. For this reason, the extension workers and biogas companies have encouraged the farmers to conserve plant nutrients. There by augmenting the quality of organic fertilizer. Application of slurry in dried from is not normally recommended, as the nutrients (especially nitrogen) contained in it are lost, when dried in the sun.

4.3.6 Use of Slurry and Agricultural Production

The digested slurry can be used as manure for agricultural production. But the sample households have also used slurry as fertilizer for increasing crop production. The use of slurry substituted the use of chemical fertilizer to a large extent that has certainly saved some money. However, sample households have different experienced in agricultural production as shown in given table.

Table: 4.19
Use of Slurry and Agricultural Production

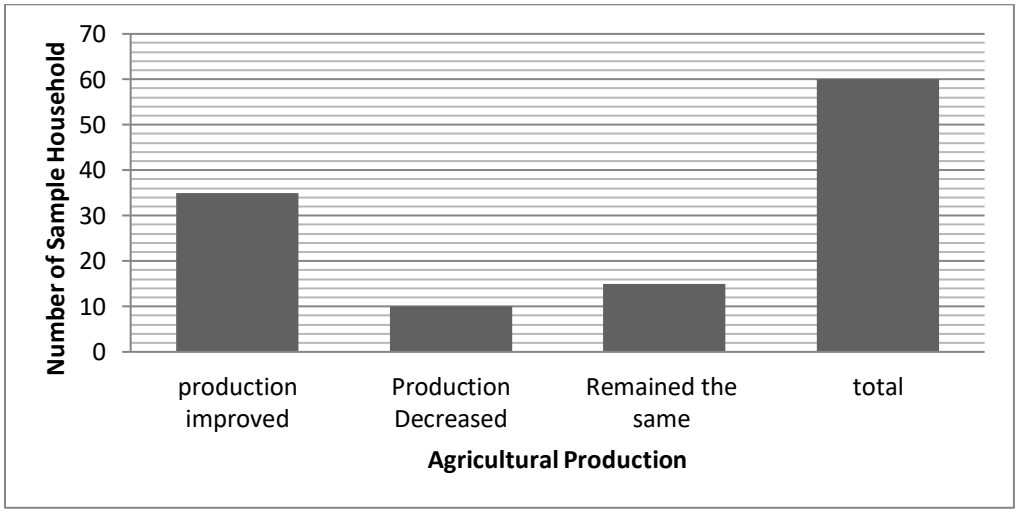
S.N.	Agricultural Production	Number of Sample Household	Percentage
1	Production Improved	35	58.33
2	Production Decreased	10	16.67
3	Remained the same	15	25
4	Total	60	100

Source: field survey, 2017.

The table 4.19 shows that 58.33.percent of sample household reported increasing level of agricultural production, 16.67 percent households reported decrease in their production and 25 percent of sample households reported no change in agricultural production.

Figure: 4.15

Use of Slurry and Agricultural Production



Source: Field survey, 2017.

The figure 4.19 show that 58.33.percent of sample household reported increasing level of agricultural production, 16.67 percent households reported decrease in their production and 25 percent of sample households reported no change in agricultural production.

4.3.7 Effectiveness of Using Slurry for Agricultural Production

Slurry is mainly used in cultivation of paddy, wheat, maize, potato, tomato, and green leaf vegetables. Naturally, the quantity of slurry used in given crops is not equal. The highest quantity of slurry used in tomato and less quantity used in paddy. However, there is a positive relationship between using quantity of slurry and agriculture productivity. Thus, use of slurry is better than use of chemical fertilizer in agricultural farming.

Table: 4.20
Effectiveness of Using Slurry for Various Crops

S. N.	Types of Crops	Growth in Productivity of Crops (%)
1.	Potatoes	58
2.	Tomato	65
3.	Paddy	17
4.	Maize	35
5.	Wheat	18
6.	Green leaf vegetables	48

Sources: Field survey, 2017.

4.3.8 Social Benefits

Gathering fuel wood for cooking takes considerably longer time. So, the use of biogas saved the time that can be used in other household and social activities. This time, saving has huge benefits basically to women and girls of the study area who use the extra time for education or household activities or income generation. The use of biogas plant also becomes a symbol of social prestige and it raises social status of the family and household in the study area.

The use of biogas produces very low emissions and thus brings less heath damage. It also makes kitchen much cleaner than the use of firewood. Biogas stoves are

very easy to handle and control that makes less risk of accidental burns or fires because the stove is turned off as soon as cooking has finished. Linking toilets to the biogas plants produces a good flame of lightening less required og animal dung. The use biogas also provides for better lighting in place of kerosene lamps that avoids kerosene fumes. The use of biogas plant also creates employment opportunity for a technician who installs the digesters or plant. Therefore, the massive adoption of biogas technology will reduce unemployment problem. Similarly, the use of biogas also reduces the use of LP gas that is to be imported from abroad by paying foreign currency. It helps to reduce to pay foreign currency to abroad.

4.3.9 Environmental Benefits

The immediate environment benefits of using biogas are very difficult to assess at the household level. It should be seen in a wider context. The introduction of biogas plants has drastically reduced the consumption of firewood or agricultural waste in the study area. It is also a smokeless technology for the cooking and lighting purpose. There is visible evidence of forest re growth in the study area. Consequently, deforestation is reduced at the local level and thereby reduction of greenhouse gases emissions. There are substantial savings in emissions of greenhouse gases including CO_2 from avoided fuel wood and kerosene used, and N_2O from synthetic fertilizer. However there is small net increase in methane emission because the unburned methane from cooking and minor leaks in slightly greater then the avoided emission of methane from manure disposal. Besides, by returning bio-slurry to the cultivated land, the depletion of nutriments and organic matter in the soil is reduced that helps to sustain the fertility of soil. For well being of farmers, the slurry significantly replaces use of chemical fertilizers. Moreover, the use of biogas was also reduces the various diseases like eye infection, respiratory diseases, lungs related diseases and cancer in lungs etc.

However, the sample households have observed few negative impacts of using biogas plant in the study area. It brings to spread bad smell around the biogas plant installation, health hazard during mixing of dung and water, increase of mosquitoes, files, white ant (***Dhamira***) and other insects, and required to spend more time to collect additional water for plant feeding.

CHAPTER – V

MAJOR FINDGINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Major Findings

The use of biogas has a positive and multiple contributions to the users, households, society and also national level. The use of biogas in the study area is being very popular day by day. The higher percentage of family members belongs to the age group of 30-40 i.e. 25.86 percent and the minimum percent is 22.41 percent that belongs to 40-50 age grouped. The average size of family members becomes 4.83. The nuclear family households hold 75 percent and rest 25 percent households have joint family members. The study area is being a multi-ethnic and multi-cultural society. The majority of the sample households of the study area fall to the Chhetry as they are socially and economically forward whereas the lowest group is *Dalit* families. Agricultural as a major source of income is regarded as the backbone occupation of all biogas user sample households in the study area followed by foreign employment. All of them have their own land to cultivate. All sample households are keeping a certain size of livestock's especially for dung or manure which is the vital part of producing biogas in the study area. Average livestock population size is 3.67 household.

Agricultural and livestock keeping are the main sources of income of the sample households in the study area. Most of the biogas users are educated i.e. 86.20 percent and rest 13.8 percent are illiterate. Most of the households have installed biogas plant in the study area for cooking and lighting due to scarcity of firewood. Before using biogas, sample households basically used fuel wood for cooking purpose and kerosene for lighting purpose. They have been motivated to install the biogas plant by different motivating factors like as staff's members of the biogas company, government agencies/office, ADB/N, NGO's, INGO's and so on. There are only two types of biogas plants i.e. 6 m^3 and 8 m^3 provided by 'Gober Gas Company Model (GGC Model)'. Size of 8m^3 biogas plants was more popular and more useful in this study area as compared to other size of plants. Subside provided by the Biogas Support Project were very

encouraging factor for installation of biogas. Using biogas is much more beneficial than the using of other alternative energy like firewood and kerosene.

After installation of biogas plant, the households have to do their regular duties for production of gas, i.e. collection of cow dung, mixed water and poured into the inlet of biogas etc. The biogas companies had conduct two days training for biogas users with support from BSP. By such training, users of biogas plant owner were highly benefited. Generally, cleaning vessels are done by female members and they need about average 45 minute for cleaning vessels in a day. Majority of sample households have not attached toilet to the biogas plant due to availability of enough of cow dung in the study area.

There are a lot of direct and indirect benefits of using biogas plant. There is a significant saving of firewood use in the kitchen with the use of biogas which is one of the biggest benefits of using biogas plant. Similarly, the use of kerosene by the sample households has become negligible. Many households had stopped using kerosene since the year 2005. The use of biogas also helps to save cooking time to the sample households and the saving time is used to various other works as shown in given figure. One of the most encouraging factors of using biogas plant is the production of slurry which is very valuable organic manure for crop farming. It has multiple advantages with these of biogas slurry. It increases agriculture production and productivity as well because of its high content of soil nutrients. Slurry is to be used in three different forms in the study area like in liquid form (11 percent), solid form (16.67 percent), and composted form (73.33 percent). Sluury is basically used in cultivation of paddy, wheat, maize, potato, tomato, and green leaf vegetables.

The use of biogas saved the time of women and girls in firewood collection and cooking that can be used for education, income generation and other household and social activities. The use of biogas plant also becomes a symbol of social prestige and it raises social status of the family and household in the study area. The use of biogas produces very low emissions and thus brings less heath damage. It also makes kitchen much cleaner than the use of firewood. Biogas stoves are very easy to handle and control that makes less risk of accidental burns or fires because the stove is turned off as soon as cooking has finished. The use biogas also provides for better lighting in place of kerosene

lamps that avoids kerosene fumes. The use of biogas plant also creates employment opportunity for a technician who installs the digesters or plant. Similarly, the use of biogas also reduces the use of LP gas that is to be imported from abroad by paying foreign currency. So, it helps to reduce the size of trade deficit..

The use of biogas plants has drastically reduced the consumption of firewood in the study area. It is also a smokeless technology for the cooking and lighting purpose. It helps to reduce deforestation at the local level and thereby reduction of greenhouse gases emissions. Besides, use of slurry significantly replaces the use of chemical fertilizers to the cultivated land, it helps to sustain the fertility of soil. Moreover, the use of biogas was also reduces the various diseases like eye infection, respiratory diseases, lungs related diseases and cancer in lungs etc. However, the use of biogas provided few negative impacts in the study area i.e. spread of bad smell around the biogas plant installation, health hazard during mixing of dung and water, increase of mosquitoes, house files, white ant (***Dhamira***) and other insects and also required to spend more time to collect additional water for plant feeding.

The use of biogas became an appropriate alternative source of energy where fairwood is only the main source for daily requirement of energy in rural area of Nepal. Excessive use of firewood directly leads to deforestation, climate change and other evil incident of ecology. So, the promotion and development of biogas is essential in the context of Nepal. In this context, the present study on the socio- economic impact of biogas plant installation in rural area was made.

5.2 Conclusion

Biogas as an alternative energy is essential for the households especially in the rural area. Biogas remains the best alternative source of energy among hydropower, solar power, wind energy, and so on. Biogas stands technically, socially, economically, biologically and environmentally feasible. The main benefits of biogas using were, time saving, convenient in cooking and lighting, reduction of indoor air pollution resulting several health benefits. Besides, it also raises the socio-economic status of the plant

owners. However, an economical and financial analysis is required to examine the economic and financial soundness of using biogas.

In general, the biogas users are significantly and positively affected that are well appreciated by the biogas users. Besides, the use of biogas has also been successful to reduce the family workload in firewood collecting, cooking, and cleaning kitchen tools etc. The main objective of the installation of the biogas plant was found to be for the cooking purpose. Some of the biogas users were also found to be enjoying the light facility form the biogas. Housewives/women are the main beneficiaries of the installation of biogas plant and they were found to be saved through biogas for the reasons like through the smoke emitted during cooking in firewood was found to be reduced in satisfactory level. Biogas helped a great deal to keep the interior parts of the house clean with contrast to firewood, from which the emitted smoke used to make the house dirty. Also, the surrounding environment condition of the home was found been better as the emission of smoke was controlled and the heap of firewood as well as pieces of firewood were not seen scattered around.

A massive use of biogas also helps in the process of forest deforestation that could help in environmental protection, conservation and management. Besides, a massive adoption of biogas technology will reduce unemployment problem. However, there are still some existing problems related to the technical and financial aspects of using biogas that had to be addressed efficiently in the days to come for more positive benefits from the biogas.

5.3 Recommendations

On the based given findings and conclusion of the study, some recommendations are made on the desired future involvement of using biogas.

i) The government should provide a sufficient subsidy and focused to those sections of people who were neglected. It has been that farmers do not know proper utilization of slurry from biogas plants.

ii) The government should provide the subsidy for slurry replacement in every decade of biogas plant owner. Local manpower should be trained on the group of maintenance, constriction and supervision by BSP/N or government and his/her salary, allowance

should be fixed by government. He/she visits regularly in plants owner and provide the service them in free cost. BSP/Government should carry the program on time saving different activities due to installation of biogas plant and it should convert into income generating activities.

iii) Method of preparing compost should be given to them. Supervision which has been conducting by BSP should be regularized because low quality construction may bring negative impacts on the users.

iv) Gobar Gas Company (GGC) should conduct women education, awareness program, publicity campaigns and other useful programmers to motivate the farmers towards the needs for biogas plant installation.

Most of the plant owners were male but most of the users were females so the training should be given for users but not for owners. Due to the lack of resource and manpower, the GGC many not be able to send technical manpower to all constructed plants but this problem can be solved if the respective plant owners are provided with and operation and maintenance training. This will be more useful because plant owners can easily repair and maintain biogas plant themselves.

v) The promotional activities are required at both local and national level. At local level, companies should distribute the pamphlets with picture, documentary and arrange workshops and some effective advertisement through newspapers, radio and television that can aware people to national level too.

vi) Adequate resources should be made available to agriculture development bank for the purpose of advancing loans to biogas programme. Loan procedures under biogas programme should be drastically simplified.

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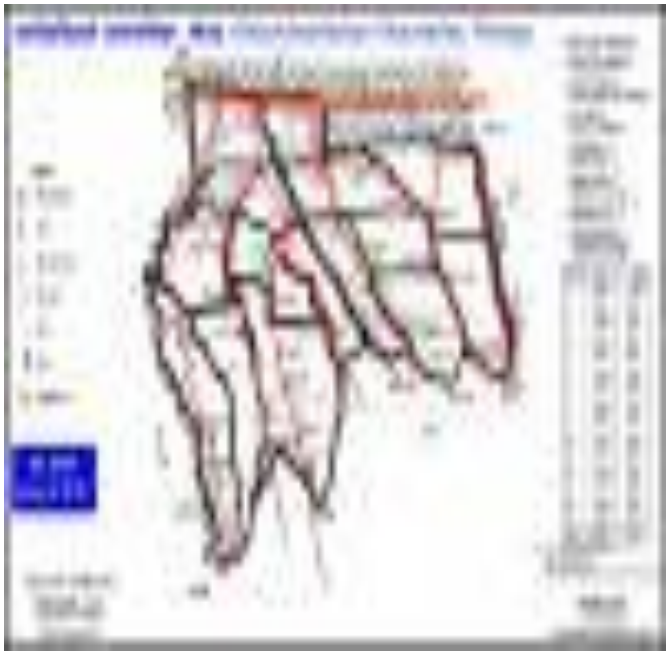
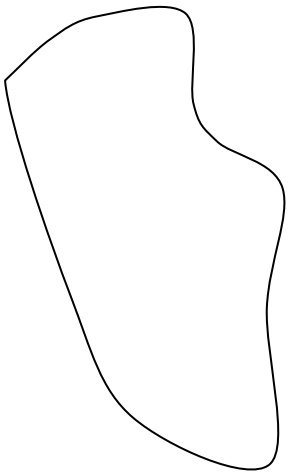
Appendix - I

Map of Study Area

Nepal	Morang District
	
Pathari Shanishchare Municipality, Morang	Ward No. 15, Study area
	

Appendix - II

Household Questionnaire

Contribution of Biogas in
Pathari Shanishchare Municipality
Morang District

A) General information of Sample Household

Name of Respondent …… Ward No.……

Age: …… Caste: …… Religion ……..

Household head: a) Male b) Female

Type of family: a) joint b) Nuclear

Class : a) High class b) UMC c) LMC d) Poor class

Family Description (Date of Interview)

S.N	Relationship	Sex	Age	Education	Occupation	Remark
1						
2						
3						
4						

B) Socio Economic Features

1. Size of Land Holding (in Romani):…….

2. Number of livestock Keeping

a) Cows: Ox…… b) Buffaloes…… c) Goal / Skeep……

4 Yearly income and expenditure

Source of Income	**Account (Yearly)**	**Expenditure on**	**Amount (Yearly)**
Agriculture		**Fooding**	
Livestock		**Housing**	
Salary and Wages		**Health**	
Business		**Clothing**	
Pension		**Interest of Loan**	
Remittance		**Other**	
Other			

5. Who encouraged you to install the biogas plant?

a) Government agencies /office b) Staff of Biogas Company

c) Biogas plant owner d) NGOs e) Other (Please secify):……

6. What benefited of Biogas Program attracted you most?

a) Environment b) Health c) Saving of time

d) Easy to cook e) Lighting f) Others:

7. What was the total cost of the plant?
Rs……Labors…….Capital

8. Did you take loan to construct the plant? a) Yes b) No

9. Did you face any problem in getting the loans sanctioned ? a) Yes b) No

10. What type of problem did you faced?

a) Non cooperative attitude of the bank staff b) Too much of paper work

c) Repeated visit d) Unusual delay

e) Graft money asked by the officials f) Other (Please specify):

11. Who did select the location of biogas Plant?

a) Myself b) Company staff c) Other (Please Specify): ……

12. Are you satisfied with the construction of your plant? a) Yes b) No

13. Who did construct the plant?

a) Gobar Gas Company b) Other (Please specify).

14. Are you satisfied with selected plant size? a) Yes b) No

15. How many stoves and mantels do you use? a) Stoves …… b) Mantel ……

16. How much fuel did you require per week before installation of biogas?

a) Firewood (kg/Bari) …… b) Kerosene (Lit) …….. c) Other……

17. How much fuel did require per week after installation of biogas?

a) Firewood (Kg /Bari) …… b) Kerosene (lit) ……

18. Where did you collect the firewood before the installation of biogas?

a) Near by Jungle b) Purchase c) Both ……

19 . Have you increased the number of cattle after installation of biogas plant?

a) Yes b) No

If yes, how many cattle have you increased ? No……

20. Have you attached your toilet to the biogas plant?

a) Yes b) No

21. Is biogas sufficient for a whole year? If not, in which month is not sufficient?

January …… to December

22. Do you feel that using biogas for cooking purpose save time?

a) Very Much b) some extent c) Not at all d) can't say

23. Do you use slurry in the farm on the time? a) Yes b) No

If yes, in which form? a) liquid. b) Solid (sun dried) c) Mixedt

24. Does it effect on the production of crops?

a) Production increase significantly
b) Production remains the same
c) Production increases to some extent
d) Production decreases
e) Can't say

25. If no, what you do with the slurry?

a) Sell to other b) give out to other c) Make dung cakes d) other (specifies

24. What advantages do you find on the use of biogas? ……. ……..
……
25. What disadvantages do you find on the use of biogas? …… …….
……
26. Do you think that biogas plant raises social status of the family? a) Yes b) No
27. Which member of your family has been benefited most from biogas plant installation? a) Male b) female c) All
29. What is your view on the impact of biogas plant on your overall financial condition? a) Improved b) Remained same c) Worsened d) Can't say

30. What is your view on the impact of biogas plant on your overall health condition?

a) Healthy b) Reminded same c) Can't say

32. How long you have been using biogas ?

a) Less than one year. B) 1 - 3 years c)3 - 5 year d) 5 -7 years e) More than 7 years

Appendix - III

Photographs of Biogas Operation

Pictures - 1: Livestock Keeping by Biogas Users

Source::Field Survey, 2017

Picture - 2: 8 m^3 Biogas Plant

Source::Field Survey, 2017

Pictures - 3: Using Biogas in the Kitchen of Sample Households

Source: Field survey, 2017