SOCIO-ECONOMIC IMPACT OF HOUSEHOLD BIOGAS SYSTEM
(A Household Biogas Study of Belbari Municipality, Morang District)

A Thesis submitted to

Faculty of Humanities and Social Science

The Central Department of Rural Development

Tribhuvan University

In the Partial Fulfillment of the Requirements of the Degree of

Degree of Master of Arts in

Rural Development

Submitted By

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March, 2019

Declaration

I hereby declare that this study entitled **Socio Economic Impact of Biogas Plant A Case Study of Belbari Municipality Morang District**is based on my original research work. Related works on the topic, by other researcher, have been duly acknowledge. I owe all the liabilities relating to accuracy and authenticity of the data or any other information included hereunder.

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APPROVAL SHEET

This thesis entitled Socio economic impact of Biogas Plant A Case Study of Belbari Municipality Morang District prepared and submitted by Bal KrishnnaNiroula has been examined by us and is accepted for the award of the degree of Master of Arts (M.A) in Rural Development by Tribhuvan University.

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Acknowledgement

Preparing and publishing a successful thesis requires help and guidance of specialized person rather than only by a single effort. This research is an outcome of the efforts of many individuals who were directly or indirectly involved. First of all I would like to express my sincere gratitude to faculty of Humanities and Social Science University Campus kirtipurfor supporting me.

I would like to express my sincere gratitude to Prof. Dr.Pushpa Kamal SubediDepartment Chief of Rural Development and entire staff members of Humanities and Social Science University Campus kirtipur for providing constructive comments, suggestions and encouragement throughout this study.

I am highly indebted to my supervisor, Dr. Ratna Mani Nepal for his continuous support, motivation and guidance throughout the study. The completion of this study could not have been possible without his expertise and precious time.

I heartily appreciate all the respondents fromBelbari Municipality for their precious time and cooperation they have extended.

At the end, I am also grateful to PunamKharel my loveable better half for encouraging in finalizing the thesis. I would like to pay my due respect brother Mr. Tanka Niroula,GhanashyamNiroula Nephew AyushNiroula, sister Radhika Niroula, SumanaNiroulaand other family members for their moral support and affection towards me.

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ABSTRACT

Basically, the domestic biogas system is being implemented in the rural areas of Nepal. This research was based on household survey and conducted in Belbari municipality. The overall objective of this research was to find Socio economic Status of Bio Gas Plant. Primary data were collected from concerned stakeholders-local house owners, health post, Municipal office Belbari Morang. Secondary data were collected from documents, journals, statistical data published by Municipal office Belbari, Central Bureau of Statistics. A total of 40householdswho had bio gas plant from the total population of 120 were taken by simple random sampling method to know the socio economic impact of bio gas.

Six m^3 biogas plants were more popular in the study area as compared to other size of plants ($4m^3$, $8m^3$). From the study it is concluded that there is difficulty in finding bio gas maintenance technicians in local level. Majority of the households have connected attached toilet (72.5 percent) with the biogas plant. There has been reduction in occurrence of diseases after installation of bio gas plant and they have been able to save Rs. 4000/- in the treatment of respiratory problem, Rs 2500/- in the treatment of others (headache, eyes etc). The respondent or plant owners are able to save as 6500/-per year in the treatment of health related disease and majority of the respondents reported that the overall economic, environmental and energy condition have been improved.

There is need of effective coordinate mechanism in between service provider and local house owners for effectiveness of the government subsidy program, it must be simpler and accessible to all level of households. Equal subsidy to all the people is not reasonable, more subsidies should be provided for the poor and downtrodden people, so that such people can install plants. Application of biogas slurry on farm should be studied systematically, qualitatively and quantitatively. For better management of slurry, training should be provided to the biogas users. Connection of the toilets to the biogas plants should be promoted. This would help further in improving the environment and sanitation.

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Abbreviation/Acronyms

ADB	Asian Development Bank
AEC	Alternate Energy Source
AEPC	Alternate Energy Promotion Centre
APP	Application
ASE	Alternate source of Energy
BSP	Bio Gas Support Programme
CBS	Central Bureau of Statistics
FF	fossil fuels
FGD	Focus Group Discussion
FM	Frequency Modulation
GDP	Gross Domestic Product
GGC	Gobar Gas Company
GoN	Government of Nepal
HHS	Household Survey
I/NGOs	International/Non-Governmental Organization
KG	Kilo Gram
LPG	Liquefied Petroleum Gas
MoF	Ministry of Finance
MoFALD	Ministry of Federal Affairs and Local Development
MWH	Meghawatt Hour
NPR	Nepali Rupees
NRM	Natural Resource Management
PQ	Pre Qualification
RE	Renewable Energy
RET	Renewable Energy Technology
RETSUD	Renewable Technology for sustainable development
TU	Tribhuvan University
VDC	Village Development Committee
WECS	Water Energy Commission Secretariat

CHAPTER-ONE
INTRODUCTION

1.1. General Background

The main challenge of present world is to harness the energy source which is environment friendly and ecologically balanced. This need has forced to search for other alternate source of energy. But unfortunately the new alternative energy sources like the solar, hydro, wind etc. require huge economic value and technical power to operate, which seem to be very difficult for the developing countries like Nepal. In the present moment biogas energy can be one and only reliable, easily available and economically feasible source of alternative and renewable source which can be managed by locally available sources and simple technology for these rural villages.

The economy of Nepal is primarily based on agriculture and other sectors of the economy are quite small. National account data shows that at factor cost, the share of agriculture in the total GDP was 32.35 percent (MOF/GoN, 2017/018).

Energy consumption pattern is divided into three parts by their sources, namely traditional, commercial and renewable. Large proportion of energy consumption is met by traditional energy resources with increasing pressure on forest resources leading to environmental imbalances to rise with increasing pressure of population growth. Nation's demand for fuel is increasing at an alarming rate. The total final energy consumption was 410,000 TJ out of which traditional biomass resources supplied 85 percent in the total energy consumption, whereas commercial energy such as fossil fuels and electricity were 14 percent. Modern biomass such as biogas and briquettes and renewable energy sources supplied about 1 percent only (MOF, 2012; WECS, 2012)

The country's energy imports mainly oil products, coal, and electricity have been growing fast, from 312 ktoe in 1990 (5.4% of the supply of primary energy that year) to 2,069 ktoe in 2014 (17.7%). On the other hand, the increase in the production of indigenous primary energy has been moderate, from 5,501 ktoe in 1990 to 9,740 ktoe in 2014 (ADB, 2017)

Biogas technology is increasingly accepted by all ethnic groups in both hills and the Terai. There is not any significant social barrier to the technology especially when cow, buffalo dung is used as

slurry. Since, combustion of biogas does not produce toxic fumes and carbon residues on the bottom of pots and pans, health conscious rural people (especially women) favor this technology. The plant owner in the Terai reported that the level of gas production decreased by about 25 percent during winter. It may go beyond 50 percent in Hills. (Study of Bio-gas installation in Nepal, Agricultural Development Bank).

Biogas is a form of clean cooking mechanism, an eco-friendly sustainable source of renewable energy, economically and environmentally compatible to use. It is produced out of organic waste and can be used for multiple purposes i.e. thermal, electric etc. The slurry that the biogas system produces is a convenient source of organic fertilizer which is a key factor on multiplying the agro-productions maintaining the environmental sustainability. The biogas technology has a key role on generating green jobs in a large numbers (at around 13000) in Nepal. Most of the villages (more than 2800, out of the total: 3915) of all 75 districts of Nepal have biogas installed. Studies have shown that, along with the biogas installation, the situation of health and sanitation is being gradually enhanced; deforestation (for the cause of firewood) is being curbed in Nepal. The technology is being concerned on caste and ethnicity, gender etc. issues to make the sector more inclusive, participative, decentralized and balanced. Waste to Energy as a form of biogas system is an large energy project newly adopted in Nepal. This system is based on the large amount of organic waste produced out of private as well as public organizations, business complexes etc. Primarily, this project is affixed with an aim of other thermal usage of biogas and electrification (https://www.aepce.gov.np/household-biogas).

Biogas is produced by anaerobic digestion or fermentation or decomposition of organic wastes by the action of methanogenic bacteria. It is composed of 50-70% methane, 30-45% carbon dioxide, 1% H_2S, 0.1%N_2, 0.1% O2, 0.1% H_2 and some other gases. During digestion about 25-30 % of the dry matter of waste is converted into a combustible gas and residue of 70-75 % of the total solids content comes out as sludge which is known as slurry. The energy content of biogas is 6-6.5 KWh/m3, and the ignition temperature is 650-750 o C. This energy allows biogas to be used as a fuel for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity. Biogas can be compressed, much like natural gas and used to power motor vehicles. This gas is about 20 percent lighter than the air which is odorless and burns with clear blue flame similar to that of Liquefied Petroleum Gas (LPG). (https://www.aepc.gov.np/household-biogas)

1.2. Statement of the Problem

The demand for energy is increasing day by day in Belbari Municipality and major share of energy consumption is met through traditional sources. Belbari Municipality is facing the energy related problem such as; raising price of fossil fuel, high rate of deflection of the forest resources etc. Traditional sources of energy are not cheap, convenient or long lasting. It is the very essence of the Belbari municipality to modernize the way for utilizing local resources by using the simple types of technology.

In the context of Belbari Municipality, people are facing the problems of firewood .The forest alone is not capable of sustaining the increasing demand of energy for growing population. Other alternative source of energy such as solar power, and wind energy is negligible in use because of high cost of installation.

In Belbari, rural women and children spend more time for the collection of firewood as well as on cooking and washing utensils. Smoke produced form firewood is poorly ventilated through room and with traditional stove creates smoke borne diseases such as respiratory problem including long-term asthma, headache and eye burning etc. Not only that the economic activity of Belbari people is affected due to wastage of time on searching of source of energy.

Due to the above difficulties on firewood use of biogas plants is an only appropriate alternative source of energy in rural area which is feasible for installation and convenient to use. Biogas plant requires animal dung and human excreta or vegetable organic matters as raw materials which are easily available in rural areas. Even if 120 household have installed bio gas in Belbari Municipality there is no study on it.

1.3 Research Question

This research was conducted to answer the following questions that lie at center of the context as stated above

- What are the socio-economic conditions of households having biogas in Belbari Municipality Morang?

- What is the impact of biogas in environment, health and sanitation in Belbari Municipality Morang?
- What are the benefits of slurry in agriculture production?
- What are the possible measures for sustainable installation of bio gas?

1.4 Objectives of the Study

The general objectives of the study are to analyze the socio-economic impact of biogas plants. However, the specific objectives are:

- To examine the socio- economic characteristics of biogas users.
- To study the impact of biogas on health and sanitation.
- To find out the benefits of slurry in agriculture production.
- To find possible measures for sustainable installation of bio gas.

1.5 Significance of the Study

This study is important to give information about the socio- economic impacts of biogas plant; the area of study depicts the socio-economic and environment aspects as well. With the shortage of energy source, high rate of deforestation, no immediate benefit for the women who are engaged in cooking and problems in restoring country's balance of payments to some extents, biogas as renewable alternative energy clearly offers the great significance of the study as it solves the above mentioned problems. The introduction to biogas technology in the study area is helpful for reducing the dependency on forest resources for energy of household purposes. It may succeed to show the reliable natural resources conservation strategy in the area of study.

People in the study area use slurry as organic fertilizer that can generate higher productivity without spending the cost of the buying chemical fertilizer. It helps to control the food crisis not only of the study area but also of the macro level (i. e. national level) and it helps to control the soil fertility day by day. So, this study is highly significant on the national economy and the installment of biogas plant which reduces the quality of life of people in this study area.

1.6 Limitations of the Study

This study has attempted to analyze the socio-economic impact of biogas plant installation within Belbari Municipality Morang district. Generalization of this study may or may not be applicable to other parts of the nation. All economic variables have been calculated in terms of local price. This study creates only social aspect, economic aspect and environmental aspect but not the other technical aspects of biogas plants. As being a case study it covers the whole aspects of biogas plant and it can help reference to further study. The sample size of households (HHs) used for the particular study gets the 33.33 percentage in total households in the study area and it is assumed that the study provides the representative figures of socio-economic impacts of biogas plants. Due to various constraints, there are some limitations of the present study which are given as follows;

a. This study is based on the biogas users of Belbari Municipality Morang district.
b. This study does not cover any technological aspect of the biogas plant.
c. The result of the study is not similar to the other areas.
d. The result has been taken out considering cost, time and resource from the household.
e. The study is based on household survey and focus group discussion.

1.7 Organization of the Study

This study has been organized into five chapters. The first chapter of the study includes general background, statement of the problems, objective of the study, limitation of the study, significant of the study and organization of study. In second chapter it elaborates the review of literature. Third chapter include methodology where research design nature and sources of data, technique and tool of data collection, rational for the selection of study area, universe and sample and data analysis and interpretation. Chapter four is major part of the whole study in which all collected relevant data are analyzed and interpreted by the help of different tools. Finally, the contents in chapter five are summary, conclusion and recommendation.

CHAPTER-TWO
REVIEW OF LITERATURE

For the purpose of the study of this subject, literature of various writers is reviewed. The literature is reviewed from the thesis presented by former students, paper and reports presented in seminars, journals, bulletins and information published by various concerned agencies and books in the concerned topics. The summary of outcome of some of thesis studies has been illustrated hereafter.

2.1 Empirical Review

Dahal (2010), submitted a master's thesis entitled "Socio and economic impact of the biogas plants" in Birpur VDC of Kapilvastu district. The objectives of the thesis were to study the benefit of slurry production, to find out the socio-economic characteristics of biogas in health and sanitation. He has not mentioned any specific statistical method but he has used primary as well as secondary source of data. The major findings of these studies were almost all plant owners use slurry on farm. The use of biogas certainly improves the natural as well as social environment. Most of the users reported the degrees in the incidence of different diseases like eye and respiratory diseases. Cleanliness of house hold environment is improved but one of the impacts of biogas plant was it increased prevalence of mosquito. Main occupation of biogas users were agriculture (68.57 %), service sector (20%) and business (11.43%). The recommendation derived from his study was for better management of slurry, training should be provided to the biogas users. Insufficiency of the gas in cold seasons has been the major problem for the biogas users. So proper alternative design of biogas plant is becoming a need, Women should be encouraged in construction training and operation and maintenance training. This would help toward gender balance issue. It is found that all the plant owners have used the gas for cooking purpose. Thus it is necessary to conduct additional studies about the use of gas for other income generating activities. These kinds of studies could be done both by government and institution of alternative energy. Initiate R and D (Research and Development) for developing low cost model appropriate for the rural poorest section of the population.

Timsina (2009), explained "socio economic impact of biogas plant in rural Nepal (A case study of Phidim VDC of Panchathar district) .The main purpose of this thesis were to find the socio-

economic conditions of biogas users, to find out the impact of biogas energy in rural area of Nepal, to analyze the problems and prospects regarding the biogas energy.

The whole study is carried out on the basis of primary as well as secondary data. He has not any specific statistical methods. The major findings of the thesis were biogas plants, one of the best options for meeting the growing need of fuel in the rural as well as in the urban areas, are being popular in the recent years in Nepal. Installation of biogas plants has been increasing rapidly day by day. Almost all biogas plant owners are in agricultural field and average size of land holding 5 to 7 Ropani. It shows that there is high variation between them. After completing the thesis, following recommendation has been derived by the researcher. The installation of biogas plants has helped saving times. But such leisure time is wasted idle. Some income generating programme should be implemented to address such leisure time by the government with the installation of the biogas plants. Most of the plants owners have complained about the subsidy. Equal subsidy to all the people is not reasonable. The poor and downtrodden people should be given more subsidies, so that such people can install plants. Most of the plants owners have suggested that the construction materials of the service provide company should be specified. The government should publish the market value of such materials annually and subsidy should be given to that materials. The regular monitoring sector of biogas companies is very weak. Due to which different problems regarding plants have not been addressed on time. So, monitoring sector should be strengthened. Importance and benefits of the biogas plant should be broadcasted by radio, TV and moreover through FM channels (most of the people in the study area listen FM radio nowadays)

Karki (2011), explained the social-economic impact of biogas plants in Anarmani VDC of Jhapa district. The objectives of the thesis were to find the social economic aspect characteristics of biogas users of Anarmani VDC, to incorporate user's perception and suggestion toward biogas plants and third objective was to examine the impact of biogas in relation to gender role, household economy, agricultural status and sustainable land use, environmental health and sanitation.

Karki has not any specific statistical method. Primary field survey was carried out for the research proposes. Primary as well as secondary data were used in his thesis. The major findings or conclusions of the thesis were to get rid of the firewood collection and to have easy and smokeless cooking. The use of biogas has brought the significant improvement in the quality of life of the family members and reduction on the workload of women who are the sole manager in kitchen and

take the responsibility of cooking. Very poor people with small size of land and lower income was found unable to construct the biogas plant After installation of biogas, people are encouraged to use toilet for better sanitation practice there is positive relation between slurry and agricultural productivity. Some bad effects of the biogas plant have also accounted in the study. People have felt it dirty business to collect dung, to mix dung, to use of manure, etc and it has produced smell and insects. The main encouraging factors to installs biogas plants are neighbors, friends, biogas company and others. The large amount of money is required in the time of installation which has given rise to economic problems among people.

After completing the thesis such recommendation were done to formulate and adopt the policy by the concerned authorities to develop and promote the biogas plan; It is found that all the plant owners have used the gas only for cooking purpose. Thus it is necessary to conduct further studies about the use of gas to other income generation activities since the biogas plant have lessened the use of firewood and hence reduced the pressure in the forest resource, the government should come up with the long term vision about the biogas technology. Research on control of mosquito and optimum utilization of slurry to increase crop production should be carried out. Most of the villagers produce vegetables for household purpose. Information should be given to them to apply bio-slurry on high value cereal crops instead of chemical fertilizers. It may help to increase the production of the concerned people.

Singh et al, (2009) presented the paper entitled "Production of biogas from poultry waste in Kathmandu" in the third International Conference on Renewable Technology for sustainable development (RETSUD-09).The poultry is growing day by day and is concentrated within the urban as well as rural community. In Nepal poultry waste produced daily both from broilers and layer chicken was largely used as organic manure for agriculture purposes. the study was done to find out the possibility of practical utilization of poultry waste to produce biogas and show the poultry industry could co- exist without disturbing the environment of the neighbors. The research was of particular interest to the poultry farmer and to the community in the Kathmandu valley who were conscious of environmental impact due to odor pollution. The overall objectives of this research were to study the various parameters of biogas production from poultry waste in Kathmandu. The specific objectives of the thesis were; to conduct experimentation by installing 10m GGC 2047-model fixes dome bio-digester as approved by BSP in Kathmandu. To record various parameters such as pH, temperature, retention time, consistency of slurry, total solids content, C/N ratio and

volatile solids content, to evaluate the production of biogas at a normal condition, to financially analyze the production of biogas in the poultry industry.

The methodology used for the study was by experimental study of digestion of poultry waste in 10 m^3 GGC-2047 model fix dome bio-digester approved by BSP-Nepal. The major conclusions of the thesis were; the bio-digester required daily feeding of 50 KG of poultry waste mixed with nearly the same volume of water. The poultry farm was capable of producing 637.50KG/day of poultry waste which indicated that it was possible to run a bio-digester of ten times greater than the constructed capacity The results showed the normal value for methanogenesis which thus produced biogas. The retention time was 82 days which was longer than cow dung digestion time. This was due to the organic matter content which was found to be 42.22 percent. Evaluation of biogas production was done at the ambient temperature. The average daily biogas production recorded was 3,500 liters. In substitution for cooking gas the simple payback period was found 2.6 years which indicated that the project was financially viable. With the daily feed of 50 KG poultry waste 3.500 liters of biogas was produced per day. At the present poultry waste producing capacity of the farm of 232,687.50 KG per year the biogas generation could be estimated to 13,961 m^3 per year. This could generate 77.62 MWh of thermal energy per year.

Base on the above research, the recommendations have been made; as the biogas produced is 70 liters per KG of chicken waste the fix dome bio-digester GGC2047 model digester can be modified in order to tap the optimum biogas thus generated. This benefit can be disseminated to the poultry industries and promoted poultry waste biogas plants in Nepal also. To attract construction of digesters in poultry industries subsidy should be provided in the poultry industry for building biogas plant.

Lamichhane et al, (2010) presented the paper entitled "High altitude biogas plant beyond 3000 meter' in the third International Conference on Renewable Technology for sustainable development (RETSUD-09). In history of Biogas support program (BSP) four biogas has been installed at an altitude of 3050 to 3850 meter and running smoothly. this paper mainly deals technical as well as field level experienced during the installation of biogas plant in that altitude. Biogas technology is very popular among farmers in the Terai and Hilly areas of Nepal. More and more people are being benefited by this multipurpose technology. To bring such technology beyond 3000 meters BSP-Nepal attempted to increase the biogas production in cold region through modification in physical,

chemical and biological methods. During this series of research BPS-Nepal had attempted various techniques to increase the gas in cold areas. Some of the systems are simple but less effective, while other are more effective but costly, which is beyond the reach of ordinary people. Therefore a simple and cost effective technology has been developed and being piloted.

The main conclusion that out of four installed experimental plants, only two plants one is Lantang and another in Ghodatabela could be monitored regularly. The slurry temperature of Ghoda tabela (13.34˚) is greater than that of langtang (8.3˚c). Similarly, the average maximum daily cooking hour is also greater in Ghodatabela than Langtang which implies the greater production in Ghodatabela. In summary, the less production of gas in both plants are due to the low ambient as well as slurry temperature, less and irregular feeding by the user. At last, the researcher has recommended that as the feeding material is irregular and proper heap composting is not applied, the production measured is less than design. A proper orientation and encouragement of user to take care of the technology could improve the gas production. This study has to carry out at least one more year to draw the concrete conclusion. The outcome of the result not only benefitted the 10,375HHs living above 3000 meter but also a cost effective breakthrough for similar condition in other countries too.

Shrestha et al, (2011) presented the paper entitled "Purification of biogas uses pressure swing adsorption method" in the third International Conference on Renewable Technology for sustainable development (RETSUD-09). The main conclusions of this research study has been carried out that purification of biogas using pressure swing adsorption method is one of the most widely used methods. It is found to be very suitable for the purification of biogas produced from the municipality waste. Biogas is compressed after purification which is then filled in cylinders. It increases the economic value of biogas and makes it possible to use in various engines as fuel. This state of arts technology has to be replicated in various municipalities so that waste would be no more waste rather it could be the source of energy.

Chhetri et al, (2009) presented the paper entitled "Review of Institutional biogas plant utilizing Human Faeces, Kitchen and Vegetable Waste" in the third International Conference on Renewable Technology for sustainable development (RETSUD-09). After completing the data collection, some recommendation and conclusions has been made by the researchers; people should be made aware of the fact that besides cow dung, other bio-degradable waste such as VFW, garbage, sewerage, slaughter, house waste, etc can also be used to produce biogas. the successful implementation of the

pilot project, the concerned stakeholders (AEPC, BSP-N, etc) should take necessary steps to extend such problem in suitable locations in collaboration with the municipalities and other related institutions in view of producing energy and bio-fertilizer simultaneously mitigating environment pollution. Concerned authority should also carry out the effective monitoring of the installations even after the expiry of the project. In addition to the use of biogas as clean fuel, the beneficiaries should also be encouraged and motivated to promote the use of bio-slurry as manure, which is rich in plant nutrients. Assessment of slurry coming out of institutional bio-digesters should be carried out to find out plant nutrient content as well as pathogen level.

Regmi (2010), explain the economic impact of biogas plants in Baniyani VDC of Jhapa districts. The objectives of the thesis wear to analyze the economic impact of the biogas plant in Baniyani VDC, to examine the impact of the biogas on income and third objective was, to examine the benefit of slurry in comparison to chemical fertilizers in agriculture production. Regmi has not any specific statistical method. Primary survey was carried out for the researches propose. The major findings of the thesis were; agriculture is the main sources of income for majority of biogas household under this study. Six meter biogas plant is very popular in this VDC as compared to other. Women have new life and all of the families have relieved from irregularities of firewood and its rising price. They are saving their at least 3 hours in a day and using their leisure time in the creative works. Agricultural production and productivity of crops and soil fertility is also going to increase.

Some recommendations made by the researcher were government should provide more grants for biogas technology. Due to the lack of grants, it is difficult for dissemination and promotion of biogas awareness programme in the remote part of VDC. Therefore, it is necessary to give awareness programme in the remote parts of VDC, frequent monitoring and supervision of biogas company is essential, it's helps the farmers for maintenance of any kinds of problems. Due to lack of monitoring and supervision biogas does not work smoothly, so the plant owners are using traditional stove (Chulo) form. It was found that maximum of biogas users were from Brahmin and Chhetri community. It is important to investigate, why it is so or why other caste is back aside in installing biogas plant.

Wagle (2010), explained the "socio- economic status of bio gas users in Tanahunsur VDC of Tanahun district". The main objectives of the thesis were to find the socio-economic characteristics

of the biogas users. To analyze the operational status of the biogas plants and to assess the impact of the use of biogas on women's health, saving of time income, etc.

Wagle has used primary as well as secondary data. Interview and field observation have been taken as a method of data collection and collected data has been analyzed using simple statistical tools such as in average, percentage, table and diagrams. The major findings of the thesis were; size of $6m^3$ biogas plants was more popular in this area as compared to other size of plants ($4m^3$, $8m^3$).his study found out that there were also the size of $6m^3$ biogas plants (77.5 percent) and $4m^3$ biogas plants (7.5 percent) and $8m^3$ biogas plants 15 percent were installed. The main source of loan for investment was Institutional (35 percent).The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose. There is a considerable reduction in the workload of the family member and women are highly benefited (82.5 percent) by the biogas plant installation. Subsidies provided by the BSP were very encouraging factor for installation of biogas. Average family size is 4.5 per household. Landholding size is 14.5 Ropani per household the users felt reduction in health related problems such as respiratory problem and others such as, headache and eye problems. Majority of the respondents felt that the menace of flies or mosquito has been increased (72.5 percent).

Some recommendations has been made by the researchers. The use of human excreta and its advantages must be made known to the installers for this purpose training, seminars, workshop and awareness programmed should be infused regularly. Provision of easy loan and cheap interest rate on loan should be made including higher percentage of subsidy. Insufficiency of the gas in cold season has been the major problem for the biogas users. So, proper alternative design of biogas plant is becoming a need. Supervision of which has been conducting by BSP should be regularized because low quality construction may bring negative impacts on the users.

Bhandari (2010), explained the "socio- economic impact of biogas plants in Bungkot VDC of Gorkha district". The main purposed of the thesis were to study the biogas plant as an alternative of forest resource, to assess socio-economic benefit of the users from the biogas and to suggest measure for suitable policy formulation. Bhandari has not any specific statistical methods but collected data has been analyzed using simple statistical tools such as average, percentage table and diagrams. Interview and field observation have been taken as a method of data collection. The major findings of the thesis were; biogas has been proved very useful for the women members of

the family. Therefore sufficient of time have been saved after biogas installation. As a result most of the women have extra time to get herself involved in other household activities like agriculture, child care, child education normal generating activities The chances of occurrence of health problems such as burning of eyes, headache, are reduced. Biogas has promoted good sanitation because of growing use of toilet it has encouraged others to build their toilet after installation of biogas. The digested slurry contains more nutrients. These nutrients are better saved if composted. The use of digested slurry has shown good increase in production. However, in most cases the slurry is not managed properly.

Some recommendations has been made by the researchers. It is found that all the plant owners have used the gas for cooking purposes. Thus it is necessary to conduct deep studies about the uses of gas to other income generating sector. The use of human excreta and its advantages must be made known to the installers. For this training seminars and workshop should be implemented. For better management or slurry training should be provided to the biogas users. Insufficiency of the gas in cold season has been the major problem for the biogas users. So, proper alternative design of biogas plant is becoming a need. Women should be encouraged in construction training and operation and maintenance training. This would help towards gender balance issue. Concerned biogas companies should carry out supervision and evaluation more elaborately. Dissemination of information should be done massively through the media like newspaper, radio, television etc. A consistent policy should be introduced to include the small marginal and poorest of the poor. Research should be carried out on lowering the cost of biogas plant to the increase efficiency of gas production in winter and control the breeding of mosquito. The cause of leakage of slurry from the burner should be studied and preventive measures should be made before new constructions to avoid the problem.

2.2 Summary of the Review

All the above mentioned studies have mainly indicated that installation of biogas has positive impact on social, economic, environmental and health condition. However, it has also been found that some of the users have experienced negative impact of prevalence of insects too. Most of the people use bio-slurry in their farms in composed form and has increased production and productivity of different kind of crops. These review also indicated that biogas reduced the level of

pollution in the kitchen and it has also improved outdoor sanitation. After installation of biogas plant, many kind of respiratory disease were reduced and which has help saved money indicated in the reviews. The reviews indicated that biogas has direct link with Clean Development Programme project which has reduced carbon in the environment. Besides that, it has also become a source of national income from carbon trading. These are the major issues that are focused in the reviews.

CHAPTER-THREE
METHODOLOGY

Reliable and relevant study can be made possible only by applying scientific method. Hence the primary purpose of this chapter is to discuss and design the framework for the research. Different procedures have been followed.

3.1. **Research Design**

Research design is a framework of the study, which helps the researcher to study in related area working on the topic of socio-economic impact of biogas plant. It is integrated system that guides the researcher in formulating, implementing and controlling the study. Useful research designs can produce the answers to purposed research questions. The study generates the focus on socio-economic characteristics of biogas plants, environment, health and sanitation, benefits of slurry in production, etc, particularly of the people of Belbari Municipality Morang district. Information has been collected from the first hand field survey. The study stand only on the family members using biogas. Actual consideration for the moderate interview, the attached case study hopes to obtain the mission. Primary as well as the secondary data have been utilized. This study is based upon quantitative as well as qualitative data.

3.2 Research Process

To achieve the objective, study was carried out upon the data collected from the primary and secondary sources, regarding the socio economic impact of bio gas. Questionnaire surveys, focus group discussion, review of available literature, documents and consultation with supervisor will be done for the research.

The household survey was collected from the local house. Quick checks, detail review and evaluation were carried out to analyze the research objective.

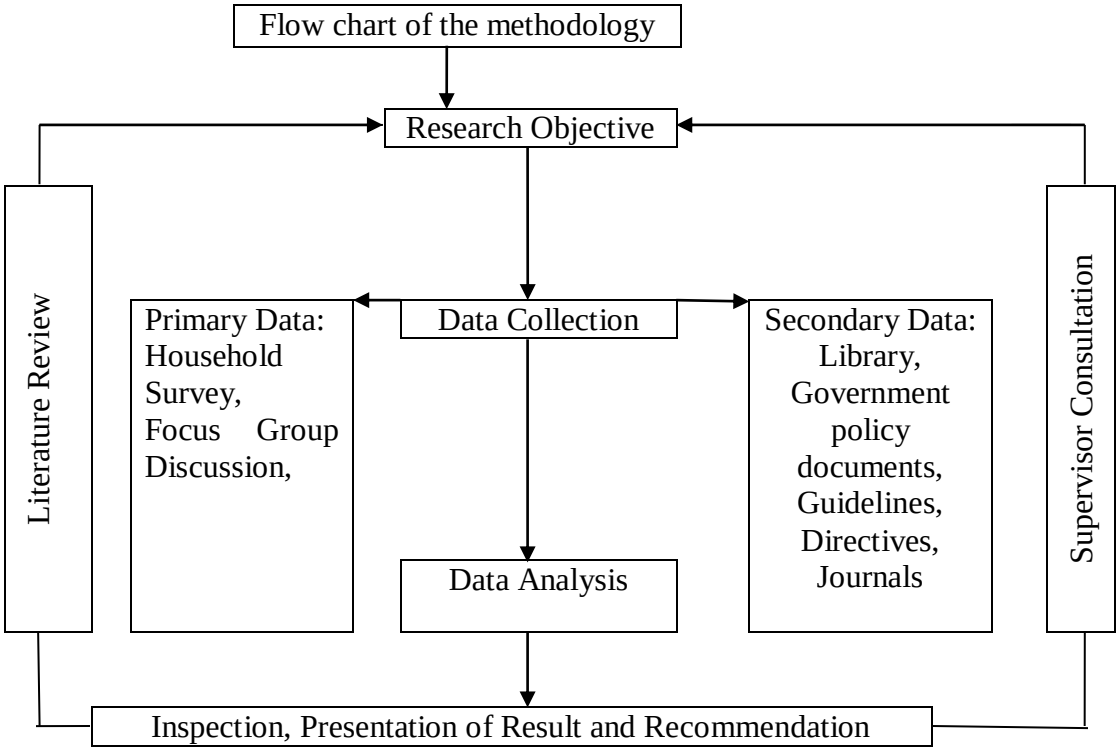


Figure: Research Process

3.3 Research Approach

The research approach follows both quantitative and qualitative approach, in this research quantitative approach consists of standardized structured questionnaires to address the socio economic status of bio gas plant. Focus group discussion was carried out for the collection of data as qualitative approach.

3.4 Nature and Sources of Data `

The primary data is the main foundation of this study. The primary data were collected through house hold survey.

3.5 Techniques and Tools of Data Collection

The data used in this study has been collected from field survey conducted in Janurary 2019. The survey is conducted through the formal method of interview in a structured questionnaire. They are used to estimate the socio-economic impacts of biogas on Belbari Municipality. The Survey was

conducted through the formal method of interview in a structured questionnaire. Following tools has been used for data collection.

3.5.1 Household Survey

A set of questions have been formulated to conduct household survey to obtain data from the plant owner. The questions included were related to size of land holding, family size, impact of biogas plants and income level etc. the questionnaire was retested, revised and finalized before administering to plant owners.

3.5.2 Focus Group Discussion

Focus Group Discussion

Focus Group Discussion was carried out with chief executive officer of Belbari Municipality, assistant chief executive officer of Belbari Municipality, Municipal engineers/technicians, local house owners, and local bio gas service provider to explore the possible measures of effective installation of bio gas.

3 focus group discussions were carried out with local house owners which consisted of 10, 20, 10 number of participants, 1 focus group discussion of local bio gas service provider representative was carried out which consisted of 2 number of local service provider likewise, 1 focus group discussion with chief executive officer of Belbari Municipality, assistant chief executive officer of Belbari Municipality, Municipal engineers/technicians.

3.4. Rationale for the Selection of Study Area

The present study has been carried out in Belbari Municipality Morang district which lies on 1 number provenance.

The reason for selecting Belbari Municipality Morang as the study area is that the researcher is currently working on the study area. This study is carried out to fulfill the thesis requirement of master's degree in Rural Development by a student; the researcher is bound to incur minimum financial expenditure. Secondly, the researcher is familiar with the local people. Therefore,

selecting this area, it is believed that more accurate information could be collected during the study. The total number of the households in Belbari Municipality is 5724. Out of them 120 households have biogas plants. Out of 120 plants, ward number 5 have the maximum number of plant (Belbari Municipal profile, 2070).

3.5. Universe and Sample

All the 11 wards with 120 biogas plants in the Belbari Municipality represented the universe of the study. However, as the inclusion of whole population is costly and time consuming process, only a few selected plants are considered under the study.

3.5.1 Sample Size

Cochran's equation as given below will be used to calculate the sample size with 90% confidence level and confidence interval of 10. Here the study population is small and if we take a confidence level of more than 90%, it may be the case of use the whole study population as a sample size. So it might be too difficult to cover and to reach a good result. This sample will be taken for the selection of houses and local house owners.

$$n_0 = \frac{Z^2 pq}{e^2}$$

For finite sample this formula is modified as

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \text{ Or } \frac{Z^2 pqN}{Z^2(N-1) + Z^2 pq}$$

Here,

n_0 = Size of infinite population,

Z = Area of normal curve and its value is 1.64 for 90% confidence level.

e = Desired level of precision (Confidence interval)

p = Estimated proportion of an attribute that is present in the population, and q is 1-p.

N= Population Size

Since the variability in the proportion is not known, therefore, maximum variability of 0.5 (i.e. p=q=0.5) is assumed.

Sample Size for Local House Owner

Sample sizes for questionnaire to local house owners will be 31 from the formula but for this N= 120. N is the total houses household installing bio gas but 40 local households are selected for sampling.

In order to select the sample, first of all, 4 wards are randomly selected with simple random sampling method .Than among 4 wards different sample is selected with purposive sampling method which is shown in table (3.2) below. So, the total sample size in the study area is 40. The sample size of each ward is not homogeneous. It is because large sample is taken from the wards with higher biogas plants. The ward wise distribution of sample is given in the table (3.2).

Table 3.2

The Frequency of Distribution of Sample Size of Biogas Owners in Sample Wards in Belbari Municipality

Ward No.	Household with Biogas Plants	Sample Size
1	33	13
2	10	
3	17	7
4	11	
5	35	14
6	5	
7	6	
8	9	
9	1	1
10	8	
11	5	
Total	**140**	**40**

Source: Field Survey, 2019.

Table 3.2 shows that 13 from were selected from ward number one and 7 from ward three, and 14 from ward number five and 1 from ward number nine. There is an unequal number of household in the sample households from different wards because there is difference in total number of households in those wards.

3.6. Data Analysis and Interpretation

The structured questionnaire is prepared to intensive household survey. The data and information received from household survey and key informant interviews were grouped, filtered, required data are tabulated and summarized according to them so to examine the socio- economic characteristics of biogas users, impact of biogas on health and sanitation, benefits of slurry in agriculture production and find possible measures for sustainable installation of bio gas and presented and interpreted by using average, percentage and other statistical tools as per requirement. The result of

the data and information were used to analyze the socio economic impact of bio gas and draw conclusion and recommendations of the study.

CHAPTER-FOUR

PRESENTATION AND DATA ANALYSIS

The data and information received from household survey and key informant interviews were grouped, filtered, required data are tabulated and summarized according to them so to examine the socio- economic characteristics of biogas users, impact of biogas on health and sanitation, benefits of slurry in agriculture production and find possible measures for sustainable installation of bio gas and presented and interpreted by using average, percentage and other statistical tools as per requirement.

4.1. Brief Introduction of the Study Area

Belbari, officially known as Belbari Municipality, is one of the major suburbs of Morang district, Province No. 1. It lies in the eastern Terai region of Nepal. It was officially upgraded to become a municipality in 2014 AD, which is 2070 BS (Bikram Sambat), which otherwise was a Village Development Committee (VDC) prior to that change. In order to meet the requirements to become a municipality, Belbari VDC merged Kaseni VDC with itself, making it larger in total area. Moreover, in 2017 AD VDC like Dangihat and Bahuni merged with it to become present Belbari Municipality.

Belbari spreads over an approximate area of 25 square miles. All of the area is plane land, geographically. It is bordered on North and East by the largest and the densest forest of Nepal, the Charkose Jhadi (English translation: "Four Yard Bush"). It is bounded on the northeast by Charkose Jhadi, while to the east lies another kanepokhari Rural Municipality. Similarly, the north part is bounded by Kerabari Rural municipality, while to the west and southwest lie the Sundarharaincha municipality and Rangeli Municipality. As of 2011 Nepal census the total population of Belbari was 24,076 which included 5,724 households.

It is not exactly known when the people were first inhabited in Belbari. However, since the end of 19th century, the Dhimals were started to settle on this region. Dhimals are one of the first aboriginal inhabitants of this lowland region who speak a Tibeto-Burman language. Not only Belbari but many lowland plain areas of Morang and Jhapa were their ancestral land. Although Dhimals are the first inhabitants of Belbari, there is no any exact literature about their place of origin.

Belbari municipality is mainly characterized by strong terrain and fertile land, where the larger flatland is compulsorily using for farming system. Due to the dense forest resource, a number of small streams and wetland, for instance Amuna khola, Sisauli Khola and Betana wetland, are available in this area and those water resources help to the larger flatland for farming system. Paddy, maize, wheat, mustard, varieties of vegetables such as cauliflower, potatoes, ginger, onion are the principal crops grown in this area. Many varieties of paddy are planted in irrigated terraces in two seasons in a single year. In two seasons, during April to September, the fields are using for paddy and maize primarily, farmers are most busy on that period. Although Belbari is semi-urban, most of the people are engaging in agricultural work for their livelihood purpose.

Well communications (STD and ISTD) services are available here. Many mobile and telephone lines are there for personal use. Radio, TV and computer are used for personal purpose. Three local newspapers are published in this municipality and 13 national and international magazine are available there. In the field of education, there is one campus, two higher secondary schools (+ 2) and five secondary schools, which have fulfilled the aspiration of the people of this municipality and some of neighboring municipalities to get their children educated. As the main occupation of the people in this municipality is agriculture, a few small industries related to agriculture are operated here.

Table 4.1

Sex and Population Distribution by Wards

ward No.	Population		Total population
	Male	Female	
1	481	627	1108
2	2061	2393	4454
3	2651	3008	5659
4	2459	2949	5408
5	3666	4323	7989
6	3012	3555	6567
7	3797	4187	7984
8	3361	3929	7290
9	3465	4190	7655
10	2465	3099	5564
11	2772	3524	6296
Total	30190	35784	65974

Source: Municipal profile, 2075

Table 4.1 indicates the population of the Belbari Municipality is various from 1,108 to 7,989 person per ward. Smallest ward is ward number 1 and largest is ward number 5. Sex wise there are more females then male in all the wards of municipality. Most of the people in the study area speak Nepali language but some ethnic groups like Tamang, Gurung, Magar, Newar, Dhimal, Tharu etc. speak their own language. Agriculture stands as a main occupation of most of the people. Some people are engaged in other sector like service, business, and labors and so on. The major agriculture production of this municipality is paddy, maize, wheat and different kind of vegetables.

4.2. Socio-economic Characteristics of the Bio-gas Users

This chapter describes the background characteristics of the bio-gas users of the Belbari Municipality. The Economic status of the plant owners seems somehow better in the study area. This chapter describes the main finding related to the economic condition of biogas users such as

their cast/ethnicity, family size, and educational status, occupational distribution, landholding size, and livestock size.

4.2.1. Caste/Ethnicity

There are different castes and ethnic groups in Belbari Municipality Morang. The data on ethnicity of the sampled biogas household is given in table 4.2.

Table 4.2

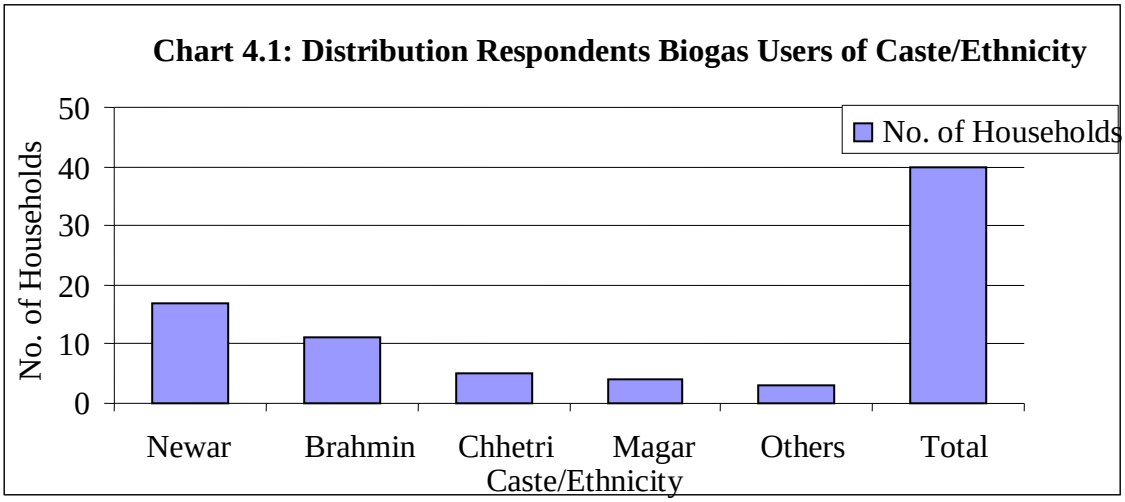
Distribution Respondents of Biogas Users by Caste/Ethnicity

S.N.	Caste/Ethnicity	No. of Households	Percentage
1.	Newar	17	42.5
2.	Brahmin	11	27.5
3.	Chhetri	5	12.5
4.	Magar	4	10
5.	Others	3	7.5
Total		40	100

Source: Field Survey, 2019.

Table 4.2 shows, that the majority of the households under study are Newar (42.5 percent) followed by Brahmin (27.5 percent), Chhetri (12.5 percent), Magar (10 percent) and others (7.5 percent). The reason behind the higher percentage of biogas users (Newar) is found that they are socially and economically forward in each and every sector.

The sample households of Newar and Brahmin is large than other castes because of large number of Newar and Brahmin biogas user households in the Municipality.



Sources: Field Survey, 2017

4.2.2. Educational Status of Biogas Users

Most of the plant owners are educated. 77.5 percent of the biogas users are literate and the remaining only 22.5 percent users are illiterate.

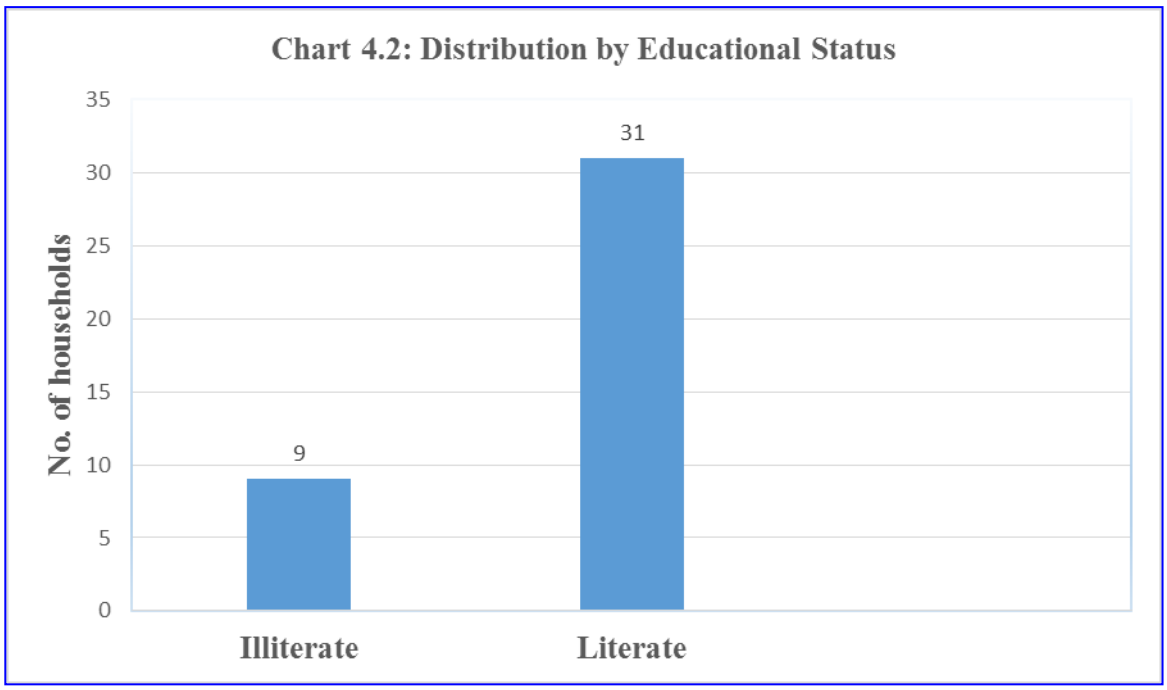
Table 4.3

Distribution by Educational Status

S.N.	Level of Education	Male		Female		Total	
1.	Illiterate	3	11.6	6	42.8	9	22.5
2.	literate	7	26.9	4	28.6	31	77.5

Source: Field Survey, 2019

The data presented in table 4.3 reveals that majority of the plant owners are literate (77.5 percent) and 22.5 percent of the total interviewed are illiterate.



Source: Field Survey, 2019

4.2.3. Occupation

The main Occupation of the plant owners is agriculture. Besides agriculture, service and business are the main occupation of the plant owners. Major occupation practiced by the sampled households is given in the table 4.4

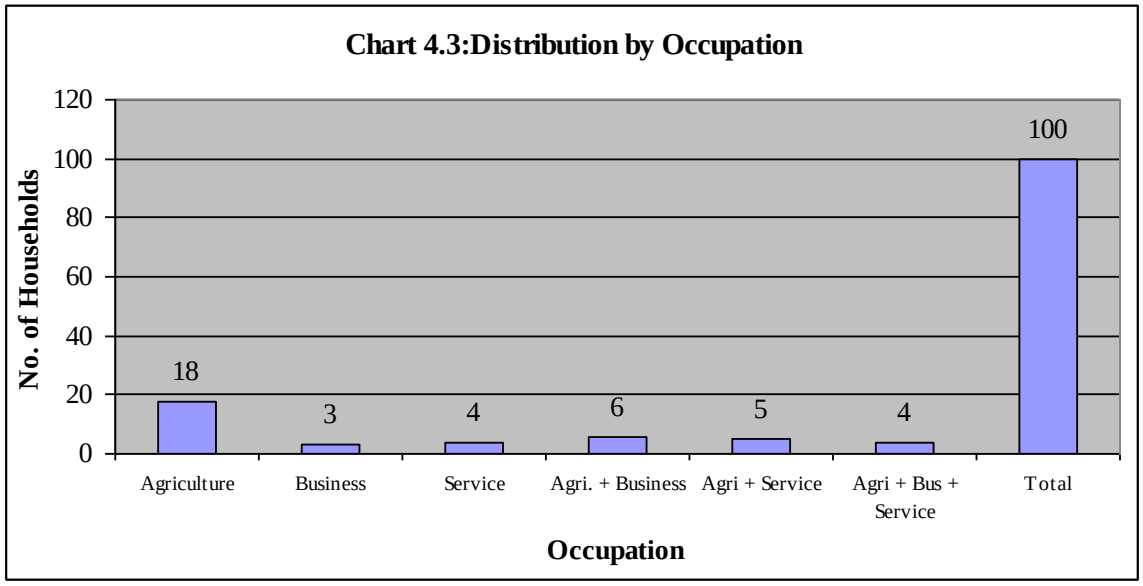
Table 4.4

Distribution by Occupation

S.N.	Occupation	No. of Households	Percentage
1.	Agriculture	18	45
2.	Business	3	7.5
3.	Service	4	10
4.	Agri. + Business	6	15
5.	Agri + Service	5	12.5
6.	Agri + Busi + Service	4	10
Total		40	100

Source: Field Survey, 2019.

Table 4.4 shows that the higher percentage of the plant owners is engaged in agriculture sector. About 45 percent of the plant owners are involved in agriculture, 12.5 percent in agriculture plus service, and 10 percent in service, 7.5 percent in business, 15 percent in agriculture plus business and 10 percent in agriculture plus business plus service. The farmers have more land and more animals for the dung needed for biogas in comparison to the serviceman and businessman. Besides agriculture, most of the households have secondary source of income as well. They are government service pensions and other business. It supports them economically to fulfill basic requirements.



Source: Field Survey, 2019.

4.2.4. Family Size

The result of the survey reveals that average family size of the sampled biogas household is 5.4. Table 4.5 shows that distribution of households by family size.

Table 4.5

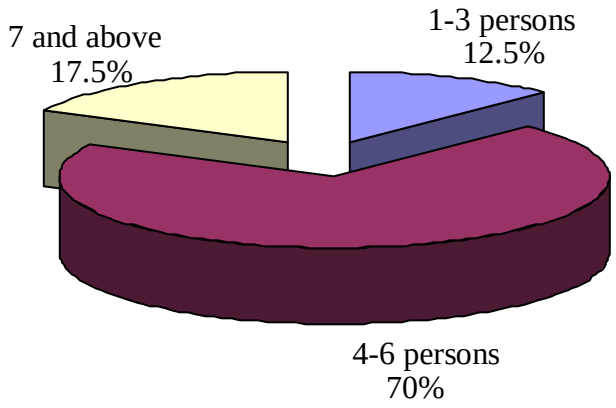
Distribution of Households by Family Size

S.N.	Family Size	No. of Households	Percentage
1.	1-3 person	5	12.5
2.	4-6 person	28	70
3.	7 and above	7	17.5
Total		40	100
Average family size is 5.4 per household.			

Source: Field Survey, 2019.

Table 4.5 shows that among all 40 plant owners, 5 households (12.5 percent) have 1 to 3 family members. 28 households (70 percent) have 4 to 6 family members and 7 above member's households (17.5 percent). The average family size is 5.4.per household.

Chart 4.4: Distribution of Households by Family Size



Sources: Field Survey, 2019

4.2.5. Landholding of Bio Gas Users

The main occupation of all plant owners being agriculture, all of them have their own land to cultivate. While calculating the landholding, only operational land holding has been taken into account. It is found in most of the cases that the land is cultivated by owners themselves. Table 4.6 shows the distribution of land holding of the plant owners.

Table 4.6

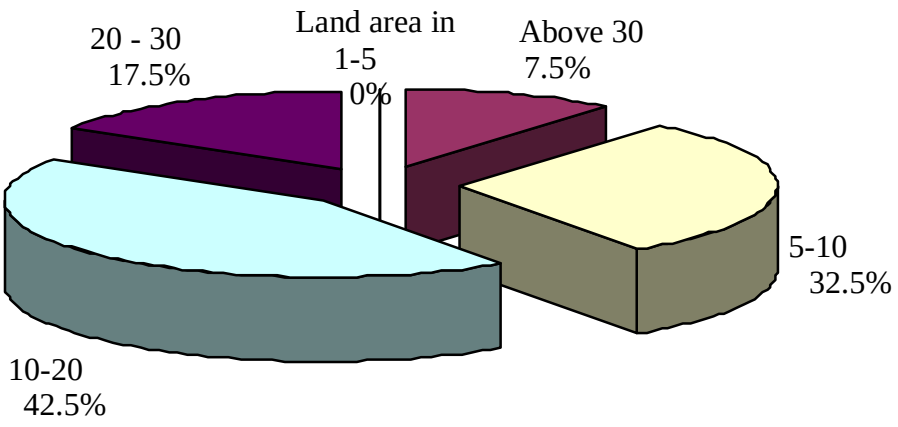
Size of Landholding

S.N.	Land area in Kattha	No. of Households	Percentage
1.	1-5	0	0
2.	5- 10	13	32.5
3.	10- 20	17	42.5
4.	20 - 30	7	17.5
5.	30 and above	3	7.5
Total		40	100

Source: Field Survey, 2019.

Table 4.6 shows that 0 percent, 32.5 percent, 42.5 percent, 17.5 percent, and 7.5 percent of houses with land below 1-5 Kattha, 5-10 Kattha, 10-20 Kattha, 20-30 Kattha and above 30 Kattha respectively. So the highest and lowest responses are recorded in respondent having land of 10-20 kattha and 1-5 Kattha. The Average landholding size is 14.5 Kattha.

Chart 4.5: Size of Landholding



Sources: Field Survey, 2019.

4.2.6. Livestock Size

The situation of the livestock holding in the sampled household in the study area is presented in table 4.7

Table 4.7

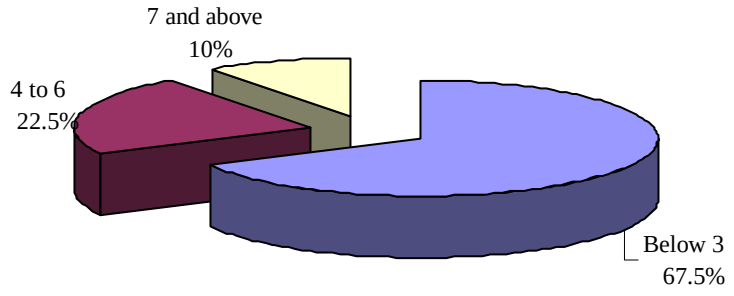
Livestock Size

S.N.	Size of Livestock	No. of Households	Percentage
1.	Below 3	27	67.5
2.	4 to 6	9	22.5
3.	7 and above	4	10
Total		40	100
Average livestock population is 3.22 per household.			

Source: Field Survey, 2019.

Table 4.7 shows that the average livestock size is 3.22 per household. About 67.5 percent respondents out of total interviewed reported that their livestock size is below 3. 22.5 percent or majority of the respondents have 4 to 6 and only 10 percent out of total interviewed stated that their livestock size is 7 and above.

Chart 4.6: Livestock Size



Sources: Field Survey, 2019

4.2.7. Income Distribution

The income of the plant owner was observed by adding the total current market value of all agricultural production and total income from non agricultural sector. As shown in the table 4.8, the house hold with annual income below 50,000 has not been found to be installing the biogas plant.

Proportion of household whose income ranges Rs. 1,50,000 to 2,00,000 was higher in the sample households.

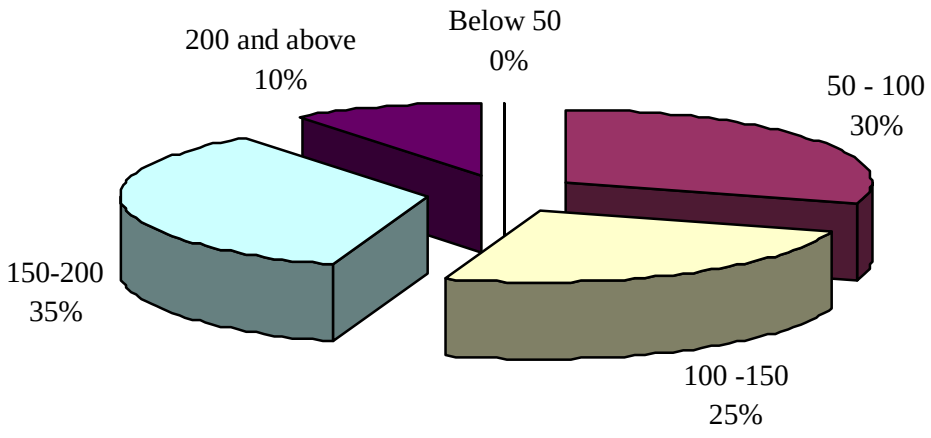
Table 4.8

Income Distribution

S.N	Income (Rs. 000')	No. of household	Percentage
1.	Below 50	-	-
2.	50 – 100	12	30
3.	100 -150	10	25
4.	150-200	14	35
5.	200 and above	4	10
	Total	40	100

Source: Field Survey, 2019.

Chart 4.7: Income Distribution



Source: Field Survey, 2019.

Main expenditure of the sample households are food, cloths, health education and interest of loan. The sample households live in their own house so that spending on housing is not accounted in their own house so that spending on housing is not accounted in the study share of expenditure on food would be greater if we count the market price of self-produced good also. Similarly, spending on education is second large part of the expenditure. Since, the number of private schools in increasing in the municipal area with increasing rate of student enrollment and moving of local student to

Kathmandu and other cities of Nepal for the study of higher level education the expenditure on education is growing. Increasing share of education in the study area shows consciousness of people towards education. Expenditure on health and clothing are also significant part of the expenditure, however, reduction of expenditure on health has been experienced by the some of the samples. According to them, some diseases generated through the smokes and burning cases have declined after the installation of plant. However due to the lack of accurate information how much expenditure on health, the plant owners have saved, could not have been explained.

4.2.8. Size of Bio Gas Plants

The biogas plant size is dependent on the average daily feed stock and expected hydraulic retention time of the material in the biogas system. Capacity of the plant should be designed based on the availability of raw materials. Capacity of the plant indicates the quantity of gas produced in a day.

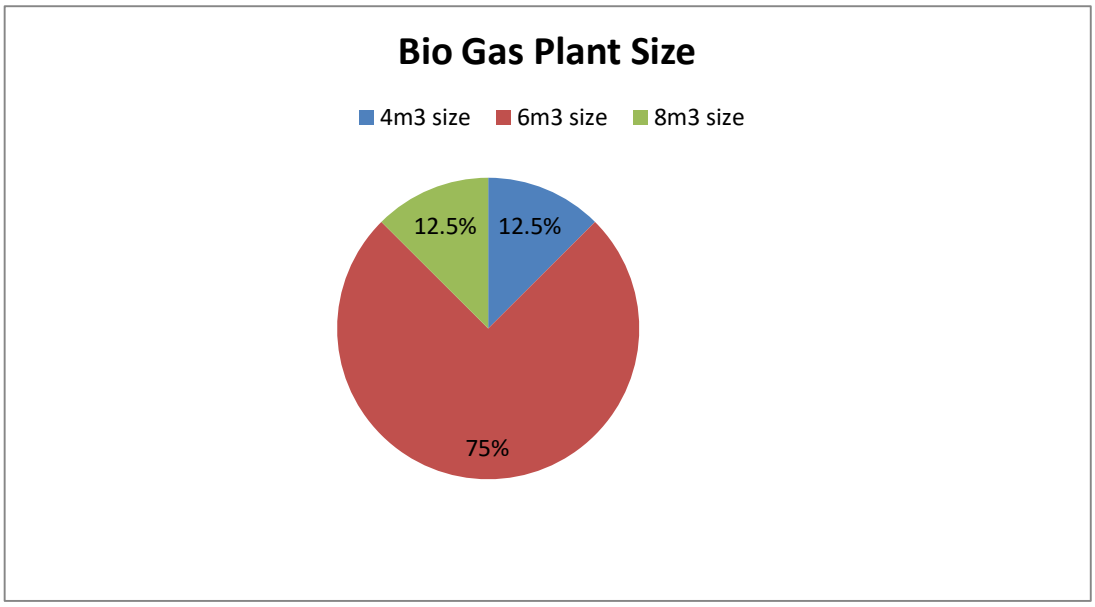
Table 4.9

Bio Gas Plants Size

Size of bio gas plant (m3)	Number. of Households	Percentage
4	5	12.5
6	30	75
8	5	12.5

Source: Field Survey, 2019

Chart 4.8: Bio Gas Plant Size



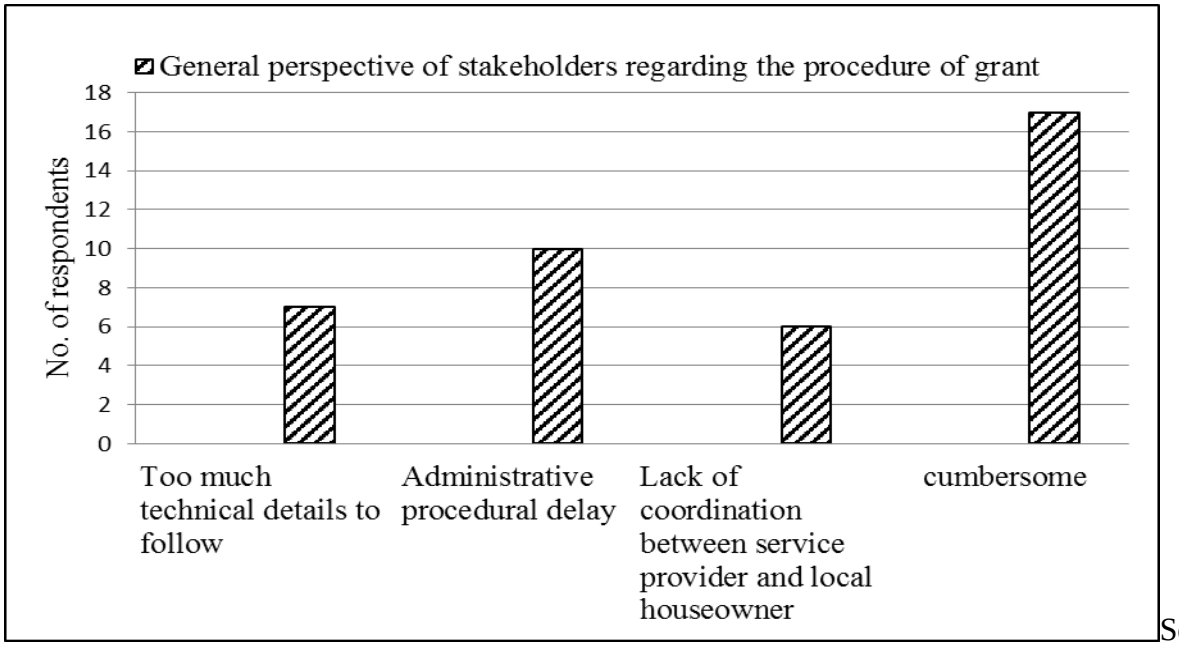
Out of 40 local households, 5 of them responded that they have installed $4m^3$ size bio gas plant, 30 of them have installed $6m^3$ size bio gas plant and remaining 5 have installed $8m^3$ size bio gas plant. It can be concluded that $6m^3$ size bio gas plant is popular within Belbari Municipality.

4.2.9 Perspective of Local House Owners Regarding the Grant Procedure

30 percent subsidy is provided for private houses currently from the core of the government support for installation of biogas plant. Therefore, there is need to examine the effectiveness of the program.

Out of 40 local house owners, 7 of them responded that the grant provision procedure involves too much technical details to follow, 10 of them responded administrative delay, 6 of them responded that lack of coordination between the service provider and house owners and rest of 17 house owner responded that there is cumbersome regarding the grant provision.

Chart 4.9: Perspective of Local House Owners Regarding the Grant Procedure



Source: Field Survey, 2019.

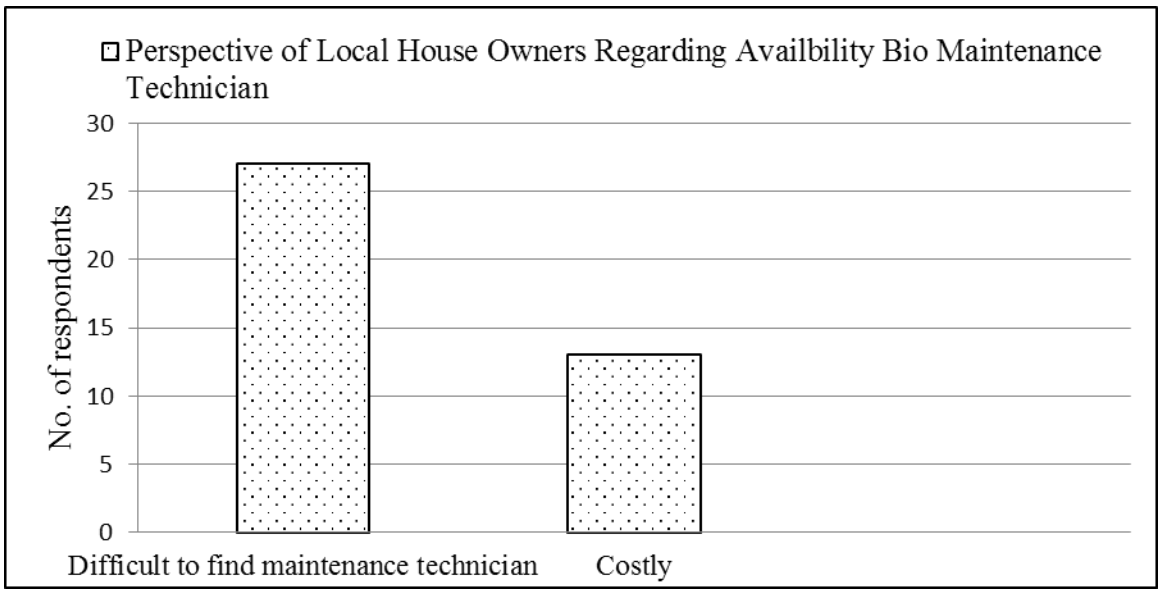
There is need of effective coordinate mechanism in between service provider and local house owners for effectiveness of the program.

4.2.10 Perspective of House Owners Regarding Bio Gas Maintenance Procedure

Maintenance plays direct role on the performance and sustainability of bio gas plant. Lack of knowledge on operation and management, dissatisfaction from services on repair and maintenance and inadequate sense of ownership is leading to negligence regarding the already installed biogas plants therefore it is important to know the maintenance procedure available on study area.

Out of 40 local house owners, 27 of them reported that it is difficult to find bio gas maintenance technician while 13 of them thought it is a costly system.

Chart 4.10: Perspective of House Owners Regarding Bio Gas Maintenance Procedure



Source: Field Survey, 2019.

Result showed that local house owners have difficulty in finding maintenance technicians. In the study area due to lack of maintenance technicians there is maximum possibility of breakdown of bio gas system.

4.2.11 Relation between Accesses to Subsidy and Income Distribution

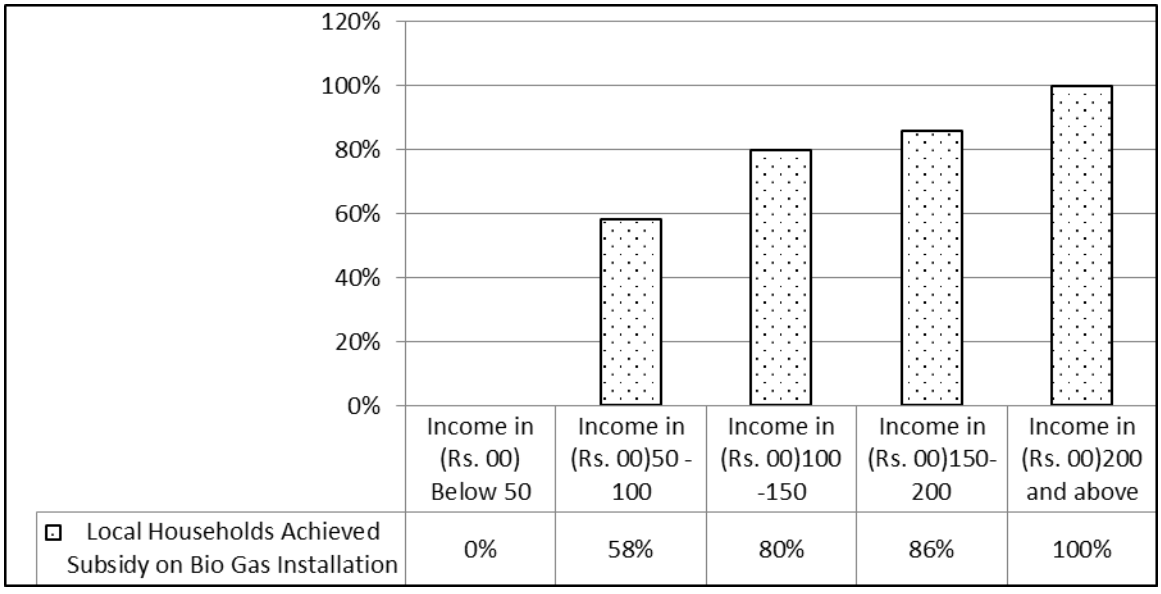
Subsidy plays important financial support for local house owner for the installation of biogas plant. AEPC provides subsidy to biogas users through the biogas companies and subsidized loan through microfinance institutions to construct the biogas plants. In addition to the subsidy, biogas users have invested in cash borrowings from financial institutions. So it is necessary to know the relation accesses to subsidy and income distribution.

Table 4.10

Accesses to Subsidy and Income Distribution

	Income Distribution			Subsidy Received	
S.N	Annual Income (Rs. 000')	No. of household	Percentage	Subsidy Received Household	Subsidy Percentage Received Household
1	Below 50	-	-	-	-
2	50 - 100	12	30	7	58.33
3	100 -150	10	25	8	80.00
4	150-200	14	35	12	85.71
5	200 and above	4	10	4	100.00
	Total	40	100	31	77.5

Source: Field Survey, 2019.



Source: Field Survey, 2019.

It is found that households having income below 5,000 have not received any subsidy on biogas installation yet, 58% household having income 5,000-100,000 have achieved subsidy. 80% of the households having 100,000-150,000 income have achieved subsidy while households receiving subsidy with income of 150,000-200,000 is 86% and all household have achieved subsidy having income above 200,000.

From the table it can be concluded that household having higher income distribution have higher percentage of accesses on subsidy compared to those having lower income.

4.3. Impact of Biogas on Health and Sanitation

The study shows that biogas has positive impacts towards health and sanitation of the respondents. Change in surrounding after the installation of biogas plant, uses of latrine, connection of latrine to the biogas plant, reduction in diseases and change in the prevalence of flies and mosquitoes have been dealt in this section.

4.3.1. Change Found in Surrounding After the Installation of Biogas Plant

The increasing number of agricultural biogas plants and higher amounts of digested waste spread on agricultural land arouse a considerable interest in the hygiene situation of digested products. Most scientific studies facing sanitation in biogas plants have provided data ascertaining reduction of pathogens by the biogas process. Some pathogens, however, are able to persist virtually unaffected due to the ability to build resistant permanent forms. However study on change in health, in sanitation and hygiene after installation bio gas is important which is studied here.

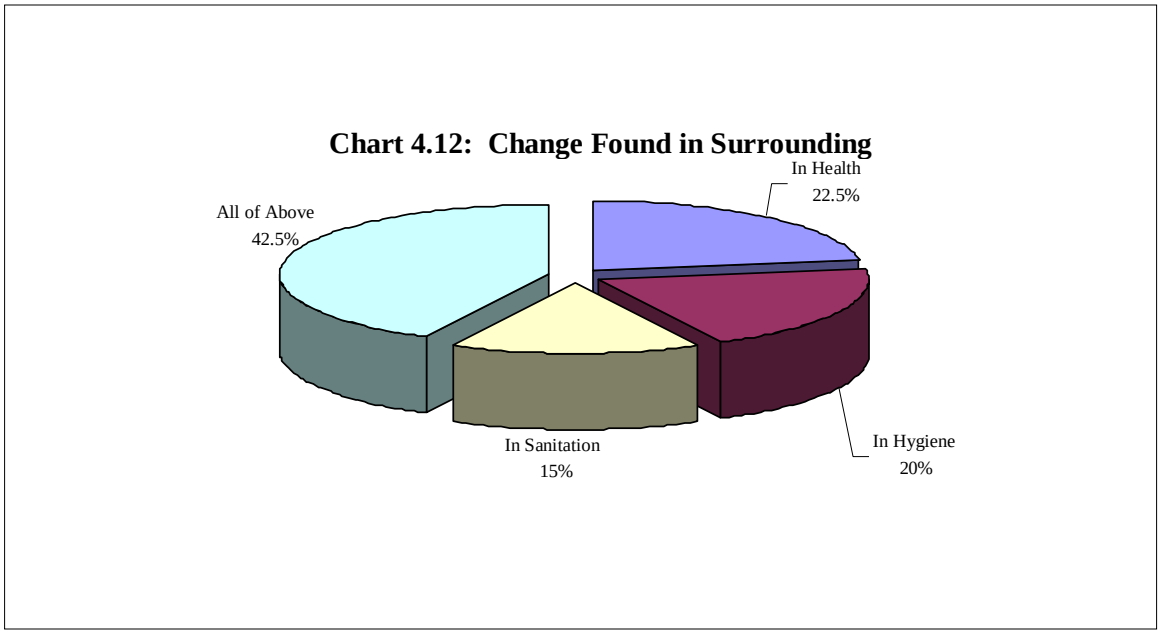
Table 4.11

Change Found in Surrounding

S.N.	Change Found	No. of Households	Percentage
1.	In health	9	22.5
2.	In hygiene	8	20
3.	In sanitation	6	15
4.	All of above	17	42.5
Total		40	100

Source: Field Survey, 2019.

Table 4.11 shows that about 22.5 percent respondents out of total interviewed reported that they found change in health, followed by 20 percent found change in hygiene. And only 15 percent respondents out of total interviewed reported that they found change in sanitation and 42.5 percent have experienced all changes. The change in surrounding is considered the improvement in all these given aspects.



Source: Field Survey, 2019.

4.3.2. Money Spend on Health Treatment

In this study, amount of money spend on health treatment has also been studied. The money spend on health treatment is presented in table 4.10.

Table 4.12

Money Spend on Health Treatment

S.N.	Treatment Item	Average Money Spent on Health Treatment per year (in Rs.)		Saving (In Rs.)
		Before Installation	After Installation	
1	Respiratory problem	6000	2000	4000
2	Others	4500	2000	2500
Total		12000	4000	6500

Source: Field Survey, 2019.

Table 4.12 shows that the amounts of money spend on health treatment before and after installation of biogas plant. It also shows the saving amount of money per year, after installation of plant. Plant

owners have been able to save Rs. 4000/- in the treatment of respiratory problem, Rs 2500/- in the treatment of others health problems (headache, eyes illness, etc) .The respondent or plant owners are able to save as Rs. 6500/-per year in the treatment of health related disease.

4.3.3. Use of Latrine

Use of latrine indicates maintenance and management of on-site sanitation facilities is a public health concern, as these facilities represent the main means of human waste collection for most of the population in the society. Among the surveyed households, 100 percent of the households have built latrine.

Table 4.13

Use of Latrine

S.N.	Have Latrine	Number of HHs	Percentage
1	Yes	40	100
2	No	0	0
	Total	40	100

Source: Field Survey, 2019.

The table 4.13 shows that, out of 40 households, all households have latrine this indicates they have better sanitation practice.

4.3.4. Toilet Attached With Biogas Plant

Toilet can provide improved household sanitation, but without effective management when it is exposed on open surface it may pose a public health threat. Toilet linked biogas plant is an anaerobic biogas digester which receives the excreta (and eventually flushing water) directly from a toilet through a pipe has also been studied which may help management of sanitation, in this study toilet attached with biogas plant was studied.

Table 4.14

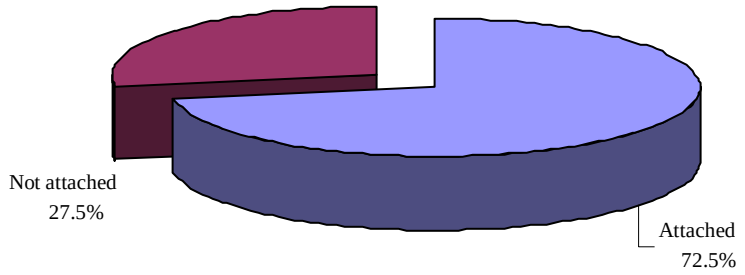
Toilet Attached with Biogas Plant

S.N.	Toilet Attached	No. of Households	Percentage
1.	Attached	29	72.5
2.	Not attached	11	27.5
Total		40	100

Source: Field Survey, 2019.

Table 4.14 shows that 72.5 percent of total interviewed reported that they have attached toilet with biogas plant and 27.5 percent reported that they have not attached toilet with biogas plants.
It is found that majority of the plant owners have attached toilet with the biogas plant.

Chart 4.13: Toilet Attached with Biogas Plant



Source: Field Survey, 2019.

The table 4.14 shows that, out of 40 households, 72.5 percent of the households have connected their latrines to the biogas plants i.e. they have used human excreta to produced biogas. The reasons for connecting latrine to the biogas plant are:

- Human excreta can be utilized as fertilizer and sufficient gas production.
- Sanitation due to the establishment and connection of latrine to the gas plant.

- The remaining 27.5 percent of households have not connected the latrine. The reason for not connecting latrine to the plant is because they have sufficient amount of gas produced from animal dung.
- Because of traditional and cultural view it is felt unholy and felt dirty.

As majority of the biogas plant owners have attached toilet with the biogas plant, there seems low load for municipality on fecal sludge management procedure.

4.3.5. Improvement in the Health Condition of Women and Children

While using the biogas for household purpose, it does not produce the smoke which is harmful for human being. That is why; the biogas has played the vital role to maintain the proper health condition for them. It is known that biogas is specially used in kitchen. Generally, the women and children are engaged in kitchen based works. Cooking in traditional fuel i.e. firewood produced smoke which caused many types of disease like eye illness, headache, burning cases, coughing and respiratory problems but cooking in biogas has reduced such problems. So biogas projects have positive health impact on women and children

.

Table 4.15

Improvement in Health Condition of Women and Children

S.N.	Diseases	Number of HHs	Percentage
1	Respiratory	13	32.5
2	Eye illness	9	22.5
3	Headache	7	17.5
4	Coughing	6	15
5	Other	5	12.5
	Total	40	100

Source: Field Survey, 2019.

Table 4.15 shows that improvement of health condition of women and children is considerable. From this study, it has been observed that about 32.5 percent of the households respiratory problems have been improved after installation of the biogas plants. Similarly 22.5 percent of them have felt

improvement in eyes problems, 17.5 percent of the sample household's have felt relief in headache problem and 15 percent of the sample households are free from coughing problems after installation of the biogas plants. 12.5 percent of the sample households are free from other health problems.

4.3.6. Reduction in Disease

It is found that there is significant improvement in the smoke born diseases such as eye illness, coughing, burning cases and headache due to installation of biogas plants. Following important information has also been revealed from this impact study:

- 72 percent respondents told that they have attached toilet to the plant. This has helped in personal health and environmental sanitation.
- All respondent said that biogas facility enable to reduce the number of burning cases and eye illness and
- 90 percent reported that the house population covered by smoke of firewood has been reduced.

4.3.6.1 Degree of Reduction in Smoke after Biogas Plant

Before biogas installation, the people in the rural communities were mostly dependent upon firewood, agricultural residues, dung cake, etc. In poorly ventilated kitchens, the amount of smoke inhaled by women and children increases. The health problem, leading to respiratory and heart disease also increase proportionally.

Table 4.16

Reduction in Smoke after Biogas Plant

S.N.		Before Bio Gas Plant	After Bio Gas Plant		
Decrease in Smoke					
		Number of HHs	Percentage	Number of HHs	Percentage
1	No smoke	32	80	2	5
2	To some extent	6	15	6	15
3	Very much	2	5	32	80
	Total	40		40	100

Source: Field Survey, 2019.

Table 4.16 shows that the very large proportion of the households with biogas plant perceived a remarkable decrease in kitchen smoke after they have the biogas installation. However 15 percent respondents still realized the decrease in smoke to some extent, while the rest 5 percent did not find reduction in the amount of smoke even after biogas installation. This finding may be attributed to either some technical defects in the plans or insufficiency of gas produced due to which they were compelled to use other sources of smoke producing fuels such as firewood, other agriculture residue etc.

4.3.6.1. Respiratory Disease

Biomass burning in indoor environments has been highlighted as a major cause of respiratory diseases. Biogas technology which reduce such exposures may be reduced. This study evaluated the impact of biogas for cooking, versus traditional fuel sources on the respiratory health of Belbari municipality.

Tables 4.17 illustrate the responses of the respiratory diseases of the households under examination with biogas plant.

Table 4.17

Respiratory Disease

S.N.	Status of Infection	Number of Household	Percentage
1	Presence of Respiratory	14	35
2	Absence of Respiratory	26	65
	Total	40	100

Source: Field Survey, 2019.

Table 4.15 shows that 65 percent of the total households have not reported the respiratory disease. This is one of the positive impacts of biogas installation. Households reporting the presence of respiratory problem may be attributed to the use of firewood even after the biogas plant to prepare khole, dud tataune (heat milk) and other activities which use the firewood that emits smoke in the kitchen.

4.3.7. Insects Prevalence

Fly and mosquito has been taken into account for the study of change in prevalence of insects. Majority of the households have reported the change in prevalence of insects.

4.3.7.1. Prevalence of Fly

Managing Slurry is highly challenging task. Low or null technologies together with economic and social difficulties often undermine the possibility to process waste safely, exposing people and the environment to severe risks. Among the common waste streams, slurry management is critical in terms of quantity and quality issues. It may contain infectious pathogens, without proper management of biogas system there is possibility of prevalence of fly.

The study reported that 40 percent of the households have felt either increase or decrease in the fly population, where 32.5 percent households reported that the fly population has decreased. Other remaining 27.5 households reported that the there is increase in the population of flies after the installation of the biogas plants.

Table 4.18

Effect on Prevalence of Fly

S.N.	Fly Prevalence	Number of HHs	Percentage
1	Increase	11	27.5
2	Decrease	13	32.5
3	No change	16	40
	Total	40	100

Source: Field Survey, 2019.

4.3.7.2. Prevalence of Mosquito

Due to the liquid slurry formation by biogas there is maximum possibility of breeding of mosquito, therefore it is essential to examine the prevalence of mosquito after installation of biogas.

The level of prevalence of mosquito after the introduction of biogas plants have been revealed in table 4.19

Table 4.19

Prevalence of Mosquito after Biogas Plants Installation

S.N.	Level of Prevalence	Number of HHs	Percentage
1	Increased mosquito	31	77.5
2	Remained the same	6	15
3	Decreased mosquito	3	7.5
	Total	40	100

Source: Field Survey, 2019.

Around 77.5 percent of biogas households reported that mosquito breeding had increased after the installation of biogas where as 15 percent household was of the opinion that mosquito breeding the same and only 7.5 percent perceived its decrease after biogas plant. The principle reasons for mosquito proliferation may be attributed to the following.

Observation indicated that the probable cause of mosquito breeding in biogas plants may be due to availability of moist space in the upper part of the biogas plants. If firewood is burnt inside the kitchen, the smoke produced from it drives out mosquitoes. On the other hand in clear illumination of electric bulbs there is every risk of mosquito bite. However the above observation needs to be confirmed by appropriate research. Simultaneously, it is also essential to suggest suitable method to the biogas households for the control and destruction of mosquito.

4.3.8. Environmental Impact

All the households have agreed that the biogas installation has reduced forest depletion. However, the major reason of construction of biogas was not to save the forest. The plant was installed as they faced difficulties in procuring firewood in the surroundings. The users felt that if biogas is installed in every household, the forest will be saved completely from depletion. From the macro perspective biogas has checked the ecological imbalance and climatic change by lessening the problem of deforestation. Similarly, use of biogas has reduced the smoke and so made the clean environment in the kitchen. Due to the attachment of toilet to the plants, the surroundings have become clean and free from bad smell. It helps in reduction of the emission of CO_2.

- The environmental impact of biogas plants can be viewed from the following perspectives: biogas, when used for cooking saves firewood, dung cakes and agricultural wastes. The organic matter and nutrients of agricultural wastes and the dung cakes which are otherwise burnt are available to sustain the fertility of soil.
- It helps in reduction of emission of carbon dioxide in the environment.

Hence, the impact of biogas use on environment must be viewed form a number of perspectives, most of which related to the conservation of biomass. Benefits of biogas could be seen in areas where living trees and dung are dried as patties, are used as primary cooking fuels. The introduction of biogas as substitute of these traditional sources allows the forests to remain intact and the dung

be used for two purposes; as gas for cooking and slurry a replacement of inorganic fertilizer in agricultural production.

4.4. Benefit of Slurry in Agriculture Production

One of the most encouraging factors to establish biogas plant is the production of slurry, very valuable organic manure for crop farming. Multiple advantages occur with the use of biogas slurry. It increases agricultural production because of its high content of soil nutrients. When the digested slurry is placed in the food chain of crops it leads to a sustainable increase in the production.

As per norms established by the Gobar Gas Company, 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 content of the digested slurry improves the soil texture, stabilizes its humid content, intensifies its rate of nutrient depot formation and increase its water holding capacity. Compared to form yard manure (FYM) biogas slurry has more nutrients because in FYM, nutrients are lost by volatilization (especially nitrogen) due to exposure to sun head and as well as by teaching.

4.4.1. Methods of Using Slurry on Form

Information on the application of the bio-slurry in different forms as reported by the respondents is presented in table 5.25.

Table 4.20

Method of Bio-Slurry Applied

S.N.	Method of Application	Number of HHs	Percentage
1	In liquid form	9	22.5
2	In dried form	13	32.5
3	In composted form	18	45
	Total	40	100

Source: Field Survey, 2019.

The data presented in table 4.20 clearly shows that about 45 percent of the biogas formers have performed using the slurry in composted forms, while 32.5 percent used it in dried form. Only 22.5 percent of the respondents reported using liquid slurry directly to fertilize 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 form is not normally recommended, as the nutrients (especially nitrogen) contained in it are lost, when dried in the sun.

4.4.2. Production Improve after Using Slurry

The digested slurry can be used as manure in the fields. All of the households have used slurry as fertilizer for increasing crop production. Though exact collections are not possible, use of slurry has certainly saved money, which might have been otherwise we to buy chemical fertilizer.

Table 4.21

Production Improve after Using Slurry

S.N.	Agricultural Production	**Number of HHs**	**Percentage**
1	Production Improve	33	82.5
2	Production Decreased	2	5
3	Remained the same	5	12.5
	Total	40	100

Source: Field Survey, 2019.

Regarding the production increment, 33 households reported that there is an increase in their agricultural production, 5 households have not felt any change in production and 2 households have felt the decrease in the production even after the application of bio-slurry on the farm.

4.4.3. Effectiveness of Using Slurry for Various Crops

Biogas plant with anaerobic digestion provides a facility to generate manure (biogas spent slurry) and energy. The digested biogas slurry (DBGS) is rich in macro and micro nutrients that provide essential plant nutrients for longer period. Biogas slurry may be considered as a good quality organic fertilizer for sustainable agriculture. Biogas slurry provides huge nutrient potential for vegetative and reproductive growth of field crops with long term sustainability. By applying the digested biogas slurry (DBGS) in the field for long term basis help in reducing fertilizer demand and provide an eco-friendly way of maintaining productivity and soil health. In this study effectiveness of using slurry for various crops is studied.

Table 4.22

Effectiveness of Using Slurry for Various Crops

S.N.	Types of Crops	Growth in productivity of crops (%)
1	Potatoes	40
2	Tomato	80
3	Paddy	19
4	Maize	39
5	Wheat	27
6	Other Green Leafy Vegetables	62

Sources: Field Survey, 2019.

The slurry is mainly used in potato, tomato, maize, wheat, paddy and green leafy vegetables production. The production relationship of using and not using slurry is very significant. The data analysis recommends that the production of these crops has increased after the use of slurry. So there is positive relationship between using slurry and agricultural productivity. Thus, slurry is better than chemical fertilizer in agricultural farming.

4.4.4. Improvement in Socio-Economic Status

Table 4.23

Improve in Socio-Economic Status

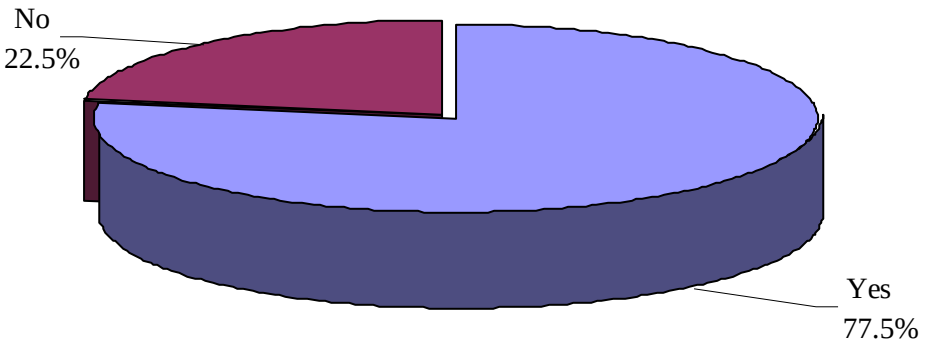
S.N.	Improvement in Socio-economic Status	No. of Households	Percentage
1.	Yes	31	77.5
2.	No	9	22.5
Total		40	100

Source: Field Survey, 2019.

Table 4.23 shows that about 77.5 percent respondents out of total interviewed reported that the social status has been raised after the installation of biogas plant whereas only 22.5 percent respondents reported that the social status has no change. Increase in socio-economic status is due to differential perception of village people about users and non users. Those who use bio gas are

considered to be economically better off families. Women also save time which would have been required in collecting fuel-wood, and in cooking and cleaning utensils. They can use the time thus save in productive activities and earn additional income.

Chart 4.10: Improvement in Socio-economic Status



Source: Field Survey, 2019.

4.5 Possible Measures for Sustainable Installation of Biogas

To assess possible measures for sustainable installation of bio gas in future the FGD with chief executive officer of Belbari municipality, Municipal engineers/technicians, local biogas service provider, and local house owners were conducted. In rural areas where there is no provision of biogas technical assistance, establishment of proper technical section must be started up for possible measures of sustainable installation of biogas in future. Similarly, regular monitoring and inspection of constructed biogas system should be conducted.

Establishment of evaluation system in systematic format, conducting training, technical orientation, technical skill upgrading training, orientation programs to local house owners, and municipal technicians are the possible ways for sustainable installation of biogas in future.

During FGD different suggestion were made for possible measures of sustainable installation of biogas in future which is drawn in table below.

Table 4.27 Possible Measures for Sustainable Installation of Biogas

S.N	Stakeholders	Suggestion made and their prioritization			
		Provision of technical support section	Increasing awareness among local house owners	Increasing the government subsidy	Regular monitoring and evaluation
1.	Chief Executive officer	2	2	1	2
2.	Municipal engineers/technicians	1	1	1	1
3.	Local house owners	1	3	1	3
4.	Local bio gas service provider	3	2	1	3

Note: 1: Extremely high priority 2: High priority 3: Medium priority

Source: FGD survey

Increasing the government subsidy is suggested to be of extremely high priority for the sustainable installation of biogas. However, all suggestions should be implemented for the sustainable installation of bio gas.

CHAPTER-FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

Biogas technology is an appropriate alternative source of energy for household purpose. Forest resources are only the source of firewood for daily requirement of energy in rural areas. Excessive use of firewood directly leads to deforestation. 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.

This study was conducted in Belbari Municipality Morang district which lies in the eastern part of Nepal in 1 number Provenance and near the east-west highway. Out of 11 wards of Belbari Municipality, only 4 wards have been selected as the sample wards using random sampling without replacement method. Out of total 120 biogas households, 40 households have been taken as the literature related to the impact study of biogas on users has been studied. Primary as well as secondary data have been used in this study. The main objective of the study is to find out the socio-economic impacts of biogas plant in Belbari Municipality. This study tries to find out the benefits of biogas produced. The popularity of biogas has been increasing in the rural areas of the country. Prior to proceeding with the study, a brief review on existing literature was made. The review focused mainly on the impact studies. For the reviews, central library of T.U. biogas experts and biogas company were consulted.

Based on research findings following conclusion were drawn:

- Size of $6m^3$ biogas plants was more popular in this area as compared to other size of plants ($4m^3$, $8m^3$).
- The study find out that there were $6m^3$ biogas plants (75 percent), $4m^3$ biogas plants (12.5 percent) and $8m^3$ biogas plants (12.5 percent) installed.
- Majority of house owner responded that there is cumbersome regarding the government grant provision for installation of biogas.
- Out of 40 household 27 of them reported that there is difficulty in finding biogas maintenance technician.

- Due to lack of maintenance technicians there is maximum possibility of breakdown of bio gas system.
- Household having low income distribution have low accesses on subsidy for installation of bio gas.
- Majority of the households have attached toilet (72.5 percent) with the biogas plant.
- As majority of the plant owners have attached toilet with the biogas plant there seems low load for municipality on fecal sludge management procedure.
- Medical expenses also have been reduced after the installation of biogas plant.
- Average livestock population size is 3.22 per household.
- Economic status of the house hold within annual income below 50,000 has not been found to be installing the biogas plant, proportion of household whose income range between Rs. 1,50,000 to 2,00,000 was higher (35 percent) in the sample households. Main expenditure heading of the sample households are food, cloths, health education and interest of loan.
- Average family size is 5.4 per household.
- Average landholding size is 14.5 kattha per household.
- The users felt reduction in health related problems such as respiratory problem and others such as, headache and eye problems.
- Majority of the respondents felt that the prevalence of mosquito has been increased (77.5 percent).
- 77.5 Percent of respondents reported that the social status has been raised.
- Majority of the respondents reported that the overall economic, environmental and energy condition has been improved.
- Increasing the government subsidy is suggested to be of extremely high priority for the sustainable installation of bio gas.

6.2. Recommendations

Following recommendations are made from the research:

- The subsidy process of government must be simpler and accessible to all level of households.
- There is need of effective coordinate mechanism in between service provider and local house owners for effectiveness of the program.
- Government must provide ease accessibility of the biogas maintenance technicians in local level.
- It is recommended to clarify the local house owners with proper information regarding the process about government subsidy on bio gas installation.
- Equal subsidy to all the people is not reasonable. The poor and downtrodden people should be given more subsidies, so that such people can install plants.
- The concerned body must prepare strong evaluation system towards the distribution of subsidy for installation of bio gas.
- The use of human excreta and its advantages must be made known to the installers. For this training, seminars and workshop should be implemented.
- Research on control of mosquito and optimum utilization of slurry should be conducted to know the actual relation between increments of mosquito due to installation of bio gas system.
- For better management of slurry, training should be provided to the biogas users.
- Application of biogas slurry on farm should be studied systematically, qualitatively and quantitatively
- Government should provide more grants for promotion of biogas technology.

6.3 Recommendations for Further Study

- Similar studies could be conducted in other municipal areas of Nepal.
- Similar studies could be conducted on Rural municipality
- Comparative analysis of socio economic impact of bio gas among one municipality with other different Rural Municipalities can be done.

- This research can be used to compare with scenario of other municipality change found regarding health sanitation hygiene after installation of bio gas.

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APPENDIX - 1

Survey Questionnaire

Socio- economic impacts of Biogas plant

(A case study of Belbari Municipality Morang district)

Household Questionnaire Model

Particulars of plant,

Name of the plant owner	BSP file plant size No.	Name of company	Construction Year

1. General:

Name of Household Head: Sex: Male/Female

District: .....Village:..... Ward No:.....

Name of the respondent: ..... Cast:

Ethnicity:..... Religions.....

2. Family backgrounds:

S.N.	Name of the Family Member	Age	Educational Status	Occupation
1				
2				
3				
4				
5				
6				

3. Income level

a) Below Rs. 25,000

b) Rs (25,000-50,000)

c) Rs (50,000-75,000)

d) Rs (75,000- 1, 00,000)

4. Land holding in local units (Kattha)

Type of land	Area in Kattha	Own Land	Other Land
Khet			
Bari			
Total			

5. Livestock holding

S. N.	Crops	Total Number	Daily Dung Production(KG Per day)
1	Cows		
2	Oxen		
3	Buffaloes		
4	Goat		
5	Duck/Chicken		
6	Other(Specify)		

6. Dwelling (types of house)

a) Kachhi []

b) Ardha pakki []

c) Pakki []

7. How did you know about biogas?

a) Radio/ T. V. []

b) Neighbors []

c) Friends []

d) Nearest Biogas company []

e) Others.....

8. Reasons for installation

a) Easy and smokeless cooking[]

b) Saving in time []

c) Get rid from fuel wood collection []

d) Add prestige []

e) Money saving []

9. Have you taken government subsidy for biogas installation?

a) Yes b) No c) No idea about it

10. Your perspective about government subsidy regarding biogas installation

a) To much technical details to follow b) Administrative procedural delay c) lack of coordination between service provider and local house owners d) Cumbersome

10. What are the uses of biogas?

a) Cooking []

b) Lighting []

c) Both []

d) Others...

11. What energy did you use for cooking before biogas plants?

a) Firewood []

b) Kerosene []

c) L. P. Gas []

d) Other []

12. How many furnace have you connected with biogas?

a) 1 b)2 c) 3 d) 4

13. Have you ever gone through maintenance of your biogas system?

a) Yes b) No

14. Your opinion about biogas maintenance procedure.....

15. Does the use of biogas reduce deforestation?

a) Yes []

b) No []

16. Dung fed per day .....kg/day.

17. Water sources for mixing..... Liters per day.

18. Fuel consumption

Fuel type	Consumption	
	Before installation	After installation
Firewood (Kg/day)		
Crop residue (kg/day)		
Kerosene (Ltr./Month)		
LP Gas (Cyl./Month)		

19. Do you have a latrine?

a) Yes []

b) No []

If yes, when did you make it?

a) Before Installation []

b) After Installation []

20. Is it connected to the biogas plant?

a) Yes []

b) No []

If not, why?

21. Has there been reduction in occurrence of disease?

a) Yes []

b) No []

If yes, which diseases?

a) Respiratory []

b) Burning cases []

c) Eye illness []

d) Coughing []

e) Others []

22. Your average money spent on health treatment per year (in Rs.)

S.N.	Treatment item	Before installation	After installation
1	Respiratory problem		
2	Others		
Total			

23. Fly prevalence

a) Little increased []

b) Much increased []

c) Little decreased []

d) Much decreased []

e) No change []

24. Status of mosquito

a) Increased mosquito []

b) Decreased mosquito []

c) Remained the some []

25. Do you feel any visible change in sanitation of your surrounding?

a) Yes []

b) No []

26. Slurry used **and agricultural productivity**

6.1 Do you use slurry on farm?

a) Yes []

b) No []

27. How do you use it?

a) In liquid form []

b) In dried form []

c) In composted form []

28. Have you felt the change in production of crops after using slurry?

a) Production increased []

b) Production increased []

c) Remained the same []

29. In which crops production do you use the slurry?

a) Oil seed []

b) Vegetable []

c) Fruits []

d) Other []

30. What is the effect of slurry in comparison to chemical fertilizer?

a) Money saved []

b) Production increased []

c) Both []

31. Has biogas increased your annual income from production?

a) Yes []

b) No []

32. Do you use chemical fertilizer now?

a) Yes

b) No []

33. What problem did you face just after installation of biogas plants in slurry to the field?

a) Porters no ready to carry []

b) Liquid form []

c) No problem []

d) Not applicable []

34. Are you satisfied with this technology?

a) Yes []

b) No []

35. What is your opinion on the impact of biogas plant in your overall health, environment and socio-economic condition of the household?

a) Improved []

b) Remained same []

c) Worse []

d) Don't know []

36. Your suggestion to the service provider company

.....

37. Your suggestion to the government

.....

APPENDIX – 2

Possible Measures for Sustainable Installation of Bio Gas

S.N	Stakeholders	Suggestion made and their prioritization				
		Provision of technical Support section	Increasing awareness among local house owners	Increasing the government Subsidy	Regular monitoring and evaluation	Tax Discount System
1.	Chief Executive officer					
2.	Municipal engineers/technicians					
3.	Local house owners					
4.	Local bio gas service provider					