CHAPTER ONE

INTRODUCTION

Nepal is primarily an agricultural country with about 27 million population out of which 81.39 percent population resides in rural area and agriculture employs 76% of the workforce(CBS,2011). The number of the households with cattle of Buffaloes in Nepal was estimated to by 2.7 million in 2001 (BSP, 2004). Based on this, the technical potentiality at Bio-gas plants installation is assumed to be around 1.9 million. By the end of Oct 31, 2009, a total number of 2,00,000 plants were installed under BSP (BSP, 2008). Fuel wood has been and still is the major source of fuel daily used by rural mass in Nepal. This total dependence on fuel wood as the source of energy for cooking has resulted in deterioration of the quality and quantity of forests and posed a serious threat in maintaining ecological balance, thereby manifesting various problems like deforestation, flood, global warming, soil erosion, landslides, climate change etc. The pressure on forest resource for energy fulfillment is considerably increasing due to high population growth in rural areas causing scarcity of fuel wood for cooking. As a consequence, many people in the rural areas are burning livestock dung and other agricultural residue. This has been one of the factors in deterioration of environment and soil fertility in the country.

Biogas is an important alternative source of energy and also a source of income for a developing and agricultural country like Nepal (BSP, 2010). As per the agreement the help of 7 dollars per Certified Emission Reduction (CER) in bio energy and 10.25 dollars per CER for micro-hydropower will be received. Currently, Nepal will receive the grant of about US $ 680,000 annually, given the number of 19511 gas plants registered in the year 2009/10 and 6774 additional plants were registered in the first 8 month of 2011(MOF, 2011).

Kerosene and other oil-based sources of fuel are scarce and costly to be easily available for small marginal and medium farmers residing in rural areas. Furthermore, frequent alarming high in prices of important oil and chemical fertilizer have serious economic threat to the rural self. Sufficiency in energy and fertilizer and to minimize the pressure on traditional biomass fuel, biogas technology has been the best

alternative energy solution, which could be achieved through the active mobilization and economic utilization of local indigenous resources available in the country.

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. It is mainly composed of 50-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It is about 20 percent lighter than air. It is an odorless gas that burns with clean blue flame similar to that of LPG gas.

Nepal has a history of over 50 years of biogas technology development. The first historical biogas system was introduced by father B.R Saubollein 1955 at St.Xavier's school of Godavari Lalitpur as his personal initiatives. It was in the agriculture year 1975/76 that the government of Nepal launched special programmed to promote biogas technology and install in the different Parts of the country in the supervision of government and non-government organizations. Since then, the technology has proved its worth in Nepal to draw interest and involvement of various private and public sectors institutions including the donor agencies.

Talking about the potentiality of biogas in Nepal, being an agricultural country, livestock plays an important role in the Nepalese farming system. The total households with cattle and buffalo in Nepal were estimated to be 207million in 2001. Based upon the study of technical biogas potential of Nepal, it is estimated that a total of 109 million can be installed in Nepal out of which 57 percent in plains, 37 percent in hills and rest 6 percent in remote hills or in mountain region.

Small rural communities throughout Nepal will reap the benefits of the carbon market with the signing today of an emission reductions purchase agreement (ERPA) for the Nepal biogas project. This is the first greenhouse gas emission (GHG) reductions project in Nepal under the Clean Development Mechanism (CDM) of the Kyoto Protocol. Each biogas plant can save more than four ton's of firewood and 32 liters of kerosene. A single biogas system with a volume of 100 cubic feet can saves as 0.3 acres of forest each year it can mitigate about five ton's of carbon dioxide equivalent per year.

The biogas project has a number of benefits to rural households along with reducing greenhouse gas emissions. Besides carbon revenue, availability of organic fertilizer,

time saving on daily household works, improvement in sanitation and health, cleanliness in and around the house, environmental protection, employment generation etc the feasibility of producing electricity from biogas as well as the slurry for animal feed is being examined. Thus, given a government favorable policy, the combined efforts of private sectors, the Biogas Company, the Agricultural Development Bank of Nepal and the united mission to Nepal could contribute significantly to the development of biogas in Nepal.

This study focused on socio-economic impact of bio-gas plant in Budhabare VDC of Jhapa district. The study also deals with the impact of biogas on health and sanitation, time and money saving, special benefits from the saving. The study includes the effect of bio-gas slurry in terms of agriculture production as well as the benefits of biogas to the rural people of Budhabare VDC of Jhapa district. The benefits are categorized as gender benefits, environmental benefits, health benefits, and economic benefits.

1.1 General Background of the Study

Biogas is indisputably one of the best alternative sources of energy particularly in the rural areas of Nepal where there is very high potentiality of biogas. And biogas has been successfully implemented in some areas of the country as well, so the mentioned study is designed to examine the economic effect of biogas in a particular region of Budhabare VDC, Jhapa.

Energy is an essential ingredient of socio economic development and economic growth of a country. The production and consumption of energy is often linked to other major issues in the society, including poverty alleviation, environmental degradation and security concerns. The experience shows that there is a definite correlation between access to energy on one hand and education attainment and literacy on the other, among the rural and urban poor. Consequently, the goals of poverty eradication, improved living standards and increased economic output imply increasing energy requirements (Kumar, 2003).

About 90 % of total energy demand is met through firewood, agricultural residue and animal wastes (dung burning) resulting to forest/environmental exploitation, deprivation of organic matter to agricultural land, irreversible loss of soil fertility as well as health and environment thrashing (WECS, 1994). The increasing population is

progressively more using the forest resources beyond its regeneration capacity thus forcing to ecological consequences in terms of soil erosion, floods and loss of precious top soil. Experts are of the opinion that continuous deforestation at this rate (Approx. 2%) will lead to almost exhaustion of the forest in near future unless major efforts on conservation and reforestation are made. So it has been so much urgent to seek for an alternate source of energy which can provide the energy demand of the country (particularly rural area) without the exploitation of the natural resource and which could be very much affordable for the rural people.

Whether we depend on one source or another, all conventional sources are finite. At some point of time we will definitely run out of them and the entire globe as well will run out of them. So we better not run out of them if we really want the human species to survive and not end within the next five or ten generations. It has been the time to think seriously of a source, which is infinite. That is the natural power, the natural energy that is available from the sun, from the wind, from the water and so on. At least it can co exist with the earth. As long as the earth survives, the power that is available to the earth from the sun will also survive.

Bio-gas has steadily becoming one of the most trusted and popular alternative sources of energy, particularly in rural Nepal. Besides cooking and lighting purposes, it more often has other indirect benefits as well. The digested slurry coming out of the biogas plant has more nutrition value more than the traditional farmyard manure, which ultimately enhances the production of crops. The installation process also helps in creation of job opportunity for skilled and semi skilled human resources. The time elapsed on collection of fuel wood or making dung cakes will definitely be cut down very highly through the biogas and the spare time could well be used on other productive, beneficial and income generating activities. Furthermore with ample subsidy around the country for biogas installation, it comes to be cheap for the customers and on the other hand it is very much a user-friendly technology.

Nepal is an agricultural country where still above 80 % of the people follows this occupation to earn their living. On the other hand animal husbandry is an integral part of the agriculture with almost every farmer rearing cattle in the rural areas of the country. So it is obvious that there is huge generation of animal bi-products and agricultural wastes which are principally the major sources of Biogas production so it

can be fully utilized for the generation of the Biogas. Therefore Biogas stands in the front in search of the alternate source of energy in the Nepalese rural context.

Due to lack of firewood for cooking purpose, many people in rural area are burning livestock dung and other agricultural wastes. The use of agricultural residues and animal dung for cooking purpose rather than being used as fertilizer reduces the crop yield in the rural area. LPG, kerosene and electricity as sources of cooking are accessible for few people and especially in urban area. They are very expensive and out of the affordability of normal rural family. Thus, in rural areas traditional energy sources will remain the main supplier of energy in the foreseeable future. Considering the energy scenario of Nepalese society, the strong and immediate need of alternative sources of energy was realized (BAJGAIN, 2003)

Biogas is the mixture of gas produced by methanol bacteria while acting upon biodegradable materials like cattle dung, human excreta and other organic wastes in an anaerobic condition within the temperature of 26 to 36 degree Celsius for a certain period. It is mainly composed of 60 to 70 percentage of methane, 30 to 40 percentage of carbon dioxide and some other gases (BSP, 2003). Biogas is 20 % lighter than air which is colorless, odorless and smokeless that burns with clear blue flame similar to that of LPG. Biogas technology was first initiated in Nepal in the mid 1950s by Father B. R. Saubolle, a Belgian teacher at Godavari St. Xavier's School who constructed a micro model digester out of an oil drum. Only a few farmers were interested in biogas technology and they installed a few bio gas plants after 1967 under the design of Khadi and Village Industry Commission (KVIC) model of India. The biogas was given priority as an alternative energy sector during the seventh five year plan (BSP).In 1992, "Biogas Support Program" was introduced at three different stages for massive dissemination of technology in the country with the long term objectives of reducing deforestation and environmental deterioration, improving health and sanitation of rural population especially women and increasing the agricultural productivity by promoting the use of digested slurry. It has successfully completed its third phase in June 2003 and have stated fourth phase from July 2004.

For networking at the central level policy making and promoting the alternative energy technology HMG/N has set up an Alternative Energy Promotion Center under the Ministry of Science and Technology in 1996. At present there are many private

companies working for the extension of Biogas technology under BSP, SNV/N. There are 44 recognized biogas companies, 13 biogas appliances workshops and 60 micro finance institutions working in different districts. The biogas program has been launched in 65 districts to the till date (BSP, 2004).

In Budhabare VDC biogas plants has been under operation since last 13 years. It has been very much popular and appreciated and acquired by lots of households for their energy supply. This research study is designed to examine the socio economic effect of biogas in Budhabare VDC, of Jhapa district.

1.2 Statement of the Problem

Energy is a critical component of development process. It is needed in all spare of life, which is directly connected with human's universal progress as in cooking, lighting, heating etc. The per capita energy consumption is a key index of development and the energy problem is one of the common problems of developing countries and Nepal could not remain untouched with this problem. Shortage of energy is a serious constraint to the achievement of sustainable development. Similarly firewood being the main source of energy is resulting to the depletion of forest on one hand and on the other hand the smoke emitted through the firewood is affecting very badly to the health of Nepalese women, which is definitely dwelling the efficiency of the women as well.

The population growth in the developing countries like Nepal is radically very high and there is no doubt that this rapid growing population will definitely require more amount of energy, which clearly signifies that the energy demand is growing high with the population increment. But we are well aware of the fact that the area of resources is constant, so with this limited resource area the growing energy demand is to be fulfilled. Therefore it can be generalized that without the vision or management of alternate source of energy, the demand cannot be fulfilled and if not done so, we have to witness the total exhaustion of our resources in very near future.

So, realizing on the mentioned facts the study tries to find out the impact of biogas in the proposed study area on the subjects like:

- Does it meet the economicaspects for all kinds of families?

- The increment of agricultural productivity through bio gas plants
- The quantity of Firewood saved
- Saving of Time of the Biogas plant users and its utilization

1.3 Objectives of the Study

The general objectives of the research are as follow:

1. To examine the economic benefits of biogas.
2. To calculate the engagement of advantaged time in income generation activities.
3. To suggest relevant way outs for the betterment of biogas plants

1.4 Significance of the Study

Since the energy problem is getting more and more hazardous in the Nepalese rural areas that further is resulting to the depletion of the precious forest and natural resources. It is consuming the lot of people's time, deteriorating the heath condition of the women. On the other hand as Nepalese people has not been such strong to afford the technology of other renewable sources of energies like solar, wind and water, Biogas being cheaper, easy to maintain plus other lots of positive aspects makes it very important in the Nepalese context.

In view with the fact that the rapidly growing population needs more amount of energy through the limited resources, over use of conventional source of energy could lead to the exhaustion of those resource in some frame of time, so it has been very much important to search for the alternative source of energy so that we may not have to face the energy crisis in near future. Realizing the fact that the raw materials like dung, agricultural and animal wastes are quite abundant in our rural areas, there could be no better technology other than biogas to replace the use of conventional sources of energy with its installation being relatively cheaper in the circumstances.

So this study is going to be carried out hoping that it will be helpful for the implementing agencies in the formulation of plans and policy makers to formulate appropriate plans for further development to gain the economic achievement. To the

end the finding of the study will definitely help the related people to decide about the installation of biogas as well as it the study will be important to find out the changes in immense status and economic activities of the users in the study area.

1.5 Limitation of the Study

The study will basically based be on household survey of biogas users in the study area of Budhabare VDC. The research targets to study the economic effect of biogas technology and the study will be very specific like that of the case studies. Since the study does not cover much area, conclusion drawn from this study will be just an indicator rather than conclusive. Since the study is in limited area i.e. some households of single VDC, the result cannot be generalized in all the places and time.

1.6 Organization of the Study

The first chapter is the introductory chapter, which discusses about the background information, statement of the problem objectives etc. Literatures related to Energy and biogas as a source of renewable energy and its impacts/effects has been reviewed on the second chapter under the heading of ' Literature review'. Third chapter is all about the research methodology applied for this research. Chapter fourdiscusses about the analysis of datainterpretation and chapter fifth chapter deals with the summary, conclusion and recommendations.

CHAPTER 2
LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter presents the summary of the outcomes of various research studies carried out to evaluate the welfare gain achieved from the installation of biogas plants by the users. The literature is reviewed from various sources such as those presented by former researcher including reports and papers presented at seminars, articles published in various bulletins, journals and newspapers, and information published by concerned agencies.

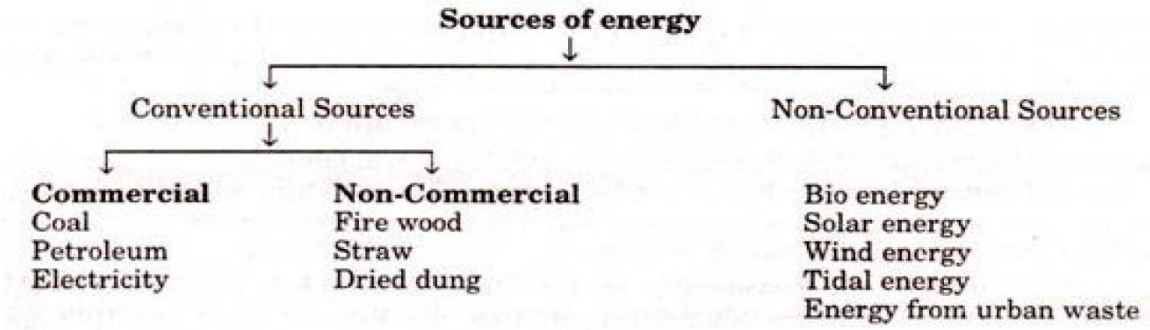
2.1 Conceptual review

Biogas is an important alternative source of energy and also a source of income for a developing and agricultural country like Nepal (BSP, 2010). Biogas is one of the most important alternative sources of energy, which has several direct and indirect benefits. The use of biogas is justified not only from economic ground that it is a substitute for expensive petroleum fuel, but it also protects environment, improves health, saves time and is convenient. Although the use of biogas gained popularity only after 1970, various studies on different aspects of biogas have been performed since then. In the context of Nepal, the technology is appreciated and used mainly as the alternative source of energy for household for cooking, lighting and the digested slurry as better organic manure for agricultural crops and vegetables (BSP, 2004).

2.1.1 Energy

Energy is one of the most important components of economic infrastructure. It is the basic input required to sustain economic growth. There is direct relation between the level of economic development and per capita energy consumption. Simply speaking more developed a country; higher is the per capita consumption of energy and vice-versa. (Pooja Mehta,2016)

Energy sources can be broadly divided into two distinct groups. They are described as below:



(E-article: economics discussion- Pooja Mehta)

2.1.2 Conventional Sources of Energy

These sources of energy are also called non-renewable sources. These sources of energy are in limited quantity except hydroelectric power. Among conventional energy sources fossil fuel, fissionable nuclear fuels and non nuclear energy sources are the major energy sources used in our daily purposes. In spite of their outstanding virtues, fossil fuels have two instrumental drawbacks. Firstly, these are non renewable and thus supply of many fuels is either approaching exhaustion getting more difficult to procure due to transport bottlenecks and steep hike in their price level. Secondly their continued increasing use creates environmental problems. Like fossil fuels fissionable nuclear fuels also suffer from two serious drawbacks. Their supply from relatively cheap sources is drying up even for the most advanced countries. Moreover the production and use of this source caused a plethora of hazards both to man and his balanced environment on earth, (Vimal and Tyagi, 1984). Excessive use of conventional resources will definitely reduce the volume or amount of these resources on one hand and on the other hand produced energy sources from these sources have adverse effects on environment but the alternative/non-conventional sources an be used to reduce the exploitation over those resources which can be cheaper as well.

These are further classified as commercial energy and non-commercial energy:

Commercial Energy Sources:

The energy industry is the totality of all of the industries involved in the production and sale of energy, including fuel extraction, manufacturing, and refining. These are coal, petroleum and electricity, nuclear energy. These are called commercial energy because they have a price and consumer has to pay the price to purchase them. High capital investment is required in the purification of these kinds of energy sources. The commercial energy has great economic value but these types of energy are limited in nature. Excessive use of commercial energy sources pollutes the environment badly. It is used in urban as well as rural areas.

Non-Commercial energy Sources

These sources include fuel wood, straw and dried dung. These are commonly used in rural Nepal. Agricultural wastes like straw are used as fuel for cooking purposes. Animal dung when dried is also used for cooking purposes. The straw and dung can be used as valuable organic manure for increasing fertility of soil and in turn productivity.

2.1.3 Non-Conventional Sources of Energy

Besides conventional sources of energy there are non-conventional sources of energy. Those energy sources that are renewable and ecologically safe are known as non-conventional source of energy. These are also called renewable sources of energy. Energy generated by using wind, tides, solar, geothermal heat, and biomass including farm and animal waste as well as human excreta falls under non-conventional energy. All these sources are renewable or inexhaustible and do not cause environmental pollution. Moreover they do not require heavy expenditure(Pooja Mehta, 2016).

The various sources are given below

i. Solar Energy

Energy produced through the sunlight radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis is called solar energy. Under this program, solar

photovoltaic cells are exposed to sunlight and in the form of electricity are produced. Photovoltaic cells are those, which convert sun light energy into electricity. Sunlight is converted into thermal power (Pooja Mehta,2016).It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. Solar energy is used for cooking, hot water and distillation of water etc.

ii. Wind Energy

Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity. Mechanical power can also be utilized directly for specific tasks such as pumping water(Pooja Mehta, 2016). Wind energy can be harnessed and used for generating electricity or for other smaller purposes by a windmill. In olden times, windmills were used to draw water out of wells or to grind flour etc. It is the rotatory motion of the shaft in a windmill that is used to rotate the turbine and convert it to the form of energy we need it in. The main advantage of wind energy is that harnessing it doesn't disrupt natural processes or harm the environment, unlike a lot of other energy sources. To generate electricity on a large scale, a number of windmills are set up over a large area, called a wind energy farm. Such areas need a wind speed of 15kmph(Wind-energy-advantages, 2012).

iii. Tidal Energy

Energy produced by exploiting the tidal waves of the sea is called tidal energy. Tidal power or tidal energy is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity. Tidal Energy is a renewable energy source. This energy source is a result of the gravitational fields from both the sun and the moon, combined with the earth's rotation around its axis, resulting in high

and low tides. Tidal power is an environmentally friendly energy source. In addition to being a renewable energy, it does not emit any climate gases and does not take up a lot of space. Due to the absence of cost effective technology, this source has not yet been tapped. Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power(Pooja Mehta,2016)

iv. Bio Energy

This type of energy is obtained from organic matter. There are two types of bio energy

(a) Bio Gas

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and in many cases exerts a very small carbon footprint. Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, and it generates no net carbon dioxide. Organic material grows, is converted and used and then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released when the material is ultimately converted to energy(Wikipedia, 2017).

Bio Gas is obtained from Gobar Gas Plant by putting cow dung into the plant. Besides producing gas this plant converts cattle-dung into manure. It can be used for cooking, lighting and generation of electricity.

(b) Bio Mass

Biomass is fuel that is developed from organic materials, a renewable and sustainable source of energy used to create electricity or other forms of power. It is also of a

source of producing energy through plants and trees. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas, also called landfill gas or biogas. Crops such as corn and sugarcane can be fermented to produce the transportation fuel ethanol. Biodiesel, another transportation fuel, can be produced from leftover food products like vegetable oils and animal fats. Several biodiesel companies simply collect used restaurant cooking oil and convert it into biodiesel.The purpose of bio mass program is to encourage afforestation for energy. So that fuel for the generation of energy based on gas technique and fodder for the cattle could be obtained for the generation of bio mass energy.

Increasingly Renewable Energy Technologies (RETs), which are also referred to as "alternative energy" options, are becoming the mainstream option for rural Nepalese to access modern sources of energy. Large numbers of households are being provided services from biogas, solar PV, and micro-hydropower technologies every year at present. The RETs, which provide both electricity based as well as non electricity based services, have been shown to most immediately meet the needs of a cleaner indoor environment, better quality lighting for education and income generating activities, alternative cooking fuels, and motive power for agriculture processing and rural industries. The major advantages of these technologies are that they are immediately available to rural families, users are prepared to make around two thirds of the investment required reducing the burden on government for their financing, and proven mechanism and supply chains exist to increase their supply to meet demand (Pandey, 2003).

2.2 Biogas: Concept and Development

Biogas or Gobar gas is a clear & odorless combustible gas, which is produced when organic matter contained in animal excreta, such as dung & human night soil & tender plant or residues, such as leaves, stems & straw, are aerobically fermented with the help of methanogenic bacteria in air or water- tight container called biogas plants. Chemically biogas is just methane gas. Biogas burns with the clear blue flame without giving smoke. Its flame temperature is up to 800^{o}C & it has a calorific value of 5,650 K Cal per cubic meter of gas (Adhikari, 1996).

The bio-methanation technology involves treatment of animal wastes, night soil, industrial and municipal solid wastes in oxygen less environment to produce valuable by products, usable energy in the form of methane gas, organic fertilizer and protein. A biogas plant is decentralized energy system, which can lead to self-sufficiency in household heat, and power needs and at the same time keeps the environment clean. Matching with the growing need for utilization of bio fuels in general and biogas in particular, growing application of scientific and engineering principles has transformed the latter into a fuel fledged discipline (Mital, 1997). On this situation of energy crisis growing rapidly, the utilization of totally waste materials into the production of very useful energy source can never be under rated by any means.

Biogas technology was first introduced in Nepal in 1955. although Gobar Gas Company has been involved in the development of biogas technology in Nepal since 1977, its wide scale dissemination in rural areas was found with the technical support from Netherlands Development Organization (SNV/Nepal), starting 1991/92. This wide scale dissemination of biogas plants has been possible because of standardization of plant design and support through subsidy by the government. It is estimated that the technical potential of biogas plants are in Nepal amounts to about 1.3 million in number of family size plants. At present more than 39 private companies are actively involved in the construction and dissemination of biogas plants in different parts of the country and so far more than 80000 family sized biogas plants have been installed in Nepal as of April 2001. Up till now, biogas has been used for domestic cooking as well as lighting purpose only, (Shrestha and Patrabansh, 2003).

Although Nepal is rich in Hydropower potential, only one percent of the total energy demand is met from this source. The remaining 99% is met from sources like coal, petroleum products, animal waste, crop residue and firewood. Firewood alone contributes 68% of the total energy need of the country for which 1.3% of the forest cover is cleared every year. A massive amount of livestock dung, estimated at 8 million tons is being burnt to supply 8% 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, (AEPC, 2003/4). Having such a great potentiality of biogas and biogas having lots of advantages in environmental as well as economical factors and an asset to increase the soil fertility; can be one of the best means of alternative sources of energy in the Nepalese rural context.

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

The Biogas Program is a successful model of development cooperation; technological innovation, engineering and market development that have helped address some of the social, economic, energy and environmental needs of the rural areas of Nepal. A total of 91,196 biogas plants received subsidies for their construction during BSP (Biogas Support Program) Phase III. The target of Phase III was to construct 100,000 biogas plants within the program period and this target was achieved to 91.2 percent. Biogas plants were constructed in 65 districts of Nepal. The growth in plant construction each year was between 10 to 26 percent. Plants construction was reduced in 2001/02 as a result of the poor security situation and the early monsoon. The provision of subsidies for biogas construction continued but was reduced over the program periods. (BSP, 2004).

2.3 Energy consumptions trends of Nepal

Traditional sources of energy still hold majority when it comes to the necessity and supply of energy. Despite several efforts made towards using renewable energy traditional consumption rate is still high. Likewise, though sources of renewable energy mainly hydropower and solar energy have enormous potentials; energy crisis has continue to grow for failing to capitalize these resources.

2.3.1 Table Showing Energy Consumption Status

Table 10(a): Energy Consumption Status

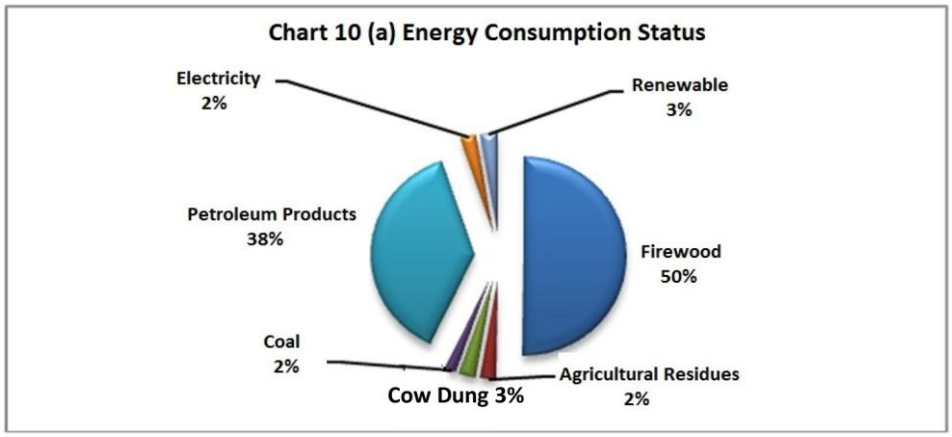
(In ToE: Tons of Oil Equivalent)

Source	Fiscal Year 2013/14 (000 toe)	Fiscal Year 2014/15 (000 toe)	Fiscal Year 2015/16* (000 toe)
Traditional	**8983**	**9104**	**6069**
Firewood	8154	8264	5509
Agricultural Residues	403	408	272
Cow Dung	426	432	288
Commercial	**1958.96**	**5256.90**	**4609.77**
Coal	320	465	192
Petroleum Products	1264	4294.62	4143.46
Electricity	374.96	397.28	274.31
Renewable	**291**	**291.64**	**291.86**
Total	**11232.96**	**14652.54**	**10970.63**

Source: Ministry of Energy **** Of first eight months***

In the first eight months of the current fiscal year the total energy consumption has reached 10,970.63 tons oil equivalent (ToE), while such consumption during the corresponding period of previous fiscal year was 41 percent higher than this. During the same period of previous fiscal year, the energy consumption was 7,781 ToE. While looking at the statistics of the last eight months, the consumption rate of traditional, commercial and renewable energy stood at 55.33 percent, 42 percent and 2.67 percent respectively. Such ratio in previous fiscal year had remained at 62.13 percent, 35.87 percent and 1.99 percent respectively. This observation hints that traditional energy users are slowly attracted towards using petroleum products, which are not produced in Nepal but to be imported.

2.3.2 Pie chart showing energy consumption status



(Source: MOE, 2015/16)

2.3.1 Renewable energy status

There has been a policy to develop and extend alternative energy technology to contribute to maintaining environment balance, employment generation, and inclusive development by generating renewable/ alternative energy that would contribute 10 percent to the total energy consumption and cover 30 percent of the population having access to electricity within coming 20 years. About 16 percent of the total population is availing electricity service through renewable energy sources. Likewise, about 27 percent of the total population are estimated to have access to clean renewable energy. 10.40 Of the implemented programs in fiscal year 2015/16, a total of 14,351 biogas plants are installed, 1,095 KW of the electricity generated through micro and small hydro electricity projects, 23,994 solar system are installed, 61,576 improved stoves/ovens installed, 308 improved water mills have been installed by the first eight months of the current fiscal year. From the aforementioned program, rural people have been availing electricity service, clean fuel for cooking and technology and drinking 173 water among others. Apart from this, There has been significant improvement in rural peoples 'education, health and environment through clean energy.

2.3.3 Table showing Alternative usage status

Table 10 (c) : Alternative Energy Usage Status

Major Programs	Fiscal Year					
	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16*
Electricity Generated through Micro and Small Hydro Electricity Project	2,453	3,258	3,366	3,288	3,346	1,095
Solar Domestic Electric System Installation	57,059	35,627	96,495	87,038	103,161	23,994
Solar Dryer/Cooker Distribution	272	202	140	202	30	-
Bio-gas Installation	17,907	18,979	17,635	31,512	30,078	14,351
Improved Water Mill Installation	353	971	1,256	341	641	308
Improved Stove Installation	84,168	118,461	120,364	140,662	310,281	61,576

Source: Alternative Energy Promotion Center, ****Of First Eight Months***

(APEC, 2015/16)

2.4 Review of Previous Studies

Biogas is one of the most important alternative sources of energy which has several direct and indirect benefits. The use of biogas is justified not only from economic ground that it is a substitute for expensive petroleum fuel, but it also protects environment, improves health, saves time and is convenient. Although the use of biogas gained popularity only after 1970, various studies on different aspects of biogas have been performed since then. In the context of Nepal, the technology is appreciated and used mainly as the alternative source of energy for household for cooking, lighting and the digested slurry as better organic manure for agricultural crops and vegetables.

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

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

urban areas. At the same time, along with alternative energy production, high quality fertilizer also comes to be available.

Shrestha (2003) revealed that biogas is used instead of traditional sources of energy. The use of biogas minimizes the consumption of firewood and kerosene. This saves foreign exchange. The changed method of cooking in the house saves time. After the installation of biogas plant, forest is preserved and people get cleaner environment.
Sharma (2004) described biogas and its commercial use. According to him, as a cooking fuel, it was cheap and extremely convenient. Based on the effective heat produced, a 2m cubed biogas plant could replace, in a month, fuel equivalent to 26 kg of LPG (nearly two standard cylinders), or 37 litres of kerosene, or 88 kg of charcoal, or 210 kg of fuel wood, or 740 kg of animal dung.

Upreti (2004) carried out the study on "Economic Impact of Biogas in Khaireni VDC, Chitwan. This study was undertaken to analyze the economic impact of biogas plants. Descriptive method was used for the study. Information was collected from field survey whereas 30 samples of biogas households were taken from whole population. Questionnaire, interview and observation were used as main tools for the study. The main findings of the research are as follows: a)There is a considerable reduction in the workload of the family members especially women; b) A significant amount of time has been saved and the saved time (63.3%) has been used mostly in agricultural activities; c) Most of the households have latrine facility (90%) but the number of latrines connected to plant is very negligible (20%); d) In-house pollution due to smell of kerosene and smoke as well as medical expenses has been reduced; e) Consumption of kerosene has been reduced by 0.25 and 0.19 litre per day per household in summer and winter respectively; f) The consumption of LPG has decreased by 43.7 % in summer and 19.8 % in winter; g) Only 10 out of 30 households have completely stopped the use of traditional stoves; and h) Most of the users use slurry in composted form (60%). Application of bio-slurry to the crop has resulted in increased agricultural productivity, which has resulted into monetary gains for them.

2.5 Theoretical Framework

Biogas as renewable energy technologies improves the quality of life for the rural farmers of Nepal and other developing countries. Dissemination of information and education about the technologies is necessary to create demand from households. Financial loan schemes provide villagers a way to purchase biogas on their own and subsidies reduce the overall cost. Biogas is appropriate technologies for adoption by the villagers of Nepal.

2.5.1 Benefits of Biogas

2.5.1.1Benefits from Replacement of Firewood

With the installation of biogas systems, the annual reduction of fuelwood was two tonnes per household and this provided an equivalent protection of 6,790 hectares of forest per year through 11,395 operational biogas plants (Winrock and Eco Securities, 2004). Use of biogas for lighting benefit to study during the dark hours as well (Bajgain and Shakya, 2005).

According to BSP (2006), with over 168,613 plants installed under the SNV/BSP programme at the end of fiscal year 2006/07, of which 97 percent are operational displace the use of 328 thousand tonnes of fuelwood, 5.2 million litres of kerosene and replace chemical fertilizers with 280 thousand tonnes of bio-fertilizer annually and save approximately 1850 ha of forest annually. The use of fuelwood has reduced by 162 kg/month/HH which accounts for the saving of nearly 2 tonnes/year/HH (CMS 2007).

2.5.1.2 Benefits of Biogas on Health and Sanitation

Review of IEIA (2002) study carried out by SNV/BSP showed that the record of toilet construction is higher among biogas households. The study conducted in Kaski and Tanahun districts revealed significant percentage of reduction in cough, eye infection and headache after biogas installation (RUDESA, 2002).

In Bhaktapur District, 67 percent of the households reported reduction in smoke related diseases (NGO Promotion Center 2003). The primary benefits of improved health among biogas households are due to reduced indoor smoke indirectly reducing

health- related expenses (East Consult, 2004). Indoor climate dramatically improved as a result of using clean biogas stoves instead of burning fuelwood, straw and dung cakes would mean that a lot of the problems with hazardous smoke particles would be avoided (Li et al., 2005).

The results of the biogas users survey showed that there is significant improvement in the incidence of smoke-borne diseases such as eye infection, cough and headache after biogas installation (BSP, 2007).Only 58 percent of households had toilet before biogas installation which have increased to 97 percent after biogas installation (CMS, 2007).

Around 70 percent of biogas households have the toilet attached into the plant (AEPC, 2008). The anaerobic fermentation of waste products, human excreta and cattle manure etc is a cheap way of getting energy and at the same time handling waste products (Gautam, 2009).

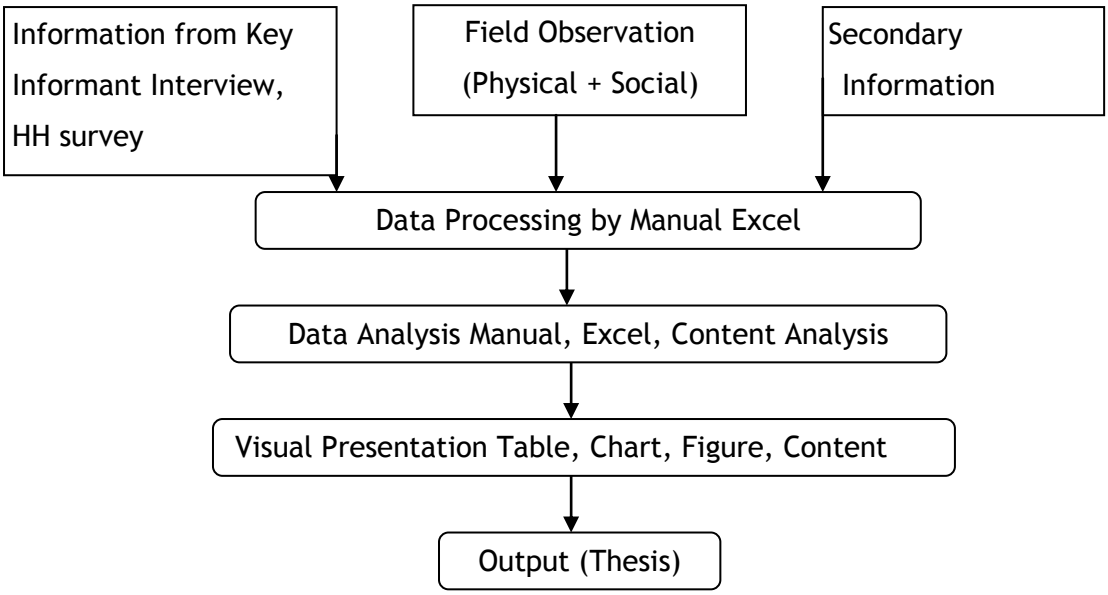
2.5.1.3 Time Saving and Workload Reduction

A study by NGO Promotion Center (2003) in Bhaktapur District found 30 percent have been involved in the income generating activities from the saved time. Biogas Users Survey Report of BSP, 2006/07 showed after biogas use rural women have more time for their children (94 percent against 51 percent before biogas use).According to CMS (2008), women are able to save 93.2 minutes per day after biogas installation and 30.8 percent of users are involved in income generating activities.

2.5.1.4 Economic Benefit

Assuming a life span of 20 years, the base analysis conducted by East Consult (2004), which included only the saving of fuelwood and kerosene at the base price of NRs. 2 per kg for the hills showed the of biogas has reduced the expenditure of the household userson fuel purchase, thereby saving NRs. 2,125 monthly, which is equivalent to an annual saving of NRs. 25,499 (CMS, 2007).

Figure 2.5.2 : Schematic Frameworks of Data Analysis



2.6 National Policies and Action Plan Regarding Biogas in Nepal

Renewable Energy Technologies have increasingly received due attention in periodic plans since the Seventh Plan (1985 -1990) where, for the first time, a targeted approach amongst other policy measures was established for its development. The Eight Plan (1992 - 1997) envisaged the need for a coordinating body for large- scale promotion of alternative energy technologies in Nepal and the Alternative Energy Promotion Centre (AEPC) were thus established as an executing body.

The Ninth Plan (1997 - 2002) formulated long term vision in the science and technology sector which has the fundamental goal of rural energy systems developed as to increase employment opportunity through gradual replacement of traditional energy with modern energy. Renewable Energy Subsidy- 2000 and the Renewable Energy Subsidy Delivery Mechanism- 2000 were formulated and implemented to realize the objectives set out in the plan. The Tenth Plan ((2002 - 2007) gave priority to suitable and relatively smaller size systems. It also encouraged research on expansion of biogas systems in the Himalayan region and towards reducing the cost.

The Perspective Plan (1991 – 2017) has recommended for development and promotion of alternative energy resources and technologies including biogas as an integral part of overall rural development activities. The proposed Renewable Energy

Perspective Plan of Nepal, 2002 – 2020: An Approach (REPPON) prepared by CES/IOE has envisaged the development objective of biogas sector so as to direct the national biogas program from technical, financial and socio-economic sustainability perspective. The current three- year plan has targeted to install additional 100,000 plants.

The Government of Nepal has promulgated the Rural Energy Policy for the first time in 2006. The policy has envisioned linking renewable energy including biogas to economic activities. The GON recently approved a new subsidy policy - Subsidy for Renewable (Rural) Energy Subsidy, 2006 and the (Rural) Renewable Energy Subsidy Delivery Mechanism- 2006 to ensure proper flow of subsidy.

The supportive government policy acknowledges the important role of biogas in meeting household energy requirements and also in mitigating environmental degradation.

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

2.7 Research Gap

The potentiality of biogas energy is very high in Nepal. However, the progress achieved in this sector is not much encouraging. The reasons for this may be numerous. There is lack of adequate information on the socio-economic impact of biogas, which necessitates further study and research in this area. Increasing population with increasing demand for fuel automatically leads us to explore the viability of biogas as an alternative source of energy.

The research in this area is adequate but most of the researchers focus mainly on the biogas plant installation and problems associated with it, and very few of them try to emphasize the probable solutions by considering the different factors into consideration and they try to generalize their findings without considering the social, demographic, religious factors into consideration.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

This chapter discusses a set of methods, which are employed to conduct the research. The whole study was carried out on the basis of primary as well as secondary data. Reliable and relevant study can be made possible only by applying scientific methods. Hence the primary purpose of this chapter is to discuss and design the framework of research. Different procedures of research methodology have been as follows:

3.1 Research Design

The study was carried out on the basis of explanation and descriptive research designs because the study mainly focuses on to investigate the socio economic condition of the users and its benefits to them. Moreover the study has tried to find out the socio economic impact of biogas with regard to time and money saving, forest resources conservation and agriculture production increment/decrement as well as the demerits of the plant, which is the basic objective of the study. In order to fulfill these objectives information were collected from the related field survey.

3.2 Selection of the Study Area

Recent study was carried out on biogas energy in Budhabare VDC and the general objective is to examine the economic impacts of biogas on users. The research methodology has been implied as selecting a small area of survey, however it is good enough topics to discuss as well as raise the development issue of biogas in Nepal. The universe of the study is Budhabare VDC of Jhapa district. Using the random sampling, 40 households of biogas users were sampled. The total numbers of respondents were 40 including both male and female of different age groups. The respondents were chosen by using random sampling method. Both the primary and secondary data were various sources. The primary data collection tools were; the structured questionnaire, semi or unstructured interviews; and observation as well as Focus Group Discussion (FGD) and key informant interviews.

Budhabare VDC is one of the 61 VDC's of Jhapa district. It is located in the eastern part of this district. It is bound by Ilamto the north, Shantinagar to the east, Dhaijan to the south-east, Shaniarjun and Garamani to the south, and Khudnabari to the west.The study area lies in the Terai region of the eastern Nepal. As per the National Population and Housing Census 2011, the total population of the village stands at 22,936, with a male population of 10,938 and a female population of 11,998

Talking about the physical structured of this VDC, the slopes of the flat region gradually decrease towards southeast. Due to the flat nature of land, the soil in the basin area is very fertile and is very suitable for cultivation. However, agricultural land is gradually shifting to the built-up area.

3.3 Rationale of the Site Selection

The people of the study area follow the traditional agriculture profession with almost every house rearing cattle, which is obviously the major source of biogas, which is the primary reason to select Budhabare as the site of study. With excessive use of firewood or biomass for fuel resulting in the depletion of precious forest and with a thought of alternative source, no other than biogas could stand as the best option in the selected area. Accessibility as well as the degree of awareness of the relevant people is among other pull factor for the selection. Last but not least the reasonable number of biogas users shows the growing interest of the people towards biogas is the exciting reason for selection.

3.4 Nature and Sources of Data Collection

In order to acquire in depth knowledge on the technical aspect of biogas plant and its working principal consultation and review of existing literature reports, information bulletins, booklets, etc. published by various institutions and personnel working in this field was done. Moreover, the respective users directly experience the impacts of biogas. Hence, to get first hand information on the impact of biogas to the users were consulted and interviewed in depth. Primary data was collected from respective biogas households and secondary data and information was collected from various published/unpublished articles and reports.

3.5 Sampling Procedure

The targeted people of the study were the biogas user households of Budhabare VDC of Jhapa district. Out of 321 households having the biogas plant, 40 of those households were selected. The total 321 biogas households has been taken as the universe and simple random sampling technique (lottery method) was followed for the selection of samples.

3.5.1 Sample Design

In the present study, the survey is based on multistage (3-stage) sampling. In the first stage, the VDC was selected purposively. The second stage was the selection of the wards of the VDC. The VDC consists of nine wards. Out of these, four wards were selected having large number of biogas plant. The third stage was the selection of the households. For the selection of the households, the total number of the households of the selected wards was found at first. Then, the sample size for each ward was determined according to the number of the households using biogas. Then, the households were selected purposively.

3.5.2 Sample Size

Total sample size of our study in Budhabare VDC was 40. The sample size was based on the density of the biogas using households of the wards. From the four selected wards, 12, 15 and 13 samples were taken purposively keeping in view the number of households using biogas in each of the four wards.

3.6 Data Collection Techniques and Tools

Mainly primary data has been taken for the study. The interview schedule served as the chief source of primary data while secondary data were taken from the concerned institution and books.

The interview schedule was developed and then used to solicit the information from the households.A set of questionnaire has been was developed and pre-tested and then finalized on the basis of feedback. The finalized interview schedule was administrated to the respondents.

The focus group discussion has also been conducted with the help of checklist. The household observation was also done to get the real impact of the biogas plant.

To generate the primary data the structured questionnaire, semi or unstructured interviews and observation as well as focus group discussion methods were applied in the field.

3.7 Procedure of Data Collection

3.7.1 Primary Data

The study has been based on primary and secondary data. Questionnaire sheets were used for collecting primary data. The survey was carried out in January 2017. Two methods were used to collect the primary data, which were explained above. Before conducting the survey, we carried out the following steps: first, sample size was decided for the selected wards; second, sampling frame was constructed with the help of Village Development Committee report and other similar types of research; third, for each ward, samples were selected purposively; fourth, questionnaire was pre-tested and revised; and finally, the revised questionnaire was directly administered to the respondent household. The chief merit of direct oral interview is that it makes crosschecking possible while the demerit is that there may be biasness from the interviewer.

3.7.1.1 Household Survey

In the household survey, information was collected from the representative or a well-informed member of the family. Different methods were used to check the validity of the data. Crosscheck was made in order to test the validity of the data. The questionnaire was divided into three parts: household identification, household income and consumption expenditure, and information on uses of biogas.

3.7.1.2 Focus Group Discussion

Focus Group Discussion was made in order to obtain further information about the uses of biogas. The members of the sampled households having sufficient information on various aspects of biogas were the participants in the discussion.

3.7.2 Secondary Data

Profiles of DDC and VDC, Journals, articles, booklets, newspaper and magazines, books on related topics and published sources of data on internet are important sources of secondary data considered. Though, both secondary and primary data are extensively used in the study, primary data (questionnaire and interview) serves as an integral part of the study.

3.8 Validity and Reliability

As both primary and secondary sources are considered for the study, the validity of secondary sources of data are assumed to be more static compared to primary source of data. Published journals, articles, books and magazines, validated websites are some of the sources of secondary data, thus, as these sources are authenticated by the publishers, the data and sources of information are considered to be valid and can be trusted upon. On the other hand, as the key primary sources of data are questionnaire and interview, the data validity may be affected by the degree of consciousness of the respondents on the subject and their degree of zeal in the subject matter.

Similarly, as secondary sources of information/data are authenticated and already accepted in many fields, the reliability of secondary data is relatively higher compared to primary data, as in case of primary data, respondent are the sole source of information and the reliability of information vary upon their interest and participation/ seriousness towards the subject.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

The chapter attempts to analyze the collected data and information for pursuing objectives of study and deriving the major finding for the study. First of all, it presents a brief introduction of Jhapa district and Budhabare VDC with demographic features. It also includes the economic impacts for bio-gas users and beneficiary aspects.

4.1 Introduction of the Study area

Budhabare is a VDC situated in Jhapa district, Mechi Zone, Nepal. With the total area of 79.78 sq. km, Budhabare VDC is located in the eastern part of this district. It is bound by Ilam to the north, Shantinagar to the east, Dhaijan to the south-east, Shaniarjun and Garamani to the south, and Khudunabari to the west. The study area lies in the Terai region of the eastern Nepal. As per the National Population and Housing Census 2011, the total population of the village stands at 22,936, with a male population of 10,938 and a female population of 11,998.

The people in Budhabare VDC have some access to the forest resource. Out of total 5270 households out of which 321 households have bio-gas plant.

Budhabare is a VDC with developed infrastructure. The land in the study area is fertile for cultivation. There is good facility of irrigation, which has made agricultural production easier. Agriculture, poultry farming, animal husbandry are common sources of livelihood.

4.2 Bio-gas users in Budhabare VDC

Budhabare is known as rural facilitated VDC of Jhapa district. The main feature of this place is known for production and export of beetle-nut and it's trade all over the country. Due to the, mountains region situated in the northern part of the VDC it has fertile land and ideal for cattle farming. As a result, the livelihood of this place is highly dependent on agriculture and animal husbandry.

Table: 4.2 Bio-gas user's ratio

Total population	Bio-gas User population	Bio-gas user percentage(%)
22936	1284	5.59

Source: Field Survey, 2016

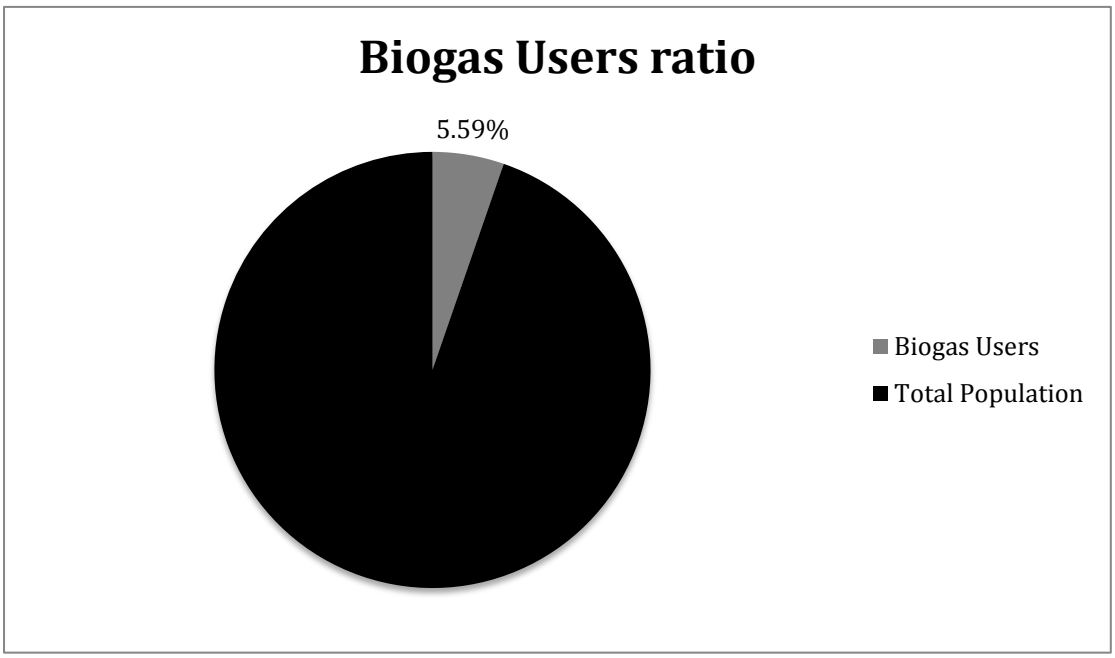


Figure: 4.2 Bio-gas user's ratio

Out of the total population of 22936 residing in Budhabare 1284 are being benefited from bio-gas plants. Out of total 5270 households 321 have bio-gas plants. And, Out of 321, this research has sampled 40 households constituting 215 population. Bio-gas user population percentage is 5.59.

4.2.1 Ethnic Composition:

Nepal is well known around the world for the religious and caste harmony as a diversity of castes constitutes the country, which is living in same places with a great instinct of synchronization. In the study area also, there are diversities of castes living together but in the case of bio-gas users the majority of the plant owners are from the so-called higher caste (Brahmin and Chhetri). It was also found that the economically established people were more of the bio-gas plant owners. Comparatively the people

from the lower caste, especially the Dalits were very far or back in the case of installation of bio-gas plants.

Table 4.2.1: Ethnic Composition of Respondents

S. N	Caste	No. of Household	Percentage(%)
1	Brahmin	13	32.50
2	Chhetri	12	30.00
3	Gurung	8	20.00
4	Dalits	2	5.00
5	Others	5	12.50
	Total	40	100.00

Source: Field Survey, 2016

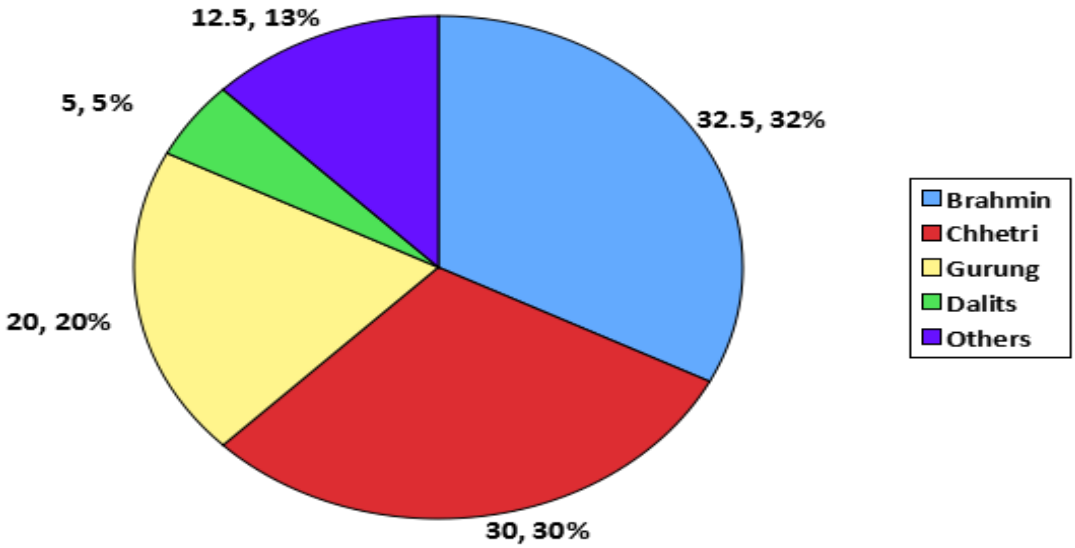


Figure 4.2.1: Ethnic Composition of Respondents

The above table signifies clearly that, among the sampled houses, the Brahmins were in the majority with regard to the ethnicity, as they comprised 32.5 percent of total

households. Following Brahmins were the Chhetri with 30 percent and the Gurungs covered 20 percent of the sampled households. Disappointingly Dalits constituted only 5 percent of the sampled households and rest of 12.5 percents were from other castes like Tamang, Gharti, Magar, Rai etc.

4.2.2 Occupation of the Respondents:

Occupation is one of the main indicators of the economic status of the people. It also some what plays a vital role to determine the energy use pattern. The economy of Nepal is largely dependent on agriculture sector. The CBS report has shown that still 76 percent people are dependent on agriculture for their livelihood. In the study area also the main occupation of the respondents was found to be agriculture with some other people engaged in business, service and Social work. The following table illustrates the occupational status of the respondents.

Table 4.2.2: Occupation of the Respondents

S. N	Occupation	Number	Percentage(%)
1	Farming	25	62.50
2	Business	2	5
3	Service	7	17.50
4	Social work	5	12.5
5	Others	1	2.50
	Total	40	100.00

Source: Field Survey, 2016

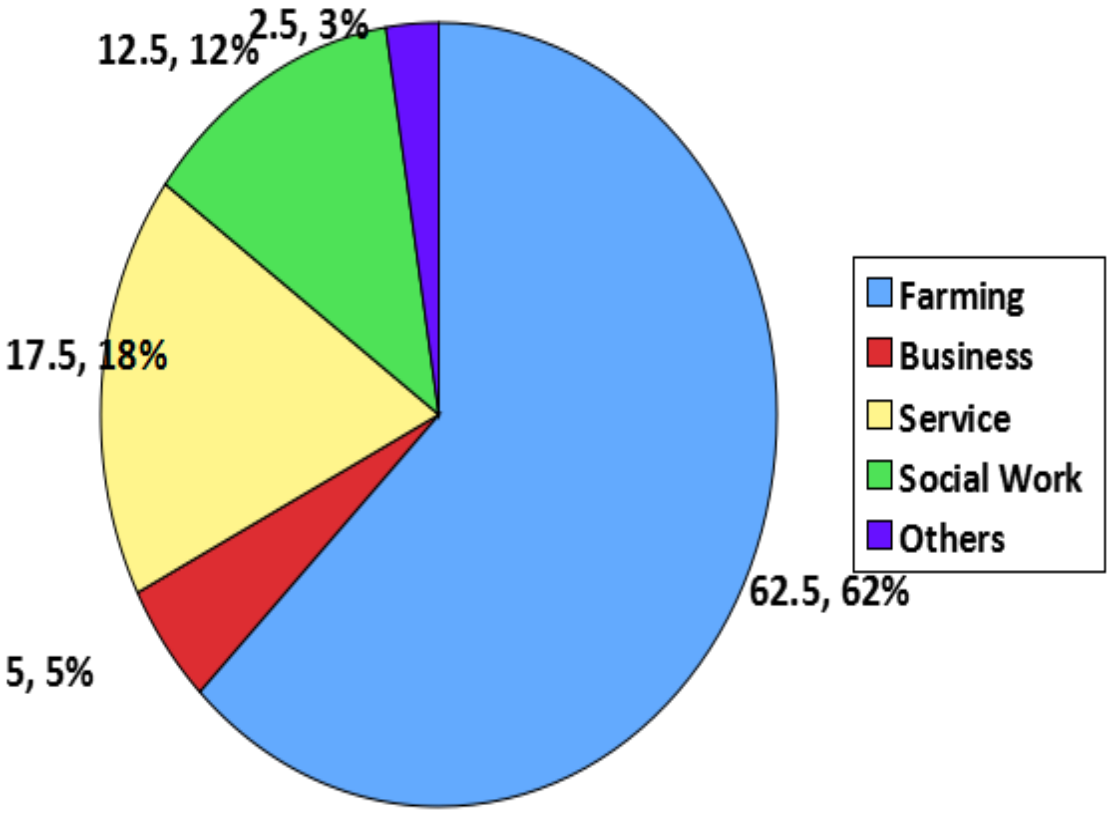


Figure 4.2.2: Occupation of the Respondents

The above table shows that the majority of the respondents that is 62.5 percent adopt agriculture as their primary occupation whereas a very significant in the country's scenario, 17.5 percent of the households is engaged in service. About 12.5 percent people are found to be active in social work, 5 percent people engaged in business and 2.5 percent in some other work.

From the field visit it was perceived that though the majority of the people are involved in farming, still most of them are following the decades old farming pattern and technology. However some of the farmers were found to be using recent vitamins in form of injection, pesticides and insecticides which accelerated the production of crops but the people are not satisfied with these new medicines as they revealed that the taste of the product was decreased due to the use of those vitamins, pesticides and insecticides etc.

4.2.3 Family Size

Household or the family is a basic unit of the society and it is an institution that plays an important role in building the society. Family size has also a dominant role in energy use pattern. The family size of the respondents is demonstrated in the following table.

Table 4.2.3: Family size distribution

S. N	Family Size	Number	Percentage(%)
1	Small (Upto 4)	17	42.50
2	Medium (5 to 7)	20	50.00
3	Large (8 or above)	3	7.50
	Total	40	100.00

Source: Field Survey, 2016

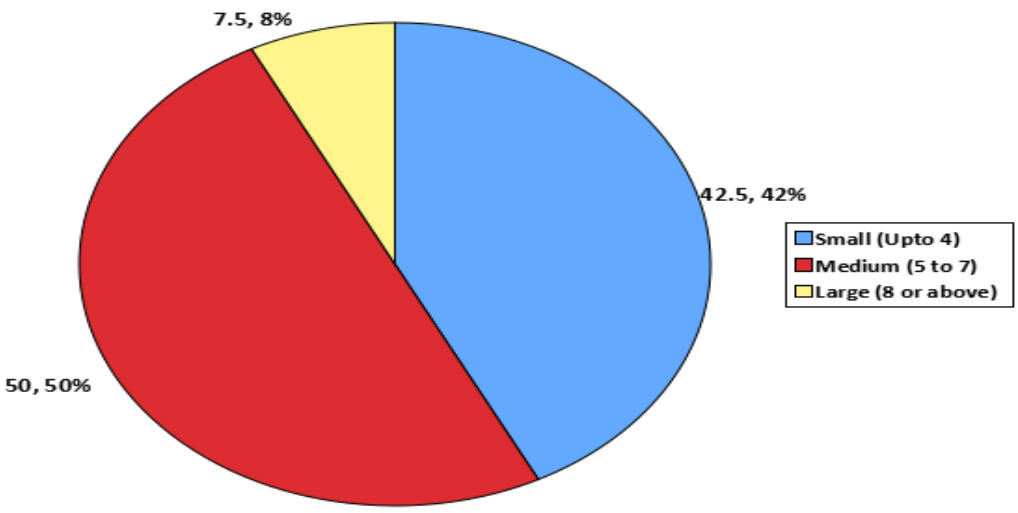


Figure 4.2.3: Family size distribution

It is very great inspiration to see that a significant 42.5 percent of the households have small family that is only up to 4 members in the family. The large part of the respondents (50 percent) was comprised of medium family and rests of the 7.5 percent respondents comprise large family constituting 8 or more members in the family.

4.2.4 Land holding Size

Land holding size portrays the economic and social status of the people living in the rural areas. Land holdings of the respondents are portrayed in the table below.

Table 4.2.4: Land holding Size

S. N	Area in Kaththa	No. of Households	Percentage(%)
1	Below 10	12	30.00
2	11 to 20	18	45.00
3	21 to 30	7	17.50
4	Above 30	3	7.50
	Total	40	100.00

Source: Field Survey, 2016

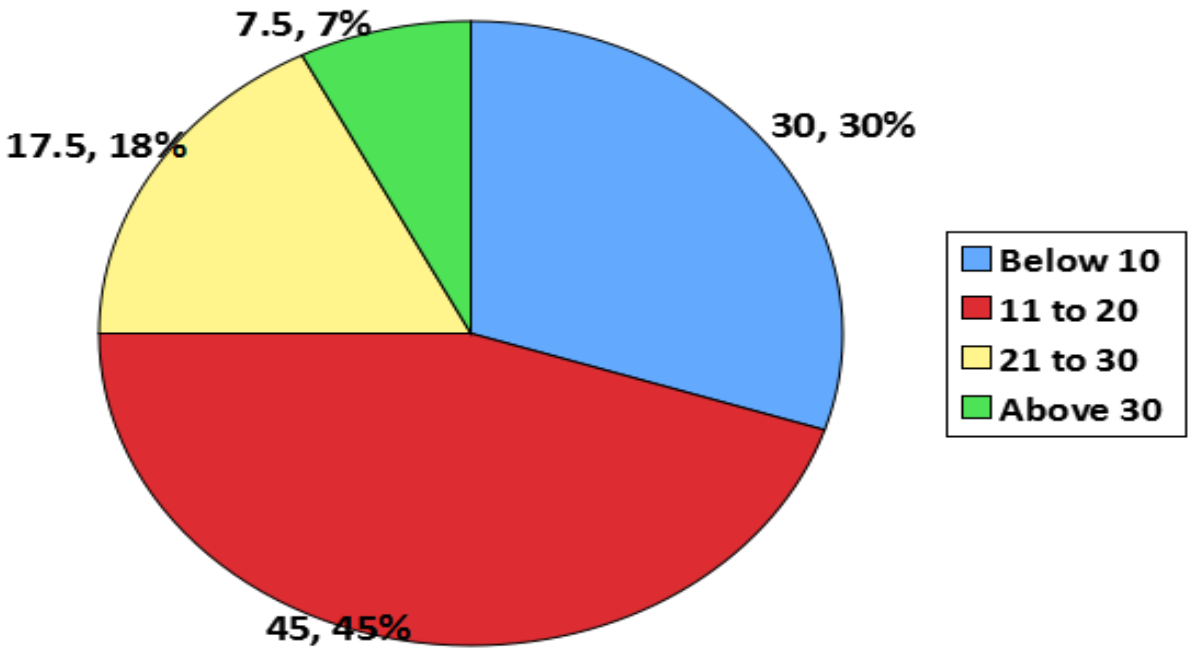


Figure4.2.4: Land holding Size

As Nepal is an agricultural country where more than 80 percent people are dependent upon agriculture as their main occupation, land has great contribution and importance and it also measures the economic status of the people. The above table signifies that most of the houses have land holding of between 11 to 20 Kaththa which is 45 percent of the total households. 30 percent of the households own land below 10 Kaththa, 17.5 percent with land ranging from 21 to 30 Kaththa whereas 7.5 percent of the total households hold land above 30 Kaththa.

4.2.5 Livestock Population

Only cow/ox and buffalo were taken in account as the livestock population because dung of only cow/ox and buffalo were used for bio-gas. Waste product of other animals like goat, cock/hen etc was not used normally for bio-gas production, so other animals were left out in the research.

The average number of livestock (cattle and buffalo) per household was 3.7 average number of cow/ox was 0.65 and average number of buffalo was 1.57. Buffaloes were more admired by the respondents.

Table 4.2.5: Livestock Population

S. N	Livestock	Number	Percentage(%)
1	Buffalo	63	70.79
2	Cow/Ox	26	29.21
	Total	89	100.00

Source: Field Survey, 2016

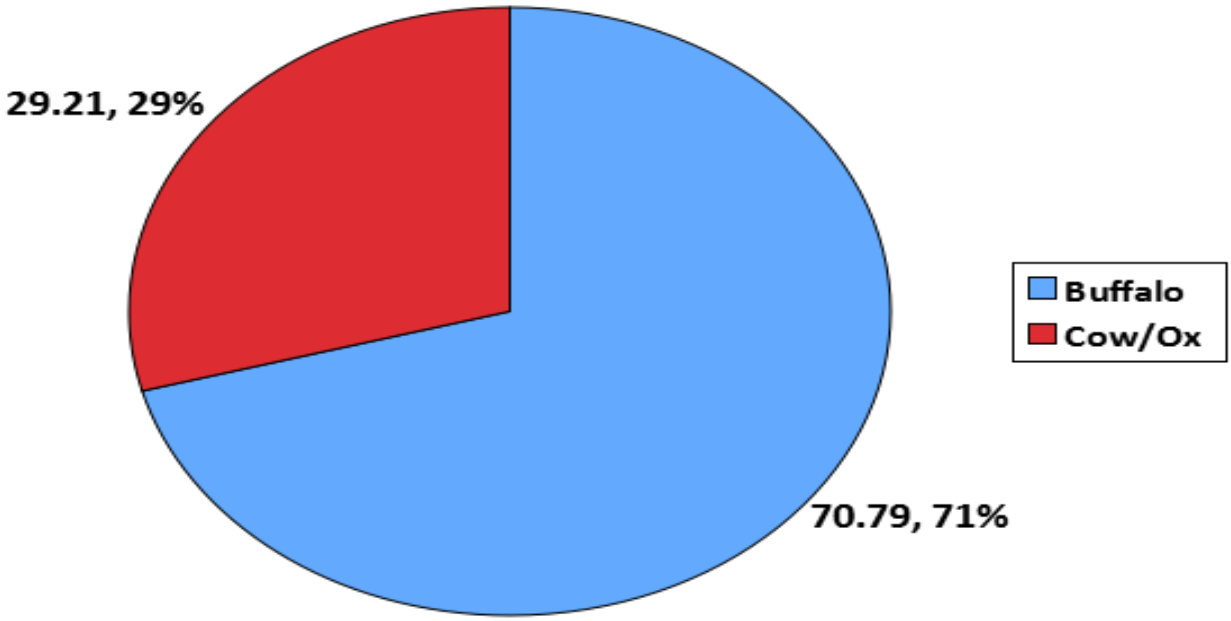


Figure4.2.5: Livestock Population

4.2.6 Type of House

The type of house in which people reside also reflects the economic level of them. Among the surveyed households only a slender 15 percent of the houses were cemented. The most popular type of house was of brick and mud house which category covered about 77.5 percent of the houses whereas only 7.5 percent of the houses were of temporary type or hay and mud hut. The following data is shown in the table below.

Table 4.2.6: Type of House

S. N	Type of House	Number	Percentage(%)
1	Cemented	6	15
2	Brick & Mud	31	77.5
3	Hay & Mud Hut	3	7.5
	Total	40	100.00

Source: Field Survey 2016

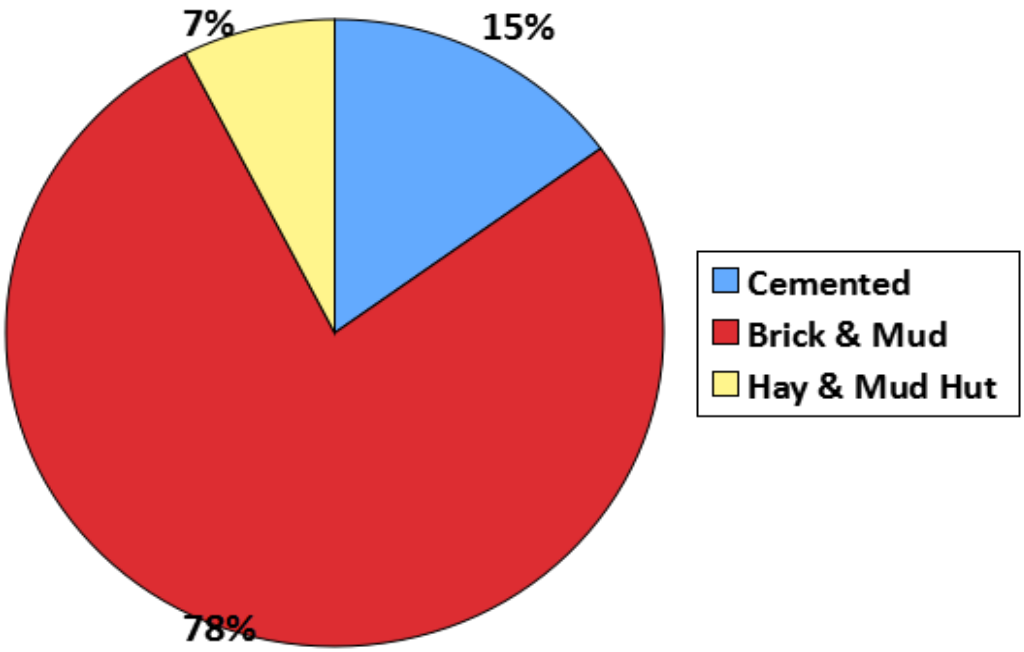


Figure4.2.6: Type of House

4.3 Educational Attainment of the Plant Owners

Education is one of the key indicators for reforming society and upgrading its economic and social status. Education enhances the ability and capability of human being to judge for right or wrong. It also plays a vital role in energy use pattern. It is the source of knowledge, attitude and behavior of the energy use pattern. So the actual figure of the education attainment of the respondents of the study area has been shown in the following table.

Table 4.3: Educational status of Respondents

S. N	Education Level	Number	Percentage(%)
1	Primary	11	27.50
2	lower Secondary	10	25.00
3	Secondary	9	22.50
4	Higher secondary	7	17.50
5	Illiterate	3	7.50
	Total	40	100.00

Source: Field Survey 2016

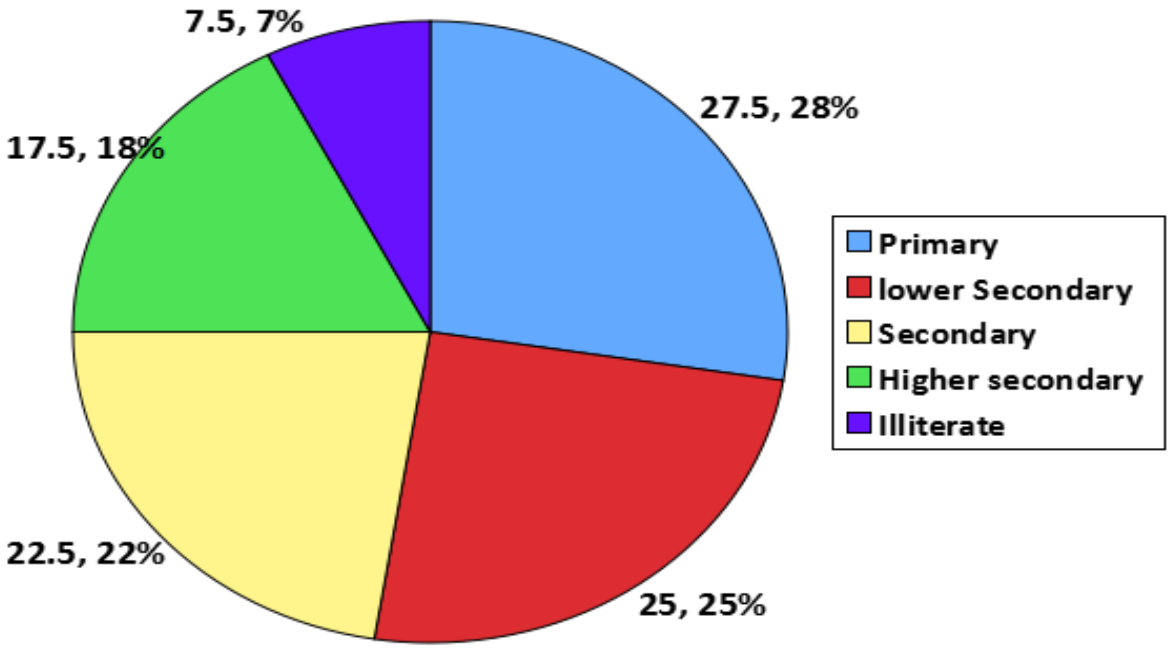


Figure4.3: Educational status of Respondents

The above table shows that the highest number of respondents (27.5 percent) respondents has achieved just only primary level of education. Similarly 25 percent of the respondents are with lower secondary level of education followed by 22.5 percent gaining the secondary level of education. Meanwhile 17.5 percent of respondents have achieved higher secondary or high level of education whereas 7.5 percent are totally illiterate.

4.4 Source of Information on Bio-gas

It is obvious that anybody have to listen or know about bio-gas before the installation. In the study area, the chief source of information was the respective bio-gas company of the respondents, which comprised of 42.5 percent. Neighbors served as the second important source as 37.5 percent neighbors got information from them. 15 percent respondent obtained information from relatives and friends whereas 5 percent were informed through some other sources.

Table 4.4: Information Source

S. N	Information Source	Number	Percentage(%)
1	Neighbors	15	37.50
2	bio-gas Company	17	42.50
3	Friends/Relatives	6	15.00
4	Others	2	5.00
	Total	40	100.00

Source: Field Survey, 2016

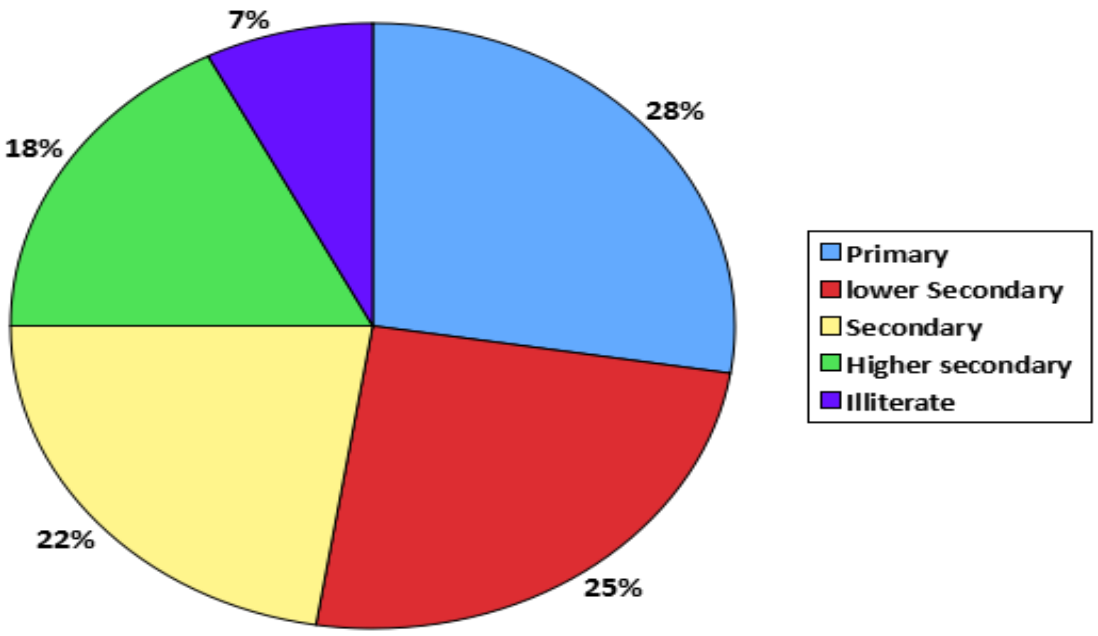


Figure4.4: Information Source

The figure implies that primary source of information was the bio-gas companies. This is because they reach more to the people for the marketing of their business. Whereas the neighbor in the second position implies that, people are convinced and satisfied with the advantages of bio-gas in the area that then encouraged their neighbors for the installation.

4.4.1 Size of bio-gas plant

The size of bio-gas plant is mostly determined by the number of family members and the number of cattle. 37.5 percent of the respondents have constructed the bio-gas of 4 m^3size. Similarly 25 percent of the respondents have constructed 6 m^3 sized bio-gas whereas 37.5 percent of respondents have the bio-gas plant of 8 m^3. The figure is shown in the following table.

Table 4.4.1: Size of bio-gas plant

S. N	Size	Number	Percentage(%)
1	4 m^3	15	37.50
2	6 m^3	10	25.00
3	8 m^3	15	37.50
	Total	40	100.00

Source: Field Survey, 2016

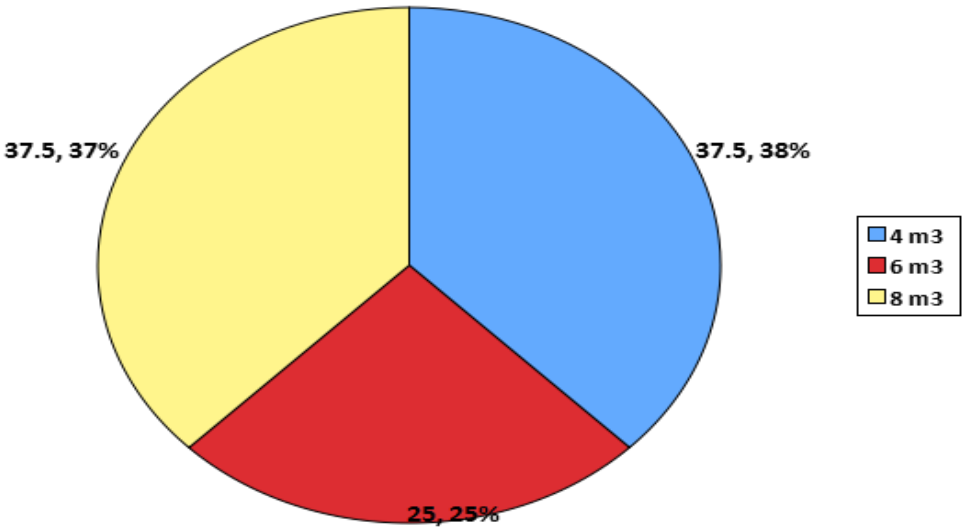


Figure4.11: Size of bio-gas plant

4.4.2 Main Objective of Installing bio-gas

Though most of the people consider bio-gas only as a source for cooking purpose, it has multiple of other uses and benefits, which could also be the objectives of installing it at home. Among the surveyed 40 house most of the respondents gave the answer that they have installed the bio-gas with the goal of cooking purpose, which comprised 90 percent of the answers. 5 percent said that they installed it for lighting purpose, 2.5 percent said because of environmental benefits whereas other 2.5 percent answer was for some other reason.

Table 4.4.2: Main Objective of Installing bio-gas

S. N	Objective	Number	Percentage(%)
1	Cooking purpose	36	90.00
2	Lighting purpose	2	5.00
3	Environment benefit	1	2.50
4	Others	1	2.50
	Total	40	100.00

Source: Field Survey, 2016

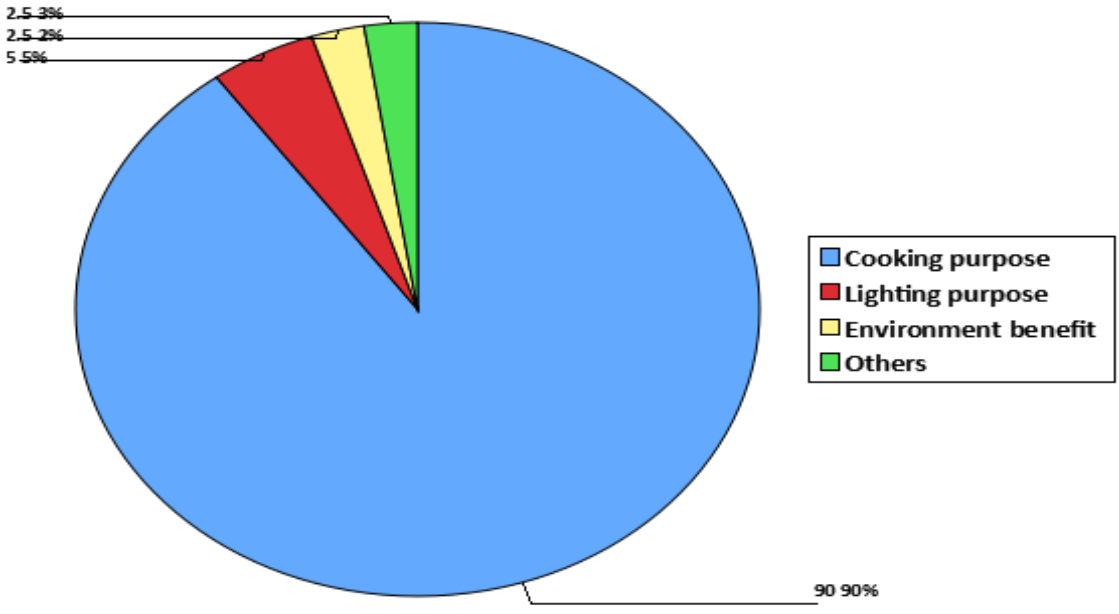


Figure 4.4.2: Main Objective of Installing bio-gas

Before installation of bio-gas, the people of the study area mainly used firewood, LP gas and kerosene oil for cooking purpose. In the study area among 40 households, 35 households used to use firewood for the cooking purpose whereas 4 of the houses

used LP gas and rest of the 1 households used kerosene for the cooking purpose. The energy use pattern seems to have changed significantly after the installation of bio-gas which has resulted in relief of women with respect to their health and sanitation. Kitchens have been in improved condition with less smoke and clean and new energy use pattern has brought behavioral change in users' livelihood.

4.4.3 Reduction in Workloads

One of the main purposes of bio-gas installation is to save time while cooking, to save the time used for collecting the fuel materials or to reduce the workload of the households. After installation of bio-gas, there was considerable reduction in workloads; of the family members especially of the women members

The reduction in workload was measured in terms of saving in working time. Observation was made on 3 category of works viz. firewood collection, cooking and washing utensils. The description of difference in workload before and after installation of bio-gas plant is given in the following table.

Table 4.4.3: Reduction in Workloads

S. No.	Category of work	Average time taken hrs/day		Reduction in workload (saving in time) hrs/day
		Before Installation	After Installation	
1	Firewood collection	3.1	0.23	2.87
2	Cooking activities	2.2	1	1.2
3	Washing utensils	1.1	0.6	0.5
	Total	6.4	1.83	4.57

Source: Field Survey 2016

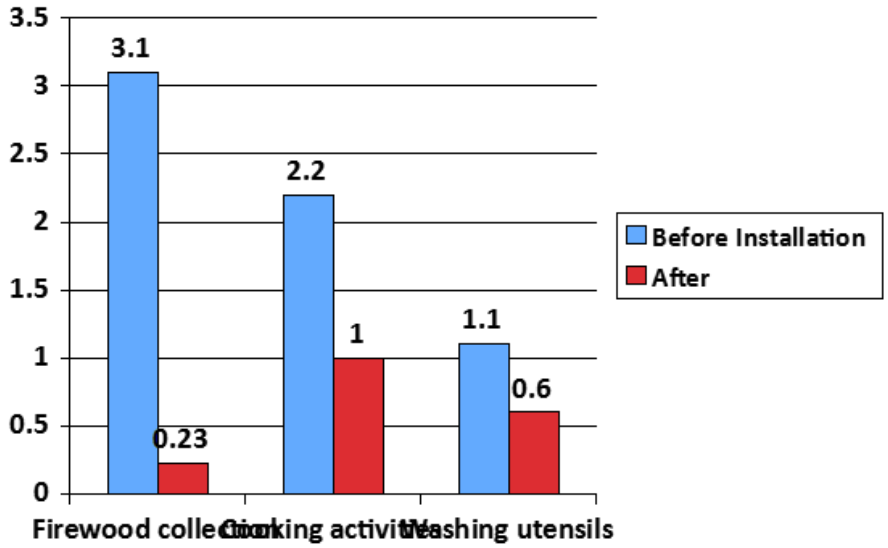


Figure 4.4.3: Reduction in Workloads

The table shows that saving in time was considerable. A great time (2.87 hours per day) was saved in firewood collection only. The total average time saving of 4.57 hour per day indicates that almost half of the day's workload of the family member was reduced.

4.4.4 Saving of Firewood

Considerable amount of firewood was found to be saved after the installation of bio-gas plants, which definitely help economically to the households and assist a great deal in the environmental improvement as well.

Table 4.4.4: Saving of Firewood

S. N	Amount Saved in bhari/month	Number	Percentage(%)
1	1 to 5	14	35
2	6 to 15	17	42.5
3	Over 16	9	22.5
	Total	40	100.00

Source: Field Survey, 2016

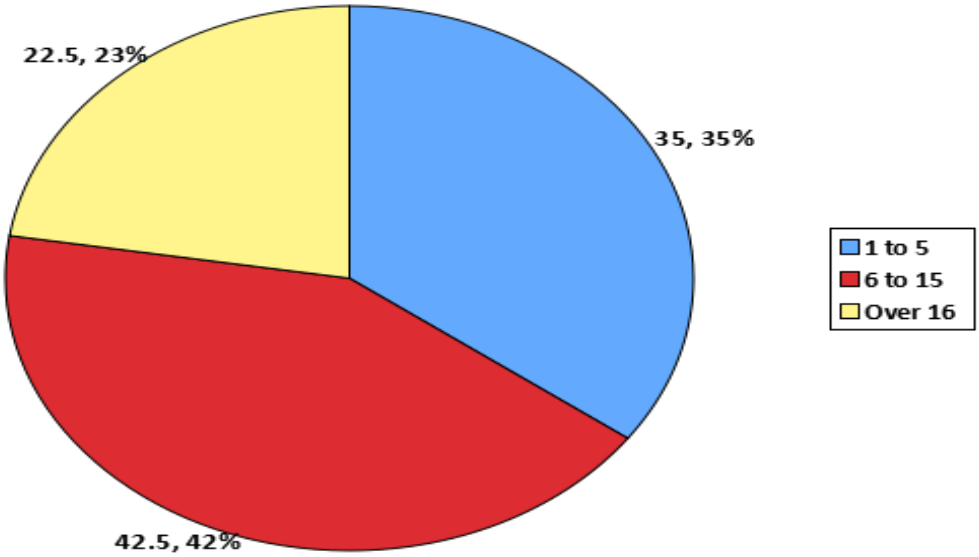


Figure 4.4.4: Saving of Firewood

As only 40 households used to use firewood as their fuel, only 40 households are taken in total in this case. Most of the respondents (42.5 percent) were found to saving firewood ranging from 6 to 15 bhari. 35 percent of the households save 1 to 5 bharis of firewood whereas 22.5 percent of the households save firewood over 16 bharis per month. The maximum quantity of firewood saved was recorded to be 22 Bhari whereas the minimum quantity saved was noted to be 4 Bhari. The normal rate of firewood in local area is rupees 100 per bhari, so the above data clearly signifies that there is a saving of substantial amount of money.

*1 Bhari is approximately equivalent to 25 kgs.

4.5 Utilization of Advantaged Time

Undoubtedly, after the installation of bio-gas a significant amount of time is saved and there is a good opportunity for the households to make the most of the gained time. Since, Nepal being very much agriculture dominated country, the majority of the households of the study areas is also found using their gained time in farm activities which comprised about 40 percent of the total respondents. Similarly 30 percent people were found to be enjoying doing the household works in elapsed time. 15 percent utilize their time in their own business, 7.5 percent in labor work and rest of the 7.5 percent do other activities.

Table 4.5: Utilization of Advantaged Time

S. N	Category	Number	Percentage(%)
1	Farm Activities	16	40.00
2	Labor work	3	7.50
3	Entrepreneurship	6	15.00
4	Household Work	12	30.00
5	Others	3	7.50
	Total	40	100.00

Source: Field Survey 2016

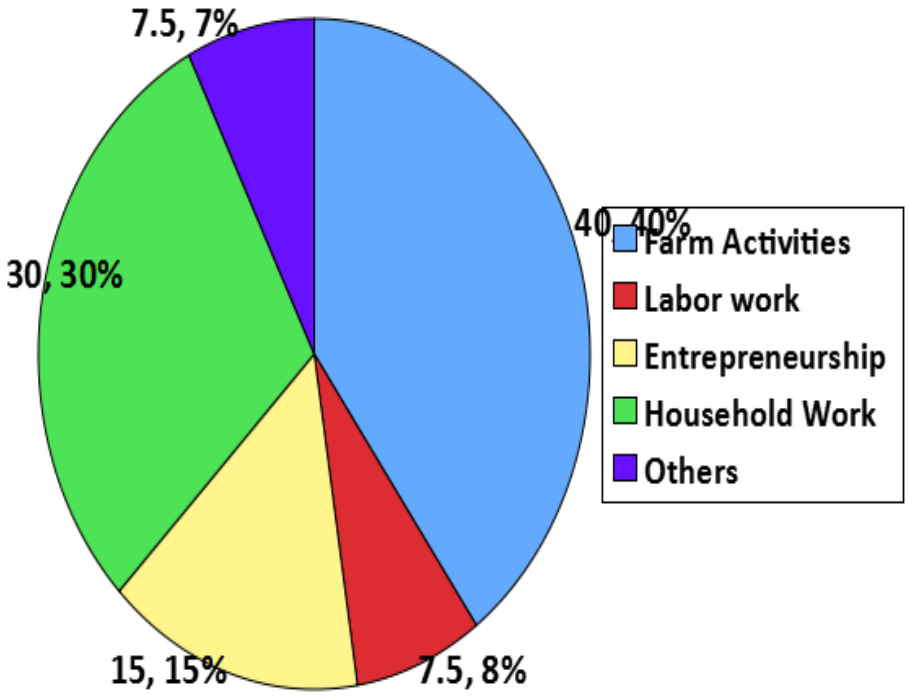


Figure 4.5: Utilization of Advantaged Time

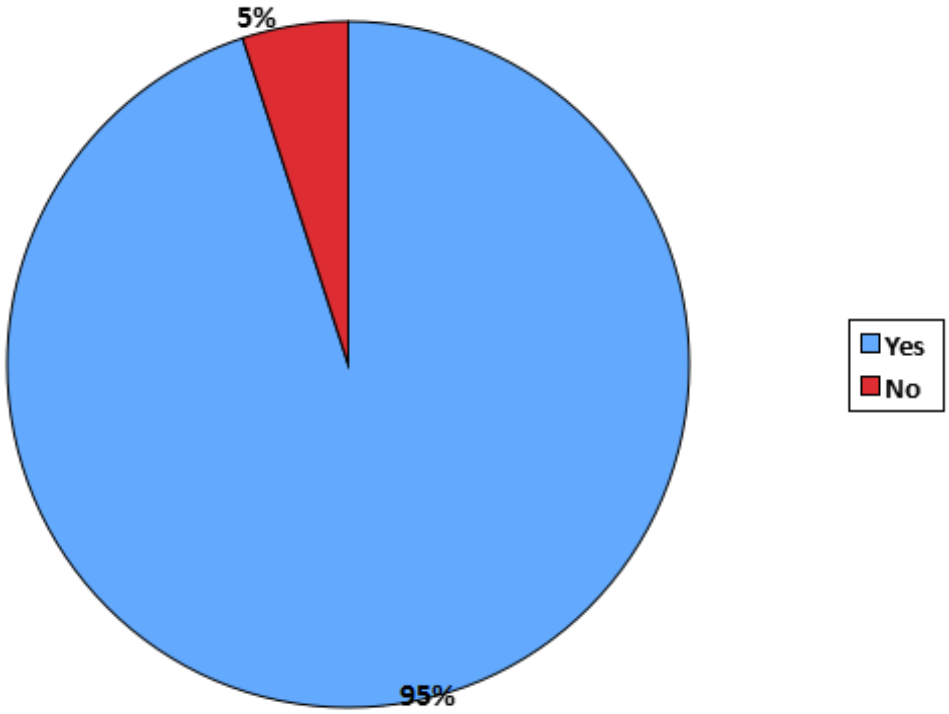
4.6 Use of Latrine

One of the major pull factors for construction of bio-gas was the opportunity to construct the toilet, in the study area and lots of people took full advantage of this opportunity as well. Among the surveyed households, 95% of the households had built latrines whereas 5% households were devoid of latrines.

Table 4.6: Use of Latrine

S.N.	Have Latrine	No. Of Households	Percentage (%)
1	Yes	38	95
2	No	2	5
	Total	40	100

Source: Field Survey, 2016



4.6.1: Reduction in diseases

One of the most positive benefits of the bio-gas plant is the betterment of the health condition of the households as well. We have well witnessed that lots of housewives in the rural areas of Nepal are suffering from respiratory, burning, headache, eye problems due to the smoke and flames of firewood, so bio-gas could be one of the noble technology to get rid of those problems. Households of the study area felt reduction in health related problems after bio-gas plant installation. The major impact on the reduction of disease is demonstrated in the following table

Table 4.6.1: Reduction in Disease

S. N	Problem	Number	Percentage(%)
1	Eye Problem	6	15
2	Burning	5	12.5
3	Coughing	3	7.5
4	Acute Respiratory	9	22.5
5	Headache	15	37.5
6	No Change	2	5.00
	Total	40	100.00

Source: Field Survey, 2016

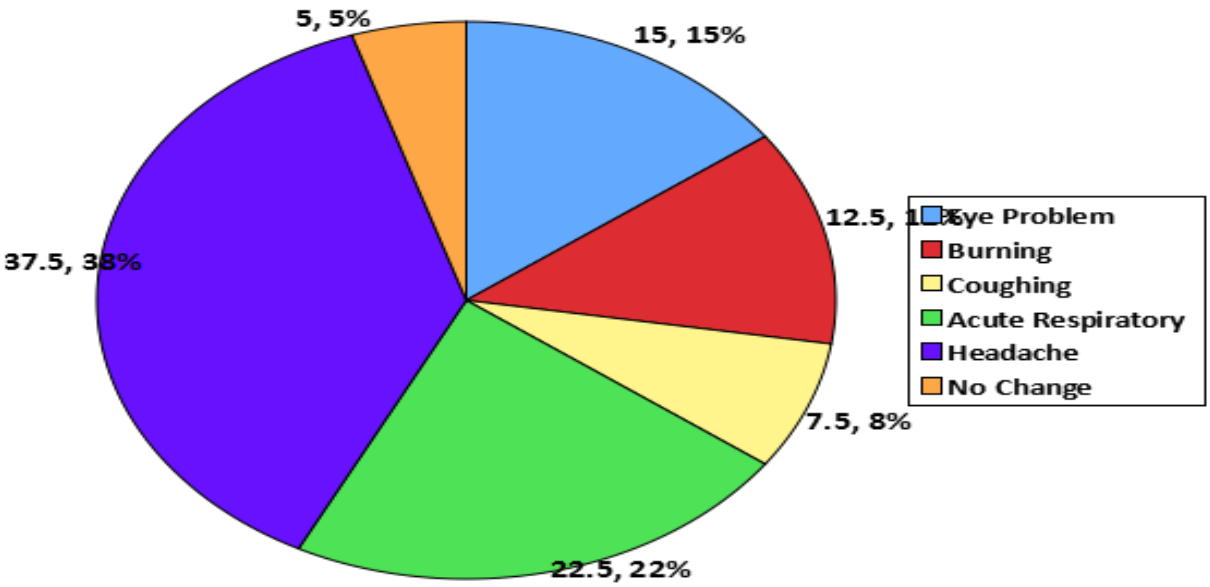


Figure 4.6.1: Reduction in Disease

As the answers in some households were more than one regarding this question, the total number of answers have reached 40, so 40 was taken as 100 percent and analysis was done likewise. The above table shows that the most relief of the people found was in the case of headache as 37.5 percent answer consisted that they headache problem has been reduced. 22.5 percent are satisfied with the reduced acute respiratory problem, followed by 12.5 percent burning problem, 15 percent eye problem and 7.5 percent coughing problem. Whereas 5 percent of the answer was that there was no change in respect of illness before and after the installation of the plant.

4.7 Slurry and Its Use

It is an obvious fact that most of the developing countries have to depend on other countries for chemical fertilizers. Our country also imports massive amount of chemical fertilizers from abroad, which is very costly and its continuous application without the addition of organic manure is detrimental to the physical properties of the soil. With the view of this thing the use of bio-gas slurry could be very much valuable. The encouraging thing is that, 100 percent of the plant owners of the study area use slurry for manure purpose.

4.7.1 Effect of Slurry

Fertilizer or manure is the most essential input for any crop. The slurry is said to be rich in various plant nutrients such as nitrogen, phosphorous, potash etc. Well fermented bio-gas slurry improves the physical, chemical and biological properties of the soil resulting qualitative as well as quantitative production of crops. The answer received from the respondents with regard to the effect of slurry is tabulated in the following table.

Table 4.7.1: Effect of Slurry

S. N	Agriculture production	Number	Percentage(%)
1	Increased	2	5.00
2	Decreased	5	12.5
3	Remain same	32	80
4	Can't Say	1	2.5
	Total	40	100.00

Source: Field Survey, 2016

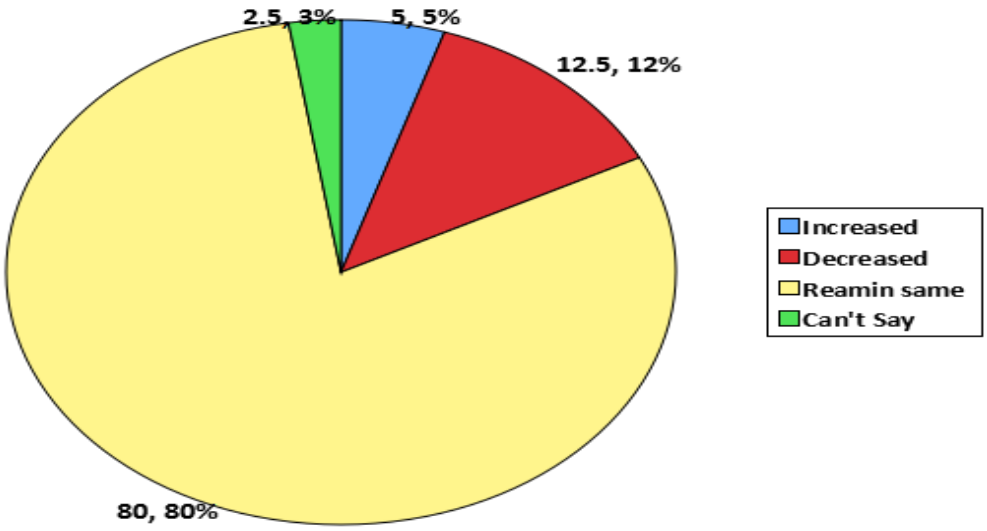


Figure 4.7.1: Effects of Slurry

Against all the speculations and writings in favor of the use of slurry, all those proved to be wrong in the study area proved. A huge majority of the respondents 80 percent said that there was no change in the production of crops before and after the use of slurry as manure. Only a slender 5 percent revealed that the use of slurry have enhanced the production of crops whereas 12.5 percent did not enjoy the use of slurry as they witnessed the decrement in the production of crops after its use. 2.5 percent of the respondents could give no answer regarding this question.

4.7.2 Effect on Insect, fly and Mosquito Prevalence

Increase in the prevalence of insects was one of the drawbacks of bio-gas installation witnessed in the study area. Most of the respondents said that the concentration of the insects was very high in the outlet of the bio-gas plant and the deposited pit of slurry provides a big breeding space for insects and mosquitoes. The following table portrays the insect prevalence in the study area.

Table 4.7.2: Effect on Insect, fly and Mosquito Prevalence

S. N	Insect/fly/mosquito Prevalence	Number	Percentage(%)
1	Increased	26	65.00
2	Decreased	3	7.50
3	No Change	11	27.50
	Total	40	100.00

Source: Field Survey, 2016

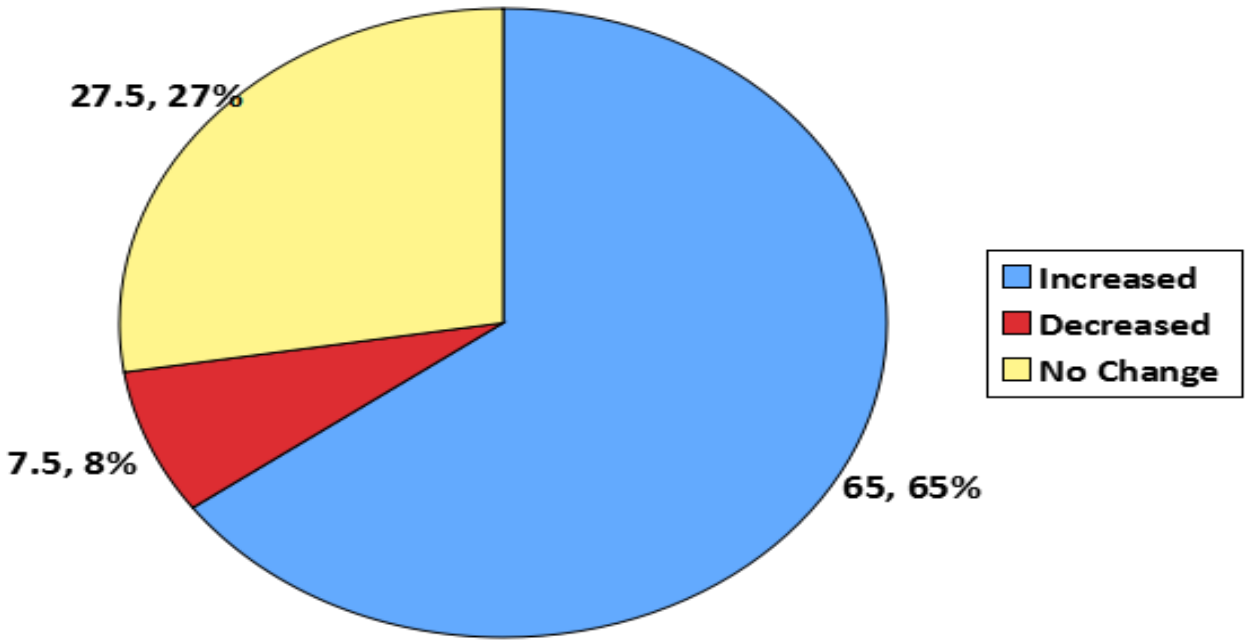


Figure 4.7.2: Prevalence In Insects

The above table shows that 65 percent of the respondents argued that the prevalence of the insects and mosquitoes have been amplified after the installation of bio-gas plant. Only a slender 7.5 percent observed the decrease of insets and mosquitoes whereas 27.5 percent of the respondents experienced no change in this respect before and after the installation.

4.8 Applications of bio-gas

bio-gas can be used for household and industrial applications. Various uses of bio-gas are explained below.

- **Cooking** bio-gas is primarily used for cooking in the developing countries. bio-gas burners or stoves for domestic cooking work satisfactorily under a water pressure of 75 to 85 mm. The stoves may be single or double varying in capacity from 0.22 to 1.10 m3 gas consumption per hour. Generally stoves of 0.22 and 0.44 m3 capacity are more popular. A 1.10 m3 burner is recommended for a bigger family with larger plant size.

Fig: 4.8. Bio-gas Burners with two Mouths Manufactured in India

Gas requirement for cooking purposes has been estimated to be 0.33 m3 per person per day under Nepalese conditions. If a family of 6 members owns a plant

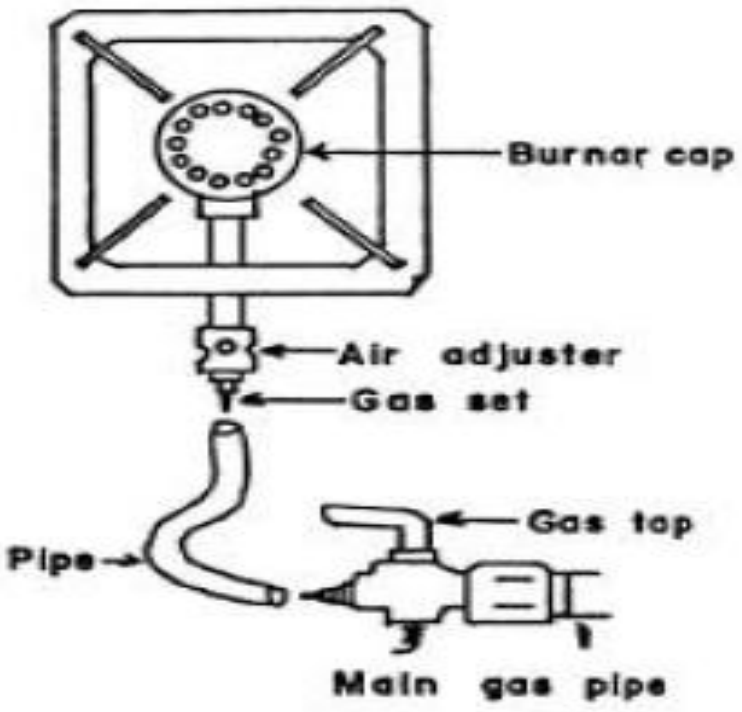


Fig: 4.8 Bio-gas Burner Manufactured by GGC Workshop at Butwal, Nepal

Producing 2 m3 of gas per day, usually two stoves (one with 0.22 m3 and the other with 0.44 m3 per hour capacity) can be used for one and half hours each in the morning and the evening to meet all cooking requirements of the family (Karki and Dixit: 1984).

- **Lighting** bio-gas can be used for lighting in non-electrified rural areas. However, it is not so popular in Nepal. Special types of gauze mantle lamps consuming 0.07 to 0.14m3 of gas per hour are used for household lighting. Several companies in India manufacture a great variety of lamps, which have single or double mantles. Generally, 1 mantle lamp is used for indoor purposes and 2 mantle lamps for outdoors. Such lamps emit clear and bright light equivalent to 40 to 100 candlepowers.

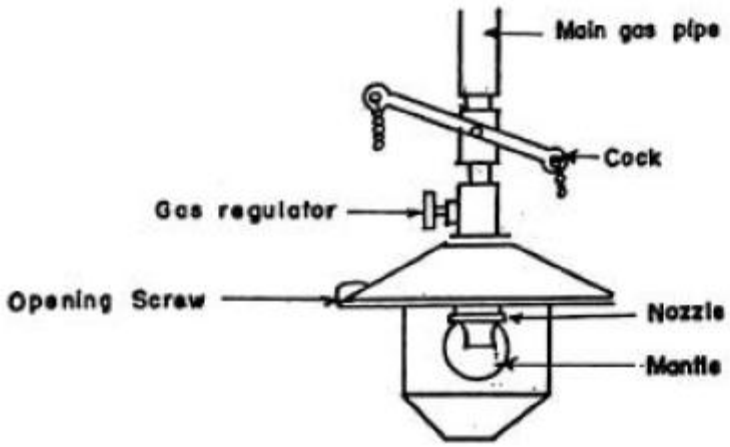


Fig: 4.8 Typical bio-gas Lamp manufactured in India

Compared to stoves, lamps are more difficult to operate and maintain. The lamps work satisfactorily under a water pressure of 70 to 84 mm.

- **Bio-gas Fueled Engines**

bio-gas can be used to operate four stroke diesels and spark ignition engines. bio-gas engines are generally suitable for powering vehicles like tractors and light duty trucks as has been successfully experimented in China. When bio-gas is used to fuel such engines, it may be necessary to reduce the hydrogen sulphide content if it is more than 2%. Using bio-gas to fuel vehicles is not so much of an attractive proposition as it would require carrying huge gas tanks on the vehicle. One of the uses of bio-gas,

which has wide application in Nepal, is to fuel engines to run irrigation pumps. A duel-fuel engine is available in India, which will run on a mixture of bio-gas and diesel (80% bio-gas and 20% diesel). In these engines, bio-gas is used as the main fuel while diesel is used for ignition. When gas runs out, the fuel engine can be switched back to run fully on diesel.

- **Bio-gas for Electricity Generation**

Generating electricity is a much more efficient use of bio-gas than using it for gas light. From energy utilization point of view, it is more economical to use bio-gas to generate electricity for lighting. In this process, the gas consumption is about 0.75 m3 per kWh with which 25-40 lamps can be lighted for one hour, whereas the same volume of bio-gas can serve lamps for one hour.

- **Refrigeration**

bio-gas can be used for absorption type refrigerating machines operating on ammonia and water, and equipped with automatic thermo-syphon. Since bio-gas is only the refrigerators external source of heat, the burner itself has to be modified. Refrigerators that are run with kerosene flame could not be adapted to run on bio-gas. In a country like Nepal, bio-gas run refrigerator could be of high importance for safe keeping of temperature sensitive materials such as medicines and vaccines in the remote areas. Gas requirement for refrigerators can be estimated on the basis of 0.6 – 1.2 m3 per hour per m3 refrigerator capacity (Updated Guidebook on bio-gas Development, 1984).

4. 9 Benefited Family Members of the Plant Owners

After installation of bio-gas plant almost all of the members of the family were found to be benefited. Workload of the family members, especially of the women was found to be reduced. A great positive view towards the reduction of workloads due to the installation of bio-gas was observed among the plant owners. Due to big flame and smokeless stoves, time has been saved in considerable amount in cooking, cleaning etc. The women were feeling quite relived by getting rid from the hectic way of creating fire by blowing it. The smokeless environment led to better health of the family. Most of the housewives expressed great satisfaction particularly with the

cooking aspect of bio-gas. About 48 percent respondents said that female members of the households are benefited from bio-gas whereas rest of the 52 percent claimed that not only female members but all the family members are benefited from the bio-gas.

4.9.1 Role of bio-gas Plant in Raising Social Status

It is not easy to measure the social impact of bio-gas as it is intangible and these needs to be assessed from user's perception which is very difficult to measure. The outcome of the study showed that there was some positive role of bio-gas in raising the social status of the people. To access the social effect the researcher has conducted interview and observation methods. From that the outcome was that 65 percent respondents said that bio-gas plant raises the social status of the holders as it has also become the symbol of local prestige. They said that bio-gas helps to offer quicker tea, coffee and short foods, which help to build up a prestige, as in prior times it took long time to manage firewood, lit it, blow it and make fire and cook. They also said that they have more time to visit relatives and to be engaged in social activities, functions etc.

4.9.2 Role of bio-gas in Financial Sector

Though the households have not observed significant economic changes directly after the installation of bio-gas, most of the respondents agree that bio-gas has helped them to manage time for financial earning activities. Some of them have realized that bio-gas have helped them to cut off the expenses required for LPG and kerosene oil. Though the researcher had tried to know the actual income and the difference made by the bio-gas installation, the respondents hesitated to disclose their income, so actual saving amount could not be accessed.

4.9.3 Negative Effects of bio-gas

Probably there is nothing in this world that has been created without having any adverse effect. Similarly though bio-gas is a very fruitful and prominent technology for the rural areas of Nepal it has some constraints as well. Basically the people are quite satisfied with the result of the bio-gas but there are some problems as well that the users of the study area are facing.

Firstly and foremost problem that the households are having is the maintenance problem. The respondents have commented that sometimes they are facing the problem of gas leakage and they are not able to use bio-gas as gas does not reach up to the stove. On the other hand the regulator sometimes gets out of order. In these cases they have to go to the bio-gas company and report and the maintenance person taken days to come and repair.

Another drawback of this technology faced by the people of the study area is that it increases the prevalence of the mosquitoes, flies and insects. The slurry coming out of the outlet provides a good breeding space for those insects and it function as a home for those insects.

The people of the study area do not seem satisfied with the result of the use of slurry as manure. Most of the people said that there is either no change or decrease in the production of crops after the use of bio-gas slurry. On the other hand people feel introverted to carry the slurry on their back as most of the bio-gas plants are connected with the toilet.

4.9.4 Benefits from bio-gas

There are numerous benefits of bio-gas to rural people in various ways. Some of the benefits are:

- Gender benefits: bio-gas provides a direct benefit, especially to rural women, as a result of the reduction of the workload when shifting from cooking on fuelwood to bio-gas. It saves approximately 3 hours time a day per family mainly due to reduction on time used for collecting fuelwood, cooking and cleaning of utensils.

- Environmental benefits: The introduction of bio-gas plants has reduced the consumption of fuelwood. BSP estimates that an average rural household uses about 2 tonnes/year of fuelwood for cooking, so the plants installed up until 2005 save a total of about 250,000 tonnes/year. There is visible evidence of forest re-growth in Nepal, brought about mainly by an active programme of tree planting, but also by the reduction of fuelwood use through the bio-gas programme. There are substantial savings in emissions of greenhouse gases, including CO2 from avoided fuelwood and kerosene use, and N2O from synthetic fertilizer. However there is a small net increase

in methane emission, because the unburned methane from cooking and minor leaks is slightly greater than the avoided emission of methane from manure disposal. Taking all of these into account, BSP estimated a net saving of about 3 tonnes/year of CO2 equivalent per plant, or a total of 370,000 tonnes/year for the plants installed up until 2005.

- Health benefits: A big problem for the rural people especially to the housewives is indoor air pollution and smoke exposure inside the kitchen while cooking. Poor indoor air quality is one of the major risks factors for acute respiratory infections with housewives and children. bio-gas reduces the smoke exposure and significantly improves the air condition inside the kitchen which ultimately the health condition especially eye infection, respiratory diseases, cough and headache. Improved sanitation with the construction and connection of toilets lead to better hygiene conditions. Better sanitation condition through bio-gas helps to reduce the infant mortality rate.

- Economic benefits: bio-gas reduces the expenses on fuel for cooking and to some extent lighting. The high quality bio-fertilizer contributes for high yield of crop and vegetables, which eventually help for generating income. The Internal Rate of Return (IRR) of bio-gas plant is about 49% (Bajagain, 2002)

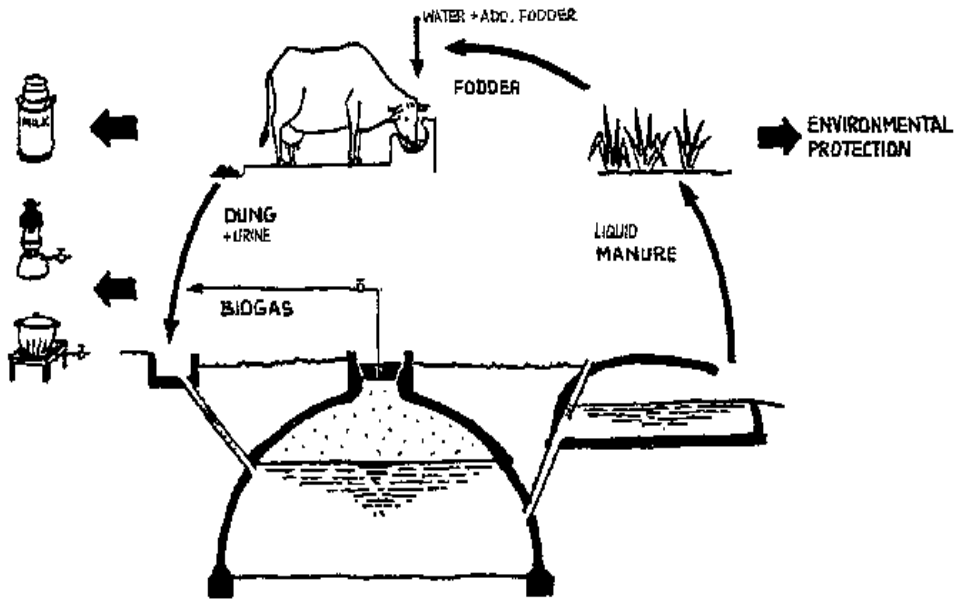


Fig: 4.9.4 Environmental protection

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The principal objective of the study is to find out the role of biogas in bringing about economic change in the users with the supporting objective of analyzing the effect of biogas plants on daily time saving and the way of use of saved time in economical value as well as the observation of negative effects of biogas plants.

The total population of the sampled household was found to be 215 where the female population constituted 51 percent and the male population 49 percent. The average family size was note to be 5.38 persons per household. The minimum family size was recorded to be of 2 persons and the maximum of 12 persons. The Brahmins and the Chhetris were found to be dominant in the installation biogas.

As in the other parts of the country the main occupation that people in this region follow is agriculture (62.5 %) with a reasonable number (17.5%) engaged in service. The average land holding of the respondents was found to be around 15 Kaththa with highest landholding of single household noted to be 44 Kaththa and the lowest to 3 Kaththa. The average cattle holding per family was 2.2, basically dominated by the buffalo population.

Education is the basic foundation for the prosperous life of a human being and the level of education attained normally figures the life and career of the person. The literacy percentage of the respondents was found very high (Over 90 %), but the level of education of most of this percent is under the secondary level.

The main sources to inform the installers about biogas were the respective biogas companies (42.5%), followed by the neighbors (37.5%). The foremost purpose of installation of biogas was for cooking purpose as 100 % of the households use biogas for cooking and some of them use for lighting purpose as well. Most of the households were found to prefer the biogas plant sized 4 and 6 m3 (62.5 %). The basic source of fuel was firewood (87.5%) before the installation of biogas with some of them using LPG and kerosene oil.

About 9 bharis of firewood per home was found to be saved per month after the installation of biogas, where 1 bhari costs 100 Rupees. Similarly an average hour of 4.57 per day per household was noted to be saved (2.87 hours per day for firewood collection, 1.2 hours for cooking and .5 hours for washing utensils). Most of the respondents use their gained time in their farm activities (40%), whereas another significant number (30%) use that time in household works.

Most of the people (95 %) realized the reduction in the effect of diseases like respiratory problems, headache, burning, coughing, eye problem etc. Although every member realized the benefit of the biogas to them, the main beneficiaries were the women. All of the households were found to be using the digested slurry for the manure purpose. 95% of the households had constructed permanent latrine along with the biogas plant.

Though the biogas has uncountable benefits, some of the constraints of this technology were witnessed or suffered in the study area. The people were suffering from the maintenance problem of biogas as they were getting much delayed repair facility from the respective companies. The people of the study area are not happy with the result of the crop yield through the use of slurry as 95% argued that the use of slurry either didn't change or decreased the yield of crops. Similarly the slurry acts as a great host for flies, mosquitoes and other insects, thus resulting in the prevalence of those insects.

5.2 Conclusion

A brief gist or conclusion of the above-discussed chapters is an attempt to be made in this chapter. The main objective of the research is obviously to study the role of biogas in the rural livelihood and focusing on this factor, the following conclusions are generated.

The main objective of the installation of the biogas plant was found to be for the cooking purpose. Some of the biogas users were also found to be enjoying the light facility from the biogas. Housewives/women are the main beneficiaries of the installation of biogas plant and they were found to be quite content as it made their work lot easier. Ample amount of time was found to be saved through biogas for the reasons like collection of firewood, cooking food and cleaning up of the utensils. In

addition, illness through the smoke emitted during cooking in firewood was found to be reduced in satisfactory level. Biogas helped a great deal to keep the interior parts of the houses clean with contrast to firewood, from which the emitted smoke used to make the house dirty. Also,the surrounding environment condition of the home was found been better as the emission of smoke was controlled and the heap of firewood as well as pieces of firewood were not seen scattered around.

On the other hand, fortification of biogas in the village has obviously reduced the exploitation to the forest vegetation and has assisted to better the environment and preserve the precious forest. The installation of biogas has emphasized people to construct toilet along with it which is a great achievement in keeping up with good health and sanitation. Adversely, the installation of biogas has helped to increase the mosquito, flies and insect prevalence as the slurry pit provides a big hostess for those insects. Usage of slurry as manure was not found to be fruitful to enhance the yield of the crops in the study area. Certain breakage, leakage and other maintenance problem has been a bit tedious for the users of the study areas.

5.3 Recommendations

- Maintenance training to all the biogas users should be given compulsorily so that they do not have to see the way of Biogas Company for days to maintain it.

- Though the different experts through research have suggested a great manure value of slurry which has not been the case in the study area, so the technical way of utilization of slurry should be suggested by the concerned agency.

- Insufficiency of the gas in winter season has been the major problem for the biogas users. So proper alternative design of biogas plant suiting that condition is urgent.

- The cause of increased prevalence of mosquito and other insects should be studied. It might happen that proper composting of slurry would reduce the chance of breeding of mosquito and reduce their prevalence.

- Training should be given to suggest the technical way of mixing the dung or bio degradable matters to get the maximum output from the limited available resources.

- Biogas is a boon for rural areas as an alternative source of energy in this time of energy crisis, so it should be promoted all around by giving ample subsidies to economically poor groups.

- It was found that unfair competition of the biogas companies have resulted in the poor construction of the biogas plant making the users its victim, so government should formulate some terms and conditions against the biogas companies

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