CHAPTER I

INTRODUCTION

1.1 General Background

The term “biogas” is commonly used to refer a gas which has been produced by the biological breakdown of organic matter in the absence of oxygen. The gas methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen and the resultant energy release allows biogas to be used as a fuel.

In the same way that ethanol and biodiesel have been around for a long time, biogas has a long history. Back in the 13th century, explorer Marco Polo noted that the Chinese used cover sewage tanks to generate power. The author of Robinson Crusoe-Daniel Defoe referred to biogas technologies back in the 17th century. Biogas has been used widely in the UK for century and back in 1895, the city of Exeter used gas from sewage to power its city street lamps. An anaerobic digester that treats farm wastes or energy crops is commonly called a ‘biogas plant’.

Among different sources of energy in our country, the fuel wood, animal dunk cake, coal petroleum, hydroelectricity, alternative sources and agricultural residue has dominant role. The present conditions of these sources are:

Petroleum Product: It is the important and expensive source of energy in Nepal which is imported from the foreign country. It occupied 75.76 percentages out of total commercial energy consumption in FY 2068/69. (Economic Survey, 2069/70)

Similarly, about 16.92 percent of the total commercial energy consumption was supplied by electricity in Nepal by FY 2068/69.

Electricity generating in Nepal consists of hydroelectric generation both from the inner connected system and remote isolated planet and some thermal generation based on fuel import. Recently, numbers of projects are installed to generate electricity. The electricity 705.6 Mega watt was generated in FY 2068/69.

Likewise, another source of energy is coal in Nepal. The consumption of coal in Nepal was 348 ton in FY 2068/69.

Moreover, agricultural residue is natural sources of energy. The contribution of agricultural in natural energy consumption was 4.33 percent in FY 2068/69. Rice husk, rice straw, rice bran, maize cobs, maize straw, jute stick etc. are used as sources of energy.

Similarly, animal dung cake is also source of energy in Nepal. The 6.6 percent of energy was fulfilled by animal dung cake out of total natural energy consumption in FY 2068/69. It is the traditional source of energy which is very much popular in the terai region.

Moreover, alternative sources of energy are also the important source of energy in order to stabilize the BOP of the economy and to minimize the heavy pressure on the forest resources. In this context, several efforts have made to search for the appropriate alternative technology in Nepal. Among it wind energy, solar energy, biogas energy etc. are in practiced.

In this context, as different sources of energy mainly traditional and commercial energy sources, the alternative sources of energy is in priority according to the demand of the time.

Electricity is supplied only in selected parts of the country and per household consumption of electricity is nominal. Most of the rural population lacking such facilities and are fulfilling their consumption of energy and fuel needs by firewood, charcoal, vegetable wastes, animal dung etc. The above mentioned factors show that the development of agriculture is the backbone of Nepalese economy in true sense but it is still in primitive stage. The proper irrigation facilities, improved seeds, pesticides and other modern agricultural equipment are mostly needed for the development of agriculture. Besides these things, fertilizer has an important element to increase the productivity. The exploitation of the forest has caused landslides, soil erosion and floods problems in our country. So, the conservation of it is essential and also the demand of time. Energy is a great pillar and plays a great role for the economic development of a nation. It plays a vital role for modernization of agriculture because it is an infrastructure of industrialization. So any country can't gain desired economic growth without energy.

The country which has plenty of energy sources can influence the economic activities of the other countries. For example, Arabian countries are rich in petroleum products and influence the economic activities of other developed nations by raising the prices.

Among all the commercial energies, the biogas is the best alternative source of energy .The slurry of a biogas plant is a valuable organic fertilizer which is rich in nutrient value than other ordinary compost fertilizer. Biogas technology not only furnishes a renewable and alternative source of energy but also well for fertilizer. The pioneer of

biogas in Nepal was late father B.R Sauboll, a Belgian teacher at Godavari Saint Xavier's School who built a demonstration plant in 1955.The family size biogas plant was popularized in 1974/75. During this period DCS built the biogas plants. The GG was formed in 1977 to construct the biogas plant. After the formation of BSP in 1992, BSP started to monitor, promote various Biogas companies for installation of biogas plants under the Netherlands development organization (SNV) and Ministry of Finance.

There is mutual interrelationship between the biogas and the forest resources. As the increasing pattern of the deforestation can be minimize with the help of the biogas uses. Because biogas helps to reduce the demand of the firewood as the traditional sources of the energy which is more in comparison of the other traditional source of energy. It also helps to reduce the dependency of the people in the forest resources and save the time of the women for searching the woods. In this context, it helps to bring the positive impact in the environment by protecting the greenery of our country and encourage for the forestation.

The energy problem of Nepal can be solved easily by biogas technology because cattle population is fairly large in Nepal. Deforestation can be stopped by using biogas. Demand of petroleum product can be minimized by using alternative sources of energy. The process of generation of biogas helps to purify the environment. The biogas plant installation also checks the expenditure on health for housewife (women who works in kitchen). So, the biogas plays significant role in the present context of Nepal.

In this context, a case study of Bardibas, VDC has been taken to analyze biogas as the source of energy along with its positive impacts in the environment and socio-economic impact of the people of this area.

1.2 Statement of the Problem

Energy plays vital role in the economy. The role of energy in the economy is more or less same as blood circulation in the human body. Nepal is facing energy problems raising the prices of petroleum energy, fossil fuels and high rate of depletion of the forest resources. Solar energy, wind energy and water energy have not been fully utilized due to lack of technology and skilled man-power. High consumption of fuel wood (firewood) has caused the declination of forests which have resulted landslides, floods and soil erosion. High percentage of people in Nepal is still burning firewood

which has increased pressure on the forest day by day. The development of hydroelectricity is backward and poorly established because of lack of capital and trained manpower. In this context, the installation of biogas reduces the demand for petroleum products which saves foreign exchange. Therefore, the alternative choice of energy is biogas in the present situation of Nepal.

The agriculture sector of Nepal is facing a lack of fertilizer to raise the agricultural productivity. The bio-gas installation process requires the raw materials such as animal dung, human wastes, agricultural residue etc. These materials are easily available in every parts of Nepal. The slurry is best fertilizer to increase agricultural productivity. Hence, we can say that biogas installation is one of the most appropriate substitutions of energy sources.

In this context, some research questions are as follows:

1) What is the role of biogas as an alternative source of energy?
2) What are the positive impacts of biogas to their users?
3) What are the different sources of biogas and their present situation?

1.3 Rationale of the Study

The increasing demand for fuel wood due to population pressure is one of the causes of forest declination. The use of biogas reduces the consumption of fuel wood which preserves the forest. The use of biogas saves the money spent for Kerosene; it reduces the export of Nepalese currency. It also saves the money for purchasing chemical fertilizer because the biogas plant produces the slurry which is more nutrient fertilizer than chemical fertilizer. It also serves the lighting purposes, of the people those who have no electricity facility.

The consumption of bio-gas increase indirect income of the bio-gas users or in aggregate, increases national income reducing payment for chemical fertilizer, Kerosene oil, coal etc. The study “An Use of Biogas as an Alternative Source of Energy” is so important. It analyses the monetary income. This study is also important because it also deals environmental benefits obtained by installation of bio-gas plants.

1.4 Objectives of the Study

The overall objective of the study is to analyze the economic benefits of biogas in Nepal. The specific objectives of the study are as:

- To analyze the role of biogas as an alternative source of energy in Bardibas VDC,
- To assess the positive impacts of biogas users in Bardibas VDC for their health,
- To explore different sources of biogas in Bardibas VDC..

1.5 Limitations of the Study

The study will be assumed to explain the economic benefit of biogas in Nepal including sanitation aspects leaving the technical aspects of biogas plant. This study will be assumed that the installation of biogas plant is fruitful for the substitution of energy as alternative source of energy and beneficial for the economic aspect in the present context of Nepal.

The limitations of the study are as follows:

- This study tries to explain the economic consequences and does not cover any technical aspects of the biogas energy.
- The validity of the study depends on the responses given by the respondents.
- This study is explorative in nature. Analysis of slurry production and gas generation are expressed approximately and the benefits of plants are explained in the monetary terms.

CHAPTER II
REVIEW OF LITERATURE

Energy is a great pillar and plays a vital role for the economic development of a nation without energy the development of human society is not successful. It plays a great role for modernization of agriculture because it is the infrastructure of industrialization. So, any country can't gain derived economic growth without energy. An indicator of the development of nation is per capital consumption of energy. The population growth leads the increasing demand of energy, and then the result is massive excavation of mines and faster deforestation. Without raising supply of energy along with increasing demand, it causes energy crises, soil erosion, landslides, drought etc. In order to remove such kinds of bad results, we have to reduce the consumption of forest and mining resources, it means declining the population pressure on them. The process of researching alternative sources of energy, the world has been taking part. In this situation, much energy was explored such as wind energy, solar energy, hydroelectricity, biomass, biogas etc.

In the context of the world, the history of the biogas was mention by Van Helmont in 1630 in a communication about an inflammable gas emanating from decaying organic matter. It has been developed in different era of the time. As in 1870 Joseph priestly reported an air that was produced by the decay of substances when submerged in water. Similarly in 1900 in India a methane generating plant from human wasted was constructed. In 1914, the Dutch try to produce biogas from the waste of the straw board manufacture. The World Bioenergy emphasizes the great global potential for biogas, pointing to estimates that biogas has consist of around 6 percent of the global primary energy supply, or one third of the current use of the fossil gas. Moving on to biogas use and the application, the report discusses biogas potential by country according to feedstock, recognizing that U.S opportunities are vastly underutilized. There are about 2,200 sites producing bio gas in the country. By comparison, Europe has over 10,000 operating digesters, and some communities are essentially fossil fuel free because of them. (The World Bioenergy Association 2013)

Similarly, in the context of the Asia, Asia biogas is the leading and largest biogas energy group in the ASEAN region. Always innovating, it has been pioneer in the biogas sector in Southeast Asia since 1999. It has been built some of the largest

projects and in 2012 commission the world's first cassava wet cake/ pulp digester was made. (Asia Biogas Company, 2013)

In the present context of Nepal, Solar energy is very complex and expensive technology. In the case of wind energy, it is irregular and seasonal. The hydro-electricity generation project is also complex and expensive. Nepalese economy is agro-based economy. The consumption of energy depends upon the agricultural and its products more than commercials energies (i.e. kerosene, petroleum liquids, and chemicals fertilizers). In this case biogas is suitable and dependable alternative energy.

In this context, several empirical scientific researches and studies have been carried out all levels i.e. local, regional, national and international level. The major findings of the available research studies are briefly summarized below in relation to effectiveness of economic benefits.

Government of India's (2002) '' Evaluation Study on National project on Biogas Development" , presents a preliminary study of two highly successful rural biogas models wherein biogas is produced and utilized as a cooking fuel by the villagers. The two models studied were the community Biogas plant established by Sumal Dairy at Bhintbudrak, Gujrat and the Individual Biogas plants established by Bhagirath Pratisthan (NGO) in south Konkan region of Maharashtra, various aspects including design, operation, economics and benefits to the stakeholders had been described. The report ends with a comparison of the two models studied on the basis of their design, vision, performance, economics and benefits.

Sagagi, et al. (2009) presented results of the study on biogas production from fruits and vegetables waste materials and their effect on plants when used as fertilizer (Using digested and undigested sludge). It has been observed that the highest weekly individual production rate is recorded for the cow dung (control) slurry with average production of 1554 cm3 , followed by pineapple waste which had 965 cm3 of biogas, then by orange waste which has 612 cm3 of biogas, lastly, pumpkin and spinach wastes had 373 cm3 and 269 cm3 respectively. The result obtained shows that difference in the production of biogas to a large extent depends on the nature of the

substrate. All the substrates used appeared to be good materials for biogas production and their spent slurries can be used as source of plant nutrients.

Reinhard Madlenera, et al. (2006) compares multi-criteria decision aiding (MCDA) and data envelopment analysis (DEA) approaches for assessing renewable energy plants, in order to determine their performance in terms of economic, environmental and social criteria and indicators. The case is for a dataset of 41 agricultural biogas plants in Austria using anaerobic digestion. The result indicate that MCDA constitutes an insightful approach, to be used alternatively or in a complementary way to DEA, namely in situations requiring a meaningful expression of managerial preferences regarding the relative importance of evaluation aspects to be considered in performance assessment.

Bhumesh Singh, et al. (2011) study on biogas generation from dairy effluent and control of water pollution has been viewed with the aim of control of water pollution through treatment of dairy waste as well as generation of biogas. Environmental parameters like Temperature, PH, Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD) was taken in to account. No change in the average value of temperature and pH was recorded but BOD and COD reduced to the extent of 50 percent. All parameters however showed statistically significant differences at 5 percent level between inlet and outlet point. Gas generation fluctuated between.5m3 /day to maximum 4.5 m3 /day with an average of 3 m3 / day was recorded.

N. Stalin, et al. (2007) modified three stage methane fermentation system was developed to digest animal manure effectively. The digester having an effective volume of 200 liter is constructed with central tube filled with burnt bricks. The burnt brick in the central portion of the digester increase the microbial concentration by immobilizing the bacteria on the surface of the burnt brick. The size of brick materials in not more than 3 to 5 mm. The carrier materials used in the digester are 5%, 10 %, 15%, and 20 % of the total volume of the digester and also for each percentage 3.5kg of cow dung and 3.5 kg of water (1:1) is well mixed and added daily. The readings were taken between biogas generations versus time for each percentage continuously up to 90 days. It was observed that 10 to 15 percentage of carrier material from the total volume for microbial growth gave more gas generation. Operational temperature

was from 30oC to 50oC. The study examines the effect of microbe growth, temperature on biogas generation and hydraulic retention time.

Vaibhav nasery (2011) presents this report a preliminary study of two highly successful rural biogas models wherein biogas is produced and utilized as a cooking fuel by the villagers. The two models studied are the community Biogas plant established by SUMUL Dairy at Bhintbudrak, Gujrat and the Individual Biogas plants established by Bhagirath Pratisthan (an INGO) in south Konkan region of Maharashtra. Various aspects including design, operation, economics and benefits to the stakeholders have been described. The report ends with a comparison of the two models studied on the basis of their design, vision, performance, economics and benefits.

Tom Bond, et al. (2011) Studied technologies which recover biogas by harnessing anaerobic degradation pathways controlled by suite of microorganisms. The biogas released acts as an environmentally sustainable energy source, while providing a method for disposal of various wastes. Biogas contains 50-70% methane and 30-50% carbon dioxide, as well as small amount of other gases and typically has a calorific value of 21-24 MJ/m3. Various appliances can be dueled by biogas, with stoves offering an application appropriate for deployment in developing countries. Widespread dissemination of biogas digesters in developing countries stems from the 1970s and there are now around four and 27 million biogas plants in India and China respectively. These are typically small systems in rural areas fed by animal manure. However, in many other countries technology spread has foundered and up to 50% of plants are non-functional. Those linked to inadequate emphasis on maintenance and repair of existing facilities. Hence for biogas recovery technology to thrive in the future, operational support networks need to be established. There appear to be opportunities for biogas stoves to contribute to projects introducing cleaner cook stoves, such as the global Alliance for Clean Cook stoves. Beyond this, there remains potential for domestic plants to utilize currently underexploited biogas substrates such as kitchen waste, weeds and crop residues. Thus there is a need for research into reactors and processes which enable efficient anaerobic biodegradation of these resources.

Hobbs, et al. (2010) studied the Benchmarking Commercial Biogas Plant to Improve Performance. The main objective was to benchmark those processes involving feedstock treatment, fermentation and mechanical aspects of the digester performance for all 13 biogas plants. Additionally we investigated the specific costs per kilowatt hour produced. Weak point and analysis was performed to determine the concerns of the operators. To ensures an efficient technology transfer into demonstration activities at full scale commercial agricultural biogas plants, selected operators (SMEs) of medium to large scale agricultural biogas plants agreed to collaborate and provide access to their plants. Analysis of this data revealed different approaches to biogas production and potential ways that may improve economic return. Weak point analysis identified the need for more pre-treatment of feedstock and monitoring and process control of fermentation processes in order to allow for better supported decision-making by the biogas plant operators.

Gebrezgabher, et al.(2009) present one of the key concerns of biogas plants is the disposal of comparative large amounts of digestives in an economically and environmentally sustainable manner. This paper analyses the economic performance of anaerobic digestion of a given biogas plant. A scenario analysis is carried out based on a linear programming model to identify feedstock's that optimize electricity production and to determine the optimal application of digest ate. The economic analysis is also based on NPV and IRR concepts, to assess the cost-effectiveness of the biogas system. In addition to a default scenario, management and policy scenarios were investigated. Findings show that treating RO as green fertilizer as opposed to manure (default scenario) is not only lucrative for the plant but also lessens the environmental burden of long distance transportation of concentrates, This paper also concludes that given the uncertainty of regulations concerning Ro and the currently low values of digest ate and heat, high investment and operating costs limit the feasibility of anaerobic digestion of wastes of farm origin and other co-substrates unless subsidies are provided.

Chankya, et al. (2012) present this paper the quest for a simple technology to realize the goal of 'Sustainable Energy for All', The conversion of non-lignified 'soft' non-woody biomass to biogas in modern anaerobic digesters is an importance component. Firstly, agro-residues, agro-industrial wastes, terrestrial/ aquatic weeds form a major

source of sustainably raised bio resources. An aerobically converting them to biogas provides a sustainable energy source to a large number of users and simultaneously facilitates nutrient recycling (nutrient-rich compost) permitting nutrient-starved agricultural systems in India to become more sustainable. When processed through biogas plants, over 95% of all plant nutrients within can be recycled making India's fragile agricultural soils more sustainable while also producing an energy source, biogas. While a lot of science and technology experience exists with regards to animal waste fed biogas plants, understanding of the underlying science, technology and sustainability of anaerobic digestion off agro-residues, weeds and leaf liter ('non-dung' soft biomass) for biogas/byproducts is poor. This potential has been inadequately tapped. In this paper, an attempt is made to review the microbiology of anaerobic digestion of various biomass residues, the conversion processes that are being developed/in use and finally to examine methods to make them attractive, provide multiple outputs and services than what was possible through animal dung biogas plants. The micro-organisms responsible, physic-chemical environment process and therefore the technology of digestion of biomass residues are not similar or as simple as that found for animal dung or food wastes. Therefore, novel fermentation concepts and modern digesters being developed for biomass residues are required to make this concept feasible and viable. Many more end-products, other than compost and biogas, as was done in the past, are required if the digesters, other than compost and biogas, as was done in the past, are required if the digesters have to be economically attractive to use and socially justifiable as well as sustainable in the long run. The sustainability issues that have and will shape this field are discussed. In this paper we show that simultaneous anaerobic digestion of biomass residues to biogas and multiple by-products could be an answer to the search for alternatives to achieve sustainable energy for all in this decade.

Ashok Kumar's work (1990) clearly shows that the biogas technology is economically a non viable technology that is beset with many social problems of re-adjustment during the transition period of moving from one technology to another. For instance it is incorrect to assume that Dung the raw material in the production of biogas is a waste product. It is used almost to the fullest possible extent, though the efficiency of such use may be questioned. Existing consumption pattern will most definitely be disrupted and as Ashok Kumar argues to the detriment of a large section

of the population. Though he has not mentioned it anywhere in his monograph his result suggest that expenditure of public money in such cases in better spent on further technological work rather than on any large scale application as it is presently being aimed.

In this paper Sapnar (1998) studied family type Gober gas plant in Nashik district. He gives table-wise achievements up to March 1997. He studied different type of biogas models and its production capacity. He give suggestion for positively react about the adopting the biogas plant.

Karve (2005) studied use of different type of gas and its problems as well as environment degradation. He tries to make a new biogas model which is provide minimum carbon (5%) mixed methane. This gas is a clean-burning fuel. It does not given smoke and also helps to save environment.

Kapali, et al. (2004) in this paper reviews the efforts made to improve the quality of biogas by scrubbing CO2 and the result obtained. There is at lot of potential if biogas could be made viable as a transport vehicle fuel like CNG by compressing it and filling into cylinders after scrubbing and drying. Thus the need emerges for a unified approach for scrubbing, compressing and subsequent storage of biogas for wider applications.

Arianne Van Buren (1979) study has revealed the advantage of bio-gas for rural area on the following ways:

- Bio-gas solves the fuel problems
- Stimulating agricultural production, here is deal of experimental results comparing the yield of four crops when a fertilizer is used with unfermented excreta and bio-gas slurry.
- Bio-gas as a health improvement: One way to eliminate schist some eggs, hookworm eggs and larva detected was reduced by 99%, where bio-gas has been developed properly, there has been effective control of parasitic diseases and schistosomiasis, the rural environment has been transformed, agricultural workers have been protected and the general standard of health has been successfully raised.

He also explains the necessary condition for fermentation of gas on the following ground:

- Suitable temperature is 10˚c to 30˚.(average temperature)
- Necessary nutrient: carbon to nitrogen must be maintained between 20:1 to 25:1.
- Water content: 90 % weight of total contain should be water.

Lang Pang explains the advantages and disadvantages of the bio- gas on the following points:

According to him the advantages of bio- gas are:

Bio-gas as a fuel conservation of forest wood, becoming more expensive and bio-gas has a definite advantage, the next cheapest fuel.

- Convenient, healthy and clean fuel.
- Foreign exchange saving in fuel of kerosene and fertilizer.

He also deals the disadvantages of bio-gas on the following way:

-High initial outlay.

-Insufficient gas during cold months.

- Could require 5 to 6 animals to maintain the plant at capacity.

Bajgain (2003) describes the benefits from bio-gas in Nepal. According to him the benefits of bio-gas can be summarized as follows:

- 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. It is calculated that the internal rate of return (IRR) of a bio-gas is 49%.

- 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 kitchen. Bio-gas reduces the smoke exposure and significantly improves the air condition insides the kitchen which ultimately improves the health condition especially eye infection, respiratory disease, cough and headache.

- Environmental Benefits

From individual perspective the use of bio gas significantly improves the indoor air quality. In addition, installation of bio-gas plant results in better sanitation due to the connection of toilets. One bio-gas plant saves about 2:3 tones of fuel wood per year. It roughly saves 0.03 hectors of forests land per year,

- 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 fuel wood to using bio-gas. It saves approximately 3.0 hours time a day per family mainly due to the reduction on time used for collecting fuel wood, cooking and cleanings utensils.

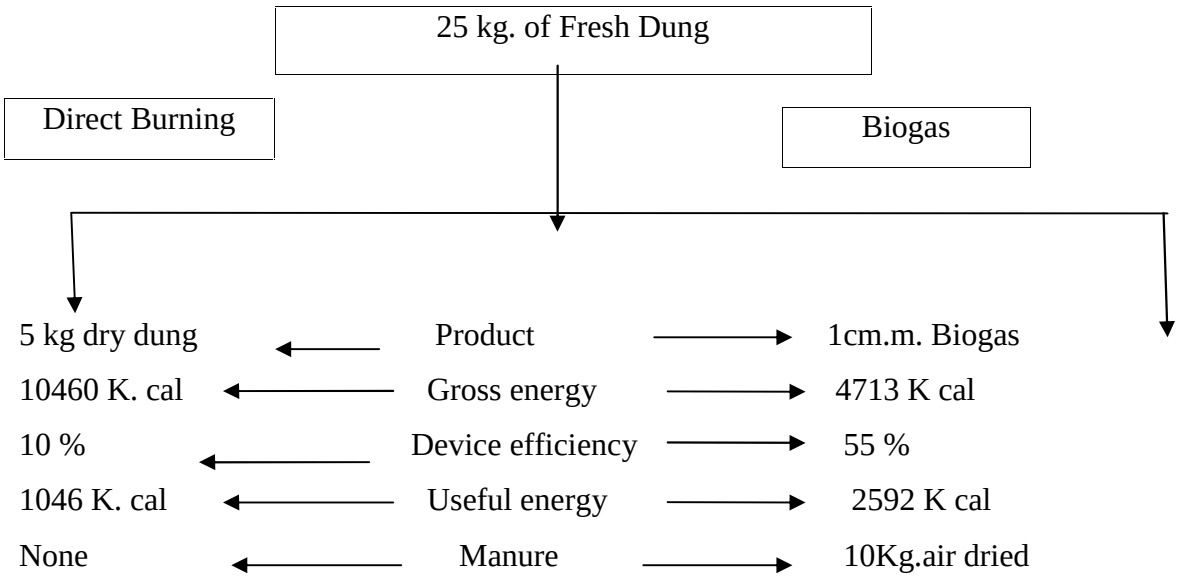
He also explains the indirect from bio-gas in terms of social educational and educational and recreational but it is clear that with the growing demand of biogas, this technology has been getting popularity day by day with in the rural Nepalese society.

Shrestha (2003) analyzes the impact of biogas plants in rural areas. She remarks that biogas technology needs space, money to build the plant, and expertise for the biogas plant. Once the biogas plant is prepared, it needs three inputs i.e. dung, water and labor and it gives two outputs i.e. effluent and gas. In villages of Nepal, people keep as cows and buffaloes for their livelihood. People's main occupation is agriculture and they performing their work themselves. Therefore, dung and labor is easily available in their own households and for water they manage from local sources such as tap well, river, pond, spring etc.

She also expresses the effects of biogas plants. Biogas is used instead of fuel wood, and kerosene consumption. The use of biogas minimizes the consumption of fuel wood, kerosene. This saves foreign exchange. The change in the method of cooking in the house saves time while cooking. After installation of biogas plant, the forest is preserved and people get clean environment.

Sharma (2004) describes the biogas and its commercial use. According to him: as a cooking fuel, it is cheap and extremely convenient and based on the effective heat produced, a $2m^3$. Biogas plant could replace, in a month. Fuel equivalent of 26 kg Of

LPG (nearly two standard cylinders), or 37 liters of kerosene or 88 kg of charcoal or 210 kg of fuel wood or 740 kg. Of animal dung:



On a life cycle basis, biogas is cheaper to the conventional biomass fuel (dung, fuel wood, and crop) as well as: PG and kerosene. Biogas stove has an efficiency of about 55% which is comparable to that an LPG stove. Thus biogas offers an excellent means of waste recycling, pollution control, labor, reduction, manure, production and public health protection.

Lamsal (May, 2001) shows the mineral value of slurry produced by bio-gas plant. According to him, the green plants (vegetables, crops etc) require 16 various notorious elements for growth like other animals. The necessary are rich in slurry than in other chemical fertilizers. According to him the average slurry compost of nitrogen is 1.27, the average slurry compost manure of the phosphorus and potash are 0.73 and 1.4 respectively.

Poudyal (1993) reveals the economic significance about the bio-gas system that role of biogas technology is to increase the biological affiance of farming system also reflects its economic significance. In case of 10 m^3 .biogas plant we can produce 2.7^{3} ^{of} gas per with feeding of 60 kgs .dung and which can run a stove for 7 hours per day. The field experiences are such that a 7 hours burning stove can easily meet the energy need for cooking purpose of the normal farm family size (|5-8 members). This biogas helps the farming system to be economically sound.

He also discussed the substitution effect of biogas on the following ground. The substitution effect of biogas produced from various plant sizes is different as the plant size of 4, 8 and 10 produced the cow dung cake in kg per day is 21.06, 28.08 and 35.8 respectively.

Dhakal (2004) researched about socio-economic impact of biogas. He analyzes the economic impact of biogas in this study. He has used the methodology as a graph, charts, and table, excel worksheet and database programmer to analyze. He describes as:

- Biogas has improved economic status after biogas plant installation.
- Control deforestation.
- Reduce landslide.
- Improve living standard of family.
- The use of slurry in the farm increases the productivity.
- Reduces the cost of fuel purchasing saving.
- Reduces the diseases of the family as Asthma, Bronchitis, Eye burning cough etc.

From the sides of biogas users group, the economic impact of biogas is explained in biogas user's survey (2003). This study analyzes the reduction of kerosene, fuel wood and chemical fertilizers due to biogas plant installation. So, biogas saves foreign exchange and money of biogas users group.

This study shows the table expressing reduction of kerosene due to biogas. Biogas has reduced the consumption of kerosene as a fuel source. According to his study the comparison of use of kerosene before and after BG installation has shown the positive result as the use of the kerosene is decreasing pattern in different season as summer and winter as 14 percent in summer and the 17 percent in the winter.

This shows the saving hard money due to installation BG plants. Saving in kerosene consumption has two fold benefits. Firstly, it saves money in terms of hard currency. Secondly, it is high products of incomplete combustion (PLC) emitting fuel.

Similarly, this survey also analyzed the reduction of consumption of fuel wood after BG plant installation. As in the hilly region in the summer and the winter season the reduction percent is 47 and 43 percent respectively. Similarly in the hilly region in the summer and the winter season the reduction percent in the fuel wood is 41 and 37

percent respectively. The decrease in fuel wood consumption has multiple benefits. Firstly, it saves money. Secondly, it reduces the existing high rate of deforestation of the country.

The survey also describes the economic benefits from biogas generation. The biogas plant produces the slurry which can be used as fertilizer to reduce the expenditure of farmers on chemical fertilizer. This reduction saves foreign exchange.

This survey shows other benefits such as health and sanitation on environment.

The Tenth fifth year plan (2002-007) targets the installation of 2, 00, 000 biogas plants. For the promotion and installation of biogas plants Various NGOs and INGOs are involved providing subsidies and credits like BSP/N, AEPC, ADB, NBL etc.

Kanel, (1999) evaluated the subsidy scheme for biogas plants. According to his report, the installation of biogas plants is very profitable in Nepal. This is shown by high internal rates of return both financial and economic, even with a decline on the ongoing subsidy rates. This study on the IRR values with different subsidy rate for an 8 cubic meter plant also shows that biogas plants are profitable in Nepal. This is mainly due to high kerosene and fire wood prices prevailing in the markets.

According to his report the internal rate of return of a plant is very high when we include the increases NPK in the slurry of a biogas plant. So, the farmers should be reminded of the fact that the installation of a biogas plant is also, to some extent, a substitution for the use of chemical fertilizers. The economic returns are higher than the financial return because of the incorporation of subsidies in kerosene and urea in our calculations of rates of return. If we allow for higher real prices of firewood the economic rates of returns will be still higher.

He has used Microsoft Excel computer package to calculate economic rates of return as methodology. He has also used graphs and table for the analysis of economic of economic rates of returns.

Bista (1981) writes 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 area of Nepal. It means that this is the urgent need for substituting rural energy through non-conventional energy resources.

Bachman and Saubolle (1983) writes about the use and importance of biogas that people living in remote areas of South East Asia or other tropical or sub-tropical countries where electricity is not sufficiently available and fuel is hard to get have a very cheap, abundant and efficient fuel is the produced from ordinary cow dung. They add ahead that a farmer with a couple of bulls and buffaloes needs of a village family of six. The cooking is clean and hygienic, the pots do not get black, there is no smoke or smell and the gas is non-toxic. The farmer can use the slurry in the field as fertilizers.

Bajracharya (2001) writes the constraint faced by the installation of biogas plants even through it has many advantages. The features of under developing countries affect the existing biogas companies. The expected returns from biogas installation is not being obtained due to lack of additional current capital, regular price rise in equipment and construction materials, low investment, unclear policy of the government and lack of skilled manpower from the biogas installation. The companies keeping high ambitions are coming with low capital, factors and resources in competition for installation of bio-gas plants without getting market promotion skills.

He also writes that there are other constraints such as social constraints, lack of education in rural area and lack of adequate cattle.

Silwal (2005) writes that bio-gas is a mixture of carbon hydrogen and nitrogen. The use of biogas reduces the amount of carbon in the environment. The clean development mechanism (CDM) provides U.S Dollar @$5 per ton of carbon. In Nepal, bio-gas plants installation is reducing carbon heavily among all the countries in the world. Nepal gets U.S. Dollar for reduction of carbon in environment through CDM after registration in Quito protocol. There is a great economic benefit from biogas plant installation.

CHAPTER III

Methodology

In this chapter, an attempt has been made to describe the procedures adopted for this research study. This chapter deals with the approach, selection of the study area, sample size and the data collection procedures.

3.1 Selection of the study Area

Bardibas VDC, which is situated intricately close to Janakpur city, was selected as the side of present study. As this VDC lies in the terai region, it has got fertile soil and agriculture as the main occupation. But the detorioting condition of environment due to the rapid deforestation and the crisis of energy sources the researcher find the alternative sources of energy as the best weapon to defeat this problem.

3.3 Sampling Procedure

The impact of biogas users to their health and education is assessed by comparing two groups. One use biogas and others does not have access to biogas in that locality. The case group consists of those households which are facilitates by biogas and those households who are deprived from the use of biogas are considered for control group. The respondents of this study were households that have been using biogas. This research was conduct by systematic sampling. The out of total 340 household from ward no 4 and 9 of Bardibas VDC , 30 samples has been selected from case group and sixty other sample has been selected from the control group.

3.4 Method of Data Collection

For this study data were collected through direct personal interview with the help of structure questionnaire. For the collection of information about socio-economic impact of biogas, the questionnaire was designed according to the objectives .The questionnaire consisted open-ended as well as close-ended question

Field questionnaire has been checked for possible errors. The data are carefully edited and processed by traditional method i.e. Bars than the required tables are generated by using computers software program.

Basically the researcher employed the following tools and techniques to meet the research objectives.

3.4.1 Household Survey

For the collection of in-depth informatio9n, semi –structure interview schedule was managed, pre tested and administered through face-to-face interview technique. The interview schedule was design to collect information on the role of biogas and its impact in the Bardibas VDC. Researcher also took orientation in the level of awareness towards sustainability of their locality.

3.4.2 Questionnaire

Questionnaire was the major tools of data collection. There were two Questionnaire design for village respondents. Prepared questions were divided into five parts including general information, socio- cultural status and employment, role of biogas, environment and agriculture situation of the study area, economic status and various sources of energy.

3.4.3Participatory Rural Appraisal

In order to cross-examine the information collected through secondary sources and personal interview, a combination of PRA tools were used to collect qualitative information from various stakeholders (village leader, ex- elected representatives, special workers, teachers, businessman and farmers). The PRA methods provide an opportunity to share ideas with participants, clarify doubts and refine information collected from the other sources. For this the following techniques were applied.

3.4.3.1 Non- Participant Observation

For qualitative information researcher has given validity for the analysis purpose. So, this researcher has made a keen observation from the view point of development in the economic benefit in the living standard of the people in and around the village through biogas. A checklist was developed to guide the observation process and record the observation remarks.

Beside the above method, the researcher has given the due emphasis on settlement pattern, land use system and other cultural and religious information while making an intensive research for the VDC.

3.4.3.2 Informal Meeting

The researcher also meets different local leaders, key informants and development experts and held discussion related to the goal of this research. The informal meetings were particularly useful for finding out some details as well as for cross checking the information collected through personal interview with the respondents.

3.5 Methods of Analysis

The impact of biogas on health, environment, education, agriculture and economic has analyzed by comparing the outcomes of care and control group. The data collected through personal interview has been presented and tabulated according to the objectives of the study in the descriptive form. The method of analysis includes comparison of average value of various variables between care and control group. For this, organizing, performing statistical analysis are the basic means for the analysis data.

After the completion of the data collection, all the collected data information was assembled in one place. The data collected from the both primary and the secondary sources were edited, coded and cast in the appropriate and required headings. It was also converted into percentage as well as frequency table after the tabulation of the data.

Similarly, the information obtained from the formal and informal meetings, interviews, observation and secondary sources were also processed, analyzed and interpreted where they were suitable. The analysis was done with the help of simple statistical tools such as percentage, average, frequency and cross tables and so on. Hence, this study views to present the analyzed data both quantitatively and qualitatively.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

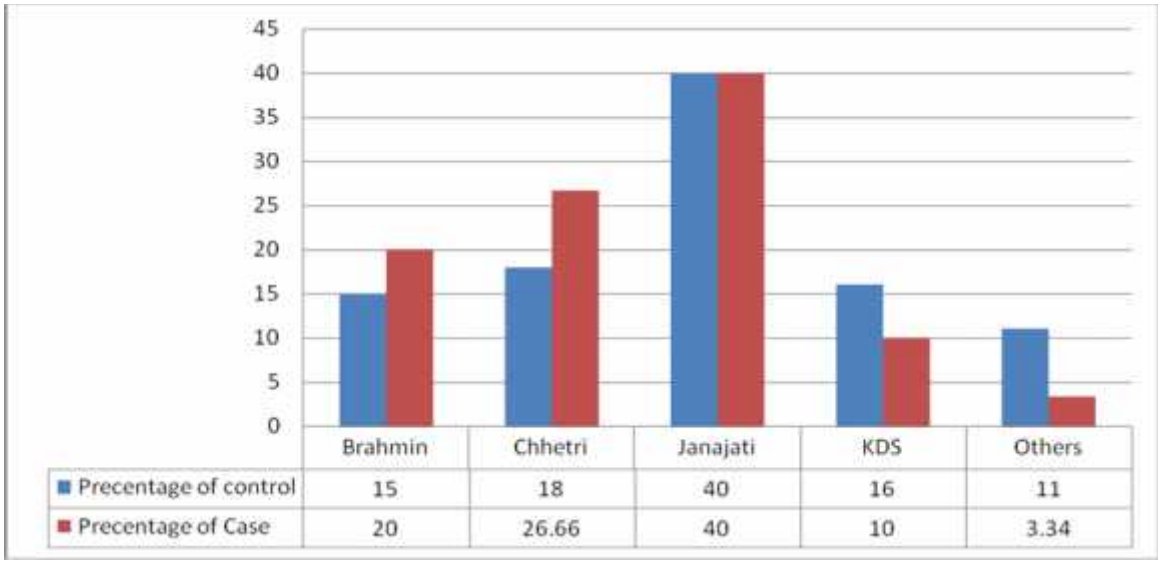
This chapter attempts to analyses the collected data and information for pursuing the objective of the study and deriving the major findings of the study. First of all, it presents the brief introduction Bardibas VDC with demographic features. This chapter deals with the analysis of the input of the micro project on agriculture and environment of Bardibas VDC. The impact of project in Bardibas on agriculture and environment would be analyses by comparing gradual changes on socio economic condition of the Bardibas VDC ward no 2 biogas by comparing with the socio economic condition of biogas not access ward no 3 and of this VDC. The questions and observation was analyzed in the descriptive form.

Socio-economic Characteristics: People of Study Area

Economically, the population of this area depends on agriculture and local trade. However some of them analyses in public services. There are many private school and government school where most of the people get opportunities to get education.

Figure 4.1.1 Caste wise Demographic Distribution of the Study Area.

.



	Brahmin	Chhetri	Janajati	KDS	Others
Precentage of control	15	18	40	16	11
Precentage of Case	20	26.66	40	10	3.34

Note: KDS denotes Kami, Damai and Sarki

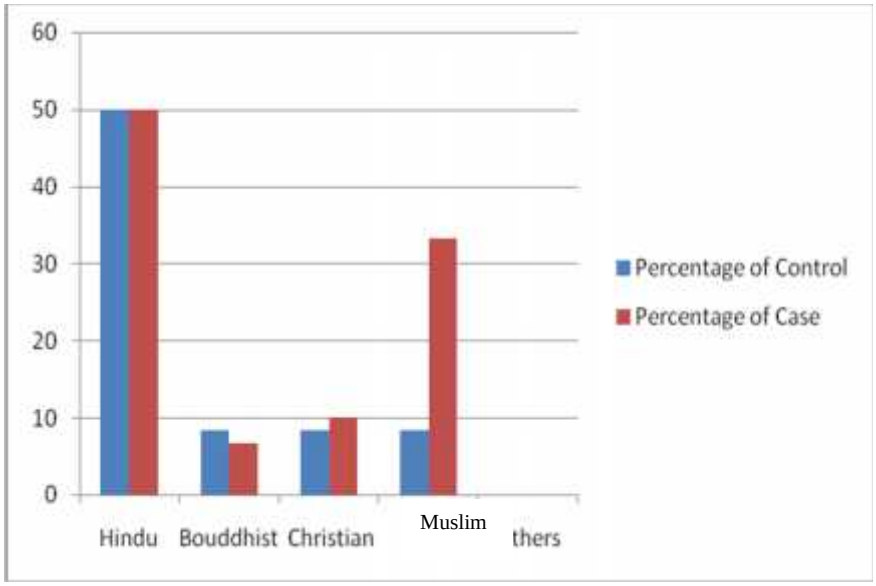
Source: Field Survey, 2014

Others include Newar and non caste categories group

Nepalese people are categories into different caste and ethnic groups. The census of 2001 identified 101 different caste and ethnic group in Nepal. Caste system is fundamentally based on Hindu religion whereas a vertical relationship among the caste exists. Brahmin, Chettri are in the apex where as KDS group is at the bottom of the social class.

Figure 4.1.1 depicts that most of the demographic distribution of study area. Janjati is the dominant caste in the both case and control group of Bardibas VDC. Chettrai and Bramins are also in excess percentage whereas majority of KDS are also remarkable. Newar and other non categories caste group are in negligible percentage.

Figure 4.1.2 Religion wise Demographic Distribution of Respondents



Source: Field Survey 2014

Note: other includes Kirat

Figure 4.1.2 presents the demographic distribution of respondents by religion. Percentage of Hindu is 50 percent in both case and control group. Muslim religion is also in dominant nature which is 33 percent. Presence of Christian and Buddhist are also accountable. Number of other is nil.

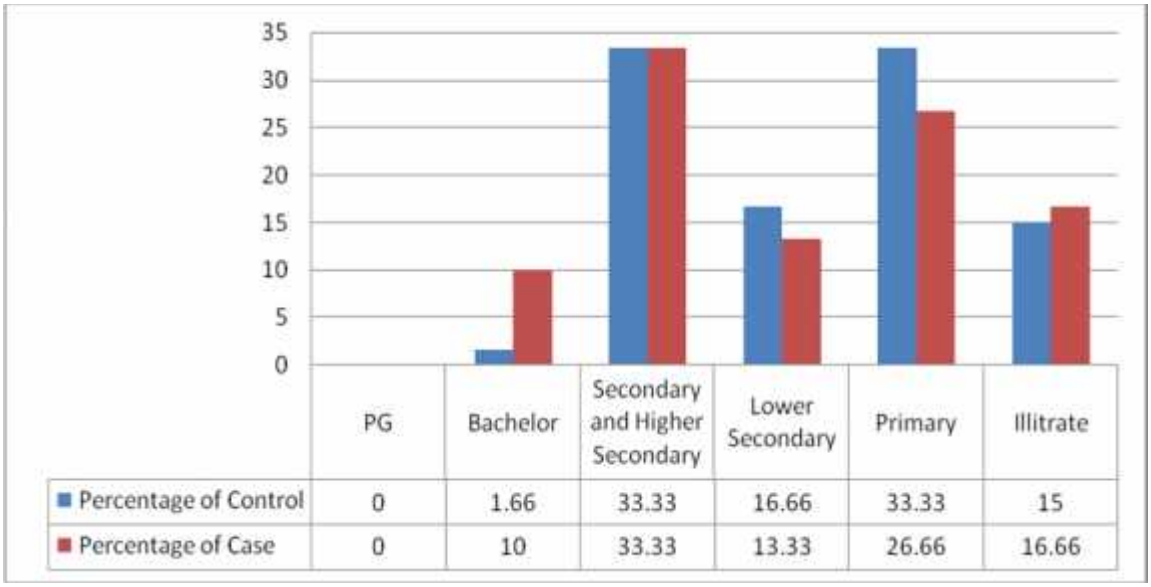
Table 4.1.3 Sex wise Demographic Distribution of the Respondent

Group					
		Control	Case	Percentage of Control	Percentage of case
Sex of the respondent	Male	25	10	41.67	33.33
	female	35	20	58.33	66.67
Total		60	40	100	100

Source: Field Survey, 2014

Table 4.1.3 describes the sex wise distribution of the respondents. Female respondents are dominant in both control and case group. As in the control group it is 58.33 as women and 41.67 of the male. Similarly it is less in the case group for male as 33.33 and the female is 66.67.

Figure 4.1.4 Education of Family Heads



Source: Field Survey, 2014

Note: PG includes Post Graduates

Most of the family heads are literate in both case and control groups. Most of the family heads achieve the secondary and higher secondary degree. Numbers of primary educated family heads are in significant in control group which is in similar percentage in case group also. Remarkable percentage of family member's gets bachelor degree in case group which is very low in control group.

4.1.5 Heads of Family Distribution by the Occupation

	Agriculture	Professional	Business	Services	Foreign employment	Other	Total
Control Percentage	50	3.33	6.66	16.66	20	3.33	100
Case Percentage	50	13.33	13.33	16.66	6.66	0	100

Source: Field Survey 2014

Note: Professional denotes (Doctor/Consultant)

Note: Other includes people in beneficent organization

Most of the family head are engaged on agriculture in both control and case group. Case group are 50% whereas dominant percent of people are involved on the agriculture in control group which is also 50%. The high percent of the people are involved in foreign employment at control.

Impact on Alternative Uses of Energy

There are a number of benefits both socio-economic as well as environmental, of using biogas project may have vital role on the alternative sources of energy for the people of this VDC, with the availability of biogas which the people has used as the energy to improve their economic and environment condition. By asking the improvement of their living and economic status in the energy, participation on any type of people of using biogas as alternative sources and the drop out of people from the other sources of energy to the biogas are taken as the measuring rod of impact of biogas project on the alternative energy sector.

Table 4.6: Improvement of Economic Status of the People

Improvement of People (at Case Group)		
	Percentage	Frequency
Yes	53.33	16
No	46.66	14
Total	100	30

Source: Field survey 2014

Table 4.6 depicts the improvement of the people in their economic status. There is too little difference between the improvements of the people in this community, which might be caused of different factors like: lack of well training and knowledge, lack of multi usages of biogas etc. The table 4.6 shows there is slightly an improvement of the people in their economic status. This is also the positive impact of biogas.

Table 4.7: Improvements in Agriculture

	Percentage of Case	Frequency
Yes	73.33	22
No	26.66	8
Total	100	30

Source: Field Survey, 2014

Table 4.7 depicts the improvement of the people in the agriculture. According to the survey taken to the case group, most of the people respond their agriculture development in the positive way and only little people respond as not improved their agriculture. The percentage of people who respond as improvement in their agriculture is 73.33 percent in comparison to other as 26.66 percent. This is also the positive improvement of the people due to the facility of biogas.

Table 4.8 Help to Increased in the Education by having Electricity Facility

	Percentage of case group	Frequency
Yes	90	27
No	10	3
Total	100	30

Source: Field Survey, 2014

Table 4.8 depicts the improvement of the children for their education due to the electricity generate by the biogas. The survey taken for the case group has shown the

significant improvement in the electricity and its positive impact in the study of the children. As in the case group 90 percent people respond as the positive improvement due to the biogas apply by them and in other hand only 10 percent of the people did not respond well for it. This is also a positive improvement of the children due to the facility of the electricity which is available by the biogas.

Table 4.9 Improvement for the Conservation of Fuel and Forest Resources

	Group		Total
	Control	Case	
No	60	10	70
Yes	0	20	20
Total	60	30	90

Source: Field Survey, 2014

People agree with biogas helps to preserve the field and forest resources which are 20 at case but people of control did not get such types of conservation. Most of the people agree with the enhancement of forest resources by the help of biogas project. There is significant role of biogas to affiliate and conserve the forest resources and fuel. Higher numbers of people agree with the role of biogas to preserve and protect the environment and fuel which is statically significant.

4.2 Impact on Health

Indoor air pollution is due to cause of smoke of firewood and smoke of kerosene for the lightning and cooking purpose which leads the serious problems on the people's health. People are suffering from the Asthama and eye infection due to indoor air pollution. Biogas has prominent role to reduce indoor air pollution by decreasing the use of firewood and kerosene. Ultimately, it is environment friendly which helps to conserve the forest and to keep fresh environment. Along with smoke from firewood, burning kerosene for the purpose of lighting is the major contributor of indoor air pollution. Indoor air pollution could lead to serious health problem such as respiratory diseases and eye infection. Having biogas supply at home reduces indoor air pollution by decreasing the use of kerosene and firewood which may lead to reduce risk of respiratory problems and eye infection. To see the impact on health, this study compares the number of such cases reported among the sample communities with and

without Micro biogas. Biogas may also have indirect benefits on health. Though increases in assess to others facilities like to watch television, movies and other activities. To estimate the impact of bio gas on health outcomes, each individual of a household was asked whether they had suffer from respiratory disease and eye related infection such as Asthama, bronchitis, ENT irritation, eye infection, headache, etc. In the past one year period, a list of these diseases along with the percentage of individual reporting such diseases in the control and case groups has been presented in the table no. 4.10.

Table no.4.10 Improvement in the Health of the People.

Number of suffer member in HHs	Control group	Case group	Percentage in Control group	Percentage in Case group
Asthma	8	2	13.33	6.66
Bronchitis	9	2	15	6.66
ENT irritation	6	0	10	0
Eye infection	13	3	21.66	10
Headache	14	4	23.33	13.33
No	10	19	16.66	63.33
Total	60	30	100	100

Source: Field Survey, 2014

Table no 4.10 shows the impact of biogas project on the health of people of Bardibas VDC. From the sample of control group 13.33 percent HHs response their family member had suffer from the asthma during one period. Similarly, 15 percent and 10 percent responses HHs of control group has been found to be infected from the bronchitis and ENT irritation during one year. But from the case group only 6.66 percent each HHs responses are found to be infected from asthma and bronchitis and no one of the people in case group suffer from ENT and irritation during one year. Eye infection in control group has found to be more than double than the case group. Whereas HHs suffers from the headache in both control and case group are 23.33 and 13.33 respectively.

There are improvements in the health status of case group than to the control group. Almost 63.33 percent of the HHs from case groups is not suffered from any respiratory diseases and eye related infection during one period year. Whereas, from

control group only 16.66 percent HHs have responses that they are not suffered from such diseases. Eye infection in control group has found to be more than double than the case group. Similarly, more the double HHs responses in control group have found to be suffering from asthma as compare to case group. Therefore, the impact of bio gas project on illness of HHs has found to be significance on health of HHs under case group than to the control group.

4.11 Households Suffering from Water Borne Diseases

Suffer member in HHS	Control Group	Case group	Percentage in Control group	Percentage in Case group
No	27	24	45	80
Yes	33	6	55	20
Total	60	30	100	100

Source: Field Survey, 2014

Table No. 4.11 shows that only 20 percent HHs members from the sample of case group are found to be suffer from the water borne disease but almost 55% of HHs from the control group reported that their family member have been infected from the water borne disease during 1 year period. 100 percent of total respondents HHs have assessed of water by water taps and have permanent toilet in their own house.

4.12 Facilities Provided by the Biogas for the Delivery of Pregnant Women

Delivery	Control Group	Case group	Percentage in Control group	Percentage in Case group
At Health Care	3	2	33.34	66.66
At Home	9	1	66.66	33.34
Total	12	3	100	100

Source: Field Survey, 2014

Table No., 4.12 shows that female gave birth to children in from control and case group are found to be 12 and 3 respectively. Most of the pregnant woman, from control group delivers at home. The reason of delivery place of control group and case group is found to be opposite. Only 33.34 percent of delivery of pregnant women of control group is under healthcare and 66.66 percent delivery at home. While 66.66 percent of delivery of case group is under health care and only 33.43 percent from this group delivery at home. It is also found that only female from the case group has

pregnant below the age of 20 years while female from control group are pregnant at the age below 20 years age 4. The major health incident in this study is the death of the two children below 5 years children from pneumonia of control group.

Source of cooking also affected the health condition of the people because if HHs use firewood as a main source of cooking then those HHs has more chance to suffer from the respiratory diseases. So to analyze the impact of biogas on the health we must examine the source of cooking pattern.

Table No. 4.13 Households Cooking Sources

Cooking Source	Control Group	Case Group	Percentage in Control Group	Percentage in Case Group
Firewood	44	15	73.33	50
Kerosene	13	3	21.66	10
Biogas	2	12	3.33	40
LP gas	1	0	1.66	0
Animal Dung	0	0	0	0
Other	0	0	0	0
Total	60	30	100	100

Source: Field Survey, 2014

Table No. 4.13 shows the source of cooking in both control and case group HHs using firewood as a main source of cooking is found to be 73.33 percent in control and 50 percent for the case group. Use of cooking source firewood produces more smoke. So, the HHs suffers for respiratory disease is found to be more in control group. While, HHs using biogas, kerosene, LP gas in control groups are 3.33 percent, 21.66 percent and 1.66 percent respectively. This is lower than in case group which is 40 percent, 10 percent and 0 percent respectively. This data easily depict the maximum use of the fuel wood by the control group in comparison to the case group which is in the decreasing pattern.

Table No. 4.15: Households Lighting Sources

Lighting Source	Control Group	Case Group	Percentage in Control Group	Percentage in Case Group
Biogas	0	30	0	100
Candle	6	0	10	0
Electricity	10	0	16.66	0
Kerosene	43	0	71.66	0
Solar	1	0	1.66	0
Others	0	0	0	0
Total	60	30	100	100

Source: Field Survey, 2014

Table No. 4.15 shows the lighting source of HHs in both control and case group. Almost all HHs in case group have been using biogas as a main lighting source. So HHs of case group has low eye infection then to the control group. Because 71.66 percent of HHs in control group is using kerosene as a source of lighting which produce smoke and this HHs have more chance of infecting from eye disease. Due to the maximum use of the kerosene in the control group in the above table, the risk of the health is more in comparison to the case group.

4.3 Impact of Biogas on Environment and Time Consumption

From individual perspective, the use of biogas significantly improves the air indoor air quality. The production of the biogas reduces the emission of the carbon dioxide in air. Reduction the emission of carbon dioxide checks global warming.

A big problem for the rural people specially for the housewives is indoor air pollution and smoke exposure and significantly improves the air condition inside the kitchen which ultimately improves the health condition specially eye infection, respiratory diseases, cough and headache. The expanses on such diseases are saved by the use of the biogas.

Biogas provides the direct benefit especially to rural women, as a result of the reduction of the work load when shifting from cooking on fuel wood to the biogas. It saves 3 hour time a day per family mainly due to the reduction on time used for collecting fuel wood, cooking and cleaning of utensils.

4.4 Importance of Energy

Energy is the main key of economic development of a country. Development works cannot be done without energy as we hope. Energy plays an important role for the modernization of agriculture and industrial development. To the implementation of agricultural instruments such as pump set, tractor, harvester, needs some kind of energy, without energy to move these machines is impossible. So we can say energy plays vital role in the agricultural sector.

The infrastructure of industrialization depends in energy because no aim of the industrialization can be taken without the development of energy. We can accept the pre-dominant role of energy in order to operate engines. By this way we can accept the influence of energy to the economic activities of a country.

Energy is not equally distributed among all countries of the world through, it is natural gift. Some have energy problem on the other hand others have enough resources. So the countries which have low energy resources, they can accept the influence of the economics activities of other countries. Even in the developed countries cost of production of goods raised high through the increased price of the petroleum products. Its result seriously experienced by developing countries like Nepal. Due to the increase in the price level of petroleum products all developmental works of the country affected seriously.

The agricultural inputs from abroad such as chemical fertilizer, insecticide, pesticide and other agricultural equipments increase their price level. In terms of high price level, it affects seriously economic activities of country.

The potential supply of energy depends upon two sources. The first one is surface such as sun, wind, water, and forest and the next one is underground sources such as coal, gas, oil etc. The surface sources are exhaustible because nature herself replenishes them net if they are used lastly. The underground resources are exhaustible because once they are exploited it decreases the quantity of these resources. Hence, most of the underground resources are declining the world which results energy crises. It is compelled us to think about alternative resources of energy because of the world energy crises. Some available energy sources are getting scare on the one hand other sources are going waste.

Sun is the freely available are of the internal energy sources. It is superior because of its many positive points compare to the other sources of renewable energy but it is exploited to the content it could be. The process of harvesting sun are trying to

improve by many institution of developed and developing countries. It is the great considerate on the problem that how to exploit such more extensively and efficient, for it all scientists of the world engage viewing the demand and supply of energy in the world.

In Nepal, we have got sun, wind, water and forest, these are surface resources. In the context of sun and wind resources, they are not being, exploited intensively. Water resources has been exploited to minimum extent in comparison to this supply forest resources has exploited too much form which creating the problem of soil erosion, flood and landslides in the country. In order to sustain economic growth and development, energy is one of the main inputs. But without any oil resource nuclear power, geothermal facilities and with limited capacity to tap energy form solar and wind, the two main sources of energy in Nepal are the water and forest resources.

Out of the total energy consumption 10,229 ton of oil energy equivalent in the fiscal year 2068/69 B.S., 85.16 percent was form traditional sources, 14.03 percent was from commercial source and 0.78 percent from renewable sources of energy. (Economic Survey, 2069/70)

In this context, the different source of energy and their consumption are taken according to the information taken by the respondent of Bardibas VDC ward no 4 and 9.

4.4 Sources of Energy in Bardibas VDC

The fuel wood, agriculture residue, animal dunk cake, coal petroleum product, hydroelectricity, alternative source i. e. biogas etc are the most important sources of energy which are used in practice in Bardibas.

The sources of energy in Bardibas are discussed below.

Table No. 16: Consumption of Fuel Wood in Bardibas in FY 2056/57- FY 2069/70.

FY	Fuel Wood Consumption (00 kg equivalent to oil energy)	Growth of Consumption (%)
2056/57	5941	-
2057/58	6068	2.14
2058/59	6315	4.07
2059/60	6151	-2.60
2060/61	6591	7.15
2061/62	6733	2.15
2062/63	7632	13.35
2063/64	8123	6.43
2064/65	9112	12.17
2065/66	9388	3.02
2066/67	9876	5.19
2067/68	10155	2.82
2068/69	10229	0.72
2069/70	10317	0.86

Source: Economic survey, 2014

The above given table has shown clearly that deforestation is increasing in this area day by day. The fuel wood sources which is collected directly from the forest reflecting an opportunity last of only time spend on collection and no direct monetary cost involved, was naturally popular among the rural population . The higher rate of fuel wood consumption is directly related to the forest damaged.

Analyzing the above given data, the fuel wood consumption is increasing year by year and maximum consumption reached 10317 kg equivalent to oil energy . The declining pattern of the fuel wood consumption has been seen in the fiscal year 2059/60 in comparison to the previous year. After that it is continuous towards the increasing pattern till the fiscal year 2066/67 and the rate of the increasing pattern start to decline in the declining rate as 0.72.The consumption of fuel wood leads to deforestation. And the alarming pattern in the consumption of the fuel wood leads to the declining of the environment and destroy the beauty of the nature. So, for the protection of the forest and to minimize the dependency rate on the fuel wood, biogas

will play the vital role. There are other causes to decline the forest. Consumption of fuel wood is one cause.

4.4.2 Petroleum Product

Another important and expensive but popular source of energy in Bardibas VDC is petroleum product.

Table No. 4.18: Import of Petroleum Product

FY	Petrol	Diesel	Kerosene	LPG	Total
2060/61	165	344	427	42	978
2061/62	254	443	313	60	1070
2062/63	314	558	244	118	1234
2063/64	256	463	207	172	1098
2064/65	342	706	355	251	1654
2065/66	469	768	526	458	2221
2066/67	622	612	557	771	2562
2067/68	764	655	494	928	2841
2068/69	748	513	418	1014	2693
2069/70	799	589	402	1088	2878

Source: Field survey, 2014

The above table shows the import of petroleum products for fulfilling energy problem commercially. The consumption of petroleum products are being increased but declined during FY 062/63 to FY 2063/64 which is shown in the table. Beside this pattern, the import of the petroleum product has been increasing in the increasing rate and the boom condition has been seen in the fiscal year 2069/70 which is 2878l. Due to the population growth and the changing demand of the time and the increasing facilities in the daily life of the people, this type of situation is shown in this area. Because of the urbanization, the import of products has been increasing every year. When urbanization increases then increase in road construction, increase in vehicle numbers, increase in air traffic and gradual replacement on fuel woods by kerosene, this make the raise in the demand of petroleum product. Among it the demand of the petrol and diesel is in dominating pattern.

4.4.3. Hydroelectricity

Electricity generate in this region is limited only to the biogas and solar and the hydroelectricity is limited in the certain places.

Table No. 4.19: Consumption of Electricity by Different Sectors

(Hundred Kilowatt in Hour)

FY	Households	Industrial	Commercial	Exports	Other	Total
2060/61	676.40	689.80	108.10	141.20	196.70	1812.2
2061/62	658.20	764.00	109.30	110.70	222.20	1964.4
2062/63	805.70	785.60	120.30	96.60	224.40	2032.6
2063/64	893.30	849.10	141.70	76.90	292.10	2253.10
2064/65	931.35	901.09	154.40	60.38	263.40	2310.62
2065/66	908.67	845.68	146.29	46.38	257.57	2204.59
2066/67	1109.29	1008.37	193.12	74.48	292.57	2677.83
2067/68	1143.18	1012.87	204.92	31.10	294.92	2686.99
2068/69	1311.07	1192.06	227.06	50.00	384.50	3164.69
2069/70	1388.05	1255.26	312.06	62.03	396.32	3413.72

Source: Field Survey 2014

This table shows electricity consumption in various sectors. The electricity consumed by household is increasing in each fiscal year and reached to 1388.05 hundred kilowatt in FY 2069/70. It is nearly similar to electricity consumed by industrial sector which is 1255.26 hundred kilowatt in same fiscal year. The total consumption including commercial, exports, others is also increasing.

The total potentiality of electric generation is 83,000 mw in Nepal. Only 42,000 mw is physical potentiality of electricity generation in Nepal. Only 705.6 mw hydroelectricity was generated till FY 2068/69. This type of the pattern shows the increasing demand of the electricity and the pitiable condition of the electricity generating. Due to the huge capacity of the hydro electricity, Nepal is not success to utilize the minimum capacity of it and to fulfill the demand of the people. So, its impact is seen in this VDC and the local people of this are facing the problems of the load shedding. It is being necessary to search for the alternative source of the energy to fulfill such kinds of crisis. Biogas seems to be the best solution to overcome this problem.

Table No. 4.20: Consumption of Coal and Animal Dung Cake.

FY	Consumption of Coal	Consumption of the Dung Cake
2060/61	171	486
2061/62	152	497
2062/63	243	507
2063/64	144	518
2064/65	193	529
2065/66	182	540
2066/67	286	551
2067/68	293	563
2068/69	348	575
2069/70	355	586

Source: Economic Survey, 2014

This table shows the consumption of coal and the animal dung cake of this VDC. Similarly, the main source of energy is coal in this area. This table shows coal consumption in various fiscal years. The maximum consumption of coal was 355 kg equivalent oil energy in fiscal year 2069/70. Then it was reduced in FY 2061/62 and FY 2063/64 reached to 152 and 144 kg equivalent oil energy. The 24.23 percentage was occupied by coal consumption out of total commercial energy consumption in FY 2068/69. Another important source of energy is Agriculture residue in this VDC. Agriculture residue is natural source of energy. The contribution of agriculture residue in natural energy consumption was 4.23 percent in FY 2068/69. Rice Husk, rice straw, Rice bran, Maize cobs, maize straw, wheat straw, jute stick etc. are used as sources of energy. Animal dung cake is also source of energy. The 6.6 percentage of energy was fulfilled by animal Dung cake out of total natural energy consumption in FY 2068/69. It is the traditional source of energy, which is very much popular in the terai region. This animal dung cake is recognized in the terai belt than hill, in certain areas of hill these sources are not used at all. The amount of dung production depends on the type of livestock and its feeding pattern. This table shows the trend of animal dung cake consumption as energy. The maximum consumption of dung cake was 586 equivalents to oil energy in FY 2069/70. The consumption of dung cake is in increasing trend. Due to the increasing pattern of the consumption of the animal dung

cake, it helps to minimize the consumption of the fuel wood and protect the environment.

The animal dung cake is achieved from the livestock. The availability of livestock is shown in given table.

Table No. 4.23: Population of Livestock from FY 2067/68 to 2069/70 in Bardibas VDC

Cattle's	2067/68	2068/69	2069/70
OX	508	750	873
Buffalo	354	365	506
Sheep	01	00	00
Goat	1172	1440	1842
Pig	858	846	915
Hen	4037	3062	4103
Total	6930	6463	8239

Source: Field Survey 2014

This table shows the sources of animal dung cake. Total population of animals including cattle's, buffaloes, goats, cows, sheep and hens are shown in the above table from the fiscal year 2067/68 to 2069/70. As the total number of the cattle's is increasing from one fiscal year to another and in the fiscal year 2069/670 it is reached to 8239.

4.4.6 Alternative Sources of Energy in Bardibas VDC

Since a long time back many efforts have been made to search for the appropriate alternative technology in this region, viewing the acute situation of the energy rises and in order to stabilize the BOP of the economy, many efforts and attempts have been made in order to control the high pressure on forest resources development of alternative sources are still in very preliminary stage. From the biogas plants the most

satisfactory performance is being attained but it has not reached at a level as it could save fuel wood, petroleum products hydroelectricity, coal at a national level. Initially, it was through to convince to the rural people to use up their manure fertilizer in the biogas plants, the development has reached up to the total installation of 190 biogas plants in FY 2069/70 and 38 biogas plants in first eight month of FY 2069/70.

Similarly, the main effort and the policy made by the VDC and the civil society of this area in the field of the alternative sources of the energy are rural energy source, renewable energy source and the three planning. In these polices, it has given emphasizes to utilize and promote the available fresh resources of this area. It is aim that within the 20 years to increase the percent of the consumption of alternative sources as 10 percent among the total energy sources. Till now 14 percent of the population is fascinated by the alternative energy sources among the total population of this VDC which is nearly thirty two thousand.

Though not in large scale, this technology does to some extent help to conserve the valuable forest resources. As far as solar energy is concerned, this is very favorable situated because it lies on the belt of 260 north latitude and 800 east longitude, where the solar energy rests the highest on the horizontal plain, the prospect of developing this source seems feasible but due to the very sophisticated technology and high cost, the development of this resources has not accelerated to the expectation, The consumption of solar energy is very low owing to technical difficulties however since 1970 A.D. Solar heater have come in use in cities and some rural areas.

Wind energy is very fluctuating source, has not been in an extensive use as well. In this context the biogas plays vital role on the energy side because it is continuous source as we provide animal dung. So among the various alternative sources of energy, bio-gas is important in Nepal.

By comparing the different sources of the energy and its present status, we can easily conclude that the use of biogas is inevitable and more effective according to the available resources and the condition of this VDC. As well as it is important to protect and promote the environment.

Economic Importance of Biogas

There are a number of benefits both socio-economic as well as environmental, of using biogas as an energy source rather than other traditional and commercial energy

sources. However here only those benefits or importance relating to the use of biogas have been elaborated.

Biogas is an organic product mainly obtained from cattle manure and in exception with combination of latrine. It is a marsh gas. This gas is principally composed of methane, carbon dioxide, hydrogen and nitrogen. It is virtually colorless and invisible in bright day light. It produces more heat than kerosene, wood, charcoal, cow- dung, chip etc.

The most important production for the biogas plant is slurry, which is rich of nutrient as compare to dung and it is color less and attracts no insects which can be used a excellent organic manure in the field, thus, increasing the crop yield, it raises agricultural production. It seems money because it is the substitution of chemical fertilizer.

Biogas saves the money which we divide to buy the kerosene and it also fulfills the necessary of lighting purpose which we have to pay higher bill to the electricity office. Kerosene is an import commodity its reduction also contributes in reducing the foreign exchange out flows.

Biogas gives the priority to the livestock, the dung we use in the biogas plans but other meat, milk etc. which are rich sources of protein, form this farmers earn a lot of money. By the livestock we can use marginal agricultural land to make it more productive and economically efficient.

Biogas checks the deforestation then we use produced timber for other purposes. Jungles do not only give us timber but raw materials for the paper factory, and herb factory. The indirect benefits of forest preservation are checking the flood, landslides and raising the sources of water. The decrease in fuel wood consumption due to its substitution by biogas stoves has threefold benefit. Firstly at individual s it has financial gives to the households as they can save money, which otherwise they would have to spend in purchasing the fuel wood. Similarly, the substitution of fuel wood by biogas also saves time and effort required on fuel wood collection, which is some cases could even be many hours of daily work. Secondly, at national level the decrease in the use of fuel wood also contributes to same extent in reducing the prevailing high rate of deforestation of the country thereby increasing the carbon bank. Thirdly, global scale it contributes significantly in reducing the prevailing high rate of deforestation of the country thereby increasing the carbon bank. Thirdly, global scale it contributes significantly in reducing the greenhouse gases since the

global warming commitment (GWC) of fuel wood is much higher and compared to biogas stoves. Sharing fuel wood means saving forests, which plays very important role in the carbon dioxide balance of any vegetation.

The bio-gas plants reduce the carbon emission in atmosphere generating biogas. A single biogas plant reduces five ton carbon dioxide gas mixing in the atmosphere which can be sold in developed nations. The cost of one ton carbon dioxide gas is $5 in the international market which can be obtained by World Bank.

Bio-gas saves the money which we pay for the import of coal from foreign countries. It saves loss of foreign currencies.

In summary we can say by slurry we may raise agriculture production, it saves the money which we divide to spend to buy kerosene, coal, chemical fertilizer, cheeks the deforestation, gives the priority for livestock, red marks in improving the economic condition and to preserve the environment and creates the employment opportunities and saves the time. Hence, economically biogas plants have vital role to this VDC.

CHAPTER VI

MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Major Findings

This study covers the impact of bio gas project on health, education and preservation of forest as well as alternative uses in different sectors of the people in Bardibas VDC of Mahottari district. As per objective, this study tries to assess the impact of biogas project on education and health by comparing two groups, case group which use bio gas and control group which has not assess of bio gas. The respondent from the case group, 30 sample has been selected and 60 sample has been selected from biogas not assess group (control). The questionnaire has design to evaluate the impact of biogas project on alternative uses of biogas and improvement on health of the local people. The questionnaire is divided in different sections and tried to observe the information related to objectives.

The results shows that there is positive impact on the alternative uses of bio gas in different sectors like: agriculture, preservation of fuel and environment, electricity and education, development and economy, etc, and impact on the health of the people which shows that more number of people were satisfy and respond as the positive impact of biogas project in case group in comparison to control group.

Bio gas project has a bit impact on enhancement of health status and awareness on agriculture and forest conservation of people lives in Bardibas VDC partially. People gain lighting facilities which helps to increase study more and which helps to decrease diseases by reduce indoor pollution due to the use of bio gas as cooking sources. The verdict of impact bio gas project has been accomplished below.

1. **Impact on Health**

   Biogas micro project has a positive impact on health of the people live in Bardibas VDC as well. Number of ills HHs member from respiratory diseases and eye related infections such as asthma, bronchitis, ENT Irritation , eye infection, headache etc and water borne diseases in the past one year period are found to be less in HHs that are connected with biogas project than to the HHs does not connected with bio project.

2. **Impact on Alternative Uses**

   Biogas project has brought positive impact in the life of the Bardibas VDC as it has alternatives uses; it became much beneficiary for the better improvement of the people. The people of this area are satisfied and interested in this project and statistical data has also shown the positive result as improvement in agriculture, education, health, preservation of forest ,improvement in economic etc, where most of the HHs in the case group has respond as good result in comparison to the control group.

5.2 Conclusion

This study has become the model for entire VDC and the Mahottary district for their economic development. As the main occupation of the people is agriculture, it is success to give the positive impact of bio gas as alternative sources of energy and try to preserve the environment by reducing the demand of the firewood.

5.3 Recommendations

Nepal is a beautiful country in the lap of Himalayas and having diversities in the natural, but the people living in the rural areas have been living in the dark and deteriorating the greenery of the nature. People are far from the modern equipment related to cooking and technology due to the compulsion of load shedding and low economy status. The condition becomes worse on day by day. Due to the rapid population growth the demand of electricity and deforestation is increasing in alarming way. It is the duty and responsibility of government and the people to solve this problem by launching the various kinds of strategy and policy to improve the life style of the people. Following recommendation are made on the basis of the study and analysis of the collected data.

A. Bio gas program should be oriented more towards remote area, benefiting poor farmers.

B. It is suggested to install a family sized biogas plant.

C. The farmer should be made aware of the importance of attaching biogas plants toilets not depending only on dung of cow and buffalo.

D. It is suggested to educate farmers to utilize their saved money replacing fuel wood, kerosene, in economically productive activities such as income generation.

REFERENCES

Animal Service Department (2062), *Annual Progress Report 2060/2061*,Harihar Bhawan : Lalitpur

Animal Service Department, MOAC 2062, Harihar Bhawan: Lalitpur

Bachman, A. And Saubolle. B.R 1983, *Fuel Gas from Cow Dung*,Sahayogi Prakashan:Kathmandu

Bajracharya, Prashuratna 2001, *Souvenir, Silver Jublee Issue,* Gobar Gas Tatha Krishi Yantra Bikash (p)ltd.2060, : Kathmandu

Biogas Support Progamme 2006, *Various Issues of Biogas Bulletion, Biogas Support Programme,* Lalitpur

Bista, N.K 1981, *Development of the Himalayan Resources for Regional cooperation and National Development.* CEDA: Kathmandu

BSP- Nepal 2005, *Biogas Nepal 2004, January* 2005, BSP-Nepal: Lalitpur

BSP, Nepal 2010, *Biogas Nepal 2009, January 2010, BSP-Nepal*: Lalitpur

BSP, Nepal 2011, *Biogas Nepal 2010, January 2011, BSP-Nepal:*Lalitpur

Ekta Books 2004, *Atlas Ekta Books, Ekta Publication:* Kathmandu

Kanel, Nav R. (2003), *Guidelines to Format Thesis and Dissertations,* New Hira Books Enterprises: Kirtipur.

Lang Pang 1978, *Economics of Biogas, Development and Consulting Services United Mission to Nepal:*Butwal.

Ministry of Agriculture and Co-operatives 2004, *Statistical Information On Nepalese Agriculture 2003/2004, Agro-Business Promotion and Statistics* Davison, MOAC: Kathmandu

Ministry of Finance 2061, *Economic Survey, FY 2061/2062, Ministry of Finance:* Kathmandu

National Planning commission 2004, *Tenth Five year plan* 2002-2007, Website: **www.npe.gov.np**

Nepal Oil Corporation 2061, *Nepal Oil Corporation*: Kathamandu

Poudyal, C.K.S. 1993, *'' Biogas: Essential Part of Integrated Farming System Economic Significance'', Bio-gas Bulletin, Seventeenth Anniversary Issue*, BAED (P) Ltd.: Lalitpur

Sharma, Vinek Dhar 2004, *'' Biogas and its Commercial Use'', Renewable Energy*: Kathmandu

Shrestha, Prof. Jagn Nath 22 July 2005, *'' Welcome Speech'', On Book Launching Programmed of Biogas as Renewable Source of Energy in Nepal*: *Theory and Development*, BSP-Nepal: Lalitpur

Silwal, Ramesh 2005, *'Quoto protocol' Science Future*, *Vol*. 1, *No.8,* Science for development Nepal: Lalitpur

Dhakal, Tej Prasad 2004, *Renewable Energy*, *Year- first*, issue *second*, NBPG: Kathmandu

Karki, Dr. Amrit, Shrestha, Prof. Jagan and Bajain, Sunder2005, *Biogas, As Renewable Sources of Energy Nepal Theory and Development*, BSP-Nepal: Kathmandu

Profile 2001, *Gobar Gas Tatha Krishi Yantra Vikash (p) L.*: Kathmandu

Sharma Nilam Kumar 2006, *Economic of Nepal*, *Pairabi Publication*: Kathmandu

APPENDIX

QUESTIONNAIRES

Central Department of Economics

University Campus, Kirtipur

Tribhuwan University,

Kathmandu

"SURVEY OF BIOGAS AS THE ALTERNATIVE SOURCES OF ENERGY - "A CASE STUDY OF BARDIBAS VDC - 2013"

I am Mr. Damodar KC from Central department of economics, TU, kirtipur and doing research on whether the biogas project impact socio-economically to the project surrounding people I need your support and cooperation. In the course of interview I will ask you questions. I assure that the information, which you provide for the survey will be kept confidential and will be used for the purpose of survey only.

Please select the appropriate choices in case of multiple choices or specify if necessary

1.0 General Information of Respondents

1.1	Name of Head of Family	
1.2	Caste (1=Bramhin, 2=Chhetri, 3= Janajati, 4= KDS, 5= Other	
1.3	Name of respondent	
1.4	Sex (please tick(✔) (1=Male, 2= Female)	
1.5	Religion (1=Hindu, 2= Buddhist, 3= Christian,4= muslim, 5= Other)	
1.6	VDC	
1.7	Ward no	

2.0 Demographic Information of Family Members of Respondents:

2.1 S.N.	2.2 name of family member	2.3 Sex 1=male 2=female	2.4 Age	2.5 Education*	2.6 Marital Status	2.7 Does9name still go to school)

3.0. Education *(please tick(✔) on appropriate number)		Marital status*(please tick(✔) on appropriate number)	
1. post graduate and above	1	1. Married	1
2.Graduate	2	2. unmarried	2
3. Higher secondary	3	3. Willowed	3
4. lower secondary	4	4. Divorced	4
5. Primary	5	5. Separated	5
6. Below primary	6		
7. Illiterate	7		

3.1 After electrification, do your children's study hours have been increased? (For case only)

(Please tick (✔)) a) yes b) no

If yes, how much time has been increased? (Please tick (✔)

a) Less than one hour

b) one to two hour

c) two to three hour

d) More than three hour

3.2 Has their performance in School improved?

a) Yes b) no

3.3 Have you conduct any literacy class at night? (Please tick (✔)

a) Yes b) no

If yes what type of program conduct?

a) Adult literacy class

b) Woman literacy class

c) Pre- primary class

3.4 Does any family member drop from school (please tick (✔)

a) Yes b) No

If yes what is the cause of dropout?

a) Unwillingness to study

b) Due to their job

c) Other (specify)……..

Family Member Drop out from School	
Number of family member	Drop out from which class
1.	
2.	

4.0. Family access on information technology		
4.1. How many electrical instruments do you posses? (please tick (✔)		
Instruments	Case	Control
Radio		
T.V.		
Refrigerator		
Washing machine		
Battery		
Mobile		
Computer / laptop		

4.2 How often you or any family member will listen radio or watch TV?

a) Every Day

b) Few times a week

c) Once a week

d) Less than once a weekend

e) Never

If other then what types of program do you prefer?

a) Entertainment

b) News

c) Health related

d) Educational

e) Agriculture related

f) Debate program

4.3 Do you have a mobile or telephone?

a. Yes b.noi

If no how long does it take to get nearest telephone?

a). less than 10 minutes

B.10-20 minutes

c. 30 minutes

d.30-45 minute e. one hour or more

4.4 Does your family member have access on internet and chat?

a) Yes b) no

5.0. Family access on information technology(control)	
5.1. How many electrical instruments do you posses?	
Instruments	(multiple choices yes or no) (please tick (✔)
Radio TV Refrigerator Washing machine Computer / Laptop Battery	

5.2 Do you listen health program in radio or TV?

a) Yes b.) No

5.3 Do you have mobile or telephone?

a) Yes b.)No

If no, how long does it take to get nearest telephone?

a) Less than 10 minutes

b) 10-20 minutes

c) 30 minutes

d) 30-45 minutes

e) one hour or more

5.4 Does your family member have access on internet and chat?

a) Yes b) no

6.0- Health

6.1 Did any of family members suffered from any illness in past one year?

a) Yes b) no

6.2 If yes refer diseases

a Asthma

b. Bronchitis

c) ENT irritation

d) Eye infection f) Other, Specify.....

6.3 Source of Drinking Water and Distance:

Source	Well	Spring	Water taps	Stream
Time (in Minute)				

6.4 Did any of your family suffered from water borne disease (typhoid, Diarrhea, cholera etc.) in past one year?

a) Yes b) No

6.5 Does your family have a toilet do you have?

a. Yes b. No

If yes, where they were treated

a) At home by local herbs

b) Health post medicine

c) At doctor

6.7 Did any child birth on your family in past one year? Please tick (✔)

a. Yes b. No

If yes where she gave birth?

a. Home

b. Hospital

6.8 Does any family member dead in the last one year (please tick? (✔)

a) Yes b) No

If yes,

Age	Cause of death

6.9 How often your family member listen health program on radio or TV? (Please tick (✔)

a) Everyday

b) Few days in a week

c) Once a week d) Never

7. Entrepreneurship

7.1 Do you have on any kind of business before the biogas project? (Please tick (✔)

a) Yes b) No

If yes, what kind of business:

.....

7.2 Do you invest on any kind of business after the biogas project? (Please tick (✔)

a) Yes b) No

If yes, what kind of business?

.....

7.3 Do you have any kind of productive work? (Please tick (✔)

a) Saw mill

b) Rice mill

c) Poultry firm

d) Oil expeller

e) Other (specify).....

7.4 Did you find that after the involving on productive work it help to increase your income level?

a) Yes b) No

c) To some extent

d) Difficult to say

If yes, how much Rs.....

8.0 Household information (control)

8.1 What did you use for agro- processing? (Please tick (✔)

a) Jato

b) Dhiki

c) Ghatta

d) Other

8.2 What is your main source of energy? (Please tick (✔)

a) Firewood

b) Kerosene

c) Bio gas

d) LP gas

e) Animal dung

f) From electricity

g) Other (specify).....

If firewood, how much required in one month?

..... (bhari) (Four bhari = 1 quintal)

If kerosene, please specify the quantity, cost and time.

Quantity in liters	Per lit. price	Total cost(in Rs)	Time(min, hour)

8.3 What is the main source of light? (Please tick (✔)

a) Kerosene

b) Animal dung

c) Biogas

d) Other (specify).....

9.0 Household information (case)

9.1 What is your main source of energy after the installation of the biogas? (Please tick (✔)

a) Firewood

b) Kerosene

c) Biogas

d) LP gas

e) Animal dung

f) From electricity

g) Other (specify)

9.2 What is the main source of light? (Please tick (✔))

a) Kerosene

b) Electricity

c) Bio gas

d) Other (specify).....

If biogas, how many bulbs in your house.....