CHAPTER- I

INTRODUCTION

1.1 Historical Background

Biogas has been gaining popularity nowadays as a reliable alternative source of renewable energy especially in domestic sector. Looking back over the origin and development of this technology, we find the history of biogas started in eighteenth century.

The first person to report the existence of biogas was Volta. He was an. Italian national. In 1776, he wrote to a friend about "combustible air". Volta wrote that the submerged plant materials in the ponds and lakes continuously give off such gas. Later, Volta's gas was shown to be identical with methane gas.

It took over hundred years to use the gas as energy forsenic of mankind. The plant for methane generation was set up in 1900 in leper Asylum in India. Another plant was installed in Indonesia in 1914.

Interest on biogas rose very high immediately by the end of second World War. By 1950 about 1000 biogas plants were installed in France. Germans converted their some 90,000 automobiles to run on biogas to save the petroleum. The second half of 20th century drew attention across the globe towards biogas (Karmacharya, 1992).

In the developing countries like Nepal, biogas gradually became popular in rural area to meet the increasing energy demand for growing population.

1.1.1 Historical Development of Biogas in Nepal

The history of biogas in Nepal starts from 50 years ago when father B.R. Saubole constructed a demonstration plant of biogas in St. Xavier School of Godavari, Lalitpur. So, the credit for introducing biogas technology in Nepal goes to late father B. R. Saubole. He constructed a model biogas plant in St. Xavier School in Godavari in 1955. After that a few plants were built in different parts of the country.

Interest on biogas increased slowly. Government authorities felt need to promote it. In the fiscal year (FY) 1975/76, 290 biogas plants were constructed with interest free loan from ADB/N (Silwal, 1999).

The government felt a need to establish a separate body to promote the biogas plant installation. In 1977, Gobar Gas Company (GGC) was established jointly by ADB/N and fuel corporation. The GGC was given responsibility of advancing the development and promoting the installation of biogas plants extensively in the kingdom. Initially drum type plants were prepared by the GGC but after 1980, dome type of plant was recommended because of many inconveniences of drum model.

To promote biogas government announced a subsidy of Rs. 5500 to the biogas plant installers in fiscal year 1982/83 as a part of special rice program in four Terai districts.

Before 1985, the rate of installation of biogas ranged between 100 to 300 plants per year. The seventh five year plan (1985 -1990) had a target of 800 biogas plants per year, with total of 4000 units. A subsidy of 25% on the capital cost and 50% on interest of bank loan was announced.

However, the programme was not regularized and subsidy provided only for last 2 years. During the period, 3862 plants were constructed by GGC.

In 1992, Biogas Support Programme (BSP) was initiated as a joint venture of ADB/N, GGC and SNV-Nepal. IN 1992, the subsidy scheme was changed to Rs.7000 in Terai and 10,000 for Hill districts. The subsidies were provided through the BSP. Later in 1995/1996. Rs. 12,000 was granted for inaccessible Hill district. Form 1999/2000, the subsidies were reduced by 1000 i.e. Rs. 6000 for Terai, Rs. 9000 for Hill and Rs.11,000 for inaccessible districts of Hill. Big. Size plants were discouraged and small family sized biogas plants were offered with additional Rs.1000 while subsidy was curtailed for $15m^3$ and $20m^3$ plants.

1.2 Introduction to Biogas Technology

1.2.1 Biogas

Biogas is a gaseous matter produced from the organic wastes such as animal dung, human excreta and plant residues by the action of bacteria in anaerobic condition i. e. in absence of oxygen. The biogas is composed of mixture of different gases. The chief component being methane gas. It is the mixture of gas produced by methaoneogenic bacteria while acting upon biodegradable materials in an anaerobic condition. It is mainly composed of 60-70 percent methane, 30-40 percent carbon dioxide and some other gases. It burns with clear blue flame similar to that of LSG The biogas is colorless, odorless and buns with a clear blue flame (BSP 2004).

1.2.2 Biogas Plant

Biogas plant is a device to produce biogas. The structure of the plant consists of a central pit covered with a dome like structure. The pit serves as digester and the dome serves as gasholder. Animal dung is mixed with water and fed through the inlet. The dung in the pit is anaerobically digested by the bacteria with generation of gas. The gas bubbles up and collects in the dome, which is then supplied to house for use (Cooking and lighting) through the pipeline. After digestion, the digested slurry flows outside through the outlet.

1.2.3 Uses and Benefits of Biogas Plant Installation

The chief purposes behind the installation of biogas plants are cooking and lighting. It is used in cooking stoves in the kitchen. It burns with a clear blue and smokeless flame. The utensils remain neat and clean and cooking environment becomes healthier. It requires lesser time for cooking than that of firewood.

Biogas can be used for lighting purpose too. However, due to low efficiency in its use for lighting is less recommended. It can also be used as a fuel in internal combustion engines. Such engines can be used in small cottage industries where there is no electricity supply.

Digested slurry produced after the digestion has rich nutrients and possessed good fertilizing quality. So, it can be used in substitution of chemical fertilizer. The use of chemical fertilizer for increasing productivity highly affects on the less fertility of land and environmental degradation.

1.3 Statement of the Problem

Despite of higher technological advancement in the field of energy generation; many developing countries are facing the energy related problems such as rising prices of fossil fuels, depleting forest resources including environmental degradation etc. and Nepal is no exception of this.

Energy is a basic requirement of human life for the betterment of human development process. Energy is needed in all major spheres of life which are directly connected with man's survival and progress such as in cooking, lighting and heating etc. Firewood, animal dung, agricultural residue and solar energy are used by the household and also in agriculture sector in rural areas of Nepal. Almost all Nepalese people are highly dependent on firewood for energy, which has resulted into degradation of forest resources.

In the Nepalese context, solar, water and wind energy have not been fully exploited. High consumption of fuel wood as a traditional source of energy leading to deforestation results into natural disaster such as soil erosion, flood, landslides and desertification etc. Firewood only has been the most common and traditional source of energy for Nepal that represents about three fourth of total energy consumption which is mainly consumed in rural Nepal.

The forest alone is not capable of sustaining the increasing demand of energy for growing population. Although there is huge potentiality of hydropower, only less than 1% has been exploited. Other alternative source of energy such as solar power, and wind energy is negligible in use because of high cost of installation.

For the collection of firewood, rural women and children spend more time as well as on cooking and washing utensils. Smoke produced from firewood in poorly ventilated room with traditional stove creates smoke borne diseases such as respiratory problem including long-tern asthma, headache and eye burning etc.

In Nepal, considerable amount of domestic energy requirement is met by the direct burning of dung. Such practice of using cattle dung as a source of energy has grave consequence on agricultural productivity. Not putting the manure back on the agricultural land as fertilizer deprives the soil of valuable nutrients and materials which drastically reduces crop production and results into food shortages. Dung obtained from cows, buffaloes and other animals can be better utilized if converted into biogas. Biogas is a reliable alternative source of energy, which replaces other expensive and pollutive energy resources. It plays crucial role for the conservation of forest and environment, reduction of fossil fuels and self sufficient in energy production.

Considering the above situation, the chief importance of this study is to decrease the rate of deforestation to improve the health situation of rural women and children and to utilize the saved time on income generating activities in Narayanpur VDC of Kailali district. Digested slurry reduces the undue use of chemical fertilizer leading to higher productivity in Narayanpur VDC, Kailali, Nepal.

Due to the above difficulties on firewood using, biogas technology 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. Hence the problems in the field of conventional energy need to be solved with proper measures.

1.4 Objectives of the Study

The general objective of this study is to assess the socio-economic impact of biogas plant in Narayanpur VDC of Kailali district. However, the specific objectives of this study are:

1. To analyze the biogas as an appropriate alternative source of energy.
2. To assess the socio-economic impact of biogas
3. To identify the potential benefits of biogas plant by product (slurry) as fertilizer for agricultural production.

1.5 Significance of the Study

Biogas plant installation is an appropriate alternative and renewable source of energy in rural areas. It has gained momentum nowadays in the absence of adequate development of energy sources such as hydropower, solar power and wind energy which require more capital for installation and operation.

Biogas technology simply reduces the workload of women and children in family for collecting firewood and washing utensils. Time and money saved after the installation of biogas plant, can be utilized on income generating activities. Biogas technology also helps to improve the health and sanitation of rural people and creates smokeless and healthy environment in the kitchen. Biogas also reduces the prevalence of insects in higher rate than that of earlier due to the neat and clean environment.

Biogas directly helps to reduce the rate of forest depletion. The consumption of firewood is curtailed after the installation of biogas plant. Reduction in the rate of forest depletion ultimately reduces the range of natural disasters such as flood, landslide, soil erosion and desertification.

Installation of biogas plant helps to increase the digested slurry avoids the undue use of chemical fertilizer which is beneficial for protecting the nutrients of fertile land.

Above mentioned benefits reveal the importance of bio-gas plant installation in rural areas.

In Nepal, hydropower has great potentiality but it is untapped due to lack of capital and trained man power. Likewise, wind power and solar energy including other renewable sources of energy require large amount of capital for installation and operation. Among other renewable source of energy biogas is the most appropriate, renewable and reliable sources of energy in Nepal where large majority of the people are living in rural areas and have the tradition of rearing cattle and buffaloes and an integral part of their fanning. Biogas has both positive and negative impacts on its uses. Except the increase in the prevalence of mosquitoes, biogas has several positive impacts upon its users.

1.6 Limitation of the Study

This study has attempted to analyze the socio-economic impact of biogas plant installation in Narayanpur VDC, Kailali district. However, it has following limitations:

L This study is primarily based on socio-economic impact of biogas plants installation in Narayanpur VDC of Kailali district.

II. This study deals with the problems and importance of bio-gas plant installation in Narayanpur VDC only.

III. This study considers only socio-economic aspects but not the technical aspects of biogas plant installation.

IV. All the data mentioned in this study based on primary as well as secondary data. Primary data have been collected from the household survey questionnaire, interview method and observation method. Secondary data have been collected from the secondary sources such as books, booklets, journal, newspaper, unpublished thesis and official data etc.

V. It is an individual study, so it can not cover whole aspects of biogas but it can be reference for further study in this field.

1.7 Organization of the Study

The study has been organized into seven chapters. Chapter one deals with the historical background, historical development of biogas in Nepal, introduction to biogas technology, statement of the problem, objectives of the study, significance of the study, limitation of the study and organization of the study.

Chapter Two comprises the biogas in Nepalese context which included background of the country, energy situation in Nepal, energy situation in Kailali and institutions related to biogas promotion.

Chapter Three is related with the literature review which includes conceptual review and review of literature in chronological order.

Chapter Four deals with the research methodology which comprises research design, rationale for the selection of the study area, introduction of the study area, nature and sources of data, sample size, tools and techniques of data collection and analysis and presentation of data.

Chapter Five consists socio-economic status of biogas plant owners.

Chapter Six deals with the uses and impacts of biogas plant installation.

Chapter Seven includes major findings, conclusion and recommendations of this study.

CHAPTER - II

LITERATURE REVIEW

The literature is reviewed from the thesis presented by former students, report bulletins, journal and information published by various concerned agencies and books in the concerned topic. Hence, in this study, before conducting research, a brief review of literature on biogas was made to have a good knowledge about the subject matter and to have a brief idea about the previous works done on the field of biogas.

2.1 Conceptual Review

Biogas is an gaseous matter produced from the organic wastes such as animal dung, human excreta and plant residues by the action of bacteria in anaerobic condition i.e. in absence of oxygen. The biogas is composed of mixture of different gases, the chief component being methane gas. It is mainly composed of 60-70 percent methane, 30-40 percent carbon dioxide, and some other gases. The biogas is colourless, odourless and burns with a clear blue flame similar to LPG (BSP, 2004).

Biogas is a wet gas as it picks up water vapour from the slurry. Biogas is 20 percent lighter than air. The main component of biogas is methane which is colourless, odourless and tasteless. But due to the presence of other gases, it gives some smell similar to that of garlic or rotten eggs (GGC profile, 2001).

Theoretically, all the biodegradable materials can be used to produce biogas through anaerobic decomposition. However, in practice, it is only the animal dung (especially cow dung, that has been primarily

used as feedstock for methane generation. The technology of using other plant materials as feedstock is not developed fully to be commonly practiced at the field level, mainly because of inadequate research (Karki, 1994).

In the context of Nepal, the technology is appreciated and used mainly as an alternative source of gas energy for household cooking and lighting, and the digested slurry as better organic manure for agricultural crops and vegetables (Karki, 1994).

In Biogas technology, an anaerobic fermentation of organic waste takes place causing its decomposition and a mixture of gases containing methane 60 percent - 70 percent evolves. After the fermentation, the sludge like residue which is left behind can be used as a organic fertilizer. The gas is colourless, odorless as well as toxicless and burns with clear blue flame. The digested slurry is not only odorless but also contains more nutrients like nitrogen, phosphorous and potash than in raw dung. (The NEW ERA, 1985).

The volume of gas produced from the plants of both types totally depends upon the temperature inside the digester. Higher the temperature, higher is the level of daily gas production. Temperature between 30 - *35*'C, is taken as suitable one for fermentation. Likewise pH of 7 to 8 is considered as the best (ADB/N, 1986).

Biogas technology is a complete system in itself with its set objectives (cost effective, production of energy and soil nutrient factors such as microbes, plant design, construction materials, climate, chemical and microbial characteristics of inputs) and the interrelationships among

these factors influence production of gas in a digester. The slurry from the biogas plant is supposed to be very fertile and its use in agriculture increases the productivity of crop tremendously (AEPC, 2000).

Biogas technology has various benefits. It provides fuel for cooking and also lighting. Other fuels can be served considerably namely the consumption of firewood, kerosene, and LPG. Time and money can be saved as cooking, biogas is faster than using kerosene or firewood.

Due to the clean and healthy environment the living standard of the people may increase. Biogas also provides the highly nutritious organic manure for field (land) which raises the productivity and lessen the requirement of chemical fertilizer. From the macro perspectives it saves the natural resources such as forest and prevents the problem of deforestation.

2.2 Review of Literature: Sharing Experiences

The literature is reviewed from the thesis presented by former students, report bulletins, journals and information published by various concerned agencies and books in the concerned topic. A brief review of literature made is as of:

Bista (1981) has focused that biogas is considered as one of the most reliable alternative energy resource replacing fuel wood of which the greatest part is used for cooking especially in rural areas of Nepal. It means that there is the urgent need for substituting rural energy through non-conventional energy resources.

Karmacharya (1992) has shown the comparative analysis of installation of biogas. Dhadikot village of Bhaktapur district for hill site and Phoolabari village of Kailali district for Terai site were chosen for the Study. A total of 30 samples were chosen, each site consisting of 15 samples.

This study has taken economic approach and the analysis is focused one the various type of benefits obtained and savings made through the installation of biogas plants.

Energy situations in global and Nepalese context has been dealt in detail

Britt (1994) has shown concise overview of studies specifically designed to measure the effects of biogas on women's workloads in different geographical setting of Nepal and the studies were done in Rolpa. Rupandehi, Nuwakot, and Chiwan district.

The result from the study states that given the overwhelming workloads for women in most part of Nepal, the saving in time in the majority of instances is quite significant.

But it remarks that the introduction of biogas does not appear to fundamentally alter the position of woman. So called traditional or unequal patterns in the division of labours are sustained, with working women for long hours simply substituting one labour activity for another.

It was found from the study that estimated time saving for women in Rupendehi was 4 hours and 30 minutes (on average) in Nuwakot. However, in a village based research, the estimated time saving was

found to be 1 hour and 55 minutes in Madanpokhara, 3 hours and 14 minutes in Pithuwa and 15 minutes in Hathilet village.

Adhikary (1996) has shown the impact of biogas plant on family health, sanitation and nutrition. This study has considered the negative and positive impacts of biogas. This report is based upon the survey of 25 samples households of Ishaneshowr village of Lamjung district.

The positive impacts on health were most significantly, reduction in eye disease, headache, coughing and throat ache whereas the negative impacts were increased prevalence of mosquito and loss of warmth in house in winter. Sanitation condition and practices were improved and the study reported 62% reduction in firewood consumption after biogas plant installation.

The report recommends for further in depth study in

- Prevalence of mosquito
- Digested slurry
- Short, medium and long term effects on health.

This review provided an idea about the impacts of biogas on health and sanitation.

BSP (1996) has assessed the operation and maintenance of the plants. Most of the plants were underfed and there was high water to dung ratio. Gas production was considerably low in winter. However, 82% of users were satisfied with working of plants.

The benefits of biogas plant installation were saving in time. Visible implication of personal health and general sanitary condition

having in firewood and kerosene. One hundred such plants were estimated to save 2.8 hectares of forest. The study noticed that users percept no significant effects of digested slurry.

In the concluding part, role of GGC and BSP in the promotion of biogas has been highlighted. The main benefit of biogas has been stated as cooking and lightening facilities, which saved considerable amount of money.

The other important benefit included were time saving, convenient cooking and elimination of indoor air pollution resulting in improvement in health.

Ghimire (1999) has tried to document the benefits of biogas produced by harvesting the more popular and appropriate renewable energy resourcecattle dung and assessed the immediate impact of biogas on respective users. The outcome of the study revealed that the main benefits of biogas plants to its owner was the cooking and lightening facilities that saved a considerable amount of money.

Economic analysis which is not done in this case,, this study has only dealt with the general impact of the biogas plant on the users. In general, biogas plants are found to have very positive impact on the users which is well appreciated by them. The total time saving of 1.22 hours per day/family on an average from the installation of biogas plants suggests that it has been successful to lower the family workload.

Ghimire (2001) has shown the biogas in relation to forestry. He has estimated that installation of 1.3 million biogas plants (total potentiality of Nepal) Would save about 4 million total of firewood per year.

Devpart-Nepal (2001) has carried out the study of the impact of biogas on users and also taken non-biogas household for the study Syanja.

Nuwakot, Kailali and Morang districts were taken as the study area representing high hills, mid hills and Terai region of the country.

The outcome of this study has shown that the whole quantity of dung produced is not collected by the biogas users and collected amount is also not entirely fed into the plant which reduced the plant efficiency.

CHAPTER-III

RESEARCH METHODOLOGY

This chapter deals with the research design, introduction to the study area, rational for the selection of the study area, sources of data, sample size and analysis and presentation of data. Tools of data collection and organization of the study are also included. These are described below. Research methodology is an important part and parcel of a research work.

3.1 Research Design

Research design is a blueprint of a planned action while conducting a research work. It is a conceptual framework within which research is carried out. Research design refers to the procedures for the collection of data and its analysis. The research design adopted in this study is descriptive research design which helps us understand the phenomenon by asking questions. The descriptive research was followed for the qualitative data obtained and derived during the study. One of the major concern of this study is to ensure the validity of the findings and conclusion.

Validity refers to correctness or the creditability of a description, conclusion, explanation, interpretation, or other accounts. As this study requires both qualitative and quantitative data, it is essential that both types of data should be valid.

3.2 Introduction to the Study Area

This study is confined to the Narayanpur VDC of Kailali district. Kailali district lies in the far-western development region of Nepal. Total area of this district is 3235 square km (kilometer). Dadeldhura, Doti and Surkhet district are in North Kanchanpur in west, Bardia in east and India in South. It has two municipalities: Dhangadhi and Tikapur. According to the census 2001 the population is 616697. Among them males and females are 31234 and 304386 respectively in the Kailali district.

All of the 42 VDCs in Kailali district, Narayanpur VDC is an important near by Tikapur municipality. The VDC borders with Bardia in the east, Tikapur in the north, Dhansinghpur in south and Thapapur and Bhajani in west. The total household of this VDC is 1800 and total population is 11560. Among which 5739 are males and 5816 are female (Census 2001). Most of the people in the study area speak Nepali language, despite of some ethnic group like Tharu, Lama, Rai speak their own language.

This VDC has more fertile land and agriculture stands as a main occupation of almost of the people in this area. Only a few people are engaged in other sector like service, business, labour and so on. The major agriculture production of this VDC are paddy, wheat, maize, pulse, oilseeds and vegetable and animal husbandry.

This VDC has enough facility of education. Since the VDC has the facility of enough schools the educational status of this area is quite satisfactory. Leaving aside the old age population almost all the people

are educated. Even Dalit caste family member allow their children to go to school for the study; While analyzing the occupation status of the study area, agriculture dominate the entire economy of this area. More than 80% of the people are engaged on agriculture. Due to the lack of irrigation facility, paddy is produced only once in a year. Besides the paddy, maize, pulse and wheat are produced. In this area vegetables are produced mostly. Main vegetables grown are potatoes, radish, cauliflower, cabbage, brinjal (Bhanta) and leafy vegetables (Rayo, Palungo, Chamsur). The production of fruit is confined only to the household consumption not for the selling purpose.

3.3 Rationale for The Selection of the Study Area

The present study has been carried out in Narayanpur VDC of Kailali district which is the part of far western development region. The VDC is not far from Tikapur municipality. It is neighbouring VDC of Tikapur municipality.

The reason for selecting VDC as the study area is that the researcher is a native villager of this study area. Secondly, the researcher is familiar with the local biogas companies and the local people. Therefore, by selecting of this area, it is believed that more accurate information could be collected during the study at area.

3.4 Nature and Sources of Data

Both primary and secondary sources of data have been used to derive the objectives of the study.

3.4.1 Primary Sources of Data

This study is mainly based on primary data collection in Narayanpur VDC of Kailali district. All households in the selected VDC are asked to respond to a brief structured questionnaire to collect information on the socio-economic impact of biogas plant installation upon its users.

The primary information are collected during the field survey with the help of questionnaire, interview and field survey. The questionnaire includes the various aspects of biogas plant installation with the respondents such as information on biogas, cattle numbers. saving of time and money, energy consumption habit before and after installation of biogas plant, loan and problems of biogas plant installation including health and sanitation situation.

To collect the quantitative information from biogas plant owner or respondent, interview method is mainly used. Thus the study is primarily based on interview with 60 sample informants who volunteered to give their opinion on different topic of general concern given in an appendix.

3.4.2 Secondary Sources of Data

This study is primarily based on primary sources of data but some secondary data are also used for background purpose. Secondary information are collected from all the materials concerning to the biogas plants such as books, journals, newspaper, published and unpublished articles and other reports etc.

The major issues on socio-economic impact of biogas plant installation in rural area are derived from BSP and other private biogas company's publication, population monograph of center bureau of statistics. The chief sources of secondary data are as of.

(a) Previous studies and research reports and record of relevant agencies.

(b) Progress reports (activities reports, and the annual reports of the program)

(c) Major conference reports on biogas support programmes and other official documents.

3.5 Sample Size

Selected study area Narayanpur VDC has altogether 9 wards. There are 1800 households altogether. Out of total households having biogas plant of Narayanpur VDC of Kailali district, only 60 samples biogas plant have been selected by using simple random sampling technique (lottery method).

The name of the selected households has been transformed into questionnaires and the house of these owners have been searched purposively and survey conducted. The household head is selected for the interview. In case of absence of household head other senior family members have been interviewed of the sampled household.

3.6 Techniques and Tools of Data Collection

The data used in this study have been collected from field survey

conducted in Narayanpur VDC of Kailali district. The present study is based mainly on primary data. They are used to estimate and analyze the socio-economic impact of biogas on the surveyed households. The survey is conducted through the formal method of interview in a structured questionnaire, interview and observation. Following tools and techniques have been used for data collection.

3.6.1 Structured Questionnaire

Keeping in view of the objectives, a detailed-structured questionnaire has been prepared. Various kinds of data such as socio-economic characteristics of the biogas users; impacts of biogas on the users after its installation etc. have been collected from the questionnaire.

The questionnaire has been finalized after consulting supervisor of the researcher. The sample of questionnaire has been included at the appendix.

3.6.2 Observation

Certain information mentioned in this study is via the observations made by researcher. The working of the plants and especially the use of digested slurry has been observed carefully.

3.7 Analysis and Presentation of Data]

Methods of data analysis and presentation of data are the careful study of facts in order to draw valid conclusion. Information collected from questionnaire have been transformed into a master sheet and data have been tabulated on the basis of master sheet. Descriptive analysis of collected data have been done in this study.;

Quantitative data are presented in terms of percentages, frequencies and tabular form. Table, charts and figures are used for profound illustration. Both qualitative as well as quantitative data have been combinely presented to sketch out the socio-economic impact of biogas plant installation in Narayanpur VDC of Kailali district.

CHAPTER-IV

BIOGAS IN NEPALESE CONTEXT

4.1 Background of the Country

Nepal is an agricultural country, and agriculture is the main occupation of Nepal. Most of the Nepalese people are dependent on agriculture. Agriculture is only one source which provides food, shelter and clothes to 85.6 percent of total population in Nepal particularly for rural area. Being an agricultural country, livestock rearing has been an integral part of farming. In rural area even the energy source is provided by livestock (cattle) dung till now.

Nepal is a small landlocked country situated between 80° 04'E to 88^{0}12'E longitude and 26°22'N to 30° 27'N latitude. It extends almost east to west along the Himalayan range of Asia. The total land area is about 1,47,181 sq. kilometers.

It is a small country which occupies 1,47,181 sq. kilometer (km), (0.03% of total land mass area in the world) areas inhabitant by 25 million people between two powerful nations India and China. Being a land locked country, overseas trade has minimum transaction. Nepal is one of the poorest and least developed country in the world with low per capita income of $310 (WDR, 2006). 86.4% of total population live in rural areas whereas 13.6 percent live in urban area. Geographically, Nepal can be divided into three ecological regions that extends from east to west viz. The northern Himalayan region, with a glaciers and peaks; Mountain range which includes Mahabharat and Churiya mountains and

southern region of Terai. The Terai is regarded as the food storage of the nation. It has very much plain and fertile land.

Nepalese economy is primarily based on agriculture and other sectors of economy are of small coverage. Although being an agricultural country, agriculture sector has not been diversified and commercialized yet. Until and unless this sector is commercialized and diversified, the prosperity and development of this nation can't be achieved.

National account data reveal that at factors cost the share of agriculture in total GDP was around 40 percent in 2002/2003. Livestock rearing is an integral part of agriculture in addition to draft power, milk and produce them necessary manure in the form of dung. People are highly dependent on firewood for their energy requirement provided either by the forest or by own land having domestic forest for the purpose of cooking, lighting and heating.

Energy consumption level is an indicator of the level of development of the nation. The level of development is reflected by the level of per capita energy consumption. Higher the level of per capita energy consumption indicates the higher the level of development. The low level of per capita energy consumption reflects the low level of development. In this connection, Nepal can be categorized as a nation having low level of per capita energy consumption, which signifies the low level of development. Being the age of higher technological advancement, Nepal's energy consumption situation is miserable. Energy has been identified one of the basic requirement of the people living in rural areas were still used traditional fuels like firewood, agricultural residue and animal dung which cover 85.2 percent of the total fuel

consumption (water and energy commission secretariat, 2003). To meet the growing energy demand of increasing rate of population (2.25 percent), forest has been depleted rapidly day by day. If this trend is continued for next 25 years, the whole Nepal will be changed into desert hill land. The growing demand of firewood as traditional source of energy is only the main cause behind the rapid depletion of forest resources in Nepal. It has also destroyed the natural habitation of several wildlives.

Due to the lack of abundant supply and difficulty in collecting firewood, rural people are using animal dung and agricultural residue as a source of fuel directly leads to decrease of soil fertility in absence of nutrient given by the domestic manure.

In this context, biogas has been one of the fundamental sources of energy consumption particularly of rural people and overall nation in general. Biogas is an appropriate alternative source of energy which can reduce the kerosene consumption, LPG use, workload to women and children, rate of deforestation and also helps to conserve the environmental situation and increase the agricultural productivity. So, biogas technology is much more useful in the context of Nepal, which is highly effective in rural areas due to it's feasibility for installation and convenient to use.

The government of Nepal has made the provision of subsidy to encourage the installation of biogas plant in rural areas which ultimately leads to the environmental protection of overall country due to lessening the dependence on forest for firewood. And it can also support balance of payment due to the curtailment of petroleum product's import through substitution of energy by installing biogas plant. Recent data reveal that

in Kailali district around 3500 biogas plants have been installed (BSP Nepal. 2004).

This study, socio-economic impact of biogas plant installation in rural areas is based on Narayanpur VDC of Kailali district. This VDC is located in far-western part of Nepal. Present study is important for not only in the rural area of the country but also for overall resource management of the nation. This study helps to provide the socio economic impacts of biogas plant installation particularly in Narayanpur VDC, rural area and of overall nation in general.

4.2 Energy Situation in Nepal

The energy resources of Nepal can broadly be classified into three categories: traditional, commercial and alternative energy. Traditional energy includes firewood, agriculture residue and animal wastes (dung cakes). Commercial energy consists of electricity, petroleum product and coal. Petroleum and coal are imported which amounts almost one third of the country's export earning. Energy sources other than traditional and commercial energy, are included in the alternative energy. Nepal has huge potentially of hydropower estimated at 83,000 MW of which 40,000 MW is considered to be technically feasible. But till now, only 400 MW of hydropower has been installed which contributes about 1% of total energy requirement of the country.

Firewood contributes about 78% of total energy consumption, which is mainly consumed in rural Nepal. Forests (which includes community, public, private forest) and private forms are the sources of firewood. The resources for firewood are depleting due to

overexploitation and lack of proper management.

Other biornass sources, agricultural residue and animal dung contribute about 10% of energy requirement.

Petroleum and coal together makes about 12% of the total consumption. These are completely imported.

Sector wise analysis shows that residential sector consumes about 89% of the total energy consumption.

4.3 Energy Situation in Kailali District

In urban and municipality areas, most people use kerosene and liquefied petroleum gas (LPG) for cooking purpose. But in rural, people use firewood for cooking purpose. Therefore, firewood has been the chief source of energy in the district.

Most of the VDCs have got electricity supply and is highly used for the purpose of lighting, heating. Biogas is used for cooking purpose. So, in Kailali, most of the households have installed biogas plant to derive the energy source for domestic or residential purpose.

4.4 Institutions Related to Biogas Promotion

Biogas support program (BSP), Nepal biogas promotion group (NBPG), and alternative energy promotion center (AEPC) are the prominent institutions related with biogas sector. These are working for promotion and development of biogas in Nepal. A brief description of these institutions are as of:

4.4.1 Biogas Support Programme (BSP)

Biogas support programme has been playing a vital role for the promotion and development of biogas in the country. The biogas support programme was initiated in July 1992 to develop and promote the use of biogas in Nepal.

For the first two phases of the programme, BSP I and II, programme was supported by His Majesty's Government of Nepal, the Netherlands Development Cooperation in Nepal (SNV/N) and the Netherlands Development Agency (NEDA). The Third Phase Programme (BSP III, 1997-2002), was supported and financed by German Government.

Implementation of BSP - III was conducted jointly with three banks (Agricultural Development Bank of Nepal, Rastriya Baniiya Bank, and Nepal Bank Limited), and 50 recognized private biogas companies.

Biogas support programme (BSP) had set its goals for the third phase as "To promote and develop biogas as a sustainable source of energy throughout rural areas of Nepal".

The main objectives of BSP are:

1. To develop a market-oriented and commercially reliable biogas industry in the country.

2. To construct 1,00,000 biogas plants.

3. To ensure plants constructed under the programme.

4. To research biogas related topics and to develop improve methods and techniques.

5. To ensure that the slurry, a by product of biogas plants, is brought to proper use (BSP, booklet).

4.4.2 Nepal Biogas Promotion Group (NBPG)

Nepal biogas promotion group (NBPG) is an association of all biogas company. It was established in Nepal and consisted of representatives of the biogas companies. It was established for the promotion of Biogas technology and at the same time protecting common interest of its members. Some of the activities of NBPG include:

1. Solve the problems with the bank.
2. Facilitate import of biogas appliances
3. Avoid unhealthy competition among the member biogas companies
4. Gradually take over the activities of the promotion of biogas, training and extension activities combined out by biogas support programme (Silwal, 1999).

4.4.3 Alternative Energy Promotion Center (AEPC)

An apex institution was felt needed for the development and promotion of biogas. As a consequence, His Majesty's Government, Ministry of Science and Technology established the Alternative Energy Promotion Center (AEPC) in November1996. The AEPC's function include:

1. Analysis of policy issues and advise on policy matters.
2. Coordination with other sectors and ministries.
3. Preparation of sector-wise plans and targets.

4. Elaboration of regulatory frameworks: setting of standards and guidelines, criteria for registration and licensing of companies.
5. Mobilization of funds and liaison with donors.
6. Review/approval of annual work plans in respect of donor funded projects on alternative energy.
7. Monitoring of development in the alternative energy sector as a whole.
8. Organize and participate in programme and project evaluations (Silwal, 1999).

CHAPTER - V

SOCIO-ECONOMIC STATUS OF PLAN OWNERS

This chapter basically consists of the analysis of the data obtained from field survey conducted in 2009. This chapter deals with the socio-economic condition of the biogas plant owners in Narayanpur VDC of Kailali district. Occupation, family size, educational status, landholding and caste/ethnicity are the main variables considered in this study.

5.1 Occupation

The main occupation of the plant owners is agriculture. Besides agriculture, agriculture and service and service are the main occupation of plant owners. Major occupation practiced by the sampled households are given in the table 5.1.

Table 5.1: Distribution of Respondents by Occupation

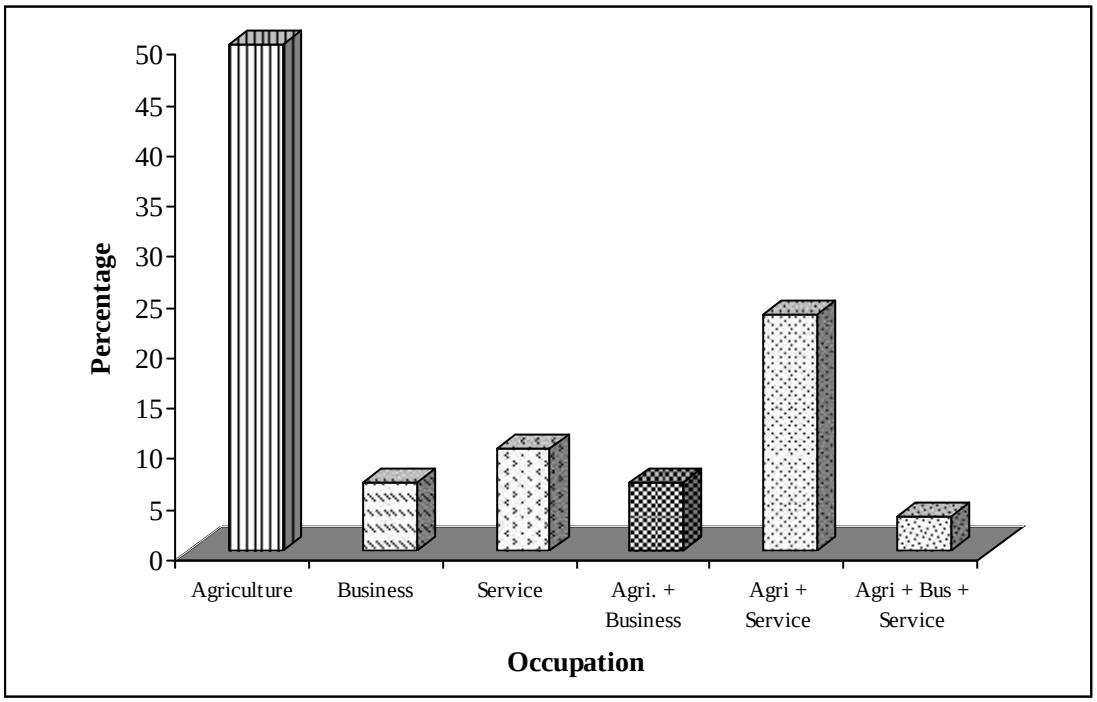
S.N.	Occupation	No. of Households	Percentage
1	Agriculture	30	50
2	Business	4	6.7
3	Service	6	10
4	Agri. + Business	4	6.7
5	Agri + Service	14	23.3
6	Agri + Bus + Service	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 5.l shows that the higher percentage of the plant owners are engaged in agriculture sector. About 50 percent of the plant owners are

involved in agriculture, 23.3 percent in agriculture plus service, 10 percent in service, 6.7 percent in business, 6.7 percent in agriculture plus business and 3.3 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 has secondary source of income as well. They are government service pensions and other business. It supports them economically to fulfill basic requirements.

Figure 5.l: Distribution by Occupation



5.2 Family Size

The result of the survey reveals that average family size of the sampled biogas household is 5.6 (Table 2). Household with maximum number of family members have 9 whereas the minimum number is 3 (Table -2). Table 2 shows that distribution of households by family size.

Table 5.2: Distribution of Households by Family Size

S.N.	Family Size	No. of Households	Percentage
1	1-3	4	6.7
2	4-6	40	66.7
3	7 and above	16	26.6
	Total	60	100.0
Average family size is 5.6 per household			

Source: Field Survey, 2009.

Table 5.2, shows that among all plant owners, 40 households (66.7%) have 4 to 6 members. Only 16 households (26.78%) have and above members. 4 households (6.7%) have 1 to 3 members. The average family size is 5.6 per household.

5.3 Educational Status

Most of the plant owners are literate (86.6%). About 23.3 percent owners out of total interviewed have completed class 1 to 5. 40 percent have completed grade 6 to SLC and remaining 23.3 percent of total plant owners have completed grade SLC and above. Table 3 shows the educational status of the sampled plant owners.

Table 5.3: Distribution by Educational Status

S.N.	Education	Male		Female		Total	
		No.	%	No.	%	No.	%
1	Illiterate	2	4.8	6	33.3	8	13.4
2	1 upto 5 Class	8	19	6	33.4	14	23.3
3	6 up to SLC	22	52.4	2	11.1	24	40
4	SLC and above	10	23.8	4	22.2	14	23.3
Total		42	100	18	100	60	100

Source: Field Survey, 2009.

The data presented in table 5.3 reveals that majority of the plant owners are literate (86.6%). Among male 52.4 percent respondents have completed class 6 up to SLC. Among female only 40 percent have completed grade 6 up to SLC. This result shows that only 8 persons (13.4%) are illiterate and they are old. Only 4.8 percent of total illiterate male whereas 33.3 percent are illiterate out of total illiterate female. So, the education status of the plant owner is satisfactory.

5.4 Landholding

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. Table 4 shows the distribution of land holding of the plant owners.

Table 5.4: Distribution by landholding

S.N.	Land (in Kathas)	No. of Households	Percentage
1	Below 10	20	33.3
2	11 to 20	18	30
3	21 to 30	14	23.4
4	31 to 40	6	10
5	41 and above	2	3.3
Total		60	100.0
Average Landholding is 17 Kathas per household			

Source: Field Survey, 2009.

Table 5.4 shows that average landholding size per household is 17.0 Katthas. The maximum landholding of the visited household is 46 Katthas and the minimum land is 6 Katthas. Majority of the plant owners

(33.3%) have below 10 Katthas of land and only 3.3 percent have 41 and above Katthas of landholding.

5.5 Caste/Ethnicity

There are different castes and ethnic groups in Narayanpur VDC, Kailali. The data on ethnicity of the sampled biogas household is given in Table 5.5.

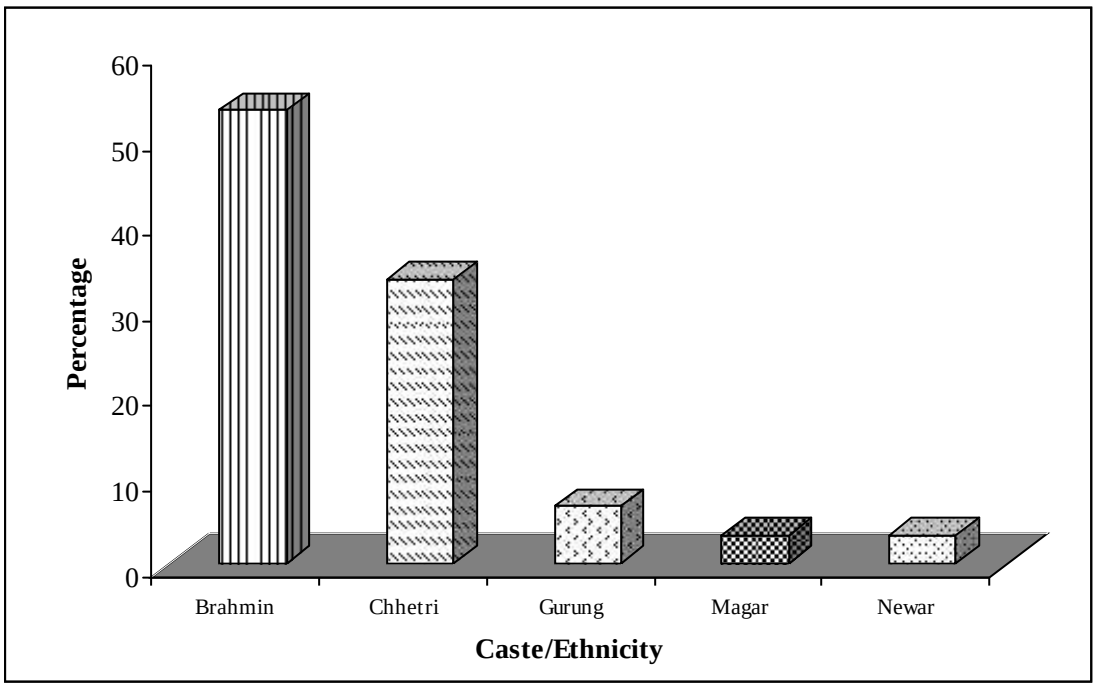
Table 5.5: Distribution of Caste/Ethnicity

S.N.	Caste/Ethnicity	No. of Households	Percentage
1	Brahmin	32	53.3
2	Chhetri	20	33.4
3	Gurung	4	6.7
4	Magar	2	3.3
5	Newar	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 5.5 shows that the majority of the households under study are Brahmins (53.3%) followed by Chhetri (33.4%), Gurung (6.7%), Magar (3.3%) and Newar (3.3%). The reason behind the higher percentage of biogas users (Brahmins) is found that they are socially and econoinically forward in each and every sector.

Figure 5.2: Distribution by Caste/Ethnicity



CHAPTER - VI

USES AND IMPACTS OF BIOGAS PLANT INSTALLATION

6.1 Uses of Biogas

Biogas technology is an alternative source of energy requirement especially in rural areas. It is widely used in both the developed and developing economies in agricultural or rural, industrial and municipal waste systems. In developing countries, biogas is valued more as a source of energy for household cooking, lighting and slurry for its fertilizing value.

The main domestic use of biogas in rural household is for cooking and lighting. In Narayanpur VDC, almost all of the households use biogas only for the cooking purpose. Since every household has the access to electricity, no one use biogas for lighting purpose. The minimum use of biogas for cooking is found to be 2 hours while the maximum use is 3 hours.

All the respondents replied in favour of biogas for cooking and they expressed great satisfaction with cooking aspect of biogas. According to them, the main benefits of cooking is biogas were ease and comfort in cooking. They also responded that they were ease and free from smoke borne diseases as they cooked in smoke-free environment. Other benefits mentioned were biogas did not need constant attention or blowing as in firewood; they were able to do other works while the food being cooked.

6.2 Impact of Biogas Plant Installation

This section includes the impact of biogas in reduction of workload, use of saved time, impacts on health and sanitation and other social, environmental impacts and impacts of slurry on production.

6.2.1 Information on Biogas

6.2.1.1 Size of the Biogas Plant

Various types of biogas plants having different size have been introduced on promoting and development of biogas. $4m^3$, $6m^3$, $8m^3$, $l5m^3$ are widely used size of biogas plants. But biogas plant of $6m^3$ are appropriate in rural area.

Table 6.1: Distribution of Biogas by Plant Size

SN.	Plant Size	No. of Households	Percentage
1	$6m^3$	54	90
2	$10m^3$	4	6.7
3	$15m^3$	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 6.1 shows that only three types of biogas plant sizes, $6m^3$, $l0m^3$ and $15m^3$ were reported. About 90 percent of interviewed households have $6m^3$ capacity plant followed by $10m^3$ capacity (6.7%) and $15m^3$ capacity (3.3%). This study shows that $6m^3$ capacity plants have been widely used in the study area.

6.2.1.2 Construction Company

Recent data reveal that more than 50 private construction companies have been established. They contribute to promote and develop biogas. Table-6.2 shows that distribution of construction company.

Table 6.2: Distribution by Construction Companies

S.N.	Construction company	No. of Households	Percentage
1	Janata	14	23.3
2	Nilkamal	16	26.7
3	Biogas Tatha Krishi Yentra	8	13.3
4	Nepal Biogas	12	20
5	Public	10	16.7
Total		60	100

Source: Field Survey, 2009.

6.2.1.3 Financed by (Financing Company)

Many finance companies have provided loan for the (installation) of biogas plant. They are mainly ADB/N, Rural Development Bank and Commercial Bank. However, some of the plant owner have installed biogas on self.

Table 6.3: Distribution by Financing Company

S.N.	Financed by	No. of Households	Percentage
1.	ADB/N	40	66.7
2.	Commercial Bank	8	13.3
3.	Rural Development Bank	2	3.3
4.	Self	10	16.7
Total		60	100

Source: Field Survey, 2009.

Table 6.3 shows that majority of the plant owners out of total interviewed have taken loan from ADB/N (66.7%), followed by commercial bank (13.3%), rural development bank (3.3%) and self finance (16.7%).

6.2.1.4 Sources of Information

There are several sources of information about the biogas plant installation. Radio/T.V., Newspaper, Neighbour, Gobar Gas Construction Company are major sources of information.

Table 6.4: Distribution by Sources of Information

S.N.	Source	No. of Households	Percentage
1	Radio/T.V.	6	10
2	Newspaper	18	30
3	Neighbour	34	56.7
4	GGC	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 6.4 shows that majority of the plants owners (56.7%) has neighbour as a source of information followed by newspaper (30%), Radio; T.V. (10%) and Gobar Gas Company (3.3%).

6.2.1.5 Reasons for Biogas Plant Installation

There are so many reasons behind the installation of biogas plant. Amongest them, cooking is the main reason for biogas plant installation.

Table 6.5: Reasons for Biogas Plant Installation

S.N.	Reasons	No. of Households	Percentaae ~
1	Easy and Smokeless Cooking	48	80
2	Toilet	4	6.7
3	Environmental Protection	2	3.3
4	Resource Conservation	2	3.3
5	Getrid of Firewood Collection	4	6.7
Total		60	100

Source: Field Survey, 2009.

Table 6.5 shows that the main reason behind the installation of biogas plant is easy and smokeless cooking (80%) followed by due to lack of toilet (6.7%), to get rid of firewood collection (6.7%) and environmental protection (3.3%). Only 3.3 percent out of total interviewed reported that the main reason for biogas plant installation is resource conservation.

6.2.1.6 Toilet Attached With Biogas Plant

It is found that majority of the plant owners have attached toilet with the biogas plant. To some extent installation of biogas plant also has solved the problem of toilet.

Table 6.6: Toilet Attached with Biogas Plant

S.N.	Toilet Attached	No. of Households	Percentage
1.	Attached	52	86.7
2.	Not attached	8	13.3
Total		60	100.0
Reasons to attach toilet with the plant.			
S.N.	Reasons	No. of Households	Percentage
1	Due to lack of toilet	24	46.1
2	To increase gas	20	38.4
3	Lack of sufficient dung	8	15.5
Total		52	100

Source: Field Survey, 2009.

Table 6.6 shows that majority of the households out of total interviewed reported that they have attached toilet with biogas plant (86.7%) whereas 13.3 percent reported that they have not attached toilet with the biogas plant.

This study also reveals that the main reason to attach toilet is due to lack of toilet (46.1%) followed by to increase gas (38.4%) and due to lack of sufficient dung (15.5%) out of those who have attached toilet.

6.3 Livestock

Livestock is an integral part of agricultural farming in Nepal. It fulfills the demand of manure for land, meat to eat and milk to drink. Since livestock dung is the main raw material for installing biogas plant, all plant owners have some kind of livestock.

6.3.1 Livestock Population

The situation of the livestock holding in the sampled household in the study area is presented in table 6.7.

Table 6.7: Livestock Population

S.N.	Total no. of Livestock	No. of Households	I Percentage
1	Below 3	24	40
2	4 to 6	26	43.3
3	7 and above	10	16.7
Total		60	100
Average livestock population is 4.3 per household.			

Source: Field Survey, 2009.

Table 6.7 shows that the average livestock population is 4.3 per household. About 40 percent respondents out of total interviewed reported that their livestock population is below 3. 43.3 percent or majority of the respondents have 4 to 6 and only 16.7 percent out of total interviewed stated that their livestock population is 7 and above.

6.3.2 Total Dung Production

The main objective behind livestock rearing is to produce dung for biogas plant in this study. Dung production situation in the sampled household in the study area is presented in table 6.8.

Table 6.8: Dung Production

S.N.	Dung Produced per day (in kg)	No. of Households	Percentage
1	Below 10	8	13.4
2	11 to 20	12	20
3	21 to 30	20	33.3
4	31 to 40	14	23.3
5	41 and above	6	10
Total		60	100
Average dung production per day is 24.46 kgs.			

Source: Field Survey, 2009.

Table 6.8 shows that majority of plant owners (33.3%) have 21 to 30 kgs dung production per day. About 23.3 percent have 31 to 40 kgs of dung production per day whereas only 10 percent have 41 and above kgs. of dung production. About 20 percent have 11 to 20 kgs of dung production per day and 13.4 percent out of total households interviewed reported that they have below 10 kgs. of dung production per day.

Majority of the households have habit of dung feeding which is less than recommended amount. Dung feeding situation of sampled household in the study is presented in table 6.9.

Table 6.9: Dung Feeding Per Day

S.N.	Amount f Dung (kgs/day).	No. of Households	Percentage
1	15.	10	16.7
2	25	24	40
3	35	18	30
4	45	8	13.3
Total		60	100
Average Dung feeding per day is 29 kgs.			

Source: Field Survey, 2009.

Table 6.9 shows that the average dung feeding per day is 29 kgs. About 40 percent of respondents out of total interviewed households reported that they use to feed 25 kgs. dung per day. It is followed by 35 kgs. per day (30%), 15 kgs. per day (16.7%) and only 13.3 percent out of total interviewed households use to feed 45 kgs. of dung per day. Majority of the households use to feed dung less than recommended amount by biogas company.

6.4 Slurry

Slurry is the by product of biogas from the outlet when dung is digested inside the plant (digester). Biogas is collected inside the dome and digested slurry is exited through outlet. It can be used in farm which directly leads to increase agricultural productivity.

Digested slurry is used in farm. Majority of the respondents have used digested slurry in farm. The use of slurry in farm is presented in table 6.10.

Table 6.10: Slurry Used in Farm

S.N.	Farm Item	No. of Households	Percentage
1	Crop	12	20
2	Maize	24	40
3	Wheat	10	16.7
4	Vegetable	6	10.0
5	Paddy	8	13.3
Total		60	100

Source: Field Survey, 2009.

Table 6.10 shows that majority of the respondents (40%) out of

total interviewed reported that they use slurry on maize. About 20 percent respondents use on crop followed by 16.7 percent use slurry on wheat and only 13.3 percent use the digested slurry on paddy. Remaining 10 percent is used on vegetables.

Slurry is used in different forms. They are presented below. (Table 16).

Table 6.11: Forms of Slurry

S.N.	Forms of Slurry	No. of Households	Percentage
1	Directly Liquid	16	*26.7*
2	Making Dung	6	10 ,
3	In Dried form	30	50
4	With Irrigation water	8	13.3
Total		60	100

Source: Field Survey, 2009.

Table 6.11 shows that forms of slurry used on farm. Majority of the respondents out of total interviewed reported that they use slurry in dried form (50%). About 26.7 percent respondents out of total interviewed reported that they use slurry in directly liquid form followed by 13.3 percent use with irrigation water and only 10 percent use by making dung.

In this study, slurry use has increased productivity mostly. The impact of slurry is presented below (Table 6.12).

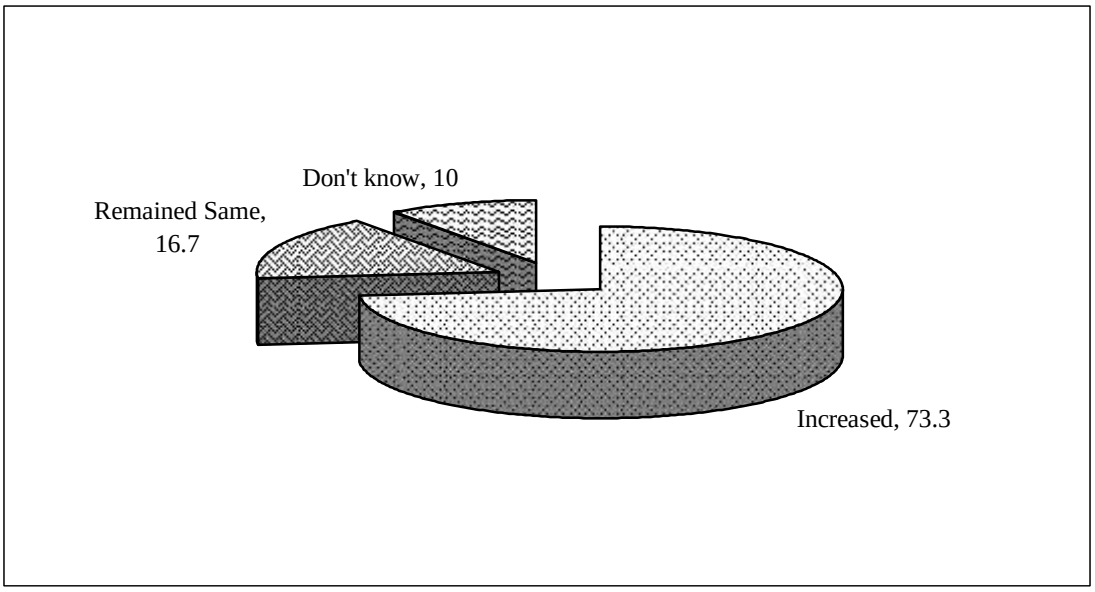
Table 6.12: Impact of Slurry

S.N.	Impact of Slurry	No. of Households	Percentage
1.	Increased	44	73.3
2	Remained Same	10	16.7
3	Don't know	6	10.0
Total		60	100

Source: Field Survey, 2009.

Table 6.12 shows that about 73.3 percent out of total interviewed households expressed that their agricultural production has increased whereas only 16.7 percent reported that the agricultural production is remained same. 3 percent reported that they don't know about the situation of agricultural production after the use of digested slurry.

Figure 6.1: Impact of Slurry



6.5 Alenterive Energy, Source, Consumption and Saving

The chief purpose behind the installation of biogas plant is to

reduce the use of firewood including other fuels such as LPG and kerosene etc. Biogas technology has got popularity as an alternative energy source especially in rural area. Consumption of energy before and after installation of biogas and saving of energy as an important impact of biogas plant installation has been presented below in detail.

6.5.1 Energy Types Used Before Installation of Biogas Plant

Several types of energy were used before installation of biogas plant. They are mainly firewood, kerosene, electricity, agricultural residue and LPG. They are presented below in Table 6.13.

Table 6.13: Energy Types Used Before Installation of Biogas Plant

S.N.	Energy types	No. of Households	Percentage
1	Firewood	36	60
2	Kerosene	6	10
3	Electricity	4	6.87
4	Agricultural residue	8	13.3
5	LPG	6	10
	Total	60	100

Source: Field Survey, 2009.

Table 6.13 shows that 60 percent of respondents out of total interviewed households reported that they use firewood for cooking purpose followed by 13.3 percent use agricultural residue, 10 percent use both kerosene and LPG and only 6.7 percent use electricity. This table clarifies that majority of the respondents (60%) are dependent on firewood as an energy source for household purpose.

This study shows that the use of biogas technology has been able to save time and also to reduce workload in household. Table 6.14 shows that situation of saving in time in detail.

Table 6.14: Saving on Time and Reduction in Workload

S.N.	Activities	Average time taken (hours/day)		Reduction in workload (saving in times) hours/day
		Before installation	After installation	
1	Firewood collection	1½	½	1
2	Cooking	2½	1½	1
3	Washing utensils	1½	1	½
Total average time taken per house per day		5½ hours	3 hrs	2½ hrs

Source: Field Survey, 2009.

Table 6.14 shows that the average time taken per day before installations 5½ hrs. After installation, 3 hrs per day is spent on all activities and the saving of time per day is 2½ hrs. This time (2½ hrs per day) is used in different activities. Saving of time directly reduces workloads in households activities.

6.5.2 Saving of Money on Energy

In this study, money is saved after the installation of biogas plant as compared to before installation of biogas plant. Especially in energy

consumption. The situation of saving of money on energy in sampled households is presented in table 6.15.

Table 6.15: Average Saving of Money on Energy

S.N.	Types of Energy	Average Consumption of Energy (Rs/Month)		Average Saving (in Rs./month)	Cost per unit (in Rs.)	Average saving (in %)
		Before installation	After installation			
1	Firewood	500	100	400	100/Bhari	80
2	Kerosene	200	100	100	50/ Liter	50
3	LPG	200	100	100	1200/ Cylinder	50
Total Average (in Rs.)		900	300	600		66.7
Annual saving amount of money is (600×12) Rs. 7200 1 Bhari = 30 kgs.						

Source: Field Survey, 2009

Table 6.15 shows that the amount of money which is saved after the installation of biogas plant. Before installation Rs. 900/- was spent but after installation it is Rs. 300/-. Hence, the average saving amount of money is Rs. 600/- per month. This table also clarifies that the annual saving amount of money (600X12) is Rs. 7200 can be contributed to pay the loan on installment of expenditure of biogas plant.

6.5.3 Utilization of Saved Time

As shown in table 19 the average time saving per day is 2½ hrs. It has been utilized in different activities. Saving of time has reduced the

workloads in household activities. The use of saved time is presented in table 6.16.

Table 6.16: Utilization of Saved Time

S.N.	Activities	No. of Households	Percentage
1	Farm Activities	26	43.3
2	Child Care	2	6.7
3	Gardening	4	3.3
4	Income Generation	20	33.3
5	Physical Labour for Wages	8	13.4
Total		60	100

Source: Field Survey, 2009.

Table 6.16 shows that about 43.3 percent of respondents out of total interviewed reported that they use their saved time on farm activities followed by 33.3 percent use on physical labour for wages and 6.7 percent use the saved time on child care. Only 3.3 percent of respondent out of total interviewed sampled household reported that they use the saved time on gardening. Data clearly show that the saved time after the installation of biogas plant has been used on production activities.

6.5.4 The Source of Firewood Collection Before Installation of Biogas Plant

There are several sources of firewood collection before installation of biogas plant. Among them, own land (private forest), government forest and market have been taken into consideration. This is shown in table 6.17.

Table 6.17: Sources of Firewood Collecting

S.N.	Source	No. of Households	Percentage
1	Own land (private forest)	22	36.7
2	Government forest	30	50
3	Market	8	13.3
Total		60	100

Source: Field Survey, 2009.

Table 6.17 shows that about 50 percent out of total interviewed respondents reported that they collect firewood from government forest, followed by 36.7 percent collect firewood from own land (private forest). Only 13.3 percent out of total interviewed reported that they bring firewood from market. This table clarifies that the chief source of firewood collection is government forest.

6.6 Loan

Many financial institutions have provided loan for the purpose of installing the biogas plant. Majority of the people have used to take loan from these (financial) institution and few of them have not taken loan while installation of biogas plant.

6.6.1 Biogas Plant Installation on Loan

Majority of the households have taken loan from financial institutions. Few of (out of total interviewed) have not taken loan from these institutions. Table 6.18 clearly shows the situation of loan taken of sampled households.

Table 6.18: Installation of Biogas Plant on Loan

S.N.	Loan	No. of Households	Percentage
1	Loan taken	50	83.3
2	Loan not taken	10	16.7
Total		60	100
50 households out of total interviewed have taken loan			
S.N.	Sources of loan	No. of households	Percentage
1	ADB/N	40	80
2	Commercial Bank	8	16
3	Rural Development Bank	2	4
Total		50	100

Source: Field Survey, 2009.

Table 6.18 shows that about 83.3 percent of plant owners out of total interviewed reported that they have taken loan from financial institutions whereas only 16.7 percent plant owners haven't taken loan. They are dependent on self-finance.

This table also clarifies that majority of the plant owners (80%) have taken loan from ADB/N followed by 16 percent from commercial banks and only 4 percent have taken loan from Rural Development Bank. Data reveal that the major source of loan is Agricultural Development Bank, Nepal (ADB/Nepal).

6.6.2 Interest Rate of Loan

As we know in earlier table the major source of investment is loan from financial institution. Persons those who want to take loan should

pay certain interest rate. Interest rate is presented in table 6.19.

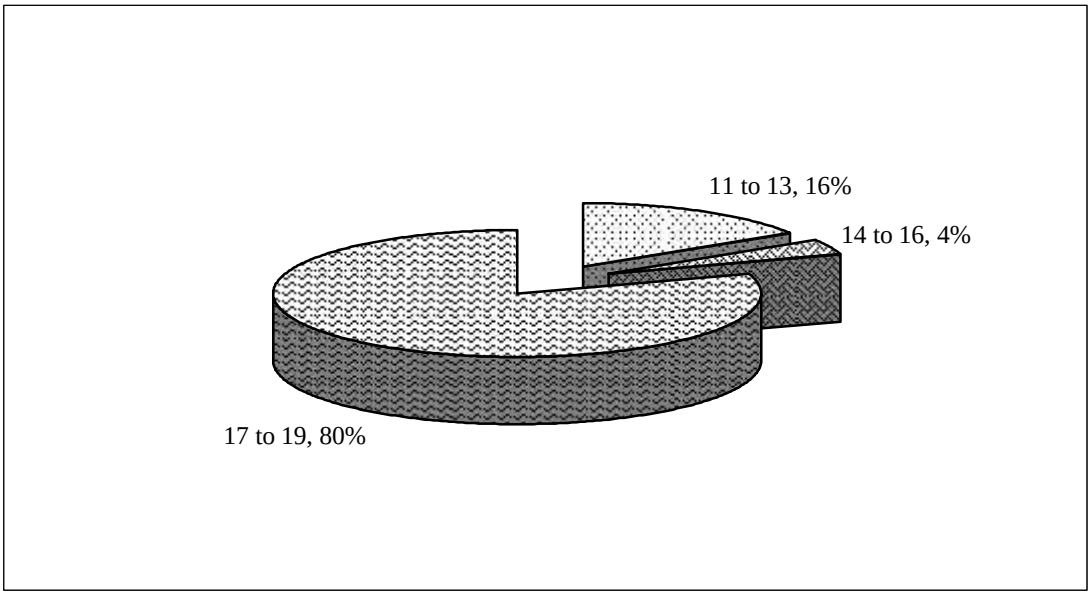
Table 6.19: Interest Rate of Loan

S.N.	Interest Rate (in percentage)	No. of Households	Percentage
1	11 to 13	8	16
2	14 to 16	2	4
3	17 to 19	40	80
Total		50	100

Source: Field Survey, 2009.

Table 6.19 shows the distribution of interest rate on loan. About 80 percent plant owners out of total interviewed reported that they have taken loan by paying 17 to 19 percent of interest on loan followed by 16 percent have paid 11 to 13 percent of interest on loan. And only 4 percent out of total interviewed plant owners have paid 14 to 16 percent of interest on loan. The average interest rate is 16.7 percent.

Figure 6.2: Interest Rat on Loan



6.6.3 Perception on Existing Interest Rate

In this study it is found out that the plant owners have different perception regarding the existing interest rate on loan. Perception of plant owners for interest has been presented in table 6.20.

Table 6.20: Perception on Interest Rate

S.N.	Perception	No. of Households	Percentage
1	Satisfied	6	12
2	Unsatisfied	44	88
Total		50	100
If not satisfied, tentative interest rate.			
S.N.	Rate of interest (in %)	No. of Households	Percentage
1.	6 to 8	20	45.4
2.	9 to 11	24	54.6
Total		44	100
Average Tentative Interest Rate is 8.63%.			

Source: Field Survey, 2009.

Table 6.20 shows that the perception of plant owners to the existing interest rate and tentative interest rate on loan which is provided for the installation of biogas plant. Among 50 plant owners those who have taken loan from financial institution, about 88 percent are not satisfied with the existing interest rate on loan whereas only 12 percent are satisfied with the existing interest rate of loan for biogas plant installation.

This study also found out that about 54.6 percent respondents out of total unsatisfied plant owners interviewed reported that the tentative

interest rate is 9 to 11 percent and only 45.4 percent respondents tentative interest rate is 6 to 8 percent. The average tentative interest rate is 8.63 percent. This study reveals that existing interest rate is high and it should be make low.

6.7 Health and Sanitation

The study has shown that biogas has positive impacts towards health and sanitation of the respondents. Change in surrounding after the installation of biogas plant and the feeling of the menace of flies, or mosquito. Remarkable achievement has been made on health and sanitation of household. The Situation of health and sanitation is presented below.

6.7.1 Change Found in Surrounding After the Installation of Biogas Plant

Table 6.21: Change Found in Surrounding

S.N.	Interest Rate (in percentage)	No. of Households	Percentage
1	In Health	22	36.7
2	In Hygiene	18	30
3	In Sanitation	12	20
4	All of Above	8	13.3
Total		60	100

Source: Field Survey, 2009.

Table 6.21 shows that about 36.7 percent respondents out of total interviewed reported that they found change in health, followed by 30 percent found change in sanitation. And only 13.3 percent respondents

out of total interviewed reported that they found change in all of above aspects. The change is considered the improvement in all these given aspects in this study.

6.7.2 Feeling on the Menace of Flies or Mosquito

Table 6.22: Feeling on the Menace of Flies or Mosquito

S.N.	Activities	No. of Households	Percentage
1	Feeling	10	16.7
2	Decreased	34	56.7
3	Remained Same	16	26.6
Total		60	100

Source: Field Survey, 2009.

Table 6.22 shows the distribution of feeling on the menace of flies, or mosquito, majority of the respondent (56.7%) out of total interviewed reported that the menace of flies or mosquito decreased whereas 16.7 percent expressed that the menace of flies or mosquito increased. Only 26.6 percent of respondent out of total interviewed reported that the menace of flies or mosquito remained same.

6.7.3 Money Spent on Health Treatment

In this study, amount of money spent on health treatment has also been studied. The money spent on health treatment is presented in Table 28.

Table 6.23: Money Spent 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	Lung Disease	200/-	50/-	150/_
2	Asthama	150/-	50/-	100/
3	Respiratory Problem Problem	100/-	40/-	60/

Source: Field Survey, 2009.

Table 28 shows that the amount of money spent 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. 150/- in the treatment of lung disease, Rs. 100/- in the treatment of asthama and Rs. 60/- in the treatment of respiratory disease. Hence, the respondent or plant owner is able to save Rs. 310/per year in the treatment of health related disease.

6.8 Social Impacts

Biogas plant installation has social impact, economic impact and environmental impact. Among them social impact of biogas is of great importance. Social impacts of biogas are mostly intangible and need to be assessed from user's perception. The outcome of this study showed that there were some positive impacts of biogas that influenced the social aspects of beneficiary households directly.

6.8.1 Raising in Social Status

Table 6.24: Raising in Social Status

S.N.	Raising in Social Status	No. of Households	Percentage
1.	Yes	52	86.7
2.	No	8	13.3
Total		60	100

Source: Field Survey, 2009.

Table 6.24 shows that about 86.7 percent respondents out of total interviewed reported that the social status has been raised after the installation of biogas plant whereas only 13.3 percent respondents reported that the social status has not been raised.

6.8.2 Benefited by the Biogas Plant

This study found that the women are highly benefited by the installation of biogas plant. It is also a social impact of biogas plant installation. The situation of benefited members of households has been presented in table 6.25.

Table 6.25: Benefited by the Biogas Plant

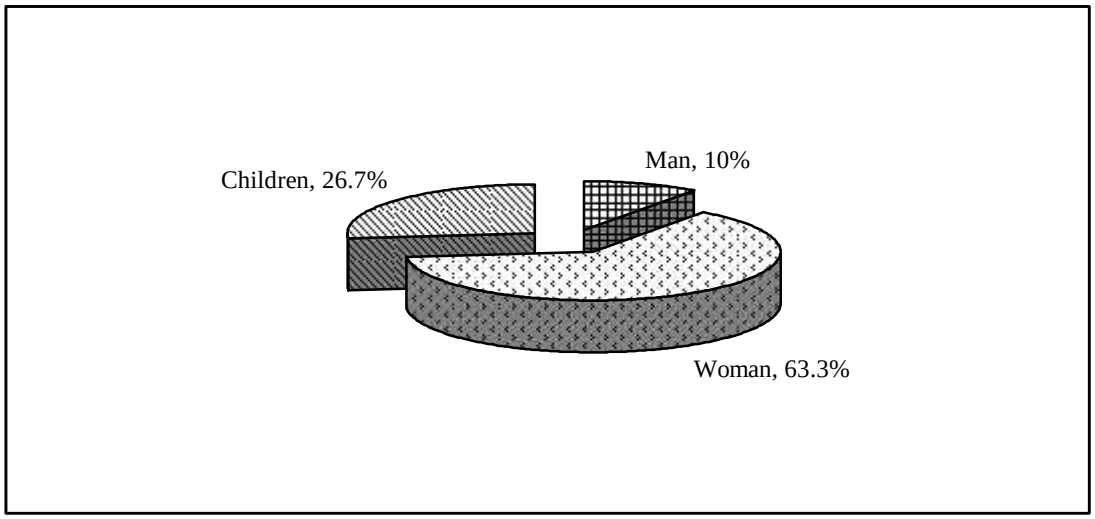
S.N.	Benefited Member	No. of Households	Percentage
1	Man	6	10
2	Woman	38	63.3
3	Children	16	26.7
Total		60	100

Source: Field Survey, 2009.

Table 6.25 shows that majority of the respondents out of total interviewed reported that the woman are highly benefited by the biogas

plant installation (63.3%) followed by 26.7 percent reported that children are benefited. And only 10 percent respondents out of total sampled households interviewed reported that men are benefited by the biogas plant installation.

Figure 6.3: Benefited by the Biogas Plant



6.9 Problems and Perceptions on the Use of Biogas Plant

There are so many problems of the use of biogas plant. Maintenance, operational, dung availability, temperature, water availability, gas leakages and paying loan are the major problems of biogas use. In this section perception of respondents also have been dealt in detail regarding the use of biogas.

6.9.1 Problems of Biogas Plant

Table 6.26: Problems of Biogas Plant

S.N.	Problems	No. of Households	Percentage
1	Maintenance	6	10
2	Operational	4	6.7
3	Dung Availability	10	16.7
4	Temperature	2	3.3
5	Water Availability	4	6.6
6	Gas Leakages	14	23.4
7	Paying Loan	20	33.3
Total		60	100

Source: Field Survey, 2009.

Table 6.26 shows that about 33.3 percent respondents out of total interviewed reported that they have problem of paying loan followed by gas leakages 23.4 percent, problem of dung availability 16.7 percent, problem of maintenance 10 percent, operational problem 6.7 percent, problem of water availability 6.6 percent and only 3.3 percent respondents have problem of temperature especially in winter season.

6.9.2 Perception of Respondents on Utility of Biogas Plant

Table 6.27: Perception of Respondent

S.N.	Utility of Plant	No. of Households	Percentage
1	Useful	28	46.7
2	Very Useful	30	50.0
3	Not Useful	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 6.27 shows that about 50.0 percent respondents out of total interviewed reported that biogas is very useful and 46.7 percent respondent reported that biogas is useful. Only 3.3 percent respondents out of total interviewed reported that biogas is not useful.

6.9.3 Opinion on the Overall Energy, Environment and Economic Condition

There are several opinions regarding the overall energy, environment and economic condition of the biogas plant installation. Opinions have been presented in Table 6.28.

Table 6.28: Opinion on the Overall Energy, Environment and Economic Condition

S.N.	Opinions	No. of Households	Percentage
1	Improved	30	50.0
2	Remained sarne	20	33.3
3	Don't know	8	13.4
4	Worse	2	3.3
Total		60	100

Source: Field Survey, 2009.

Table 6.28 reveals that about 50 percent respondent out of total interviewed reported that the overall energy, environment and economic condition has been improved. About 33.3 percent respondents out of total interviewed reported that the overall energy, environment and economic condition has been remained same. About 13.4 percent respondents reported that they don't know and only 3.3 percent respondents opined that the overall energy environment and economic condition have been worst.

CHAPTER - VII

MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 Major Findings

Biogas technology is an appropriate alternative source of energy for household purpose. Forest resource is only the source of fuel wood for daily requirement of energy in rural area. Excessive use of firewood directly leads into 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 Narayanpur VDC of Kailali district. Narayanpur lies nearby Tikapur Municipality. This study is based on the sample of 60 households who were selected by using simple random sampling technique. In this VDC, there are 1,800 households. There are altogether 11,560 people reside in this VDC. Total sample households are 60. Total sampled households occupy only 3.33 percent of the total households of Narayanpur VDC.

Before conducting the study, a brief review on existing literature was made. The review focused mainly on the impact studies. For the reviews, central library of TU, BSP office and biogas experts were consulted.

The major findings of the study are summarized as follows:

1. Size of $6m^3$ biogas plants was more popular in this area as

compared to other size of plants ($8m^3$, $10m^3$, $15m^3$).

2. This study found out that there were also the size of $10m^3$ biogas plants (6.7%) and $15m^3$ biogas plants (3.3%) installed. But these size of plants were installed in initial stage.

3. The main source of loan for investment was ADB/N (66.7%).

4. People installed biogas as a substitute to firewood and to have ease in cooking.

5. The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.

6. There is a considerable reduction in the workload of the family member and women are highly benefited (63.3%) by the biogas plant installation.

7. Subsidies provided by the BSP was very encouraging factor for installation of biogas.

8. Majority of time has been saved and the saved time has been used mostly in farm activities (43.3%) followed by income generation activities (33.3%).

9. Average amount of dung feeding was lesser than the capacity of plant.

10. Majority of the households have connected toilet (86.7%) with the biogas plant.

11. Medical expenses also has been reduced after the installation of

biogas plant.

12. Average livestock population size is 4.3 per household.

13. Average family size is 5.6 per household.

14. Average landholding. size is 17 Katthas per household.

15. The users felt reduction in health related problems such as eye burning, headache, and respiratory problems such as asthama.

16. Majority of the plant owners are not satisfied with the existing interest rate for loan and they also want to decrease the interest rate of the installation of biogas plant.

17. Almost of all plant owners use slurry on farm and agricultural production has been increased.

18. Majority of the respondents felt that the menace of flies, or mosquito has been decreased (56.7%).

19. 86.7 percent of respondents reported that the social status has been raised.

20. Majority of the respondents reported that the overall economic; environmental and energy condition has been improved (50%).

7.2 Conclusion

This study was conducted in Narayanpur VDC of Kailali district. Sixty households out of 1,800 households have been taken as sampled households. This study was confined only in Narayanpur VDC.

Being an appropriate alternative source of energy biogas technology has been proved very useful specially in rural setting. Biogas has improved the socio-economic condition of biogas plant owners. It has reduced the workload of women in household activities because before installation of biogas plant they had to invest more time and after the installation of biogas plant they have spent less time on cooking, cleaning utensils and collecting firewood.

Biogas technology has also improved the health and sanitation situation. It has helped to reduce the prevalence of smokeborne disease such as respiratory problem, headache and eye burning etc. This technology has also improved the overall energy, environment and economic condition of the plant owners.

This study also has reduced the rate of deforestation so it is highly effective on reducing the rate of deforestation. Before installation of biogas plant each household used to collect firewood from forest in large amount whereas after installation it has been reduced by 80 percent. Biogas plant has improved the surrounding environment. And it also has improved the economic condition by saving money spent on energy source such as kerosene, firewood and LPG.

This study has also found that the biogas plant byproduct (slurry) has many potential benefits as fertilizer for agricultural production. Bio Slurry has curtailed the use of chemical fertilizer and increased agricultural productivity with sustainability.

In a nutshell, biogas technology has been proved as an

appropriate alternative source of energy to fulfill the increasing demand of energy requirement for growing population in rural area of Nepal. It also has been able to protect the forest resource which is the main source for firewood in rural area. Hence, biogas technology is very much useful technology for rural households.

7.3 Recommendations

On the basis of analysis of this study, the following recommendations are drawn to formulate and adopt the policy by the concerned authorities to develop and promote biogas technology.

1. 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 uses of gas to other income generation activities.

2. A great deal of time and money of households has been saved after installation of biogas plant. Therefore, women members should have chance to work in income generation activities. Concerned authorities should pay attention to this.

3. Initiate R & D (Research and Development) for developing low cost models appropriate for the poorest section of the population.

4. Connection of the toilets to the biogas plants should be promoted. This would help further improving the sanitation.

5. 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.

6. Provision of easy loan and cheap interest rate on loan should be made including higher percentage of subsidy.

7. Importance and benefits of the biogas plant should be demonstrated.

8. Application of bio slurry on farm should be studied systematically, qualitatively and quantitatively.

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APPENDIX

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF RURAL DEVELOPMENT

KIRTIPUR, KATHMANDU

BIOGAS PLANT SURVEY IN NARAYANPUR VDC, KAILALI 2009

HOUSEHOLD SURVEY QUESTIONNAIRE

Name of Plant Owner/Respondent: ..... :

District: VDC: Ward No.:

Age/Sex: Caste/Ethnicity: Education completed:

Name of construction company:

Name of financing company:

Family size:

1. What is your family occupation?
   a) Agriculture b) Business c) Service
   d) Agri.+Service e) Agri.+Business
   f) Agri.+Business+Service g) Others (specify).....

2. How much agricultural land do you have (in katthas)?
   a) below 10 b) 11-20 c) 21-30
   d) 31-40 e) 41 and above

3. How did you come to know about biogas plant?

a) Radio/TV b) Newspaper c) Neighbours

d) GGCC e) Others (specify) .....

4. Who encouraged you to install the biogas plant?

a) Self interest b) NGOs c) Biogas company

d) Bank e) Others (specify).....

5. What are the reasons behind the installation of biogas plant?

a) Easy and smokeless cooking b) Toilet

c) Environmental protection

d) Get rid of firewood collection

e) Resource conservation

6. When did you install this plant?

Year: .....Month: .....

7. Have you attached toilet with this plant?

a) Yes b) No

8. If not, why?

a) Due to the concept of unholy b) Dirty

c) Separate toilet d) Sufficiency of gas

e) Others (specify).....

8. If yes, why?

a) Due to lack of toilet b) To increase gas

d) Lack of sufficient dung d) Others(specify) .

9. How much dung is necessary for this size of plant (in kgs)?

.....

10. How much water is necessary for mixing the dung (in liters)? .....

11. What is the source of water to mix dung?

a) Canal b) Pipe tap c) well

d) Electric motor e) Others (specify).....

12. What is the chief purpose for the installation of biogas plant?

a) Cooking b) Lighting c) Heating

d) Digested slurry e) Others (specify) .....

13. Dung production

Livestock	No. of livestock	Dung produced/day
Cattle		
Buffaloes		
Pigs		
Total dung produced per day		

14. For what this amount of dung is sufficient to feed your plant for your domestic purpose ?

a) Cooking b) Heating c) Lighting

d) Others.....

Purpose	Number of burner	No. of mantles	Use hours/ day
Cooking			
Lighting			
Total gas used per day (in hour)			

15. How much slurry do you generate daily (in kgs) ? .....

16. How much chemical fertilizer do you use?

Use of C.F.	Consumption		Cost per unit	Saving	Saving amount (in Rs.)
	Before installation	After installation			
C.F.					
Total saving per month (in Rs.)					

17. In which crops do you use most of the slurry?

a) Crop b) Maize c) Wheat

e) Vegetable f) Others (specify) .....

18. How do you use digested slurry?

a) Directly (liquid) b) In dried form (solid)

c) Making dung d) With irrigation water

19. Which source of energy did you use before installation of plant?

a) Firewood b) Electricity c) Dung cake

d) Kerosene e) Agricultural residues f) LPG

20. Do you save fuels after the installation of biogas plant?

a) Yes b) No

21. If yes, how much fuel is saved in terms of money ?

S.N.	Energy type	Consumption		Saving unit	Cost per unit	Saving amount
		Before	After			
1.	Firewood (in kgs)					
2.	Kerosene (in litre)					
3.	LPG (in cylinder)					
Total saving amount of money per month						

22. How much time do you require for cooking, firewood collection and washing utensils?

S.N	Activities	Responsible person	Time allocated		Time saved per day (in
			Before installation	After Installation	
1.	Firewood				
	Cooking				
3.	Washing utensils				
Total time saved per day (in hour)					

23. In which activity, do you utilize this saved time?

a) Farm activities b) Child care

c) Gardening d) Physical labour for wages

e) Income generating activity

24. Which is the source for firewood collection before installation of biogas plant?

a) Own land (Private forest) b) Govt. forest

c) Market d) Others (specify).....

25. Did you take loan for installing the biogas plant?

a) Yes b) No

26. If yes, which is the source of loan?

a) Moneylender b) Commercial Bank

c) ADB/N d) Rural Development Bank

27. How much percent interest do you pay for loan?

a) 8-10 b) 11-13 c) 14-16

d) 17-19 e) 20-22

28. Are you satisfied with the existing interest rate of loan?

a) Yes b) No

29. If not, what rate do you think is appropriate?

a) 3-5 b) 6-8 c) 9-11 d) 12-14

30. Is the saving from fuelwood, kerosene and or LPG sufficient to pay the annual installment?

a) Yes b) No

31. Is there any health problem before installing the biogas plant?

a) Yes b) No

32. If yes, which type of disease?

a) Eye illness c) Respiratory problem

e) Headache g) Others (specify) .....

33. If there any change after the installation of biogas plant?

a) In health b) In hygiene

d) All of above e) Others (specify) .....

34. What is your feeling on the menace of flies, or mosquitoes in and around your houses after the installation of biogas plant?

a) Decrease b) Increase c) Remained same

35. Money spend on Health treatment.

Treatment item	Money spend on treatment		Saving
	Before installation	After installation	
Lung disease			
Asthma			
Respiratory problem			
Others			
Total amount of saving per month			

36. Does biogas plant raise social status of the family?

a) Yes b) No

37. Which member of family is highly benefited by the plant?

a) Man b) Women c) Children

38. What are the problems faced with the installment of bio-gas plant?

a) Maintenance b) Operational

c) Dung Availability d) Temperature

e) Water availability g) Others (specify).....

39. What do you think about the plant?

a) Useful b) Very useful c) Not useful

40. What is your opinion on the impact of biogas plant on your overall energy, environment and economic condition of the household?

a) Improved b) Remained same

c) Worse d) Don't know

Thank You !