A STUDY ON THE SOCIO-ECONOMIC IMPACT OF BIOGAS PLANT ON USERS

(A CASE STUDY OF SAUDIYAR VDC, DANG DISTRICT, NEPAL)

A THESIS
SUBMITTED TO THE CENTRAL DEPARTMENT OF RURAL DEVELOPMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ARTS IN RURAL DEVELOPMENT

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LETTER OF RECOMMENDATION

This dissertation work entitled "**A Study on the Socio-Economic Impact of Biogas Plant on Users: A Case Study of Saudiyar VDC, Dang District, Nepal"** is an independent work of Ganga Sharma, completed under my supervision.

It is prepared for the requirement of partial fulfillment of Master of Arts in Rural Development. To the best of my knowledge, this study is original and carries useful information in the field of biogas in Dang district.

I forward to the dissertation committee for approval with recommendation.

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Date: 13 February, 2010

APPROVAL LETTER

This thesis entitled "**A Study on the Socio-Economic Impact of Biogas Plant on Users: A Case Study of Saudiyar VDC, Dang District, Nepal"** submitted by Ganga Sharma has been accepted as a partial fulfillment of the requirements for the degree of Master of Arts in Rural Development.

Evaluation Committee:

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Date: 13 February, 2010

ACKNOWLEDGEMENTS

It is my great pleasure to present this thesis to the Central Department of Rural Development, Tribhuvan University, Kirtipur, as a part of partial fulfillment of the requirements of the Master Degree in Rural Development.

I would like to express my sincere thanks and appreciation to my thesis advisor Mr. Bimal Khadka for his constant inspiration and invaluable guidance throughout the research period. I am also grateful to all respected professors, lecturers and staffs of the Department of Rural Development for helping me in different ways.

My sincere appreciation goes to the staffs of Biogas Support Program for providing me the required materials from their library. I am also grateful to various concerning officials of Ministry of Energy and Alternative Energy Promotion Center (AEPC) who helped me in getting the relevant documents.

Finally, I would like to acknowledge my husband Nagendra for his sincere support and encouragement he gave throughout this study period.

Date: February, 2010 Ganga Sharma

ABSTRACT

This thesis entitled "Socio-Economic Impact of Biogas Plant on user: A Case Study of Saundiyr VDC, Dang, Nepal". The general objective of this study is to find out the socio-economic impact of biogas plant installation in Saundiyar VDC, Dang. The specific objectives of the study are: to study the biogas plant as an alternative of forest resources, to assess the time and money saving due to the adaptation of biogas plant, to study the benefits of slurry in agricultural production and to give suggestions and recommendations to promote biogas plant installation.

This study has been chosen as a special topic to address the problem of energy in the study area and to provide the scope for the dissemination of the biogas technology. This study is basically based on both primary and secondary sources of data.

Saundiyar V.D.C of Dang district has been taken as the study area. Out of the total of 154 biogas households in ward no 1 and ward no 2, 30 households have been taken as the sample households using simple random sampling.

Before selecting a topic, a brief review of the literature related to the impact study of biogas on users has been studied. Primary as well as secondary data have been used in this study

Household Survey through interview, field observation has been taken as a method of data collection and collected data has been analyzed using simple statistical tool such as, average, percentage table.

This study found that majority of the households (50%) out of total interviewed reported that they had adopted agriculture as a main occupation. About 60% out of total interviewed reported that they were from Brahmin caste. About 90.7% plant owners out of total interviewed were literate whereas only 9.7 % were illiterate. And most of bio-gas plant owner (30) % had 21 to 30 kattha land.

Out of total sampled biogas plant owners, majority of the households (40%) had reported that they used their saved time in farm activities and income generation activities. About 76.7% households reported that the main reason behind the installation of biogas plant was easy and smokeless cooking. Total average time saving was 4.9 hrs per day per household. Average saving amount of money was Rs.650 per month per household.

Furthermore, Most of bio-gas plant owner (93.4%) had latrine facility. Among them 76.7 % plant owners had attached latrine with the biogas plant. This study also revealed that improvement was found in health and sanitation situation Majority of the respondents (83.4%) reported that the agricultural production had been increased.

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ABBREVIATIONS/ACRONYMS

ADB/N	-	Agriculture Development Bank Nepal.
AEPC	-	Alternative Energy Promotion Center
BDC	-	Biogas Development Committee (BDC)
BSP	-	Biogas Support Program
CBS	-	Central Bureau of static
CDM	-	Clean Development Mechanism
CES	-	Centre for Energy studies
CRT	-	Centre for Rural Technology
DCS	-	Development and Consulting Services
ERDG	-	Energy Research and Development Group
FCN	-	Fuel Corporation of Nepal
FY	-	Fiscal Year
FYM	-	Farm Yard Manure
G.D.P	-	Gross Domestic Product
GGC	-	Gobar Gas Company
GON	-	Government of Nepal
KVIC	-	Khadi and Village Industries Commission
LPG	-	Liquefied Petroleum Gas
MOF	-	Ministry of Finance
MOST	-	Ministry of Science and Technology
MW	-	Mega Watt
NBPG	-	Nepal Bio-Gas Promotion Group
NPC	-	National Planning Commission
R & D	-	Research and Development
RET	-	Renewable Energy Technology
SNV	-	Netherland Development Organization
UMN	-	United Mission to Nepal
V.D.C.	-	Village Development Committee
WECS	-	Water and Energy Commission Secretariat

CHAPTER ONE

INTRODUCTION

1.1 Background

Although Nepal is rich in hydropower potential, only one percent of the total energy demand is met form this source. The remaining 99 percent is met form sources like coal, petroleum product, animal waste, crop residue and fire hood. Therefore the sources of energy are primarily conventional. The energy consumption in 2002, by percent is 75.78 percent fuel wood, 9.23 percent petroleum product, 1.47 percent electricity, 5.74 percent animal waste, 3.75 percent agricultural residue, 3.53 percent coal and 0.48percent renewable energy (WECS, 2003). A massive amount of livestock dung estimated at 8 million tons is being burnt to supply 8 percent of the energy in rural areas of Nepal. This amount of dung otherwise would have produced an estimated 1 million tons of additional food grains. In order to check the serious problem of deforestation and soil fertility depletion Nepal started biogas program since 1975. As a viable eco-friendly alternative technology, it can substitute firewood for cooking, heating and kerosene for lighting. It's by- product slurry could be used as nutrients rich manure in farms and could tremendously improve agricultural production.

Being a country with agricultural dominance, Nepal has as huge potential of biogas. Introduced in Nepal in the 1950's, family size biogas plants were first popularized in 1974/75 in the auspicious of "Agriculture Year". The pace of biogas development took momentum in Nepal after the formation of Biogas Support program (BSP) in 1992 under the Netherlands Development Organization (SNV). Apart from

SNV/BSP and AEPC, various organizations such as commercial banks, Biogas construction companies, NGOS, consulting firms, etc are directly or indirectly in the promotion of biogas programme in Nepal. Due to the concerted efforts of these governmental and non governmental organizations, a total of 181,612 biogas plants have been established in Nepal till 30 June 2008. Out of total biogas plant, 174,591 plants have been established by BSP and 2,383 plants by GSP. These plants have located over 67 out of 75 district of the country.

Based on the animal population, there is potential of installing 1.3 million family sized biogas plats in Nepal. Eventually, the success of a program can only be judged by increasing number of biogas plants in the country. On the other hand, various direct and indirect but important benefits enjoyed by the users of biogas technology may be taken into consideration. It is imperative to know how far the user of biogas, who is the ultimate beneficiary of the programme, has derived benefit from his / her plant and the programme as a whole and to what extend him/her, is satisfied with the technology. It is equally important to assess socio-economic impact brought about by this technology. Thus, in order to obtain necessary feedbacks about the technology. It is essential to monitor both the technology and its impact on user satisfaction by conducting appropriate and detailed survey at regular intervals.

In Nepal, livestock farming is an important component in Nepalese farming system. A survey conducted in 1990/91 had estimated that the total population of cattle and buffalo to be 9.3 million (i.e. 6.3 million cattle and 3.0 million buffalo). Based on the study, technically biogas potential in Nepal is assumed to be around 1.49 million plants (BSP, 2003), and dung availability is assumed to be 23.1 million tons per day

for biogas production. However, the potentiality of biogas may rise when we use other biodegradable sources like industrial waste, municipal wastes and other biomass. The geographical region wise production potential and production of biogas is reflected in the following table:

Table 1.1: Biogas plants in Nepal

Geographical Region	Number of plants Constructed	Coverage Percentage
Terai	86,260	49.4%
Hills	87,533	50.13%
Remote Hills	798	0.46%
Total	174,591	100**%**

Source: BSP, 2007

The mountain region, due to the cold temperature is not feasible for biogas production. Only around 1 percent of biogas plants potential fall in this region, whereas the Hill shares 37 percent and plain shares 62 percent (BSP, 2007).

The per capita consumption of fuel wood in Nepal at present is 224 kilograms per year (WECS 1991). This amount indicates that forests in Nepal are being used beyond their capacity which is alarming indicator of deforestation. Nepal has been placed in second position after Brazil in potential water resources. However due to financial and technological constrains in one hand and selfish nature of political leader in past in other, favorable environment to harness the potential was not created. Even after the emergency of democratic system in the country, the situation is similar due to unwillingness and non-commitment of the political parties to work for this sector.

1.2 Historical Development of Biogas in Nepal

The history of biogas in Nepal goes back to 1955, when a Late Father B. R. Saubolle, a Belgian School Teacher at St. Xavier's School, Godavari in Kathmandu, built a demonstration plant of used oil drum. The development of biogas got its momentum after the world energy crisis in 1973, which caused the global interest in this sector. In 1975, as a part of Energy Research and Development Group (ERDG), a Biogas Development Committee (BDC) was formed (Ghimire, 2000).

When the Ministry of Agriculture observed the fiscal year 1975/76 as the 'Agriculture year', biogas was included as a special programme for its effectiveness in controlling deforestation and preventing burning of animal dung which otherwise could be used as fertilizer (IOE,2001).

In 1975/76, two hundred and fifty family size biogas plants were installed by private contractors under the supervision of Department of Agriculture. All those plants were floating drum design based on Khadi and Village Industires omission (KVIC) India (GGTKYS, 2000).

Agriculture Development Bank (ADB) of Nepal played an active role in the promotion of biogas technology. Similarly, Development and Consulting Services (DCS) of United Mission to Nepal (UMN),Balaju Yantra Shala (BYS) and Agricultural Tool Factory (ATF) were the pioneering agencies to make biogas programme success (IOE, 2001).

The Gobar Gas and Agricultural Equipment Development Company Pvt. Ltd. (GGC) were formed in 1977 as a private company for research, development and dissemination of the technology throughout the country. Research on various design of biogas plants such as floating drum, concrete fixed dome, precast tunnel, plastic biodigester, ferro-cement gas

holder, brick mortar dome were carried out and experimented. Among the various designs, the fixed dome design (GGC model 1990) has become popular in Nepal (Devkota, 2001).

Biogas Support Programme (BSP) was initiated in July 1992 to develop and promote the use of biogas in Nepal (BSP, 2003) with the financial support of Netherlands Development Organization (SNV). After the establishment of BSP, the pace of biogas plant installation has increased in an accelerating rate. By the end of the year 2002, the total number of 95,462 biogas plants have been installed under BSP (BSP,2003).

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/SNV. 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.

For the promotion and extension of the program, in 1996, His Majesty's Government of Nepal (HMG/N) setup Alternative energy promotion centre (AEPC) under the Ministry of science and Technology (MOST). The role of AEPC is as the networking at the central level policy making (GGC profile 2001 i 1,2).

During the Eighth Five Year Plan (1992-97), the energy sector received high priority. Government had set a target of commissioning 30,000 plants, and the Ninth Five Year Plan (1998-2002) had fixed target of installing 1,00,000 plants during the period (IOE,2001).

By the end of 2006, there are 157675 biogas plants, 65 private biogas companies, 16 biogas appliances manufacturing workshops and 130 micro-finance institutions which are supporting for the development of biogas energy. 98 percent of the plants are in operation and 102719 toilets are constructed. Now, it is developed as a Clean Development Mechanism (CDM) project in Nepal for the first time. Two CDM Projects of 19396 biogas plants have been constructed under BSP phase IV and it registered with and approved by the CDM Executive Board. The expected outputs of BSP IV phase are to reduce the workload of 135000 households mainly women and girls by 3 hours / day / household. The saved time of the girls and women can be used in income generation, education and other development activities.

As the forest resource is decreasing, threatening the environmental problem, government is being aware to develop the biogas installation activities, including national planning process. Biogas installation program was in corporate in the seventh plan (1986-90) period and the emphasis has been continued even in the tenth plan (2002 – 2007). In this course, HMG/N has made strategies for the further development of biogas. Privatization Policy is becoming the key efforts to the government to increase biogas plants in the country (WECS: 1994/95).

Table 1.2: Subsidy Rate for Biogas Plants

Plant size	Terai Districts	Hill districts	Remote Hill Districts
4 & 6 m^3	Rs 5,500	Rs 8,500	Rs 11,500
8 & 10 m^3	Rs 5000	Rs 8,000	Rs 11,000

Note: Eighteen low biogas penetration districts receive extra Rs. 500.
Source: Alternative Energy Promotion Centre (AEPC), Lalitpur

The potential for biogas generation is based on the number of cattle and buffaloes. In Nepal, house hold with animals are 27,84,585 and the

potential biogas household is 19,37,015 (BSP, 2005), Regarding the potentiality of Biogas is higher in terai then hill, remote hill and mountain (Source:- Final report on the bio-gas support programme, phase III)

1.3 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 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). The given data are useful in the design of biogas plant.

Table 1.3 Design of biogas plant

Suitable digesting temperature	$20\text{-}35^{0\,c}$
Retention time	40-100 days
Biogas energy content	6 kwh/m3=0.61x diesel fuel
Biogas generation	0.3-0.5m3 gas/m3
	Digester volume x day
1 cow yield	9-15kg dung/day = $0.4m^3$gas
Gas requirement for cooking	$0.1\text{-}0.3m^3$/person
Gas requirement for lighting 1 lam	$0.1\text{-}0.15m^3$/h

Source: 2nd National Conference on Science & Tech Ronast, Kathmandu

The type of Gases found in Bio-gas is given below:

Table 1.4: Percentage of gas found in Bio-gas

Description	**Percent (Quantity)**
Methane	50-60 percent
CO_2	30-40 percent
Hydrogen	5-10 percent
Nitrogen	1-2 percent
Water vapour	0-3 percent
Hydrogen sulphide	Little

Source:-Singh. R.B; A Technical Evaluation of Renewable Energy Biogas in Nepal. SCITECH Journal NEC April 2004, Vol 7 No.2

Figure no. 1

Type of dome

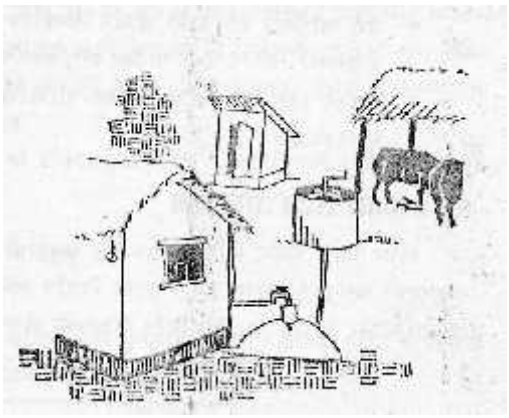
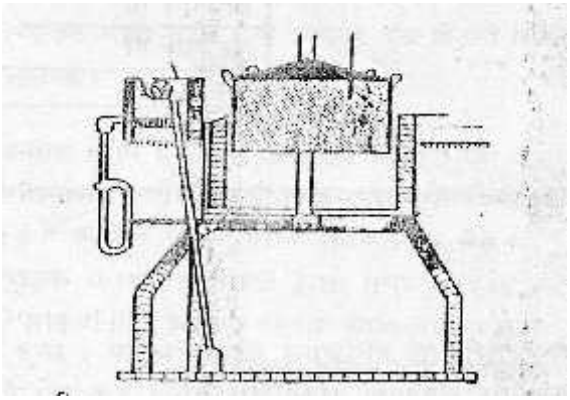


Figure no. 2

Type of drum



1.4 Statement of the problem

Energy is a critical component of the development process. It is needed in all such major sphere of life which are directly connected with man's survival and progress such as in cooking, lighting heating etc. Due to population growth, the demand for energy is increasing day by day in the country. Major share of energy consumption is met through traditional sources. The renewable energy sources are to be developed and biogas

energy promotion will be a significant one to struggle for improving this condition. The per capita energy consumption in Nepal is very low (14.6 GJ) and most of the energy is being used for domestic purpose. In Nepal, the sources of energy are primarily conventional. Therefore the dependency on forests for energy in Nepal is very high and forests are being used beyond their capacity causing deforestation and environmental degradation. Due to many constraints of technology, finance, politics and many others; the country has failed to create a favorable environment to harness the high potential of water resource and other as well.

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 consume 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 form firewood in poorly ventilated room with traditional stove 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 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 and money on income generating activities in Saundiyar VDC of Dang district. Digested slurry reduces the undue use of chemical fertilizer leading to higher productivity in Saundiyar VDC, Dang, 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 measure

1.5 Objectives of the study

The general objective of the study is to find out the socio- economic impact of the biogas plant on users in Saundiyar VDC of Dang district and

The specific objectives are:

i. To study the biogas plant as an alternative of forest resources.
ii. To assess the time and money saving due to the adaptation of biogas plant.
iii. To study the benefits of slurry in agricultural production
iv. To give suggestions and recommendations to promote biogas plant.

1.6 Significance of the study

From the last few years, biogas has been identified as an integrated energy and environmentally friendly technology for the village of Nepal. This technology provides a clean and cheap source of energy in villages. In addition to producing enriched organic manure for supplementing the use of chemical fertilizers, it also improves sanitation, hygiene, relieves women of some drudgery and saves time and money of the users.

As we know, bio-gas as a renewable energy clearly offers the great significance of this study. Biogas provides a direct benefit, especially to rural women, men and children, as a result of the reduction of the

workload when shifting from cooking on fuel wood to using biogas. It saves approximately three hours time a day per family mainly due to the reduction on time used for collecting fuel wood, cooking and cleaning The introduction of bio-gas technology in the study area will be helpful for reducing the dependency on forest resources for household purposes. It helps to save money and time in collecting firewood and cooking activities. Biogas reduces the smoke exposures and significantly improves the air condition inside the kitchen which ultimately improves the health condition especially eye infection, respiratory diseases, cough and headache. It has economic benefits as it reduces the direct expenses on fuel for cooking. Raising rate of chemical fertilizer helps to increase production cost and decrease the soil fertility day by day on national level, the introduction of the bio slurry as an organic fertilizer can generate highest productivity without spending the money on buying chemical fertilizer.

All these advantages show the importance of bio-gas. It's found that the use of bio slurry fertilizer is better than the chemical fertilizer. As the study is aimed to see the socio-economic impact of bio-gas in rural areas and found that the use of slurry (fertilizer) is better than chemical fertilizer in terms of cost and productivity. It is especially beneficial for a poor agrarian economy like ours. It provides a renewable source of energy, when the entire world is today scared of saturation of the non-renewable sources of energy fossil fuel.

The growing attention to install biogas plant occupies a key position due to its various advantages. With the shortage of energy, high rate of deforestation, immediate benefits accruing to the women who cook and restoring countries balance of payment to some extent. Biogas as a renewable energy clearly offers the great significance of this study.

1.7 Limitation of this study

Due to the limitation of time and resource constraints, this study attempts to analyze the economic impact of biogas plants in Saudiyar VDC of Dang district only. However, it has following limitations:

i. It focuses on socio-economic impact of bio-gas in concerned VDC. It does not deal with the technical aspect of biogas plant
ii. This study is focus on the domestic bio-gas system only
iii. It is an individual study, so it does not cover whole aspects of biogas but it can be a reference for the further study in this field
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

1.8 Organization of the Study

The study has been organized into six 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. In the second chapter, literature review is presented. The third chapter 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 four consists socio-economic status of biogas plant owners'

.Chapter five deals with the uses and impacts of biogas plant. Six includes major findings, conclusion and recommendations of this study.

CHAPTER- TWO

LITERATURE REVIEW

2.1 Theoretical Framework

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

(BSP 2005) Biogas is the mixture of gas produced by methanogenic bacteria while acting upon hide gradable materials in an anaerobic condition. It is mainly compassed 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.

(GGC profile 2001:7)Biogas is a wet gas as it picks up water vapor from the slurry. Biogas is about 20 percent lighter than air. The main component of biogas is methane which is colorless odorless and tests less. But due to the presence of other gases, it gives some smell similar to that of garlic of rotten eggs.

(Kurian, 2004:n.p). For the human, energy is vital component of development. There are two types of energy sources on the earth: (a) conventional energy sources and (b) non – conventional energy sources. Conventional is obtained from a static storage, for example fossil fuel etc. These are the finite and non renewable energy. On the other hand, non – conventional is obtained from natural sources which can continuously form a current in the environment. These sources are known as renewable

sources of energy. Solar energy, wind energy, geo- thermal energy and bio energy fall in to this category. Non – conventional energy sources are pro – rural, decentralized, infinite, locally available and safe when out of action.

(Rai, 2005**)** Renewable energy technologies provide reliable and affordable energy supplies to millions of people in developing countries. Timely monitoring and evaluation is one way to enable organizations and communities who install and implement energy technology system and programs to check the efficiency and effectiveness of their work. This information can be feed back to governments and donors to improve the effectiveness of future programs .

(Pradhan and Pradhan, 2006:169). However, in Nepal's case Pradhan and Pradhan have classified the sources of energy in three categories? According to them energy sources may broadly be classified into three groups: traditional (biomass), commercial (conventional) and alternative (renewable)" (Pradhan and Pradhan, 2006:168). Coal, electricity and petroleum are the commercial energy sources. By alternative sources, we mean to understand biogas, micro-hydro, solar thermal, solar photovoltaic and wind energy (Ibid). The most usual energy sources in rural Nepal are biomass from the centuries. These include bio fuel sources such as firewood, agricultural residues and animal waste.

(Bajgain,2005:27). However, Agriculture Development Bank (ADB/N) has been the leading bank for biogas loans since the inception of the program. The ADB/N was also initially responsible for channelling the available subsidies to eligible end-users. It accomplished this through its field officer by combining the subsidy with its loans. Later on the subsidy was channelled through the central ADB/N office directly to the

biogas companies. Two other commercial banks, the RBB and the NBL was also involved in providing loans to farmers for the installation of biogas systems, but their role has been as significant as the ADB/N, with branch offices in rural areas, the ADB/N was much better placed to provide loans to interested farmers .

(Kurian, 2004:n.p). Regarding the search for the non conventional energy sources Kurian further explains that there are several factors that prompted human to search them. These are the 1970s oil crisis of the world, the realization of exhaustiveness of conventional sources of energy, problems of pollution and a concern for developing appropriate energy sources for the rural population. The key concern that guided the search for the alternative energy sources were that such alternative energy sources need to be renewable, safe, local specific cheap , decentralized and appropriate. Biogas is an important source of alternative energy .

Dr. Poornakanta Adhikari (1996) in report entitled effects of bio-gas on family health, sanitation and nutrition: has evaluated both positive and negative impacts of bio-gas. The positive impacts on health were most significantly reduction on eye diseases, headache, coughing and throat ache. The negative impacts of bio-gas were increased prevalence of mosquito and loss of warmth in house in winter, sanitation conditions and practices were improved and the study reported 62 percent reduction in firewood collection.

According to bio-gas support program (Phase III). The bio-gas technology is one of the viable devices among alternative energy source in the country Nepal. 1,23,395 number of plants are built by BSP – Nepal in the end of fiscal year 2003/004. If this capacity could be utilized in an effective manner. It can fulfill about 10 percent of the country’s total

energy requirement without adversely effecting the production of the agriculture. Based on the estimated that a total number of 1.9 million domestic bio-gas systems can be installed in Nepal.

According to the final report of bio-gas users' survey 2000/001).A Bio-gas user household saves 990kg of firewood & 6 liter of kerosene oil per year. The gas production was insufficient of in the winter as reported by majority of the respondents one third of the household are attached their latrines to the bio-gas plants. Above half of the respondents used the slurry in the cultivated land and other uses in gardens. The decrease in occurrence of disease was the positive benefit of bio-gas plant installation. However negative part of installation was increased prevalence of mosquito and some even reported occurrence of typhoid. Most of the household were in the value of male. The major problem in the bio-gas plant in the value problems, high rate of interests, high cost and non-availability of spares, increased prevalence of mosquito.

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

Sigdel and Das (1990) Surveyed biogas plant in rural context. A total of 13 plants from Leknath village near Pokhara were taken into consideration. It was found that there are a growing awareness in this technology as a forest saver. People have felt that it would be more applied in a semi – urban area where people are richer. Since the village people suffered from problems of finding capital to repay loans and installation cost was found to be high, realization of temperature

constraints and the strong need for government subsidy could be observed.

WECS (1994) has argued that by the use of biogas there was an increase in agriculture productivity through increased soil fertility from the slurry. It was also considered as a positive impact of technology on the economy. Moreover the time and money saved through improved health and hygienic e.g. reduced cased of eye and respiratory illness and the no. of burning cases could be considered as other direct positive impact on the economy.

BSP (1996) has assed the operation and maintenance the plants. Most of the plants were underfed and there was high water to dung ration. Gas production was considered low in winter. However, 28% of users ware satisfied with working of the plants.

The benefits of biogas installation were saving in time, visible implication of personal health and general sanitary condition, saving in firewood and kerosene one hundred such plants were estimated to save 2.8 hectors of forest. The study notice that users percept no significant effectiveness of slurry.

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

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

Karki (2001) has implemented the research programme to study the influence of bio- slurry application on maize and cabbage in Lalitpur district. The result of the experimentation has revealed the supremacy of organic manure, in all forms viz, FYM (Farm Yard Manures), slurry compost and liquid slurry over the inorganic manure. The increment in the field of cabbage and maize was realized after the application of slurry compost.

(Pokharel 2001: 8): Bio-gas promotion has suffered due to the initial capital cost required for the plant, low yield of gases in region with cold climate and low social acceptance of use of gas. The capital cost involved in the stage still discourages the most rural people from making effective use of bio-gas potential. A possible alternative is identified as being the community sized Issues are concerning the mode of community ownership, its organizational form for day to day operations and equitable distribution of the benefits from the by products still remain unanswered.

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

The New ERA (1995) study has revealed that one of the main attractions towards the biogas plants is the easy availability of gas for cooking. Almost all of the users used gas for cooking purpose and more than half of the owners used gas for lighting purpose as well. The main reasons behind not using biogas for lighting were the availability of electricity frequent insufficient gas particularly in winter was found. However, most of the users reported that they were satisfied with the use of gas for cooking, no black shoot on cooking pot, smokeless kitchen etc. Regarding the used of slurry, only 44 % of users reported that the

problem of eye diseases and respiratory diseases were reduced and the users felt some relief.

(Shrestha 2002)- Bio-gas plant is a device to produce bio-gas. The structure of the plant consists of central pit covered with dome structure. The pit serves as digester and the done serves as gas holder. Animals dung is mixed with water and through by inlet. The dung in the pit is an aerobically digested by the bacteria with generation of gas. The gas bubbles up and collects in the dome. Which is then supplied to house for its use through the pipeline. After digesting the digested slurry flows outsides through the out let.

Karki (2001) has focused the study in Dhading district. The study was mainly focused on the adaptation of renewable energy technology and its impact on income generating activities. The outcome of this study shows that three among the five biogas users reported an increase in crop production by 5 to 10 percent due to the application of bio-slurry. However, uses of other types of renewable energy technology (RET) did not report an increase in crop production as experienced by the biogas users. The biogas users' household's main income generating activities are agricultural based wine (Rakshi) production. Fertilizer required for vegetable production has been reduced and so the amount of money spending on chemical fertilizer.

The bio gas technology as suggestion by the study has been helpful in relieving members from daily house hold chores. However, proper skill training needs to be imparted to the beneficiaries for producing marketable production. This of course requires initial capital requirement which these days is readily available from rural lending institutions in view of the above the study has been suggested to implement the bio gas

technology in a more intelligent in a more integrated approach in future days.

(Bhattarai, no date: 8,9). The government of Nepal has also taken renewable energy as a means for poverty reduction. The Tenth Five Year Plan (2002 – 2007) puts emphasis on increasing energy consumption in rural households by developing and extending alternative energy sources as energy could be a powerful tool in poverty alleviation. The other consideration has been driving the concept of commercialization in rural areas by developing and promoting alternative energy technology based on resources and tools, not to mention the aim of imported commercial fuels and increasing their access to indigenous alternative sources.

2.2 Policy of Government (Three Year Interim Plan, 2008)

The Plan emphasizes development of alternative energy systems for improving the living standards of people in rural areas. The Plan gives priority to the use of environmental friendly fuels. Rural Energy Fund will be strengthened and gradually extended to district and village levels. In line with decentralization policy, District Energy Cells will be established in VDCs to coordinate all alternative energy programs in the district. High priority will be accorded to research and development as well as technology transfer initiatives. The plan envisages using alternate technology to provide electricity to additional 4.5% of the rural population. An additional 1,500 VDCs will be covered under the program. This plan has emphasized in the construction of 100,000 biogas plants in 73 districts, leading to generation of energy equivalent to 22 MW.

2.3 Bio gas program

As the popularity of biogas is growing among rural families due to its diverse benefits, it would be expanded since it saves fire wood, reduce dependency on imported energy and there is no negative impact in the people's health. In addition, the use of bio gas plant brings no environmental pollution and the slurry, which came out from the plant as by product is use as the best fertilizer. So, the interim plan has target of installing a total of 1,00,000 bio gas plant, including 199,500 private bio gas plants and 500 community bio gas plants. Priority will be given to suitable and relatively smaller size plants and necessary researches would be carried out for its expansion in the Himalayan region and to reduce costs.

The forest serves as the main source of fire wood. Excessive use of fire wood has posed a serious burden on the forest. Our population is increasing day by day while the forest area is decreasing. So the forest alone is not capable of sustaining the increasing energy demand of growing population. In this situation there is a threat of depletion of the forest. This depletion will lead to many natural calamities such as soil erosion, land slide, flood and destruction of natural balance.

For, the collection of fire wood, rural women spent a great part of time further more, they spend considerable amount of time in cooking. Another problem of using firewood in kitchen is smoke produced which makes the women suffer from indoor air pollution.

To understand about bio gas provided direct benefit, especially rural area. For reduction work load when shifting from cooking on fire wood. It

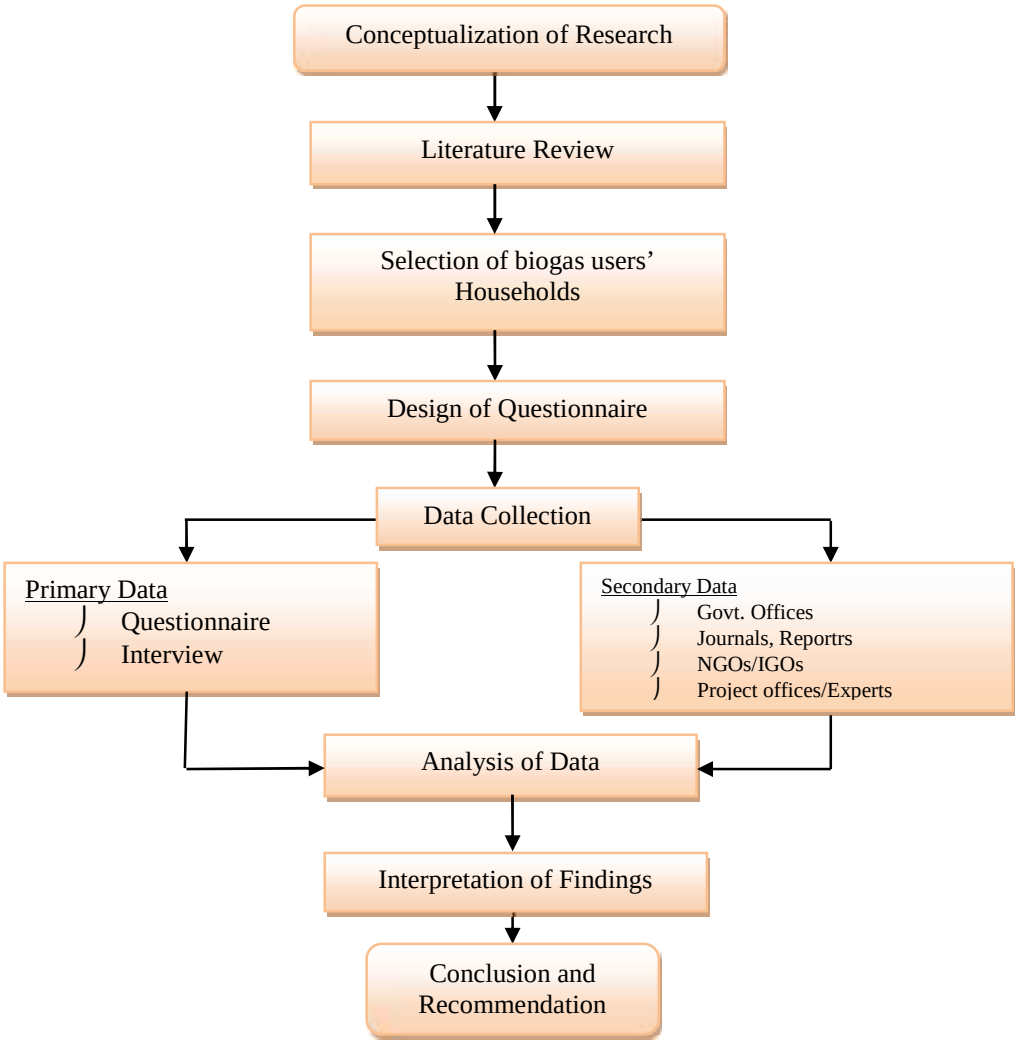
saves 3 hours time a day per family due to the reduction in time used for collecting fuel-wood, cooking and cleaning utensils.

The biogas technology as suggested by the study has been helpful in relieving members form daily household chores. However proper skill training needs to be imparted to the beneficiaries for producing marketable production. This, of course requires initial capital requirement, which these days is really available from rural lending institutions. In view of the above, the study has suggested implementing the biogas technology in more integrated approach in future days.

CHAPTER THREE
RESEARCH METHODOLOGY

The third chapter 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 The whole study is carried out the whole primary as well as secondary data. So, the relevant and reliable data can be made possible only by applying scientific method. This research is mainly devoted to achieve the objective of the study.

Figure 3.1: Research Methodology



The methodology of research is briefly explained as below;

1.1 Research Design

This study has been carried out on the basis of descriptive research design. Economic impact of bio gas with regard to time and money saving, forest resource and agriculture production are the objectives of the study. In order to fulfill the objectives, information has been collected from the field survey. Questionnaire interview and observation are the main tools that have been utilized to obtain the information form the biogas users. Only the biogas users Families have been taken into consideration for interview. Primary as well as secondary data has been utilized. Analysis of data has been made from the averages and percentage.

1.2 Introduction to the Study Area

This study is located in the Saundiyar VDC of Dang district. Dang lies in the mid- western development region of the Nepal. It is located between $27^0$37' and $28^0$21' North Latitude and $82^0$2' to $85^0$54'.The total area of this district is 2,955square km (Kilometer).Its political boundary is: Argakhanchi and Kapilvastu district in the East, Banke and Surkhet district in theWest, Salyan, Puthan and Rolpa district in the North and Banke and U.P of India in the South. The average temperature of the district is 32^0C and average annual rainfall of 1706 ml. The major River of the district is Rapti Babai. The major parts of the district are Inner Tarai (about 80%) and hills (about 20%) and the climate is subtropical.

The total population of the district is 4, 62,380. Out of 4, 62,380 population, 2, 33,422 are female and 2, 28,958 are male (district profile

2061B.S). The economic backbone of the disrtrict is agriculture. The literacy figure of the district is 58%.

According to the population census- 1991, the total population of Saundiyar was 8,052. Out of 8,052 populations, 3,984 are males, and 7,068 are females with average household size of 7.55. Similar, the total population of Tribhuvan Municipality was 29,050 (14,888 males and 14,262 females) with average households size of 5.55.

1.3 Rationale for the Selection of the Study Area

As an alternative energy source, biogas is being utilized in Saundiyar VDC of Dang district, which does have a significant potentiality. The area has selected due to its diverse socio- economic structure. This District lies in the mid – western development region in Rapti Anchal. The area of Dang district is 2,955 square kilometers.

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

1.4 Nature and Sources of Data

Both primary and secondary sources of data have been used to generate and analyze the objectives of this study.

3.4.1 Primary Sources of Data

Primary data has been collected during the field survey by structured questionnaire, interview and field observation. The responses of biogas

plant owners are regarded as the main source of field's observation, 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 30 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

In addition to primary data, secondary data has been collected form different biogas related office such as CBS, AEPC, BSP, TU Central library, different book, published and unpublished articles, thesis, earlier biogas research report and other central office of biogas company.

3.5 Sample Size

Saundiyar VDC in Dang district has been divided into several (9) wards. But the present study has been concentrated only on ward no. 1 and 2 of this VDC. These wards are the main area for biogas plants in this VDC. There are altogether 322 biogas plants in saundiyar VDC. Out of 322 biogas plant, 66 biogas plants are in ward no.1 and 88 in ward no. 2 and 46,25,21,20,14,21,21 biogas plants are in ward no.3,4,5,6,7,8,9 respectively (BSP Nepal).

Out of the total households having biogas plant of Saundiyar VDC of Dang district at ward 1 and 2, only 30 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 houses 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

Primary data have been collected using various tools and techniques. The techniques are described bellow.

3.6.1 Household Survey

The household survey has been conducted in order to collect qualitative and quantities facts about socio-economic aspect of the users and impact bio-gas. Information also has been collected through discussion with the people. The primary data has been collected from the selected house of V.D.C. Questionnaire has been used as a tool for interviewing the user of biogas plants. The respondent of the household has filled the questionnaire. The nature of study is based on primary source.

3.6.2 Key Informant Interview

The primary data also has been collected from key informant using the structured or unstructured interview method as well as open and close ended questions. The interview has been taken as cross checking for data obtained from interviewing those key informants The key informants are

energy specialist, staff of biogas company, intellectuals of biogas, local biogas user people who are not include for household survey.

3.6.3 Field Visit and Observation.

Each household selected in by randomly. The researcher has been visited and observed directly. Data has been recorded while observing the household who are participants in the programme.

3.7 Method of Data Analysis and Presentation

Methods of data analysis and presentation of data are the careful study of facts in order to draw valid conclusion. Information collected from questionnaire are edited, coded, tabulated and presented in appropriate formats. The quantitative data have been presented in tabular form and suitable statistical tools like percentages, ration, mean etc and interpreted and analyze in logical way. Table, charts and figures are used for profound illustration. The qualitative data have been interpreted and analyze in descriptive way based on their numerical characteristics.

CHPTER FOUR
SOCIO-ECONOMIC STATUS OF PLAN OWNERS

This chapter deals with the socio-economic condition of the biogas plant owners in Saundiyar VDC of Dang district. Caste/ ethnicity, Occupation, family size, educational status, and landholding are the main variables considered in this study

4.1 Caste/Ethnicity

Caste is divided in the past by their occupation and it is also social division. There are different castes and ethnic groups in Saundiyar VDC. The data on ethnicity/caste of sampled biogas households is given in Table 4.1

Table 4.1: Caste/Ethnicity of sampled Households

S.N.	Ethnicity/Caste	Number	Percent
1	Brahmin	18	60
2	Chhetri	7	23.33
3	Tharu	4	13.33
4	Other	1	3.34
	Total	30	100.00

Source: Field survey, 2009

Table 4.1 shows that the majority of the households are Brahman households. Brahman is leading in number or 60% of sample households. Similarly, Chhetri is in second majority comprising of 23.33 of total households. Tharu is in the third position comprising 13.33% and the remaining 3.34% belong to other castes. The reason for behind the higher percentage of biogas users (Brahmin) is found that they are socially & economically forward in every field

4.2 Occupation

Occupation such as agriculture and animal husbandry is directed related with the installation of biogas plants, since biogas needs dung to feed digester, while bio- slurry produced as by product is needed as fertilizer. The main occupation of the plant owners is agriculture. Agriculture is not only the main occupation of the some of the households' heads but also the major source livelihood for their family. Beside agriculture, agriculture and service, agriculture and business are the second main occupation of plant owners. The people grow various crops like paddy, maize, wheat, mustard, vegetables and fruits. The vegetable includes potato, tomato, bean, carrot, cauliflower, onion, spinach, radish, pumpkin and so on. Major occupation practiced by the sampled households are given in the table 4.2

Table 4.2: Occupation distribution of Plant owners

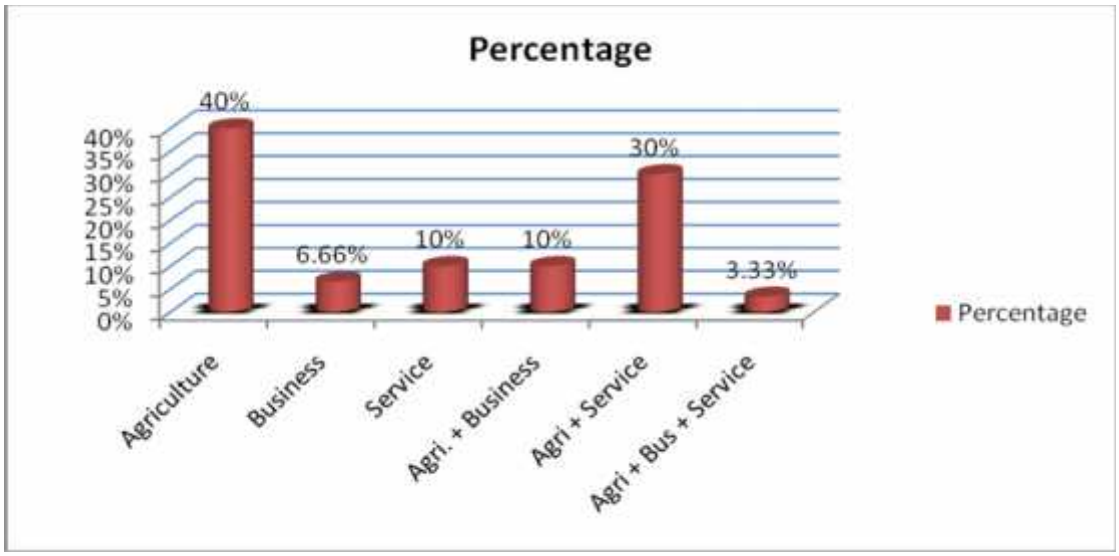
S.N.	Occupation	No. of Households	Percentage
1.	Agriculture	12	40
2.	Business	2	6.66
3.	Service	3	10
4.	Agri. + Business	3	10
5.	Agri + Service	9	30
6.	Agri + Bus + Service	1	3.33
Total		**30**	**100**

Source: Field Survey, 2009

Table 4.2 shows that the higher percentage of the plant owners is engaged in agriculture sector. About 40 % of the plant owners are involved in agriculture, 9% in agriculture plus service, 3% in service, and agriculture plus business, 2% in business and remaining 1% is in agriculture plus business plus service. In the field survey the researcher found that there

are mix occupation like farming and service in the same house. For example, parents are involved in farming and their sons and daughters are doing government and private services**.**

Figure 4.1: Occupation Distribution of the Plant Owner



4.3 Family Size

Family size shows about the number of father, mother and children. Small size of family is indicator of happiness life. Distribution of sampled household by family size is given in Table 4.3.

Table 4.3: Distribution of Households by Family Size

S.N.	Family	No. of Household	Percent
1	Small(1-4 person)	4	13.33
2	Medium(5-8 person)	19	63.33
3	Large(9- above)	7	23.33
Total		**30**	**100**

Source: Field Survey, 2009

Table 4.3 shows that among all 30 plant owners, 13.33 % households have 1 to 4 members. They are categorized as small size family. 63.33% household have 5 to 8 members and are categorized as medium size

family. The large size family have above 9 members and comprises 23.33% households.

4.4 Educational Status

Education is the key of development. This chapter describes the educational status in Ward no. 1 and 2 of this VDC. Most of family member of the plant owners are educated. The literacy rate of the selected household is found to be 9.3(Table 4.4). Table 4.4 shows the educational status of the sampled households.

Table 4.4: Educational Status of Plants Owners and their Family Member

S.N	Educational Level	No. of Person				Total	
		Male	Percentage	Female	Percentage	Number	%
1	1 – 10	22	34.8	20	44.5	42	38.8
2	Above SLC	30	47.7	16	35.6	46	42.6
3	Literate	7	11.2	3	6.6	10	9.3
4	Illiterate	4	6.3	6	13.3	10	9.3
Total		**63**	**100**	**45**	**100**	**108**	**100**

Source: Field Survey, 2009

This table shows that most of people are literate. 38.8% people fall under grade 1 -10 of formal education. 42.6% have passed SLC. Similarly, 9.3 people are in literate and 9.3 are illiterate.

This table also shows that 44.5% female falls under 1 - 10 grade against 34.8% of the male in the same grade. Similarly, 47.7 male has passed SLC against 35.6% female in the same level. Only 11.2 of male and 6.6 of female are literate and 6.3% of male and 13.3% of female are illiterate. Most of illiterate male and female are old. This result shows that the educational status of the plant owner is satisfactory.

4.5 Land holding

Land is the main resource of the rural people. The possession of land and animal indicates well economic of condition of the rural people. The main occupation of plant owners are agriculture, all of them have their own land to cultivate. Only operational land holding has taken into account. It is found that most of the cases, land is cultivated by owners themselves. All the plant owners have their own l land. Land distribution is given in the Table 4.5.

Table 4.5: Distribution by landholding

S.N.	Land (in Katthas)	No. of Households	Percentage
1.	Below 10	5	16.7
2.	11 to 20	7	23.3
3.	21 to 30	9	30
4.	31 to 40	6	20
5.	41 and above	3	10
Total		**30**	**100**

Source: Field Survey, 2009.

Land holding pattern is not equal. The table 4.5 shows that the maximum landholding of the visited household is 70 Katthas and the minimum land is 6 Katthas. Majority of the plant owners (30%) have 21 to 30 Katthas of land and only 3% percent have 41 and above Katthas of landholding.

CHAPTER FIVE
USES AND IMPACTS OF BIOGAS PLANT INSTALLATION

5.1 Uses of Biogas

The main domestic use of biogas in rural household is for cooking and lighting. In Saundiyar 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 5 hours. This cooking time is less than firewood cooking time.

5.2 Impacts of Biogas installation

This section includes the impacts of biogas in reduction of workload: use of gained time, saving of money on energy, reasons for biogas plant installation; impacts of health and sanitation and other social, environmental, economic impact and impact of slurry in production.

5.2.1 Reduction in workload and Time saving

After installation of biogas there is reduction in workload of the family members especially for women like firewood collection, cooking activities and washing utensils. The reduction of workload has been measured in terms of saving in working time. The table 5.1 shows workload and time saving of sampled households.

Table 5.1 Reduction in workloads and time saving

S. N.	Activities	Average time taken hours/day		Reduction in workload (saving in time hrs/day)
		Before installation	After installation	
1	Firewood collection	4.50	1.5	3.00
2	Cooking activities	2.55	1.50	1.05
3	Washing utensils	1.30	0.45	0.85
Total		**8.85 hours**	**3.45 hours**	**4.9 hours**

Source: Field Survey, 2009

Table 5.1 shows that the average time taken per day before installations is 8.85 hrs. After installation, 3.45 hrs per day is spent on all activities and the saving of time per day is 5.9 hrs. This time (4.9 hrs per day) is used in different activities. Saving of time directly reduces workloads in households' activities.

5.2.2 Utilization of Saved Time

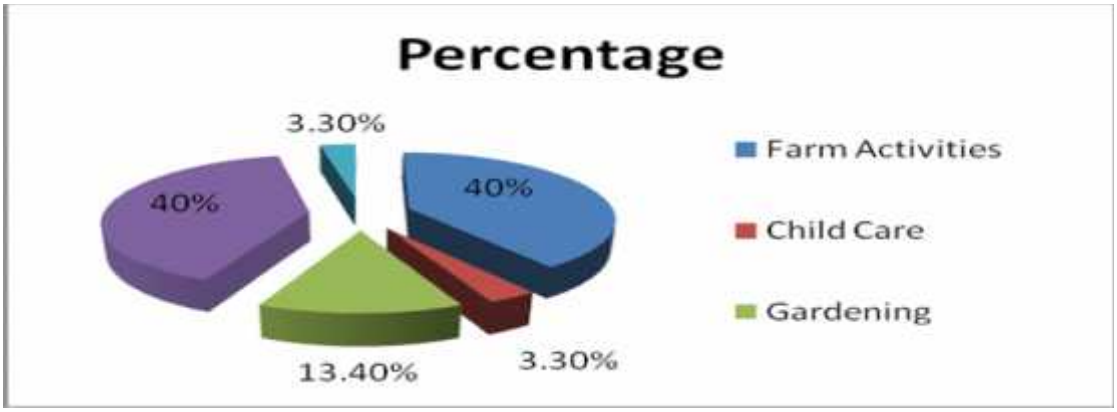
After installation of biogas, time has been saved. Time saved in firewood collection, cleaning utensils, cooking activities has many positive benefits to the households. Most of the households have used time for agriculture purpose. The use of saved time is presented in table 5.2.

Table 5.2: Utilization of Saved Time

S.N.	Activities	No. of Households	Percentage
1.	Farm Activities	12	40
2.	Child Care	1	3.3
3.	Gardening	4	13.4
4.	Income Generation	12	40
5.	Physical Labour for Wages	1	3.3
Total		**30**	**100**

Source: Field Survey, 2009

Table 5.2 shows that about 40 % of respondents out of total interviewed reported that they use their saved time on farm activities and income generating activities. 4% use their saved time on gardening. Only 3.3% of respondent out of total interviewed sampled household reported that they use the saved time on child care and physical labour of wages. Data clearly show that the saved time after the installation of biogas plant has been used on production activities.



5.2.3 Saving of Money on Energy

In this study, not only time but also the 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 5.3.

Table 5.3 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	600	100	500	100/Bhari	83.3
2.	Kerosene	100	50	50	60/ Liter	50
3.	LPG	200	100	100	1125/ Cylinder	50
Total Average (in Rs.)		900	250	650		72.2
Annual saving amount of money is (650×12) Rs. 7800					1 Bhari = 30 kgs.	

Source: Field Survey, 2009.

Table 5.3 shows that the amount of money which saved after the installation of biogas plant. Before installation Rs. 900/- was spent but after installation it is Rs. 250. Hence, the average saving amount of money is Rs. 650 per month. This table also classified that the annual saving amount of money (650×12) is Rs. 7800 can be contributed to pay the loan on installment of expenditure of biogas plant.

5.2.4 Reasons for Biogas Plant Installation

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

Table 5.4: Reasons for Biogas Plant Installation

S.N.	Reasons	No. of Households	Percentage
1.	Easy and Smokeless Cooking	23	76.7
2.	Toilet	-	-
3.	Environmental Protection	1	3.3
4.	Resource Conservation	-	-
5.	Get rid of Firewood Collection	6	20
Total		**30**	**100**

Source: Field Survey, 2009

Table 5.4 shows that the main reasons behind the installation of biogas plant are easy and smokeless cooking (76.7%) and to get rid of firewood collection (20%). Only 3.3 percent out of total interviewed reported that the main reason for biogas plant installation is environment protection.

5.2.5 Health and sanitation

Many study carried out in the past and this study proves that installation of biogas at individual or community level contributes greatly to improved health and sanitation condition. Compared to fire hood

cooking, smoke-less cooking with biogas is considered more advantages especially to women who have to undergo drudgery of cooking. Uses of latrine, connection of latrine to the biogas, reduction in disease, and change in the prevalence of insects have been deal in this section.

5.2.5.1 Use of Latrine

Among the survey household, 93.4 percent of the households have built latrine, 6.6 percent household are devoid of latrine.

Table 5.5 Use of Latrine

S. No	Have Toilet	No of Households	Percent
1	Yes	28	93.4
2	No	2	6.6
Total		**30**	**100**

Source: Field survey, 2009

This table shows that out of 20 households, 28 household have toilet and only 2 households have no toilet and they use open field instead of toilet.

Above findings clearly reflect that the households with biogas are encouraged or more conscious to use toilet for better sanitation.

5.2.5.2 Toilet Attached With Biogas Plant

The data regarding toilet connected biogas plats are shown in table 5.7.

Table 5.6: Toilet Attached with Biogas Plant

S.N.	Toilet Attached	No. of Households	Percentage
1.	Attached	23	76.7
2.	Not attached	5	16.6
3.	Do not have toilet	2	6.7
Total		**30**	**100**

Source: Field Survey, 2009

Table 5.7: Reasons to Attach Toilet with the Plant.

S.N.	Reasons	No. of Households	Percentage
1.	Due to lack of toilet	4	17.3
2.	To increase gas	11	47.9
3.	Lack of sufficient dung	8	34.8
Total		**23**	**100**

Source: Field Survey, 2009

Table 5.7 shows that majority of the households out of total interviewed reported that they have attached toilet with biogas plant (76.7%) whereas 16.6% reported that they have not attached toilet with the biogas plant. Only 6.7% of households have no toilet.

This study also reveals that the main reason to attach toilet is to increase gas (47.9%) followed by due to lack of sufficient dung (34.8%) and due to lack of toilet (17.3%) out of those who have attached toilet. And those who have not attached the toilet with plant is due to sufficiency of gas from dung only.

5.2.5.3 Reduction in disease

The respondents have been asked to express their opinion about the status of general health problems of the family members before and after the installation of biogas plants. It is –well know fact that biogas technology helps to reduce some diseases like eye infection, respiratory problem, headache, diarrhea Lung disease, Asthma etc because of improvement of in door as well as outdoor environment after the installation of biogas plants with toilet attachment with plants. Reduction of disease is shown in the following table:

Table 5.8: Reduction in disease

S. N.	Illness	No. of households	Percent
1	Eye illness & Headache	24	80
2	Respiratory problems	21	70
3	Lung disease	8	26.7
4	Asthma	3	10
5	No change	2	6.7

Source: Field Survey, 2009

Number and percentage exceed the sample size above 100 because of multiple responses.

The table 5.8 shows that before the installation of biogas plant, eye infection, respiratory problem, headache asthma etc are common disease found among the family member especially women. The respondents who stated improvement in their health condition explained that they used to cook food on firewood. The smoke and other noxious gases have caused health problems. After biogas installation, because of the smoke free and clean environment, their health status has been improved.

5.2.5.4 Status of Flies or Mosquito Breeding

The status of mosquito breeding after biogas plant installation has been shown in table 5.9

Table 5.9: Status of Mosquito Breeding

S.N.	Activities	No. of Households	Percentage
1.	Increased	22	73.4
2.	Decreased	2	6.6
3.	Remained Same	6	20
Total		**30**	**100**

Source: Field Survey, 2009.

About 73.4 % household reported for increased Mosquito after installation of biogas. 6.6 % household reported for decreased prevalence of Mosquito after bio-gas installation. And 20 % household reported for not change in prevalence of Mosquito after installation of bio-gas plant.

5.2.6 Impacts of slurry

The fertilizer use is mandatory in agriculture production system. The farmers are using farm yard manure (FYM), compost and chemical fertilizer in their crop field. With the introduction of biogas plant, the bio-slurry is becoming an additional source of fertilizer to enrich nutrients to the soil which is very useful for agricultural production increment.

As per norms established by the GGC, the slurry produced from the biogas plant contains 1.6 percent nitrogen, 1.2percent phosphorous and 1.0 percent potash against 0.5 percent phosphorus and 0.6 percent potash in livestock dung. Biogas slurry is high quality organic manure. The organic contain of the digested slurry improves the soil texture, stabilizes its humid content, intensities its rate of nutrient depot formation and increases its water hording capacity.

5.2.6.1 Bio-slurry Application

Bio-slurry use as fertilizer is a new practice in Nepal. As indicated by previous studies, the present study also found that biogas users have started using bio-slurry as fertilizer in their crop field and kitchen garden in different form which is shown in the following table.

Table 5.10: Methods of using Bio-slurry

S. N.	Method of Application	No of Households	Percent
1	In liquid form	1	3.4
2	In dried form	3	10
3	Composted form	26	86.6
Total		**30**	**100**

Source: Field survey, 2009

The above table shows that 86.6 % people use slurry in composted form, while 10 % used it in dried form. And only 3.4% of the respondents reported using liquid form.

5.2.6.2 Use of Slurry in Agriculture Production

Biogas slurry is useful for agricultural production increment.In this study, slurry use has increased productivity mostly. The impact of slurry or slurry and production increment in agriculture sector is presented below.

Table 5.11: Slurry and production

S. N.	Agriculture	No of households	Percent
1	Increased	25	83.4
2	Decreased	1	3.3
3	Remained the same	4	13.3
	Total	30	100.00

Source: Field Survey, 2009

Table 5.11 shows that about 83.4 % out of total interviewed households expressed that after using bio-slurry, their agricultural production has increased whereas 13.3 % reported that the agricultural production is remained same. And only 3.3 % reported about decreased in agriculture production.

In various crop productions, paddy production has accounted the highest ratio than wheat, maize, oil seed so and other.

So, the slurry reduced the quantity of chemical fertilizer used in the crops and also save the money to some extent which had been used to buy more chemical fertilizer.

5.2.7 Size of the Biogas Plant

Various types of biogas plants having different size have been introduced on promoting and development of biogas. $4m^3$, $6m^3$, $8m^3$, $10m^3$ and $15m^3$ are widely used size of biogas plants. The factors e.g. capacity of Land holding, water availability, capacity of livestock are the source for determining the size of the plant. Size of the bio-gas plant is given in the Table 5.12.

Table 5.12: Distribution of Biogas by Plant Size

S.N.	Plant Size	No. of Households	Percentage
1.	$6m^3$	22	73.4
2.	$10m^3$	5	16.6
3.	$15m^3$	3	10
Total		**30**	**100**

Source: Field Survey, 2009.

Table 5.12 shows that only three types of biogas plan sizes, $6m^3$, $10m^3$ and $15m^3$ were reported. About 73.4 % of interviewed households have $6m^3$ capacity plant followed by $10m^3$ capacity (16.6%) and $15m^3$ capacities (10%). This study shows that $6m^3$ capacity plants have been widely used in the study area.

5.2.8 Problems and Perceptions about the Use of Biogas Plant

There are so many problems of the use of biogas plant. The main problem is less gas production from plant especially in winter seasons. The other major problems are maintenance, operational, dung availability, temperature, gas leakages and paying loan. In this section perception of respondents also have been dealt in detail regarding the use of biogas.

5.2.8.1 Problems of Biogas Plant

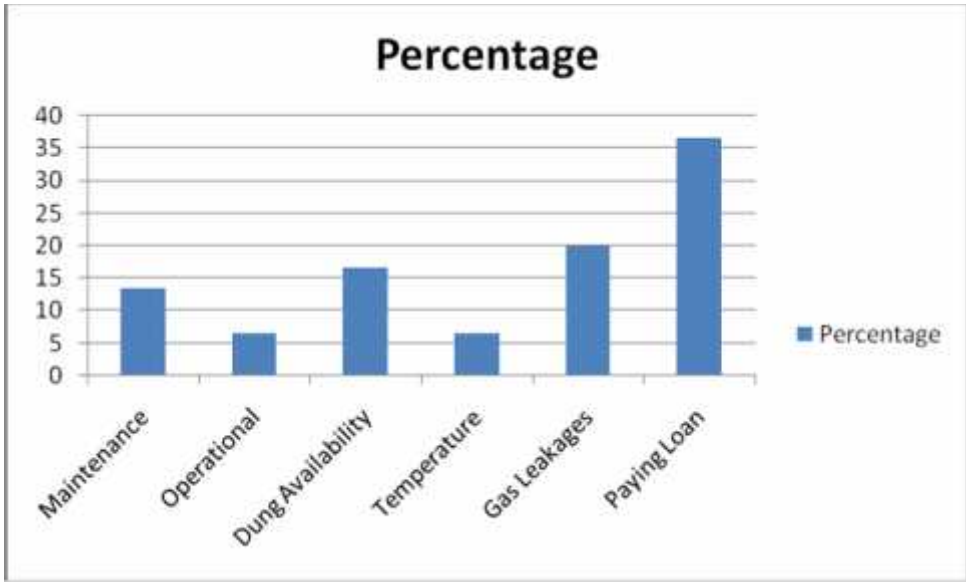
Table 5.13: Problems of Biogas Plant

S.N.	Problems	No. of Households	Percentage
1.	Maintenance	4	13.4
2.	Operational	2	6.6
3.	Dung Availability	5	16.7
4.	Temperature	2	6.6
5.	Gas Leakages	6	20
6.	Paying Loan	11	36.7
Total		**30**	**100**

Source: Field Survey, 2009

Table 5.13 shows that about 36.7 % respondents out of total interviewed reported that they have problem of paying loan followed by gas leakages 20 %, problem of dung availability 16.7 %, problem of maintenance 13.4%, operational problem 6.6 and also temperature problem especially in winter season 6.6%

Problems of Biogas Plant



5.2.8.2 Perception of Respondents on Utility of Biogas Plant

Table 5.14: Perception of Respondent

S.N.	Utility of Plant	No. of Households	Percentage
1.	Useful	14	46.7
2.	Very Useful	16	53.3
3.	Not Useful	-	3.3
Total		**30**	**100**

*Source: Field survey, 2009***.**

Table 5.14 shows that about 53.3% respondents out of total interviewed reported that biogas is very useful and 46.7 % respondent reported that biogas is useful.

CHAPTER SIX
FINDINGS CONCLUSION AND RECOMMENDATION

6.1 Major Findings

Energy plays a crucial role in the Nepalese economy of the country and livelihood of the people. Biogas technology is one of the clean and alternative sources of energy for household purpose. It has important place for overall development of the study area. The major findings of the study are summarized as follows:

- The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.
- There is considerable reduction in workloads of the family member, especially for women. The household save 3.00 hrs/daily firewood collection. 1.05 hrs/daily for cooking activities and 0.85 hr saving for cleaning utensils.
- Majority of sampled household reported that time has been saved and majority of respondent saved time has been used for farm activities (40%) and income generation activities (40%).
- Most of sampled households have saved firewood on each cooking time. The average saving for firewood by the installation of biogas plant per household is accounted Rs 650 per month.
- Fuel saving in summer is high compare for winter in the monetary valve. It is because of the insufficiency of gas in winter due to low temperature factor.
- Most of the household have toilet facility (93.4 %) but (76.4 %) toilets have connected to the bio-gas plant.

- Medical expenses also have been reduced after the installation of biogas plant.
- Indoor air pollution of smoke or kerosene fumes has been reduced .
- The users of biogas felt the reduction of smoke in the kitchen. This had induced the frequency health related problem such as eye illness and headache (80%) and respiratory problem (70%).
- Breeding of Mosquito has increased significantly in 73.4% of the sampled household. It is one of the negative impact of bio-gas plants
- Almost all plant owner uses slurry on farm.
- Most of the users use slurry in composted form (86.6%). Application of bio-slurry to the crop has resulted increasing agricultural productivity (83.4%)
- Sizes of 6 m^3 biogas plants are more popular in this area as compared to other size of plants ($10m^3$, $15m^3$).
- This study found out that there is the size of $10m^3$ biogas plants (16.6%) and $15m^3$ biogas plants (10%) installed. But these size of plants were installed before 10 years
- The main problems of plant owner are paying loan (36.7%), gas leakages (20%), Dung availability (16.7%), and maintenance (13.4%) which is also negative impact of biogas plant

6.2 Conclusion

This study is conducted in Saundiyar VDC of Dang district. This study is based on the sample of 30 households in Ward no 1 and wards no 2 who have install bio-gas plant. Households under study use bio-gas mainly for cooking purpose. To gain the economic benefit, most of the households have connected toilet to the bio-gas plant but still few have separate toilet not connected with the plant.

It has reduced the compulsion of family member especially women to fetch firewood and saved their time and energy which let them time to involve in other economic activities and made their life easier. The improved Chulhas (ovens) reduces the drudgery of women, changes their lifestyle and encourages them to come out for income generating economic activities. It also saves women and children from the risk of fire and pollutants caused by firewood as it does not have dangerous emissions. Thus, biogas improves the health condition of family member especially women and children.

Installation of bio-gas plant has saved Rs 650 per household per month by saving money spent on energy source such as kerosene, firewood and LPG. The households are satisfied with the saving they do.

By product (bio-slurry) of biogas plant is very useful for increasing crop production and also reduces using chemical fertiliser. Biogas plant has not only reduced indoor air pollution but also reduces diseases like respiratory and eye infections, cough and headache to family member. Adversely, the installation of biogas plant has significantly increased the problem of mosquitoes. Thus, biogas improves the health condition of family member especially women and children.

This technology has also improved the overall energy, environment socio and economic condition of the plant owners.

6.3 Recommendations

On the basis of analysis of this study, the following recommendations are drawn.

- 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.
- 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.
- Initiate R & D (Research and Development) for developing low cost models appropriate for the poorest section of the population.
- Connection of the toilets to the biogas plants should be promoted. This would help further improving the sanitation.
- 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.
- Provision of easy loan and cheap interest rate on loan should be made including higher percentage of subsidy.
- Importance and benefits of the biogas plant should be demonstrated.
- The exact cause for the increase of mosquito population due to introduction of biogas should be investigated with necessary solution for the control of mosquito.

- Application of bio slurry on farm should be studied systematically, qualitatively and quantitatively.
- Women are the main user of biogas, special emphasis such as operation, maintenance and installation training has to be given directly to women. Women technicians should get a priority in the rural sector.

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APPENDIX
TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF RURAL DEVELOPMENT
KIRTIPUR, KATHMANDU
BIOGAS PLANT SURVEY IN SAUNDIYAR VDC DANG
2009

HOUSEHOLD SURVEY QUESTIONNAIRE

1. General Information:-

1.1 Name of the household head/ Respondents:

1.2 Sex: M/F

1.3 Caste/Ethnicity:

1.4 Ward number:

1.5 Occupation:

1.6 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 ☐

1.7 What is your family occupation?

a) Agriculture ☐ b) Business ☐ c) Service ☐
d) Agri.+Business ☐ e) Agri.+Service ☐
f) Agri.+Business+Service ☐ g) Others (specify) ☐

1.8. Family Size and education

Age (Year)	Male	Female	Total	Literate	Illiterate
0-10					
10-20					
20-30					
30-40					
40-50					
50-60					
60+					

2. Information On Biogas

2.1 Do you have biogas plant?

a. Yes ☐ b. No ☐

2.2 Size of that plant ☐ m^3

2.3 Type of Gobar gas plant?

a) Dome ☐ b) Drum ☐

2.4 What is the name of your biogas company?

2.5 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 ☐

2.6 Cost of installation of biogas plant (in Rs.)

Total cost	Source of investment	Govt. subsidy amount

2.7 When did you install this plant?

Year: …… Month: …….

2.8 Have you attached toilet with this plant?

a) Yes ☐ b) No ☐

2.9 If not, why?

a) Due to the concept of unholy ☐ b) Dirty ☐

c) Separate toilet ☐ d) Sufficiency of gas ☐

e) Others (specify) …….

2. Livestock:

3.1. Dung production

Livestock	No. of livestock	Dung produced/day
Cow		
Buffaloes		
Other		
Total dung produced per day		

3.2. Dung feed per day ……..kg

3.3 Water used for mixing ……..liters

3.4 Uses of biogas

Purpose	Number of burner/mantles	Use hrs/day/unit
Cooking		
Lighting		

3.5 Source of water

a. Well b. River

c. Hand pump d. Canal

e. Tap water f. others

3. Alternative Energy Source, Consumption and Saving

4.1 Source of energy used before biogas installation

a. Firewood b. Agriculture residue

c. Electricity d. Kerosene

e. Dung cake f. Others g. L.P. gas

4.2 Source of the energy used after installation

a. Firewood b. Agriculture residue

c. Electricity d. Dung cake

e. L.P. gas f. Others

4.3 Do you save fuels after the installation of biogas plant?

a) Yes ☐ b) No ☐

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

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

4.5 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 hr.)
			Before installation	After Installation	
1.	Firewood collection				
2.	Cooking				
3.	Washing utensils				
				Total time saved per day (in hour)	

4.6 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 ☐

4.7 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) …….

5. Health and Sanitation:

5.1 Is there any health problem before installing the biogas plant?

a) Yes ☐ b) No ☐

5.2 If yes, which type of disease?

a) Eye illness ☐ b) Lung disease (T.B.) ☐
c) Respiratory problem ☐ d) Asthma ☐
e) Headache ☐ f) All of the above ☐
g) Others (specify) …….

5.3 If there any change after the installation of biogas plant?

a) In health ☐ b) In hygiene ☐ c) In sanitation ☐
d) All of above ☐ e) Others (specify) ……

5.4 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 ☐

6. Loan:

6.1 Did you take loan for installing the biogas plant?

a) Yes ☐ b) No ☐

6.2 If yes, which is the source of loan?

a) Moneylender ☐ b) Commercial Bank ☐

c) ADB/N ☐ d) Rural Development Bank ☐

6.3 How much percent interest do you pay for loan?

a) 8-10 ☐ b) 11-13 ☐ c) 14-16 ☐

d) 17-19 ☐ e) 20-22 ☐

6.4 Are you satisfied with the existing interest rate of loan?

a) Yes ☐ b) No ☐