CHAPTER – ONE
INTRODUCTION

1.1 Background of the Study

Nepal is a small landlocked country which occupies 1, 47,181 sq. kilometer, 0.03% of total mass area in the world inhabitant by 27 million people between two powerful nations India and china. Being a landlocked country, overseas trade has minimum transactions. It is one of the poorest and least developed countries in the world with low per capita income of $310. Most of the people (82.5%) of the total population live in rural areas where as 17.5% lives in urban areas. Geographically, Nepal can be divided into three ecological regions that extend from east to west viz. The northern Himalayan region with a glaciers and peaks in middle. Mountain regions which include Mahabharata and Churiya mountains and south region is Tarai. The Tarai is regards as the food storage of the nation .It has very much plain and fertile land (WB, 2006).

Nepal has one of the lowest per capita income energy consumption in the world of just 15 Gj, in which the traditional source of energy shared the largest proportion of the total energy consumption in the country. 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 indicator, higher level of development. The low level of per capita energy consumption reflects the low level of development. Being the age of higher technological advancement, Nepal's energy consumption situation is miserable.

In the developing country like Nepal in rural areas people are still using traditional fuels, like firewood, agriculture residue and animal dung which cover 85.2% of the total fuel consumption (water and energy commission secretarial 2005). To meet the growing energy demand of increasing rate of population (2.24%), forest has been depleted rapidly day by day. If this trend is continued for next 50 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. (WECS 2003)

In this regards, Nepal has vast potential for the development of renewable energy resources. To face the problems occurring from depletion of forest traditional sources of energy should replace by renewable sources. The potential comes from the nature of the subsistence economy in the rural areas in agriculture and livestock and standard of sanitation there. For Nepal, being agriculture country, livestock plays an important role in the Nepalese farming system. The total households with cattle and buffalo in the Nepal were estimated to 2.7 million in 2001. Based upon the study of study of technical biogas potential of Nepal, it is estimated that a total of 1.9 million plants can be installed in Nepal out of which 57% in plains 37% in hills and rest 6%in remote hills or in mountain region. (BSP, 2008).

Potentiality and Biogas Construction:

Technical potentiality of biogas plants (2001) -1.9 millions. Total economic potentiality of biogas plants -1 million plants (source: BSP 2008).

Further it is highly experienced that the life of renewal women has become easier after the installation of biogas plants in rural households. After installation of biogas plants the consumption of women to fetch firewood has come to an end their time and energy have been saved and they are able to involve themselves in other economic works. In this way, alternative energy has emerged as an attractive option where one can reasonably except that properly harnessed bio-energy can achieve the sustainable economic development of the rural livelihood with less cost and time. Similarly, from gender point of view it has also made the life of women easier. Livestock is the integrate part of installing biogas plants in different parts of the country especially in Terai and mid hills. (Shrestha, 2007).

In 1992, biogas support program (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 10000 for hill districts. The subsides were provided through the BSP. Later, in 1995\1996, reduced by 1000 i.e. 6000 for Terai, 9000 for hills and 1100 for in accessible hills. Big size plants were discouraged small family sized biogas plants were offered with additional Rs. 1000 while subsidy was curtailed for $15m^3$ and $20m^3$ plants. (GGC, 2001).

1.1.1 Introduction to 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 methaneogenic 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 LPG. The biogas is colorless, odorless and burns with a clear blue flame (BSP 2007).

Biogas is used for cooking and lighting, refrigerator engine operation and electricity generation. Today, biogas is used mainly for cooking (80%) and lighting (20%) in Nepal. (BSP 2007 the biogas plants have been constructed under BSP has following characteristics.

- ✓ Fixed dome(GGC 2007 model),
- ✓ Sizes 4,6,8 and 10 cubic meter,
- ✓ Feeding materials: cattle dung and water and human excreta,
- ✓ Individual household plant,
- ✓ Feasible up to 2100meter altitude,
- ✓ Modified GGGC-2047 with leap composting techniques is recommended for up to 3000 meters altitude. (BSP, 2007).

1.1.2 Uses and Benefits of Biogas Plant Installation:

The chief purposes behind the installation of biogas plant are cooking and lighting. It is used in cooking stove in the kitchen. It burns with a clear blue and smokeless flame. The utensils remain neat and clean and cooking environment becomes healthiest. 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 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 environment degradation.

1.1.3 The History of Biogas in World and Nepalese Context

The first person to observe the decaying vegetation produced a combustible gas was Alexander Volta in 1776. He was an Italian national. He had noticed that when he disturbed the bottom sediment of the lake, bubbles of gas would rise to the surface. He noticed that when the sediment contained more plant material, more bubbles came up. The first plan for production of methane gas from wastes was set up in a leper asylum in India in 1990. The interest in biogas reached to the peak in the beginning of Second World War.

In 1940, French scientist working in north America developed the technology of production of biogas from agricultural wastes and it was reported that about 1000 biogas plants were in operation in France and French north Africa by 1950(New ERA, 1985)

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

Interest on biogas increased slowly. Government authorizes 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 establish 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.

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

In 1992, Biogas support program (BSP) was initiated as a joint venture of ADB\N, GGC and SNV-Nepal. In 1992, the subsidy scheme was charged to Rs.7000 in Terai and 10000 for hill districts. The subsides were provided through the BSP. Later in 1995/19996 Rs.12000 was granted for inaccessible hill districts. From 1999/2000, the subsides were reduced by 1000 i.e. 6000 for Terai, Rs.9000 for hill and Rs.11000 for inaccessible districts of hill. Big sized plants were discouraged and small family sized Biogas plants were offered with additional Rs.1000 while subsidy was curtailed for $15m^3$ and 20m3 plants.

1.2 Statement of the Problem

Despite of higher technology advancement in the field of energy generation many developing countries are facing the energy related problems such as rising prices of fossil fuels, depletion 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 cooking, lighting and heating etc. firewood, animal dung, agricultural residue and solar energy are used by the people household and also in agriculture sector on 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 firewood 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 to sustain the increasing demand of energy for growing population. Although there is huge potentiality 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 ventilate room with traditional store creates smoke

borne diseases such as respiratory problem including long-term 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 of 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 polluted 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 Lele of Lalitpur. Slurry reduces the undue use of chemical fertilizer leading to higher productivity in Lele VDC of Lalitpur, 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, human excreta and 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.

1.3 Objectives of the Study

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

1. To examine whether the biogas is an appropriate alternative source of energy.
2. To find the impact of biogas on Socio-economic situation, health and environment.
3. To identity the potential benefits of biogas plant by product (slurry) as fertilizer for agriculture production.

1.4 Significance of the Study

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 disaster such as flood, landslides, soil erosion and desertification. Installation of biogas plants 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 biogas plant installation in rural areas.

In Nepal, hydropower has great potentiality but it is untapped due to lack of capital and trained manpower. Likewise, wind power and solar energy including other renewable source 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 source 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 farming. Biogas has both positive and negative impacts on its uses. Except the increase in the prevalence of mosquitoes especially in Tarai, biogas has several positive impacts upon its users.

1.5 Limitations of Study

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

- This study is primarily based on socio-economic impact of biogas plants installation in Lele of Lalitpur.
- This study deals with the problems and importance of biogas plant installation in Lele VDC only.

- This study considers only socio-economic aspects but not the technical aspects of biogas plant installation.
- 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 for the secondary source such as books, booklets, journal, newspaper, unpublished thesis and official data etc.
- It is an individual study, so it can not cover whole aspects of biogas but it can be reference for further study in the field.

1.6 Organization of the Study

The study has been organized in to five 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 is related with the literature review which includes conceptual review and review of literature in chronological order. It also comprises the policy of government relating to biogas and institutions related to biogas promotion.

Chapter three is related with the research methodology which comprises research design, rational for the selection of the study area, introduction of the study area, nature and source of date, sample size, tools and technique of data collection and analysis and presentation of data.

Chapter four is related with the socio-economic impacts of biogas plant owners. Among them socio-economic characteristic of the biogas plant owners, installation and use of biogas, social impacts of biogas installation, economic impacts of biogas installation and environmental impacts of biogas installation.

Chapter five is related with the major findings, conclusion and recommendation.

CHAPTER-TWO
LITERATURE REVIEW

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

2.1 Conceptual Review

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 mainly composed of 60-70 percent methane 30-40 percent carbon dioxide and some other gases. The biogas is colorless, odorless and burns with a clear blue flame similar to LPG (BSP, 2004)

Biogas is a wet gas as it picks up water vapor from slurry. Biogas is 20 percent lighter than air. The main component of biogas is methane which is colorless, odorless and tasteless. But due to the presence of other gases, it gives some similar 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 fees tock for methane generation. The technology of using other plant materials

as feedback 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 agriculture, crops and vegetable (Karki, 1994).

In biogas technology an anaerobic fermentation of organic waste takes place causing its decomposition and a mixture of gases containing methane 60%-70% evolves. After the fermentation, the sludge like residue which is left behind can be used as an organic fertilizer. The gas is colorless, odorless as well as toxic less 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, higher is the level of daily gas production. Temperature between 30-35c, is taken as suitable one for fermentation. Likewise pH of 7 to 8 is considered as the best (ADB/N, 1996)

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, contraction materials, climate, chemical and microbial characteristics of inputs) and the interrelationship 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 served as cooking; biogas is faster than using kerosene of 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 which raises the productivity and lessens the requirement of chemical fertilizer. From the macro perspectives it saves the natural resource 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 is made as of:

Bista (1981) has focused that biogas is considered as one of the most reliable alternative energy resources 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. Dadhikot village of bhaktapur district for hill site and phoolbari 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 on the various type of benefits obtained and savings made through the installation of biogas plants.

Energy situation 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 workload in different geographical setting of Nepal and the studies were done in Rolpa, Rupendehi, Nuwakot and Chitawan 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 women. So called traditional or unequal patterns in the division of labors are sustained with working women for long hours simply substituting one labor 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 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.

Adhikari (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 Ishaneshwor 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 impacts of biogas on health and sanitation.

BSP (1996) has assessed the operation and maintenance of the plant. 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 hectors of forest. The study noticed that user's 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 resource cattle 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 on Nepal) would save about 4 million total of firewood per year.

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

Nuwakot, Kailali and Morang district 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 efficiency.

2.3 Policy of Government Relating To Biogas

By installation of biogas plant, the major benefits for women and children are seen in the changes in cooking environment such as biogas cooking produces no smoke which means that eye and lungs disease can be reduced, cooking utensils gets less dirty. Then firewood and cooking on biogas comes easier and faster. Similarly, it is less time consuming than collecting firewood and making dung cake preparation, girls gets more time for other activities going to school.

The seventh plan (1985-1990), for the first time, recognize the role of RETS in the conservation of forest and in providing alternative sources for meeting the energy needs of the rural population. The plan incorporated few policies addressing technology like biogas, solar thermal, wind energy, improved cooking stoves (ICS) and small water mills. A few policies and program on RETS relevant to sector were as follows:

- Encouraging the development of alternative energy sources especially biogas, solar and wind energy with emphasis on making the private sector participation more active.
- Set forth target to install a total of 4000 biogas system and provisioned 25 percent subsidy on investment costs and 50 percent subsidy on bank loans,

- Allocated budget for on estimated expenditure of NRS. 154.80 million For the development of RETS and expected private sector to interest NRS. 104.8 million. A sum of nrs.50 million was allocated for the subsidy and the balance was for support activities.

In the tenth plan (2002-07), as the popularity of biogas is growing among rural families due to its diverse benefits. It would be expanded since it saves firewood, reduce dependency on imported energy and there is no negative impact in the people's health. In addition, the use of biogas plant brings no environmental pollution and the slurry which comes out from the plant as by product is used as the best fertilizer. So, the tenth plan has set a target of installing a total of 200000 biogas plant s including 199500 households' biogas system and 500 community biogas system in 65 districts. Priority will be given to suitable and relatively smaller size plants and necessary research would be carried out for its expansion in the Himalaya region and towards reducing the cost. (Silwal, 1999)

2.4 Energy Situation in Nepal

The energy resources of Nepal can broadly be classified into three categories:

- Traditional
- Commercial
- 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 export. Energy sources other than traditional and commercial energy are included in the alternative energy. Nepal has huge

potentiality of hydropower estimated at 83,000 MW of which 40000 MW is considered to be technically feasible. But till now, only 400 MW of hydropower has been installed which contributes about one percent of total energy requirement of the country.

Firewood contributes about 78 percent of total energy consumption, which mainly consumed in rural Nepal. Forest (which includes community, public, Private forest) and private farms are the sources of firewood. The resources for the firewood are depending due to over exploitation and lack of proper management.

Other biomass sources, agriculture residue and animal dung contribute about 10 percent of energy requirement. Petroleum and coal together makes about 12 percent of the total consumption. These are completely imported. Sector wise analysis shows that residential sector consumes about 89 percent of the total energy consumption. Nepal's per capita energy is estimated to be 14.6 Giga joules.

About 87 percent of the Nepalese people live in rural areas and rural residential sector consumes 89 percent of the total energy. Cooking activates makes a share of 65 percent of the total rural energy consumption. The rural area consumes only 30 percent of total commercial energy.

2.5 Institutions Related to Biogas Promotion

Biogas support program (BSP), Nepal biogas promotion group (NBPG), and Alternative Energy promotion centre (AEPC) are the prominent institutions related with biogas sector. These are working for promotion and development of biogas in Nepal. Brief descriptions of these institutions are as of:

a. Biogas Support Program

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

For the Nepal two phases of the program, BSP I and II program was provided by His Majesty's Government of Nepal, the Netherlands development cooperation in Nepal (NSC/N) and the Netherlands Development Agency (NDA). With the start of third phase of the program (BSP III, 1997-2002), the German Government, through KFW, enforced the programs support with financial assistance to the subsidy and component.

Implementation of BSP III is done with three banks (agricultural Development Bank of Nepal, Rastriya Banijya Bank and Nepal Bank limited),and 50 recognized private biogas companies. 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 program,

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

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

B.Nepal Biogas Group

NBPG is association of all biogas company. It was established in 1995 and consisted of representative 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:

- Solve the problem with the banks,
- Facilitate import of biogas appliances,
- Avoid unhealthy competition among the member biogas companies,
- Gradually take over the activities of the promotion of biogas, training and extension activities combined out by BSP (Silwal, 1999).

c. Alternative Energy Promotion Centre

An apex institution was felt needed for the development of biogas. As a consequence, His majesty's Government, ministry of science and technology established the Alternative Energy Promotion centre (AEPC) in November 1996. The AEPC's function includes:

- Analysis of policy issues and advice on policy matters,
- Coordination with other sectors and ministries,
- Preparation of sector- wise plans and targets,
- Elaboration of regulatory frameworks; setting of standards and guidelines,

- Criteria for registration and licensing of companies,
- Mobilization of funds and liaison with donors,
- Review/approval of annual works plans in respect of donor-funded projects in alternative energy,
- Monitoring of development in the alternative energy sector as a whole,
- Organize and participate in program and project evaluations.

CHAPTER-THREE
RESEARCH METHODOLOGY

This chapter deals with the research design, introduction to the study are, source of data, sample size and analysis and presentation of the data. The whole study is carried out on the basis of primary as well as secondary data. Tools of data collection and organization of the study are also included. Different prcedures have been followed.

3.1 Research Design

The research is based on the exploratory and descriptive research design. It is exploratory because it has tried to accumulated the primary data and it is descriptive as the stuffy describes the different caused for and against the significances of the technology. Hence it is of importance that various conditions prevailing in the respective households selected for the study after the installation of biogas plants is also know to compare them with the conditions. The historical and other references are also taken for assistances of the micro level. In order to fulfill the objectives, information's has been collected from the field survey, questionnaire, interview and observations which were the main techniques that have been used to obtain the information as from the biogas users families have been taken into considerations for interview.

3.2 The Universe and Sample

The case is conducted at Lele VDC of Lalitpur district. All together 55 (70%) households out of 82 households having biogas plants were taken as sample in the present study. During the field survey all kinds of plants having different capacity and different age group of people were chosen by random sampling technique.

3.3 Nature and Sources of Data

On the basis of nature, both quantitative data has been agglomerated. The age, sex, occupation, income belongs to the quantitative nature where as why and how they are dependent on biogas energy is collected hereby in qualitative nature. On the basis of resources both primary and secondary data has been collected during the entire research process.

a. Primary Data

The primary information is collected during the field survey with the help of questionnaire. The questionnaire includes the various aspects of biogas plant installations 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 installation including health and sanitation situation.

Interview method is used to collect the quantitative information from biogas plant owner or respondents. Thus the study was primarily based on questionnaire with 55 sample informants who gave their opinion on different topic of general concern.

b. Secondary 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 material concerning to the biogas plants such as book , journals , newspaper ,published and unpublished articles and other reports etc.

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

- Previous studies and research reports and records of relevant agencies
- Program reports [activities reports , and the annual reports of the program]
- Major conference report of biogas support programs and other official documents etc.

c. Sample Size and Sampling Procedure

Selected study area Lele VDC has altogether 9 wards. There are 82 households having biogas plant. Out of total households, only 55 samples, biogas plant have been selected by using sample random sampling technique (lottery method)

The name of the selected households has been transformed in to questionnaire and the houses of these owners have been searched purposively and survey conducted. The households head is selected for the interview. In case of absence of households head other senior family members have been interviewed of the sample households.

3.4 Techniques and Tools of Data Collection

Mainly primary data are taken for the story and this study has been collected from the field survey. They are use to estimate and analyze the socio-economic impact of biogas on the survey and surveyed households. The questionnaires serve as the chief sources of primary data while

secondary data were taken from the concerned institutions and books. Following techniques has been used for data collection

a. Observation

Some of the biogas plants are observed directly to have better idea about the biogas plant. Observation include following;

- Biogas plant under construction ,
- Working of biogas plants
- Working of cooking gas stoves,
- Site of slurry output and its utilization in garden and fields

b. Household Survey Questionnaire

Keeping in view of the objectives, a detail structured questionnaire had been developed for direct interview. Serious precautions have been taken while conducting interview. Various kinds of data such as socio-economic characteristic of the biogas users, impact of biogas on the user after its installation etc. has been collected from questionnaire. The questionnaire has been finalized after consulting supervisor of the researcher. The appeared questionnaire has served as a basic tool of data collection.

c. Key Informant Interview

The primary data also collected from key informants using the semi or unstructured interview method. Interview was taken as cross checking for data obtaining from questionnaire. The informants were interviewed on the impacts of biogas on health and hygiene, sanitation, environment, workload etc. the numbers of participants in key informant interview were

7 people. To collect these information and data than those covered by the questionnaire, interviews with open ended questions was made with concerned people who included:

- Government and NGO officials,
- Municipality (area) people,
- Staffs of biogas companies,
- Masons and labors,
- Owner4s of biogas plants,
- Household without biogas plants etc.

d. Focus Group Discussions

The concerned users in the community were consulted for focus group discussions. The number of participants in each discussion ranged from 8 to 10 numbers. Information related to the impacts of biogas on environment, social life, health and sanitation and other relevant issues were collected during focus group discussion. The focus group discussions were divided into two groups.

3.5 Analysis of Data and Interpretation

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

CHAPTER-FOUR

SOCIO-ECONOMIC STATUS OF PLAN OWNERS

This chapter basically consists of the analysis of the data obtained from field survey conducted in 2011. This chapter deals with the socio-economic condition of the biogas plant owners in Lele VDC of Lalitpur district. Family size, Caste/ethnicity, Occupation, educational status and land holding are the main variables considered in this study.

4.1 Socio-Economic Characteristics of the Biogas Plant Owners

4.1.1 Family Size

The result of the survey reveals that average family size of the sampled biogas households is 5.6 (Table 1). Household with maximum number of family members have 9 where as the minimum number is 3 (Table 1). Table 1 shows that distribution of households by family size.

Table 4.1: Distribution of Households by Family Size

S.N	Family size	No. of households	Percentage
1	1-3	5	9.1
2	4-6	35	63.6
3	7 and above	15	27.3
Total		55	100.0
Average Family size is 5.5 per households			

Source: Field survey, 2011

Table 4.1 shows that among all plant owners, 35 household (63.6%) have 4 to 6 members. Only 15 households (27.3%) have 7 and

above members. 5 households (9.1%) have 1 to 3 members. The average family size is 5.5 households.

4.1.2 Caste/Ethnicity

There are different castes and ethnic groups in Lele VDC, Lalitpur. The data on ethnicity of the sampled biogas households is given in Table 4.2.

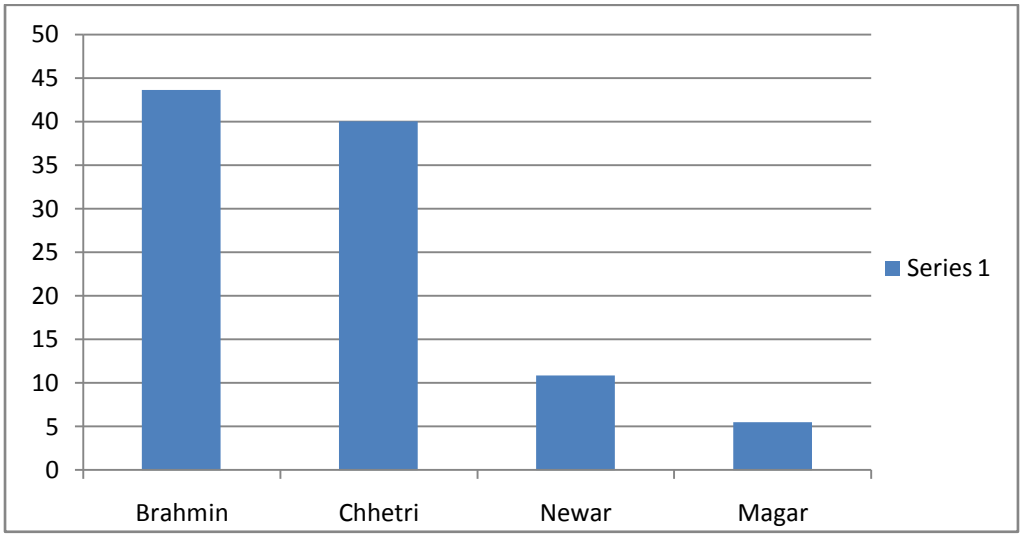
Table 4.2: Distribution of Caste/Ethnicity

S.N	Caste/ethnicity	No. of households	Percentage
1	Brahmin	24	43.6
2	Chhetri	22	40.0
3	Newar	6	10.9
4	Magar	3	5.5
Total		55	100.0

Source: Field survey, 2011

Table 4.2 shows that the majority of the households under study are Brahmins (43.6%) followed by Chhetri (40%), Newar (10.9%) and Magar (5.5%). The reason behind the higher percentage of biogas users (Brahmins) is found that they are socially and economically forward in each and every sector.

Above table is made clear in the following figure no. 1



4.1.3 Occupation

The main occupation of the plant owners is agriculture. Besides agriculture, agriculture and service are the main occupation of plant owners. Major occupations practiced by the sampled households are given in the table 4.3.

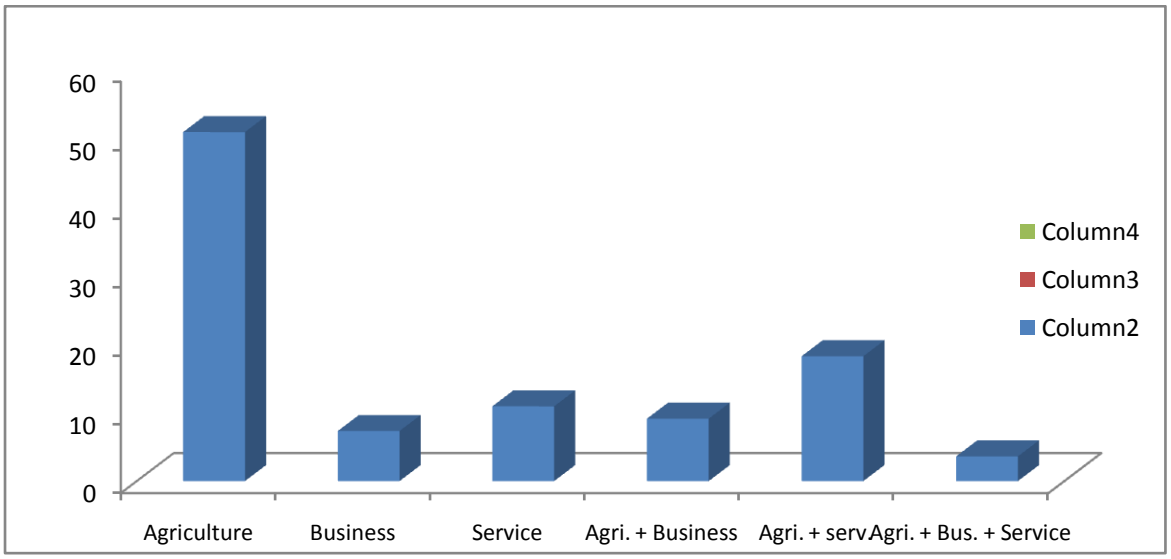
Table 4.3: Distribution of Respondents by Occupation

S.N	Occupation	No. of Households	Percentage
1	Agriculture	28	50.9
2	Business	4	7.3
3	Service	6	10.9
4	Agri. + Business	5	9.1
5	Agri. + Service	10	18.2
6	Agri. + Business + Service	2	3.6
Total		55	100.0

Source: Field survey, 2011

Table 4.3 shows that the higher percentages of the plant owners are engaged in agriculture sector. About 51percent of the plant owners are involved in agriculture, 18.2 percent in agriculture plus service, and 10.9 percent in service, 9.1 percent in agriculture plus business and 3.6 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.

Above table is made clear in the following figure No. 2



4.1.4 Educational Status

Most of the plant owners are literate (85.5%).About 20 Percent owners out of total interviewed have completed class 1 to 5. 40 percent have completed grade 6 to SLC and remaining 25.5percent of total plant owners have completed grade SLC and above. Table 4.4 shows the educational status of the sampled plant owners.

Table 4.4: Distribution by Educational Status

S.N	Education	Male		Female		Total	
		No.	%	No.	%	No.	%
1	Illiterate	3	7.5	5	33.3	8	14.5
2	1 up to 5 class	7	17.5	4	26.7	11	20
3	6 up to SLC	19	47.5	3	20	22	40
4	SLC and above	11	27.5	3	20	14	25.5
Total		40	100.0	15	100.0	55	100.0

Source: Field survey, 2011

The data present in table 4.4 reveals that majority of the plant owners are literate (85.5%). Among male 47.5 percent respondents have completed class 6 up to SLC. Among female only 20 percent have completed grade 6 up to SLC. This result shows that only 8 persons (14.5%) are Illiterate and they are old. Only 7.5 percent of total illiterate are male whereas 33.3 percent are illiterate out of total illiterate female. So, the education status of the plant owner is satisfactory.

4.1.5 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 in to account. Table 4.5 shows the distribution of land holding of the plant owners.

Table 4.5: Distribution by Landholding

S.N	Land (in Ropani)	No. of households	percentage
1	Below 5	8	14.5
2	6 to 10	10	18.2
3	11 to 15	22	40
4	16to 20	11	20
5	21 and above	4	7.3
Total		55	100.0
Average Landholding is 12.3 Ropanies per households			

Source: Field Survey, 2011

Table 4.5 shows that average landholding size per households is 12.3 Ropanies.The maximum landholding of the visited households is 24 Ropanies and minimum land is 4 Ropanies. Majority of the plant owners (40%) have 11 to 15 Ropanies of land and only 7.3 percent have 21 and above Ropanies of landholding.

4.2 Installation and uses of Biogas Plant

This section includes the size, source, reason, impact of biogas in reduction of work load, uses of saved time, impacts on health and sanitation and other social, environmental impacts and impacts of slurry on production.

4.2.1 Size of Biogas plant

Various types of biogas plants having different size have4 been introduced on promoting and development of biogas. $4m^3$, $6m^3$, $8m^3$, $10m^3$ are widely used size of biogas plants. But biogas plant of $6m^3$ is appropriate in rural area.

Table 4.6: Distribution of Biogas Plant by Size

S.N	Plant size	No. of Households	Percentage
1	$4m^3$	2	3.6
2	$6m^3$	49	89.1
3	$8m^3$	4	7.3
	Total	55	100.0

Source: Field Survey, 2011

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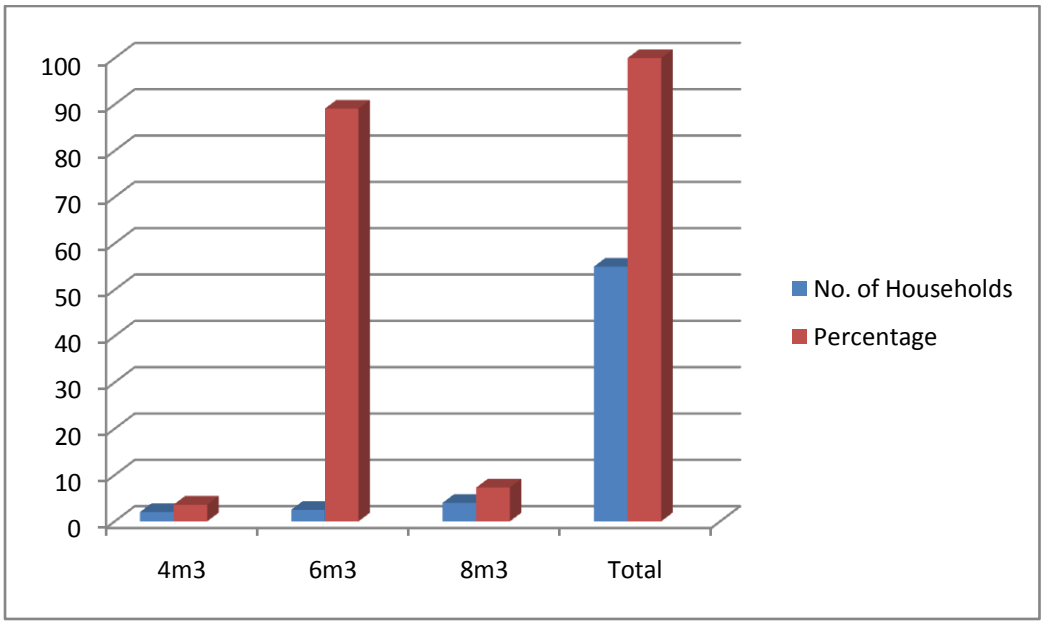

Table 4.6 Shows that only three types of biogas plant sizes, $4m^3$, $6m^3$, and $10m^3$ were reported. About 89 percent of interviewed households have $6m^3$ capacity plant followed by $8m^3$ capacity (7.3%) and $4m^3$ capacities.6%). This study shows that $6m^3$ capacity plants have been widely used in the study area.

4.2.2 Sources of Information

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

Table 4.7: Distribution by Sources of Information

S.N.	Sources	No. of Households	Percentage
1	Radio/T.V.	7	12.7
2	Newspaper	10	18.2
3	Neighbor	29	52.7
4	GGC	9	16.4
	Total	55	100.0

Source: Field survey, 2011

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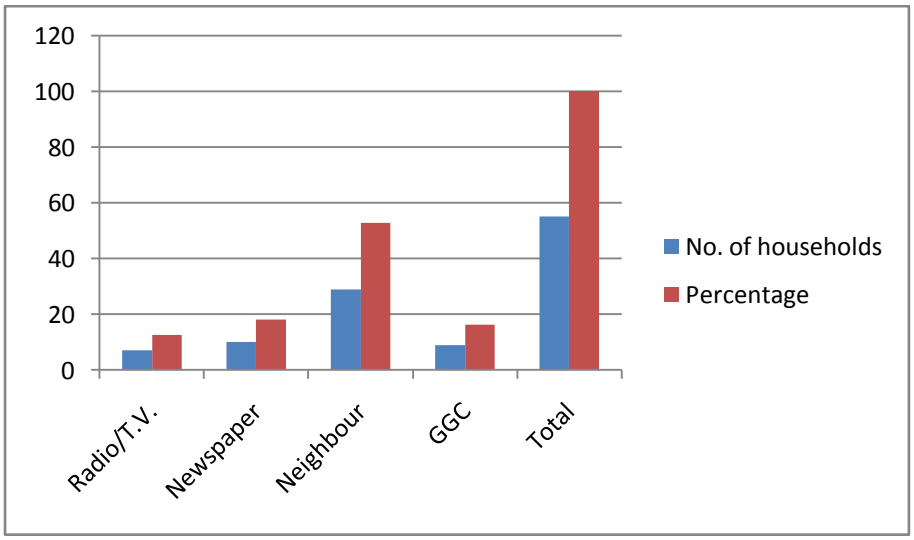

Table 4.7 shows that majority of the plants owners (52.7%) has neighbor as a source of information followed by newspaper (18.2%), Gobar Gas Company (16.4%) and Radio/T.V. (12.7%).

4.2.3 Reasons For the biogas plant installation

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

Table 4.8: Reasons for Biogas plant Installation

S.N.	Reasons	No. of Households	Percentage
1	Easy and smokeless cooking	41	74.6
2	Toilet	2	3.6
3	Environmental Protection	4	7.3
4	Resource Conservation	2	3.6
5	Get rid of firewood collection	6	10.9
Total		55	100.0

Source: Field survey, 2011

Table 4.8 shows that the main reason behind the installation of biogas plant is easy and smokeless cooking (74.6%) followed by get rid of firewood collection (10.9%) and environmental protection (7.3%). only 3.6 percent out of total interviewed reported that the main reason for biogas installation is resource conservation and due to lack of toilet.

4.2.4 Construction Company

Recent data reveal that more than 50 private construction companies have been established. They contribute to promote and develop biogas. Table 4.9 shows that distribution of Construction Company.

Table 4.9: Distribution by Construction Companies

S.N	Construction Companies	No. of Households	Percentage
1	Everest Gobar Gas (EGC)	10	18.18
2	Gobar Gas Tatha Krishi Yantra Bikash(GGC)	29	52.73
3	Rapti Renewal Energy Service(Rap)	4	7.27
4	Rastriya Gobar Gas NirmanTathaSewa(RGG)	12	21.82
Total		55	100.0

Source: field survey, 2011

Table 4.9 shows that majority of the plants (52.73%) are constructed by Gobar gas tatha Krishi yantra Bikash (GGC) which is followed by Rastriya Gobar Gas Nirman tatha Sewa (21.82%).Least number of plants (7.27%) are constructed by Rapti Renewal Energy Service (RAP) and that of Everest Gobar Gas(EGC) is (18.18%).

4.2.5 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 the biogas also has solved the problem of toilet.

Table 4.10: Toilet Attached With Biogas Plant

S.N.	Toilet Attached	No. of Households	Percentage
1	Toilet Attached	45	81.8
2	Not Attached	10	18.2
Total		55	100.0

Reasons to Attach Toilet with the Plant.

S.N.	Reasons	No. of Households	Percentage
1	Due to lack of toilet	12	21.8
2	To increase gas	28	50.9
3	Lack of sufficient dung	15	27.3
Total		55	100.0

Source: Field survey, 2011

Table 4.2.5 shows that majority of households out of total interviewed reported that they have attached toilet with biogas plant (81.8%) whereas 18.2 percent reported that they have not attached toilet with the biogas plant.

This study also reveals that the main reasons to attach toilet is to increase gas (50.9%) followed by due to lack of sufficient dung (27.3%) and lack of toilet (21.8%).

4.2.6 Livestock

Livestock is an integral part of agriculture 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.

The situation of the livestock holding in the sampled households in the study area is presented in table 4.11

Table 4.11: Livestock Population

S.N	Total no. of Livestock	No. of Households	Percentage
1	Below 3	34	61.8
2	4 to 6	16	29.1
3	7 and above	5	9.1
	Total	55	100.0
Average livestock population is 3.4 per households.			

Source: Field survey, 2011

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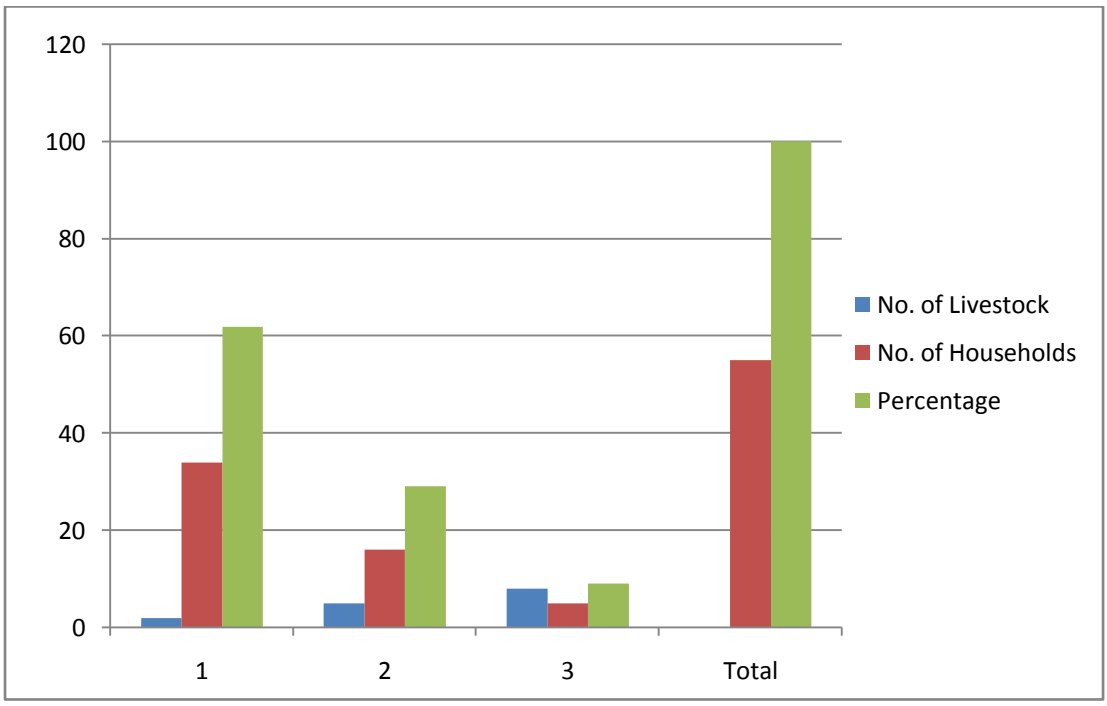

Table 4.11 shows that the average livestock population is 3.4 per households. About 61.8 percent respondents out of total interviewed reported that their livestock population is below 3 which is followed by 4

to 6 (29.1%) and only 9.1 percent out of total interviewed stated that their livestock population is 7 and above.

4.2.7 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 households in the study area is presented in table 4.12

Table 4.12: Dung production

S.N.	Dung produced per day(in kg)	No. of Households	Percentage
1	Below 10	12	21.8
2	11 to 20	20	36.4
3	21 to 30	13	23.6
4	31 to 40	8	14.5
5	41 and above	2	3.7
Total		55	100.0
Average dung production per day is 19.2 kg			

Source: Field survey, 2011

Table 4.12 shows that majority of plant owners (36.4%) have 11 to 20 kg dung production per day. About 23.6 percent have 21 to 30 kg of dung production per day where as only 13.7 percent have only 41 and above kg of dung production. A bout 14.5 have 31 to 40 kg and 21.8 percent out of total interviewed households reported that they have below 10 kg of dung production per day.

4.2.8 Dung Feeding per day

Majority of households have habit of dung feeding which is less than recommended amount. Dung feeding situation of sampled household in the study is presented in the table 4.13

Table 4.13: Dung Feeding Per Day

S.N	Amount of Dung (kg/day)	No. of households	Percentage
1	10	22	40
2	15	23	41.8
3	20	8	14.5
4	25	2	3.7
Total		55	100.0
Average Dung feeding per day is 14 kg.			

Source: Field survey, 2011

Table 4.13 shows that the average dung feeding per day is 14 kg. About 41.8 percent of respondents out of total interviewed households reported that they use to feed 15 kg dung per day. It is followed by 10 kg. Per day (40%), 20kg per day (14.5%) and only 3.7 percent out of total interviewed households use to feed 25 kg of dung per day. Majority of the households use to feed dung less than recommended amount by Biogas Company.

4.2.9 Ratio of Mixing

Dung has to be mixed with water at the time of feeding of the biogas plant. The recommended amount of water is equal part to the dung according to the norms of biogas companies. Production of biogas will be affected if the amount of water is too less or high.

Table 4.14 Ratio of Mixing

S.N.	Water to dung	No. of households	Percentage
1	1(Normal slurry)	36	65.4
2	<1(Thicker slurry)	9	16.4
3	>1(Dilute slurry)	10	18.2
Total		55	100.0

Source: Field survey, 2011

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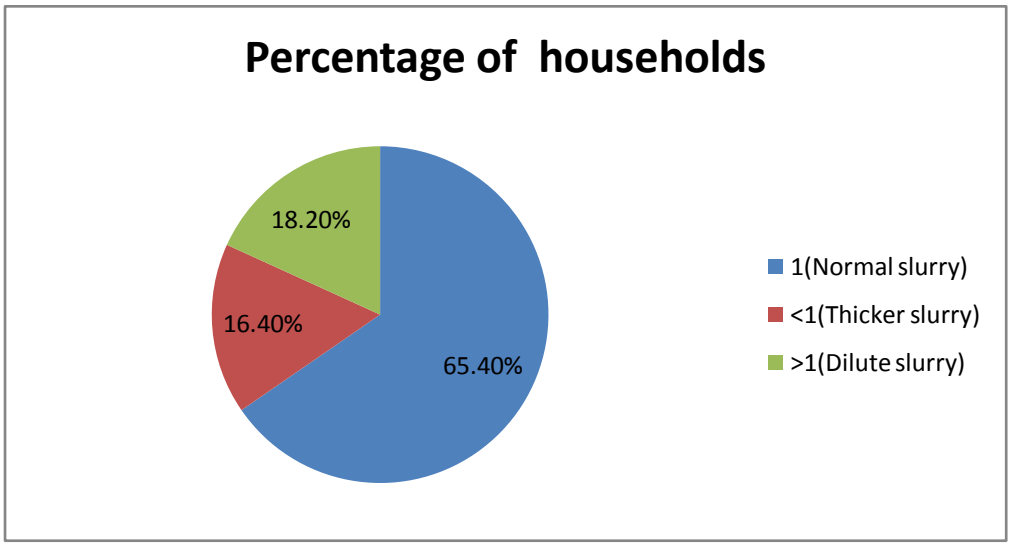

The table shows that 4.14 percent of the households used equal amount o Dung and water, 16.4 percent of the households used less than recommended and 18.2 percent of the households used more than recommended amount of water.

4.2.10 Use of Biogas

All the households reported that they are using biogas only for cooking purpose. As there is provision of electricity of facility of electricity, use of biogas wasn't lighting purpose. Majority of the households had two gas burners in their kitchen.

On an average, one household used biogas for 4.5 hours per burner. The minimum use was 2 hours while maximum use was 6 hours.

4.3 Social impacts of Biogas Installation

Biogas Plant 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.

4.3.1 Raising in Social Status

Table 4.15: Raising in Social Status

S.N.	Raising in social status	No. of Households	Percentage
1	Yes	43	78.2
2	No	12	21.8
Total		55	100.0

Source: Field survey, 2011

Table 4.15 shows that about 78.2 percent respondents out of total interviewed reported that the social status has been raised after the installation of biogas plant whereas only 21.8 percent respondents reported that the social status has not been raised.

4.3.2 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 4.16

Table 4.16: Benefited by the Biogas plant

S.N.	Benefited Member	No. of Households	Percentage
1	Man	3	5.4
2	Women	42	76.4
3	Children	10	18.2
Total		55	100.0

Source: Field survey, 2011

Table 4.16 shows that majority of the respondents out of total interviewed reported that the women are highly benefited by the biogas plant installation (76.4%) followed by 18.2 percent reported that children are benefited. Only 5.4 percent respondents out of total interviewed reported that men are benefited by the biogas plant installation.

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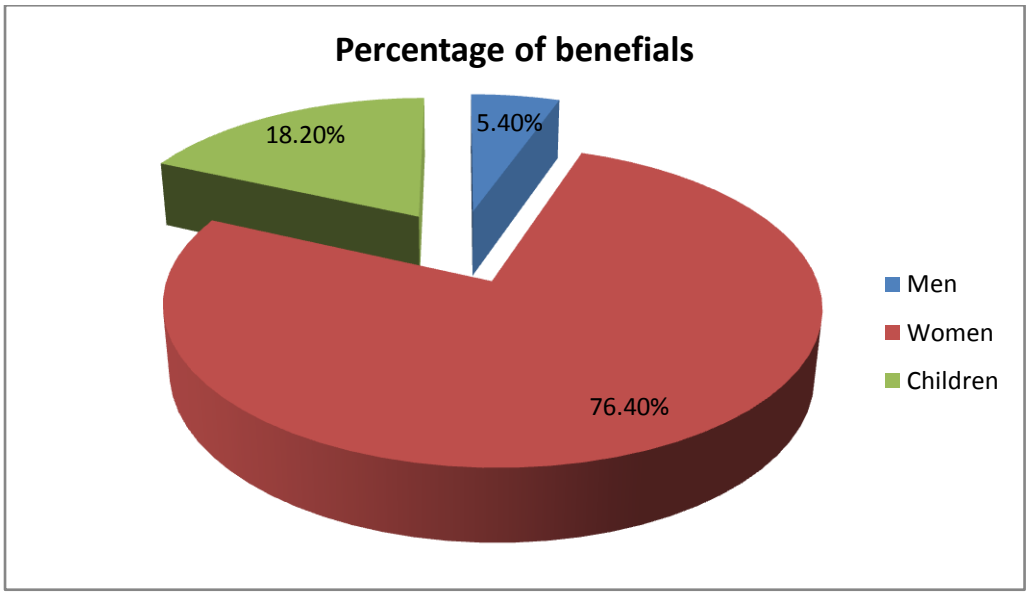


4.3.3 Time saved and Reduction in Workload

After installation of biogas plant the workload of mainly women is reduced. Therefore, the respondents said that introduction of biogas has a positive effect on the workload of family members. Time saving in cooking, cleaning utensils, firewood collection due to smokeless stove is the direct benefit to the female members.

Table 4.17: Saving on Time and Reduction in Workload

S.N.	Activities	Average time taken (hours/day)		Reduction in workload(hrs/day)
		Before Installation	After Installation	
1	Firewood collection	2 ½	1	1 ½
2	Cooking	2 ½	1 ½	1
3	Washing utensils	1 ½	½	1
Total average time taken per house per day		6 ½	3	3 ½

Source: Field survey, 2011

Table 4.17 shows that the average time taken per day before installation of biogas plant is 6 ½. After installation, 3 hours per day is spent on all activities and the saving of time per day is 3 ½ hours. This time (3 ½ hrs per day) is used in different activities. Saving of time directly reduces workloads in household activities.

4.3.4 Utilization of Time Save

The entire biogas user's experienced significant time due to adoption of biogas technology. As shown in table 4.18, the average time saving per day is 3 ½ hrs. It has been utilized in different activities. Saving of time has

reduced the workloads in household's activities. The use of saved time is presented in table 4.18

Table 4.18: Utilization of Saved Time

S.N.	Activities	No. of Households	Percentage
1	Farm Activities	28	50.9
2	Child care	4	7.3
3	Gardening	2	3.6
4	Income Generation	16	29.1
5	Physical Labor for wages	5	9.1
Total		55	100.0

Source: Field survey, 2011

Table 4.18 shows that about 50.9 percent of respondents out of total interviewed reported that they use their saved time on farm activities followed by 29.1 percent used the saved time on income generation and 9.1 percent use the saved time on physical labour for wages. Only 3.6 percent of respondent out of total interviewed sampled household reported that they use the saved time on gardening. Data clearly show that saved time after the installation of biogas plant has been used on production activities.

4.3.5 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 4.19

Table 4.19: Sources of Firewood Collection

S.N.	Sources	No. of Households	Percentage
1	Own land(Private forest)	16	29.1
2	Government	32	58.2
3	Market	7	12.7
Total		5529.1	100.0

Source: Field survey, 2011

Table 4.19 shows that about 5.8.2 percent out of total interviewed respondents reported that they collect firewood from government forest, followed by 29.1 percent collect firewood from their own land. Only 12.7 percent out of total interviewed reported that they bring firewood from market. This table clarifies that the chief sources of firewood collection is government forest.

4.3.6 Easy Cooking

The smokeless cooking stove gives easiness in cooking to rural women. It reduces cooking time as well. It also removes the burden of collecting firewood. Women need not blow air as they used to fire the firewood. This helps women to save their body energy and keeps free from mental tension.

4.3.7 Health and Sanitation

The study has shown that biogas has positive impacts toward health and sanitation of the respondents. While using the biogas for household's 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 especially used in

kitchen, generally the women children are engaging 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.

a. Change Found in Surrounding After the Installation of Biogas plant

Table 4.20: Change Found in Surrounding

S.N.	Different Aspects	No. of households	Percentage
1	In Health	20	36.4
2	In Hygiene	15	27.3
3	In Sanitation	12	21.8
4	All of above	8	14.5
Total		55	100.0

Source: Field survey, 2011

Table 4.20 shows that about 36.4 percent respondents out of total interviewed reported that they found change in health, followed by 27.3 percent found change in sanitation. And 0only 14.5 percent respondents out of total interviewed reported that they found changed in all of above aspects. The change is considered the improvement in all these given aspects in this study.

b. Feeling on the Menace of Flies or Mosquito

Table 4.21: Feeling on the Menace of Flies or Mosquito

S.N.	Activities	No. of Households	Percentage
1	Feeling	5	9.1
2	Decreased	33	60
3	Remained same	17	30.9
Total		55	100.0

Source: Field survey, 2011

Table 4.21 shows that the distribution of feeling on the menace of flies, or mosquito, majority of the respondents (60%) out of total interviewed reported that the menace of flies or mosquito decreased whereas 9.1 percent expressed that the menace of flies or mosquito increased. Only 30.9 percent of respondents out of total interviewed reported that the menace of flies or mosquito remained same.

c. Reduction in disease

All of the respondents felt reduction in health related problems after installation of biogas plant. The table shows that 54.5 percent of the people were saved from eye burning and headache, in the same way 21.8 percent of the people were saved from fever and asthma and 16.4 percent of respondents were saved from respiratory problems. Only 7.3 percent of people were found different who were saying there was no change in health. The major impact on the reduction of disease was as follows.

Table: 4.22 Reduction in disease

S.N.	Reduction on illness	No. of households	Percentage
1	Eye burning and headache	30	54.5
2	Fever and Asthma	12	21.8
3	Respiratory Problems	9	16.4
4	No change	4	7.3
Total		55	100.0

Source: Field survey, 2011

4.4 Economic Impact of Installation of Biogas plant

The impacts of biogas on household's economy were not tangible and hence the user often felt insignificant impact. This section discusses about the saving of firewood, Specific benefits of the saving, saving in health treatment and use of slurry in relation to agriculture. It increases in Production operation and maintenance of biogas plants.

4.4.1. 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 4.23

Table 4.23: 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	700	150	550	100/Bhari	78.6
2	Kerosene	400	100	300	85/ litres	75
3	LPG	400	200	200	1300/cylinder	50
Total Average (in Rs.)		1500	450	1050		70
Annual saving amount of money is (1050×12) is Rs. 12600 1 Bhari =30kgs						

Source: Field survey, 2011

Table 4.23 shows that the amount of money which is saved after the installation of biogas plant. Before installation Rs. 1500 per month used to spend but after installation it is Rs 450 per month spent. Hence the average saving amount of money is Rs. 1150 per month. This table also clarifies that the annual saving amount of money (1050×12) is Rs. 12600can be contributed to pay the loan on installment of expenditure of biogas plant.

4.4.2 Saving of Money on Health Treatment

On this study, amount of money on health treatment has also been studied. The money spent on health treatment is presented in table 4.23

Table 4.24: 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	Eye illness, Headache	450	200	250
2	Asthma	375	100	275
3	Respiratory problems	250	75	175
Total		1075	375	700

Source: Field survey, 2011

Table 4.23 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 250 per year in treatment of eye illness and headache, Rs. 275 in asthma and Rs.175 in treatment of respiratory problems. Hence, the respondents or plant owner is able to save Rs. 700 per year in the treatment of health related disease.

4.4.3 Slurry and Agriculture

One of the most important factors to establish biogas plant is the production of slurry, very valuable organic manure for crop farming. Multiple advantages occur with these of biogas slurry. It increases agricultural production because of its high content of soil nutrients, when

the digested slurry is placed in to the food chain of crops and animals it leads to a sustainable increase in income.

As per norms established by the Gobar gas accompany, the slurry produced from the biogas plant contains 1.6 percent nitrogen, 1.2 percent phosphorous and 1.0 percent potash (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 digested slurry improves the soil texture, stabilizes its humid content, intensifies its rate of nutrient formation and increases its water holding capacity. Compare to form yard manure (FYM) biogas slurry has more nutrients than FYM because in FYM, nutrients are loss by volatilization (especially nitrogen) due to exposure to sun head and as well as by teaching (GGC, 2001).

d. Methods of Using Slurry on Farm:

Information on the application of the bio slurry in different forms as reported by the respondents is presented in table 4.24

Table: 4.25: Methods of Using Slurry

S.N	Methods of application	No. of households	Percentage
1.	In liquid form	15	27.3
2.	In dried form	8	14.5
3.	Both (liquid + dried)	4	7.3
4.	In composted form	28	50.9
Total		55	100.0

Source: Field survey, 2010

The data presented in the table clearly shows that about 50.9%of the biogas formers have performed using the slurry in composted forms, while 27.3% of the biogas users used it in liquid form, 14.5% of the users used it in dried form and only 7.3% of the respondents reported using liquid slurry directly to fertilizer their crops. It is worth nothing that using the slurry in liquid form is the best practice form the point of view of conversation 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. 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.

a) Increment of Agricultural Production:

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 were not possible, use of slurry has certainly saved money, which might be otherwise we to buy chemical fertilizer.

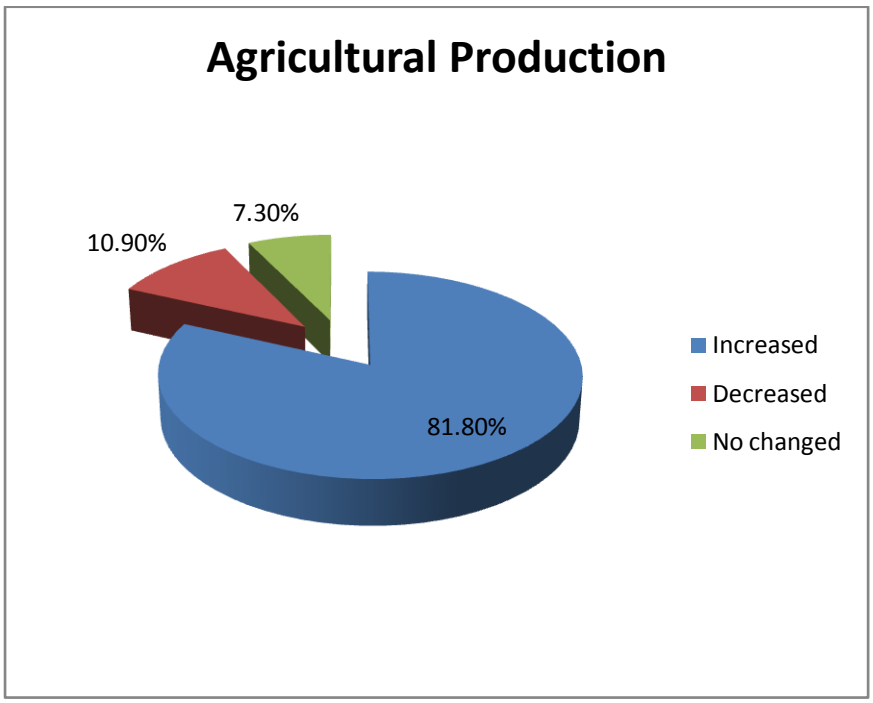
The user's surveys and impacts studies carried. Different institutions biogas companies, NGOs/INGOs, community forest groups, consultancies and individuals have reported that agriculture production is increased after the adoption of biogas technology. However the present study indicates different scenario in case of increment in agriculture production.

Table: 4.26: Slurry and Production Increment

S.N	Agriculture production	No. of households	Percentage
1.	Increased	45	81.8
2.	Decreased	6	10.9
3.	No changed	4	7.3
Total		55	100.0

Source: Field survey, 2010

Above table is made clear in the following figure: No.8



The slurry is mainly used in maize, vegetables and paddy production. The production relationship of 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 possible relationship between

using slurry and agriculture productivity. Thus, slurry is better than chemical fertilizer in agricultural farming.,

The table shows that most or 81.8% of households responded that biogas increased production. However 10.9 of households felt that slurry is not a good fertilizer and decreased the agro production and 7.3% of households felt that there is no change in their agriculture product.

4.4.4 Environmental Impacts

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 everybody installs biogas plant, the forest will be saved completely from depletion. From the macro perspective biogas has checked the ecological imbalance and climatic change due to lessening the problem deforestation. Similarly, use of biogas has reduces 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 absence of bad smell. It helps in reduction of the emission of co_2.

The environment impact of biogas plants can be viewed from the following perspectives.

- Biogas, when for cooking saves firewood, dung cakes and agriculture 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 environment.

Hence, the impact of biogas use on environment must be viewed from 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 low dung as dried 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.

4.4.5 Perception of Respondents on utility of Biogas plant

Table 4.27: perception of Respondents

S.N.	Utility of plant	No. of households	Percentage
1	Useful	23	41.8
2	Very useful	28	50.9
3	Not useful	4	7.3
Total		55	100.0

Source: Field survey, 2011

Table 4.26 shows that about 50.9 percent respondents out of total interviewed reported that biogas is very useful and 41.8 percent respondent reported that biogas is useful. Only 7.3 percent respondents out of total interviewed reported that biogas is not useful.

4.4.6 Opinion on the overall Energy, Environment and Economic condition

Table 4.28: Opinion on overall Energy, Environment and Economic Condition

S.N.	Opinions	No Of households	Percentage
1	Improved	36	65.5
2	Remained same	15	27.3
3	Don't Know	3	5.5
4	Worse	1	1.7
		55	100.0

Source: Field survey, 2011

Table 4.27 reveals that about 65.5 percent respondents out of total interviewed reported that the overall energy, environment and economic condition have been improved. About 27.3 percent respondents out of total interviewed reported that the overall energy, environment and economic condition have been remained same. About 5.5 percent respondents reported that they don't know and only 1.7 percent respondents opined that the overall energy, environment and economic condition have been worst.

4.4.7 Problems of Biogas Users

Although the biogas has several benefits, the researcher finds several problems from the respondents. Biogases users have listed out problems that have been observed on field survey were discussed below:

a. Higher Maintenance and Repair cost:

   The users consider high establishment cost, high interest rate and efficiency if biogas in space heating as the greatest advantages of biogas plant while high repair cost and difficulty of maintenance, not

available of GGC staffs are considered important disadvantages of biogas plant. For the most highly rated disadvantages i.e. the high establishment cost diversity in responses has been observed.

b. Time Consuming:

Some of the families complained that they had to spend more time to collect additional water for plant feeding. Hence, in areas with longer water fetching time, biogas plant installation has increased workload to users specially women members because they engaged daily in kitchen room. As it requires daily feeding of cow dung mixed with water for the smooth operation users consider it as an extra burden.

c. More Water to Collect:

Feeding of biogas requires mixing of dung and water in equal proportion. Larger the biogas plant, greater the amount of dung as well as the water required. Collecting water is the main problem because there are not available sources of water nearby.

d. Less Tasty Food:

A few respondents reported that food cooked in biogas is less tasty as compared to food cooked in firewood.

e. Increase in Mosquito Breeding:

In biogas household's survey, it is found that there is an increase in the population of mosquito due to the installation of biogas plants.

f. Damaged of Wooden Ceiling:

In traditional rural households, the ceiling of the room is made with woods that are protected against insects due to deposition of soot production from firewood burning, as biogas produces smoke free flame, the wooden ceiling are liable to be damaged by insects such as ants, termite etc.

g. Unnecessary Tension:

Some of the plant owners complained that the loans taken for biogas installation create unnecessary tensions as they did not have such practice of taking loan before. As biogas plants did not fetch direct cash income and they were not able to express the saved time and efforts.

h. No Direct Income:

Although biogas has several benefits, it does not generate cash income. Farmers prefer direct income to enable them to pay back the principal and interest on loan. They have very little income generating opportunity to utilize the time saved from installation of biogas plants and therefore hesitate to invest the loan money.

4.4.8 User's Perception and Suggestions

a. Perceptions:

Except three households all the respondents were of positive opinion about biogas installation. They felt improvement in the quality of livelihood after installation the biogas plant. The people felt marked differences in saving in time. Reduction in work burden, cleanliness of the environment and better crop production too.

b. Suggestions:

All of them had given the suggestions that "Every biogas company regularly checking biogas plant for their respondents after warrantee period". Out of the total, 60 percent of respondents had given the suggestions that "everyone should install the biogas plant".

→ Subsidy for the biogas installation should be provided directly instead of through biogas companies,

→ There should be provision of paying money in installment,

→ Biogas installation should e made completely free for the very poor people who cannot afford,

→ One house suggested that the use of urine of livestock and water together for mixing with dung increased the amount of gas production,

→ One house suggested that using stone instead of brick in the masonry works for biogas plants construction etc.

CHAPTER –V

MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 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 biogas plant installation in rural area was made.

This study was conducted in Lele VDC of Lalitpur district. This study is based on the sample of 55 households who were selected by using simple random sampling technique. In this VDC, there are 1300 households. There are altogether 14560 people residue in this VDC. Total sample households are 55. Total sampled households occupy 4.23 percent of the total households of Lele 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, DDC Lalitpur 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 $4m^3$ biogas plants (3.6%) and $8m^3$ biogas plants 7.3%) installed. But these sizes of plants were installed in initial stage.

3. People installed biogas as a substitute to firewood and to have ease in cooking.
4. The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.
5. There is a considerable reduction in the workload of family member and women are highly benefited (76.4%) by the biogas plant installation.
6. Subsidies provided by the BSP were very encouraging factor for installation of biogas.
7. Majority of time has been saved and the time saved has been used mostly in farm activities (50.9%) followed by income generation activities (29.1%)
8. Average amount of dung feeding was lesser than the capacity of plant.
9. Majority of the households have connected toilet (81.8%) with the biogas plant.
10. Medical expenses also have been reduced after installation of biogas plant.
11. Average livestock population size 3.4 per household.
12. Average family size is 5.5 per household.
13. Average landholding size is 12.3 Ropanies per household.
14. The users felt reduction in health related problems such as eye burning, headache, and respiratory problems such as asthma.
15. Majority of plant owners are not satisfied with existing interest rate for loan and they also want to decrease the interest rate of the installation of biogas plant.
16. Almost of all plant owners use slurry on farm and agricultural production has been increased.

17. Majority of the respondents felt that the menace of flies or mosquito has been decreased (60.0%).
18. 78.2% of respondents reported that the social status has been raised.
19. Majority of the respondents reported that overall economic environmental and energy condition has been improved (65.5%).

5.2 Conclusion

This study was conducted in Lele VDC of Lalitpur district. Fifty five households out of 1300 households have been taken as sampled households. This study was confined only in Lele VDC.

Being an appropriate alternative source of energy biogas technology has been proved very useful especially 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 spent less time on cooking, cleaning utensils and collecting firewood.

Biogas technology has improved the health and sanitation situation. It has helped to reduce the prevalence of smoke borne diseases such as respiratory problem, headache and eye burning etc. this technology has also improved the overall energy, environment and economic condition on 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%. Biogas plant 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 by product (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 areas of Nepal. It also has been able to protect the forest resource which is the main source firewood in rural area. Hence, biogas technology is very much useful technology for rural households.

5.3 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 foe 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. Research should be carried out of lower the cost of biogas plant to increase efficiency of gas production in winter and control the breeding of mosquito.

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.
9. Concerned agencies conduct social awareness program among rural people to maximize the adoption of biogas.
10. Biogas appliances and spare parts should be made easily available to the customer at reasonable cost.
11. A consisted policy should be introduced to penetrate the small marginal and poorest to the poor.
12. The concerned biogas companies should mobilize local NGOS to promote biogas technology so that they can act as bridge between users and the companies.

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