SOCIO-ECONOMIC IMPACT OF BIO-GAS ON USER

(A Case Study of Hungi VDC of Palpa District)

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Submitted By:

Arjun Prasad Dumre

Roll No. 222/068

T.U. Regd. No. 6-1-49-93-2006

Central Department of Economics,

Tribhuvan University, Kirtipur,

Kathmandu, Nepal

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RECOMMENDATION LETTER

The thesis entitled **SOCIO-ECONOMIC IMPACT OF BIO-GAS ON USER** (**A Case Study of Hungi VDC of Palpa District)** has been prepared by Mr. Arjun Prasad Dumre under my guidance and supervision. I hereby recommend this thesis for examination by the Thesis Committee as a partial fulfilment of the requirements for the Degree of Master of Arts in Economics.

……

Prof. Dr. Sohan Kumar Karna

Central Department of Economics

Kirtipur, Kathmandu, Nepal

Date: 2075/05/01 B.S.

August 17, 2018 A.D.

APPROVAL LETTER

The thesis entitled **SOCIO-ECONOMIC IMPACT OF BIO-GAS ON USER (A Case Study of Hungi VDC of Palpa District)** submitted by Arjun Prasad Dumre has been evaluated and accepted as a partial fulfillment of the requirements for the Degree of Master of Arts in Economics by evaluation committee comprised of:

Evaluation Committee:

……

Prof. Dr. Kushum Shakya

(Head of the Department)

……..……

Prof. Dr. Ram Prasad Gyawali

(External Examiner)

……..……

Prof. Dr. Sohan Kumar Karna

(Thesis Supervisor)

Date: 2075/05/18 B.S.

September 03, 2018 A.D.

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September 2018 Arjun Prasad Dumre

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS/ACRONYMS

ADB/N	-	Agriculture Development Bank Nepal
AEPC	-	Alternative Energy Promotion Center
BDC	-	Biogas Development Committee
BSP	-	Biogas Support Program
CBS	-	Central Bureau of Statistics
CDM	-	Clean Development Mechanism
CES	-	Centre for Energy studies
CER	-	Certified Emission Reduction
CO2	-	Carbon Dioxide
CRT	-	Centre for Rural Technology
DCS	-	Development and Consulting Services
FCN	-	Fuel Corporation of Nepal
GDP	-	Gross Domestic Product
GGC	-	Gobar Gas Company
GON	-	Government of Nepal
HMG/N	-	His Majesty Government of Nepal
IOE	-	Institute of Engineering
LPG	-	Liquefied Petroleum Gas
MOF	-	Ministry of Finance
MOST	-	Ministry of Science and Technology
MW	-	Mega Watt
NBPG	-	Nepal Bio-Gas Promotion Group
NPC	-	National Planning Commission
RET	-	Renewable Energy Technology
VDC	-	Village Development Committee
WECS	-	Water and Energy Commission Secretariat

CHAPTER ONE

INTRODUCTION

Nepal is primarily an agricultural country with about 27 million population out of which 81.39 percent population resides in rural area and agriculture employs 76% of the workforce (CBS, 2011). The number of the households with cattle of Buffaloes in Nepal was estimated to by 2.7 million in 2001 (BSP, 2004). Based on this, the technical potentiality at Bio-gas plants installation is assumed to be around 1.9 million. By the end of Oct 31, 2009, a total number of 200,000 plants were installed under BSP (BSP, 2008). Fuel wood has been and still is the major source of fuel daily used by rural mass in Nepal. This total dependence on fuel wood as the source of energy for cooking has resulted in deterioration of the quality and quantity of forests and posed a serious threat in maintaining ecological balance, thereby manifesting various problems like deforestation, flood, global warming, soil erosion, landslides, climate change etc. The pressure on forest resource for energy fulfillment is considerably increasing due to high population growth in rural areas causing scarcity of fuel wood for cooking. As a consequence, many people in the rural areas are burning livestock dung and other agricultural residue. This has been one of the factors in deterioration of environment and soil fertility in the country.

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

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

biomass fuel, biogas technology has been the best alternative energy solution, which could be achieved through the active mobilization and economic utilization of local indigenous resources available in the country.

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. It is mainly composed of 60-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It is about 20 percent lighter than air. It is an odorless gas that burns with clean blue flame similar to that of LPG gas.

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

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

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

The biogas project has a number of benefits to rural households along with reducing greenhouse gas emissions. Besides carbon revenue, availability of organic fertilizer, time saving on daily household works, improvement in sanitation and health, cleanliness in and around the house, environmental protection, employment generation etc the feasibility of producing electricity from biogas as well as the slurry for animal feed is being examined. Thus, given a government favorable policy, the combined efforts of private sectors, the Biogas Company, the Agricultural Development Bank of Nepal and the united mission to Nepal could contribute significantly to the development of biogas in Nepal.

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

1.1 General Background of the Study

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

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

About 90 % of total energy demand is met through firewood, agricultural residue and animal wastes (dung burning) resulting to forest/environmental exploitation, deprivation of organic matter to agricultural land, irreversible loss of soil fertility as well as health and environment thrashing (WECS, 1994). The increasing population is progressively more using the forest resources beyond its regeneration capacity thus forcing to ecological consequences in terms of soil erosion, floods and loss of precious top soil. Experts are of the opinion that continuous deforestation at this rate (Approx. 2%) will lead to almost exhaustion of the forest in near future unless major efforts on conservation and reforestation are made. So it has been so much urgent to seek for an alternate source of energy which can provide the energy demand of the country (particularly rural area) without the exploitation of the natural resource and which could be very much affordable for the rural people.

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

Bio-gas has steadily becoming one of the most trusted and popular alternative sources of energy, particularly in rural Nepal. Besides cooking and lighting purposes, it more often has other indirect benefits as well. The digested slurry coming out of the biogas plant has more nutrition value more than the traditional farmyard manure, which ultimately enhances the production of crops. The installation process also helps in creation of job.

Opportunity for skilled and semi-skilled human resources. The time elapsed on collection of fuel wood or making dung cakes will definitely be cut down very highly through the biogas and the spare time could well be used on other productive, beneficial and income generating activities. Furthermore with ample subsidy around the country for biogas

installation, it comes to be cheap for the customers and on the other hand it is very much a user-friendly technology.

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

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

Biogas is the mixture of gas produced by methanol bacteria while acting upon biodegradable materials like cattle dung, human excreta and other organic wastes in an anaerobic condition within the temperature of 26 to 36 degree Celsius for a certain period. It is mainly composed of 60 to 70 percentage of methane, 30 to 40 percentage of carbon dioxide and some other gases (BSP, 2003). Biogas is 20 % lighter than air which is colorless, odorless and smokeless that burns with clear blue flame similar to that of LPG. Biogas technology was first initiated in Nepal in the mid-1950s by Father B. R. Saubolle, a Belgian teacher at Godavari St. Xavier's School who constructed a micro model digester out of an oil drum. Only a few farmers were interested in biogas technology and they installed a few bio gas plants after 1967 under the design of Khadi and Village Industry Commission (KVIC) model of India. The biogas was given priority as an alternative energy

sector during the seventh five year plan (BSP). In 1992, “Biogas Support Program” was introduced at three different stages for massive dissemination of technology in the country with the long term objectives of reducing deforestation and environmental deterioration, improving health and sanitation of rural population especially women and increasing the agricultural productivity by promoting the use of digested slurry. It has successfully completed its third phase in June 2003 and have stated fourth phase from July 2004.

For networking at the central level policy making and promoting the alternative energy technology HMG/N has set up an Alternative Energy Promotion Center under the Ministry of Science and Technology in 1996. At present there are many private companies working for the extension of Biogas technology under BSP, SNV/N. There are 44 recognized biogas companies, 13 biogas appliances workshops and 60 micro finance institutions working in different districts. The biogas program has been launched in 65 districts to the till date (BSP, 2004).

In Hungi VDC biogas plants has been under operation since last 10 years. It has been very much popular and appreciated and acquired by lots of households for their energy supply. This research study is designed to examine the socio economic impact of biogas in Hungi VDC, of Palpa district.

1.2 Statement of the Problem

Nepal is a technology traditional and background country as regard to the energy issue of the fuel. Energy sector is the back bone of the country. Nepal has been facing energy problems such as high price of petroleum fuel and high rate of depletion of the forest resources using fire wood causes discriminate destruction of the forest wealth. Forest area of Nepal is decreasing at the rate of 1.7 percent annum. If the forest decline rate is not control after 27.30 year Nepal may be changed into desertification. It is well known that the deforestations results into natural climates, such as lands slide, floods, land erosion etc.

Fire wood has been the most common and traditional sources of energy for Nepal. Firewood represent about three forth (75.78%) of the total energy consumption which are

mainly consumed in the rural Nepal. A great part of this is consumed is residential sectors for cooking purpose.

Hence, in order to solve the energy problem of remote area of Nepal, a fast easily implemented, cost efficient, small scale, completely decentralized renewable alternative which is technically feasible and economically viable has to promoted. Biogas, in this context is well realized to be most alternative and useful energy sources.

Most of the rural people use traditional sources of energy such as cow dung, firewood, agricultural residue etc. by the use of this kitchen room and vessels always are dark and dirty. Health of the family member especially of women is affected by the smoke and there overage living year is being diminished and education of children is also being influence by the use of traditional fuel. Firewood collection consumes more time expenditure and ultimately produces ill health. There for people bound to live always poor condition sociality, culturally economically and environmentally. That's why biogas is the only one solution for these problems.

There may be one or more reason as mentioned above in a specific area for slow adoption of technology. This study focus on to solve of these questions:

- What is the socio economic condition of biogas households in Hungi V.D.C of Palpa District?
- What are the impacts of biogas users after the adaptation of biogas technology especially in the field of environment, health, sanitation and gender issue?
- What are the problems being faced by biogas users after the adaption of biogas technology?

1.3 Objectives of the Study

The general objective of the study is to assess the socio-economic impact of biogas on its users. The specific objectives of the study are:

- To analyze the socio-economic condition of biogas users.
- To examine the impact of biogas in relation to energy, health, sanitation and gender issue.
- To study the problems being faced by biogas users after the adaptation of biogas technology.

1.4 Significance of the Study

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

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

So this study is going to be carried out hoping that it will be helpful for the implementing agencies in the formulation of plans and policy makers to formulate appropriate plans for further development to gain the economic achievement. To the end the finding of the study will definitely help the related people to decide about the installation of biogas as well as it the study will be important to find out the changes in immense status and economic activities of the users in the study area.

1.5 Limitation of the Study

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

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

1.6 Organization of the Study

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

CHAPTER-2

LITERATURE REVIEW

In this chapter research paper, booklets, bulletin published in the subject of these publication, information are available at national and international context. This chapter consists of conceptual review of the related literature as well as empirical review, especially international and Nepalese context.

2.1 Conceptual and Theoretical Review

Energy is critical component of the development process. It is needed in all such major sphere of life which are directly connected with man's survival and progress such as in cooking, lighting, heating etc. Due to population growth, the demand for energy is increasing day by day in the country. Major share of energy consumption is met through traditional sources. The renewable energy sources are to be developed and biogas energy promotion will be a significant one to struggle for improving this condition. The per capital energy consumption in Nepal is very low (14.6 GJ) and most of the energy is being used for domestic purpose. In Nepal, the sources of energy are primary conventional. Therefore the dependency on forest for energy in Nepal is very high and forest are being used beyond their capacity causing deforestation and environmental degradation. Due to many constraints of technology, finance, politics and many other, the country has failed to create a favorable environment to harness the high potential of water resource and other as well.

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

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

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

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

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

Energy has become the backbone of the people in modern society. Nepal has been facing energy problem of fossil fuel and depletion of forest resources. Non-conventional energy like solar, wind, water power are not utilized property in Nepal. High rate of using fuel wood invites natural disaster such as flood, land slide, soil erosion, deforestation and ozone layer depletion. 70% percent people still use firewood as a main source of fuel. Therefore, destruction of forest is increasing every day. If develop the biogas technology, then demand

of petroleum product will be reduce and foreign exchange may be saved. Adaptation of biogas technology helps to raise the agriculture production in Nepal. Slurry of it is very useful for fertilizer.

The construction cost of biogas plant should be minimized to benefit mass of the people. The government had targeted to install 2,50,000 biogas plants during the tenth five years plan period with the assistance of Netherlands Development Organization (SNV Nepal) and co-financing from the Kreditamstall Fur Wewideranfban (KFW), a development bank of German. For the promotion of biogas, HMG/N has been providing subsides based on geographical region. For the hill region the sum of subsidy is Rs. 8,000, 11,000 for mountain and 5,000 for Terai for up to ($4m^3$ to $6m^3$ to $10m^3$) respectively (BSP,2004).

Biogas plant is a tank which has the concrete inlet and outlet basins. Fresh cattle dong is deposited into a charge pit which leads into the digestion tank and remains there. After laps of time depending upon ambient temperature sufficient amount of biogas is accumulated in gas tank which is used by household on various purpose. Digested sludge is removed from the outlet basin and is used as fertilizer. The waste materials of plant and animal origins consists carbohydrates, lipids, proteins and small amounts of metabolites which are insoluble in water. If these materials are incubated in an aerobic condition, a combustible das is produce by the action of bacteria known as methane gas.

May products, byproduct and intermediates are produced in the anaerobic digestion process input materials before the final product is produced. Different species of methanogens are involved in breakdown of complex organic matter into acetate acids which is one of the substrates of methanogenic bacteria and Hydrogen with CO2 is a general substrate from methanogenesis. Generally the biogas energy is used on the purpose of cooking, lighting and boiling water instead of fuel wood, LP gas, kerosene and electricity (WECS, 2010).

2.2 Review of Previous Studies

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

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

Chalise (1998) has written that the animal population Nepal is theoretically sufficient to provide biogas energy forever 6 million people, if people well collect cattle dung and co-ordinate in community biogas production. The major environmental problem of Nepal could be identified as deforestation and soil erosion.

Karmacharya (1992) has shown the comparative analysis of installation of biogas plant under the hill and Terai context. Dhobigat village at Bhaktapur district of hill side and fulmar village of Chitwan district for Terai side are chosen each side consisting of 25 samples.

The study has taken economic approach and the analysis is focused on the various types of benefits obtained and saving made through the installation of biogas plant. Energy situation in global and Nepalese context has been seen in detailed.

No significant differences of impacts were noticed between hills and Terai. However, same noticed differences include.

- Lamp use pattern was zero in Terai but 27% in the hill.
- Gas production was less in hills.
- Use of slurry as fertilizer was low in hill.

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

resulted in increased agricultural productivity, which has resulted into monetary gains for them.

Nepal (2001) has carried out the study of the impact of biogas on users and also taken non-biogas household for the study; Syanja, Nuwakot, Chitwan and Morang districts were taken as the study area representing high hills, mid hills and Terai region of the country.

The outcomes of this study have shown that the whole quantity of dung produced is not collected by the biogas users and collected amount is not entirely fed into the plant which reduced the plant efficiency. However, the plant efficiency was found to be increased with the latrine attachment. This study has also shown comparatively greater benefits to biogas users that non biogas household with regarded to cooking food because of time saved. Similarly the total saving of kerosene was significant (2.7 liters per years per household). However, than seemed to specific correlation between average use of firewood and kerosene and the family size.

BSP (2005) has discussed the mixture of gas produced by methanogenic bacteria while acting upon hide gradable materials in an anaerobic condition. It is mainly compassed of 60-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It burns with clear blue flame similar to that of LPG.

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

Adhikari (1996) has evaluated both positive and negative impacts of bio-gas. The positive impacts on health were most significantly reduction on eye diseases, headache, coughing and throat ache. The negative impacts of bio-gas were increased prevalence of mosquito

and loss of warmth in house in winter, sanitation conditions and practices were improved and the study reported 62 percent reduction in firewood collection.

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

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

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

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

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

MOPE (2003) has indicated that in production of biogas has impact on the control of enough, symptomatic eye infection and incidence of dysentery and tapeworm infection. Besides there were also indicated that the demand of fuel woods and kerosene were decreased significantly. Though many efforts were practiced energy sector has received high priority since the eighth five years plan. For the promotion of biogas following the establishment of SNV/BSP, the government adopted a subsidy policy and aimed at commissioning 30000 palnts. The ninth five year plan has formulated the 20 year long term

renewable energy as a strong mechanism for poverty alleviation. It has fixed a target of planning 2000000 biogas plants (195500 in household level and 500 in community level).

With the significance of energy on national development, the government formulated the following policies for the rural energy development.

- Improving pricing policy, market management and quality energy.
- Promoting proven technology.
- Implementing area based development program in the areas with no national grid.
- Carrying out search and development.
- Linking up alternative energy technology with rural development program.
- Establishing rural energy development fund.
- Establishing Energy Park.
- Extension of financially viable energy technology.
- Involving INGOS and private.
- Reducing firewood consumption.

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

Economic analysis which is not done in the case, this study has only deal with the general impact of biogas plant on the users. In general biogas plant are found to have positive impact on the users which is well appreciated them. The total time have saving 1-22 hour/day/family on an average from the installation of biogas plant. The plant owners suggest that it has been successful to lower the family workload.

Karki (2001) has focused the study in Dhading district. The study was mainly focused on the adaptation of renewable energy technology and its impact on income generating

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

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

Guragain (2017) carried out the study on Economic Impact of Biogas Plant in Budhabare VDC, Jhapa. This study was undertaken to analyze the economic impact of biogas plants. Descriptive method was used for the study. Information was collected from field survey whereas 40 samples of biogas households were taken from whole population. Questionnaire, interview and observation were used as main tools for the study. The main findings of the research are as follows: a) There is a considerable reduction in the workload of the family members especially women; b) A significant amount of time has been saved and the saved time (40%) has been used mostly in agricultural activities; c) Most of the households have latrine facility (95%); d) Most of the people (95 %) realized the reduction in the effect of diseases like respiratory problems, headache, burning, coughing, eye problem etc; e) About 9 bharis of firewood per home was found to be saved per month after the installation of biogas, where 1 bhari costs 100 Rupees. Similarly an average hour of 4.57 per day per household was noted to be saved.

2.3 Research Gap

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

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

CHAPTER THREE

RESEARCH METHODOLOGY

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

3.1 Research Design

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

3.2 Selection of the Study Area

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

Hungi VDC is one of the 66 VDC's of Palpa district. It is located in the eastern part of this district. It is bound by Syangja district to the north, Heklang VDC to the east, Pipaldanda VDC to the west and Foksingkot VDC to the south. The study area lies in the Hill region of the western Nepal. As per the National Population and Housing Census 2011, the total population of the village stands at 4,579, with a male population of 1933 and a female population of 2646.

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

3.3 Rationale of the Site Selection

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

3.4 Nature and Sources of Data Collection

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

secondary data and information was collected from various published/unpublished articles and reports.

3.5 Sampling Procedure

The targeted people of the study were the biogas user households of Hungi VDC of Palpa district. Out of 160 households having the biogas plant, 40 of those households were selected. The total 160 biogas households has been taken as the universe and simple random sampling technique (lottery method) was followed for the selection of samples.

3.5.1 Sample Design

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

3.5.2 Sample Size

Hungi VDC in Palpa district has been divided into several (9) wards. But the present study has been concentrated only on ward no. 1, 2 and 3 of this VDC. These wards are the main area for biogas plants in this VDC. There are altogether 160 biogas plants in Hungi VDC. Out of 160 biogas plant, 42 biogas plants are in ward no.1, 38 biogas plants are in ward no.2 and 20 in ward no. 2 and 12, 10, 8, 15, 6, 9, biogas plants are in ward no. 4,5,6,7,8,9 respectively (VDC Profile).

Out of the total households having biogas plant of Hungi VDC of Palpa district at ward 1, 2 and 3, only 40 samples biogas plant have been selected by using simple random sampling technique (lottery method).

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

3.6 Data Collection Techniques and Tools

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

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

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

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

3.7 Procedure of Data Collection

3.7.1 Primary Data

The study has been based on primary and secondary data. Questionnaire sheets were used for collecting primary data. The survey was carried out in March 2018. Two methods were used to collect the primary data, which were explained above. Before conducting the survey, we carried out the following steps: first, sample size was decided for the selected wards; second, sampling frame was constructed with the help of Village Development Committee report and other similar types of research; third, for each ward, samples were

selected purposively; fourth, questionnaire was pretested and revised; and finally, the revised questionnaire was directly administered to the respondent household. The chief merit of direct oral interview is that it makes crosschecking possible while the demerit is that there may be biasness from the interviewer.

3.7.1.1 Household Survey

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

3.7.1.2 Focus Group Discussion

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

3.7.2 Secondary Data

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

3.8 Validity and Reliability

As both primary and secondary sources are considered for the study, the validity of secondary sources of data are assumed to be more static compared to primary source of data. Published journals, articles, books and magazines, validated websites are some of the

sources of secondary data, thus, as these sources are authenticated by the publishers, the data and sources of information are considered to be valid and can be trusted upon. On the other hand, as the key primary sources of data are questionnaire and interview, the data validity may be affected by the degree of consciousness of the respondents on the subject and their degree of zeal in the subject matter.

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

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

The chapter attempts to analyze the collected data and information for pursuing objectives of study and deriving the major finding for the study. First of all, it presents a brief introduction of Palpa District Hungi VDC with demographic features.

It also includes the economic impacts for bio-gas users and beneficiary aspects.

Hungi is a VDC situated in Palpa district, Lumbinii Zone, Nepal. With the total area of 22 sq. km, Hungi VDC is located in the eastern part of this district. It is bound by Syangja district to the north, Heklang VDC to the east, Pipaldanda VDC to the west, and Foksingkot VDC to the south. The study area lies in the Hill region of the western Nepal. As per the National Population and Housing Census 2011, the total population of the village stands at 4579, with a male population of 1,933 and a female population of 2,646.

The people in Hungi VDC have some access to the forest resource. Out of total 1081 households out of which 160 households have bio-gas plant.

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

4.1 Bio-gas Users in Hungi VDC

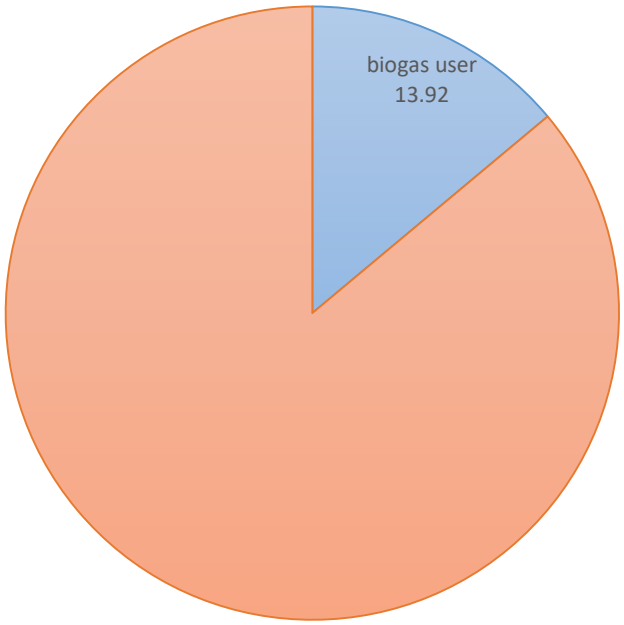
Hungi is known as rural facilitated VDC of Palpa district. The main feature of this place is known for production of crop. Due to the, mountains region situated in the western part of the VDC it has fertile land and ideal for cattle farming. As a result, the livelihood of this place is highly dependent on agriculture and animal husbandry.

Table: 4.1 Bio-gas User's Ratio

Total population	Bio-gas User population	Bio-gas user percentage (%)
4597	640	13.92

Source: *Field Survey*, 2018

Figure: 4.1 Bio-gas User's Ratio



Source: Based on the table 4.1

Table 4.1 and figure 4.1 shows that out of the total population of 4579 residing in Hungi 640 are being benefited from bio-gas plants. Out of total 1081 households 160 have bio-gas plants. And, Out of 160, this research has sampled 40 households constituting 200 population. Bio-gas user population percentage is 13.92.

4.2 Ethnic Composition

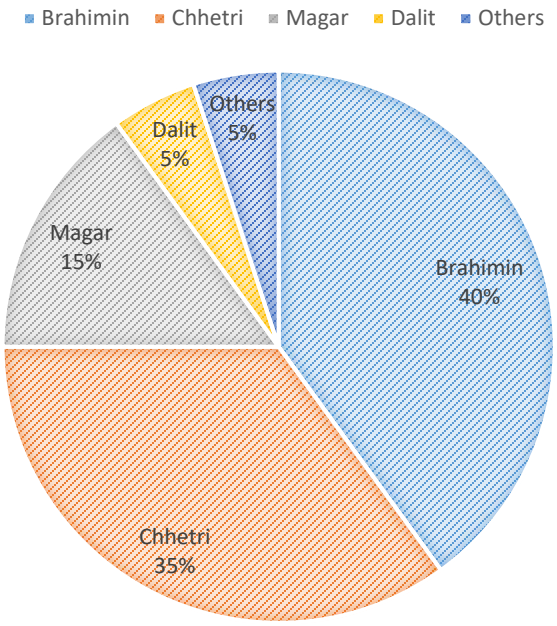
Nepal is well known around the world for the religious and caste harmony as a diversity of castes constitutes the country, which is living in same places with a great instinct of synchronization. In the study area also, there are diversities of castes living together but in the case of bio-gas users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

Table 4.2: Ethnic Composition of Respondents

S. N	Caste	No. of Household	Percentage (%)
1.	Brahaman	16	40
2.	Chhetri	14	35
3.	Magar	6	15
4.	Dalits	2	5
5.	Others	2	5
	Total	**40**	**100**

Source: *Field Survey,* 2018

Figure 4.2: Ethnic Composition of Respondents



Source: Based on the table 4.2

The table 4.2 and figure 4.2 signifie clearly that, among the sampled houses, the Brahamans were in the majority with regard to the ethnicity, as they comprised 40 percent of total households. Following Brahamans were the Chhetri with 35 percent and the Magar covered 15 percent of the sampled households. Disappointingly Dalits constituted only 5 percent of the sampled households and rest of 5 percents were from other castes like Gharti, Gurung, Newar etc.

4.3 Occupation of the Respondents

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

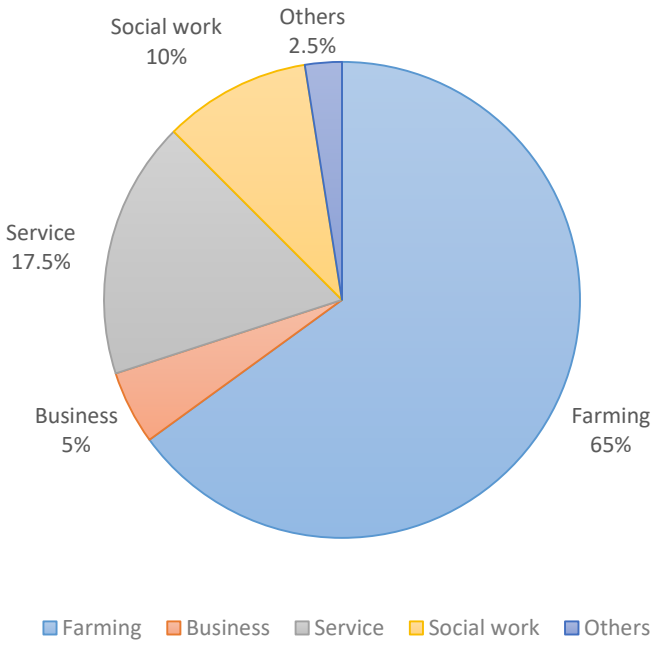
in business, service and Social work. The following table illustrates the occupational status of the respondents.

Table 4.3: Occupation of the Respondents

S. N	Occupation	Number	Percentage (%)
1.	Farming	26	65
2.	Business	2	5
3.	Service	7	17.50
4.	Social work	4	10
5.	Others	1	2.50
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.3: Occupation of the Respondents



Source: Based on the table 4.3

The above table and figure shows that the majority of the respondents that is 65 percent adopt agriculture as their primary occupation whereas a very significant in the country's

scenario, 17.5 percent of the households is engaged in service. About 10 percent people are found to be active in social work, 5 percent people engaged in business and 2.5 percent in some other work.

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

4.4 Family Size

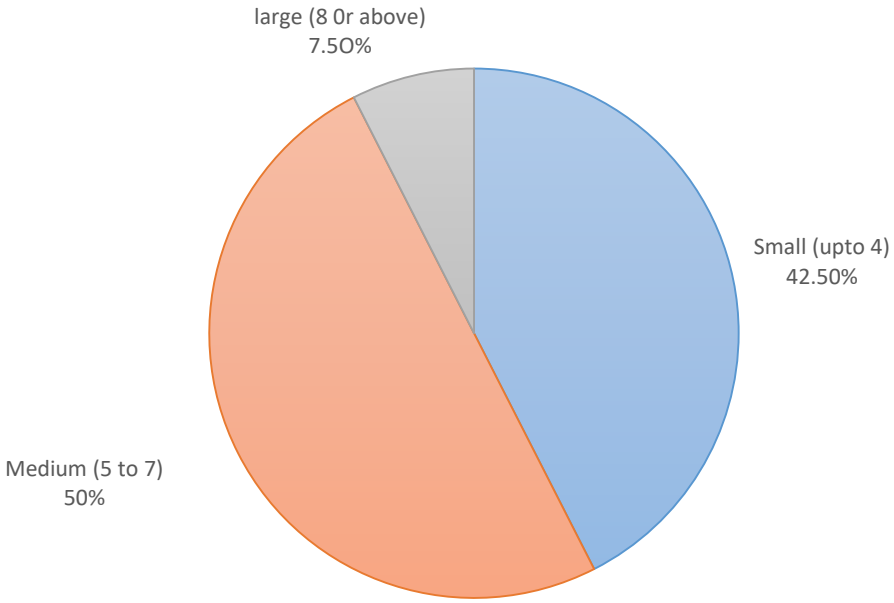
Household or the family is a basic unit of the society and it is an institution that plays an important role in building the society. Family size has also a dominant role in energy use pattern. The family size of the respondents is demonstrated in the following table.

Table 4.4: Family Size Distribution

S. N	Family Size	Number	Percentage (%)
1.	Small (Upto 4)	17	42.5
2.	Medium (5 to 7)	20	50
3.	Large (8 or above)	3	7.50
	Total	**40**	**100**

Source: *Field Survey,* 2018

Figure 4.4: Family Size Distribution



Source: Based on the table 4.4

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

4.5 Land Holding Size

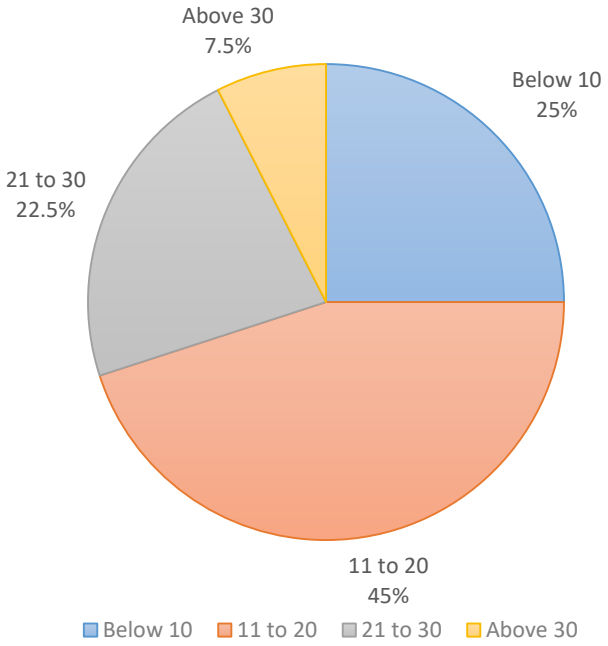
Land holding size portrays the economic and social status of the people living in the rural areas. Land holdings of the respondents are portrayed in the table below.

Table 4.5: Land Holding Size

S. N	Area in Ropani	No. of Households	Percentage (%)
1.	Below 10	10	25
2.	11 to 20	18	45
3.	21 to 30	9	22.5
4.	Above 30	3	7.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.5: Land Holding Size



Source: Based on the table 4.5

As Nepal is an agricultural country where more than 80 percent people are dependent upon agriculture as their main occupation, land has great contribution and importance and it also measures the economic status of the people. The above table signifies that most of the houses have land holding of between 11 to 20 Ropani which is 45 percent of the total households. 25 percent of the households own land below 10 Ropani, 22.5 percent with

land ranging from 21 to 30 Ropani whereas 7.5 percent of the total households hold land above 30 Ropani.

4.6 Livestock Population

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

The average number of livestock (cattle and buffalo) per household was 2.55, average number of cow/ox was 0.55 and average number of buffalo was 2. Buffaloes were more admired by the respondents.

Table 4.6: Livestock Population

S. N	Livestock	Number	Percentage (%)
1.	Buffalo	80	78.43
2.	Cow/Ox	22	21.57
	Total	**102**	**100**

Source: *Field Survey*, 2018

4.7 Economic Status

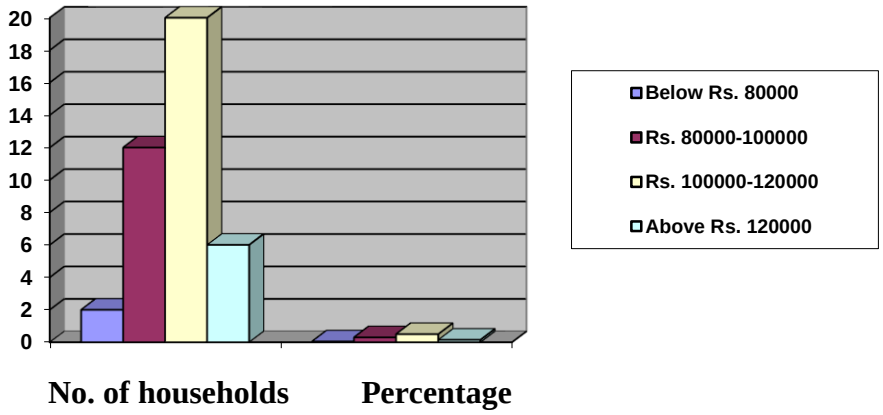
Income level is the major indicator of assessing economic status in the society. The research study indicated that economically medium level households have adopted biogas technology in wider scale.

Table No. 4.7: Income Level of Sample Bio-gas Household

S.N.	Income level annually	No. of households	Percentage (%)
1.	Below Rs. 80000	2	5
2.	Rs. 80000-100000	12	30
3.	Rs. 100000-120000s	20	50
4.	Above Rs. 120000	6	15
	Total	**40**	**100**

Source: *Field survey*, 2018

Figure 4.7: Income Level of Sample Bio-gas Household



Source: Based on the table 4.7

Above table and figure shows that majority of households 50% had annual income of Rs. 100000-120000, followed by 30% households with Rs. 80000-100000 income. This depicts that medium level of biogas households from economic point of view are associated with wide scale adaptation of biogas technology.

4.8 Type of House

The type of house in which people reside also reflects the economic level of them. Among the surveyed households only a slender 17.5 percent of the houses were cemented. The

most popular type of house was of stone and mud house which category covered about 82.5 percent of the houses. The following data is shown in the table below.

Table 4.8: Type of House

S. N.	Type of House	Number	Percentage (%)
1.	Cemented	7	17.5
2.	Stone & Mud	33	82.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

4.9 Educational Attainment of the Plant Owners

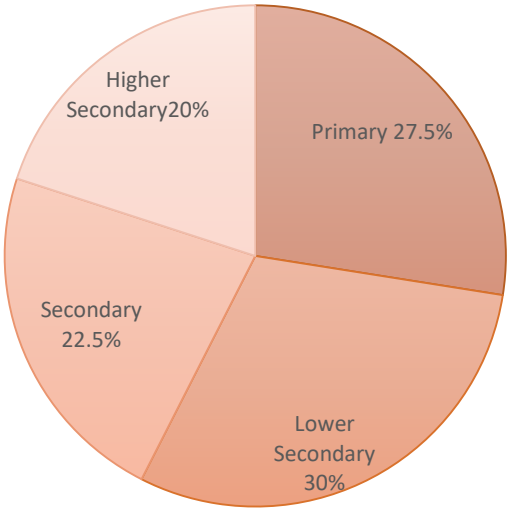
Education is one of the key indicators for reforming society and upgrading its economic and social status. Education enhances the ability and capability of human being to judge for right or wrong. It also plays a vital role in energy use pattern. It is the source of knowledge, attitude and behavior of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

Table 4.9: Educational Status of Respondents

S. N.	Education Level	Number	Percentage (%)
1.	Primary	11	27.50
2.	lower Secondary	12	30
3.	Secondary	9	22.50
4.	Higher secondary	8	20
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.9: Educational Status of Respondents



Source: Based on table 4.9

The above table and figure shows that the highest number of respondents 27.5 percent respondents has achieved just only primary level of education. Similarly 30 percent of the respondents are with lower secondary level of education followed by 22.5 percent gaining the secondary level of education. Meanwhile 20 percent of respondents have achieved higher secondary level.

4.10 Source of Information on Bio-gas

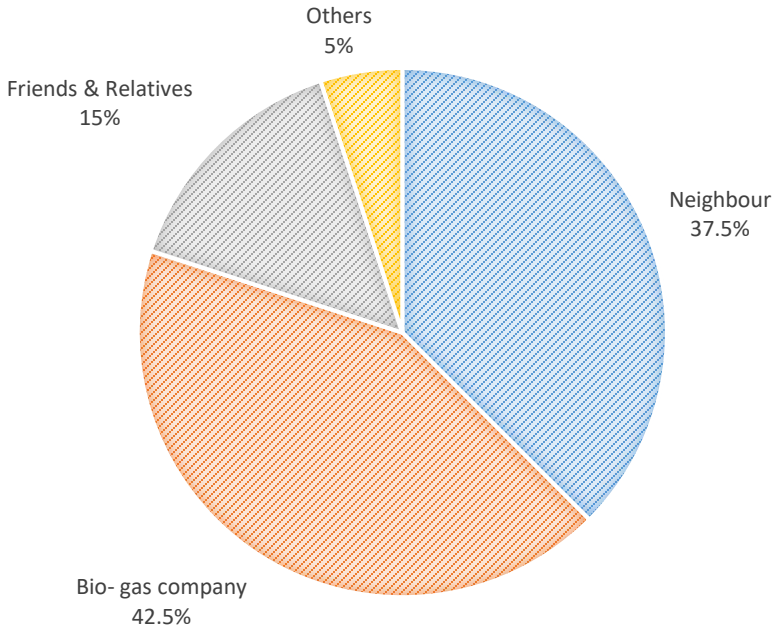
It is obvious that anybody have to listen or know about bio-gas before the installation. In the study area, the chief source of information was the respective bio-gas company of the respondents, which comprised of 42.5 percent. Neighbors served as the second important source as 37.5 percent neighbors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

Table 4.10: Information Source

S. N.	Information Source	Number	Percentage (%)
1.	Neighbors	15	37.50
2.	bio-gas Company	17	42.50
3.	Friends/Relatives	6	15
4.	Others	2	5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.10: Information Source



Source: Based on the table 4.10

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

4.11 Size of Bio-gas Plant

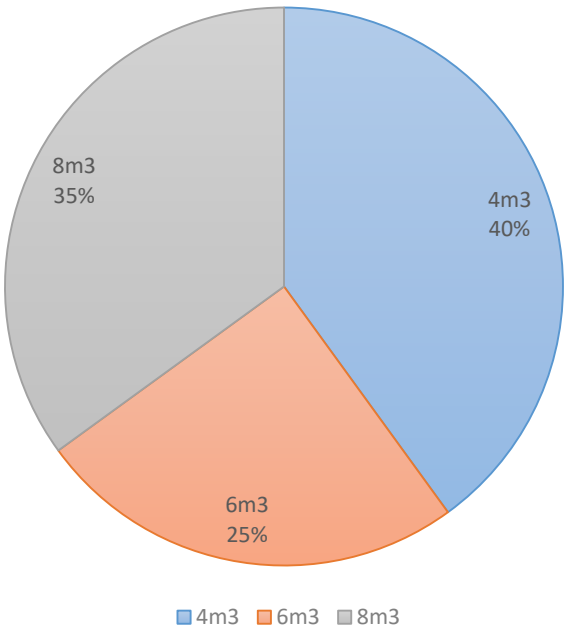
The size of bio-gas plant is mostly determined by the number of family members and the number of cattle. 40 percent of the respondents have constructed the bio-gas of 4 m^3 size. Similarly 25 percent of the respondents have constructed 6 m^3 sized bio-gas whereas 35 percent of respondents have the bio-gas plant of 8 m^3. The figure is shown in the following table.

Table 4.11: Size of Bio-gas Plant

S. N.	Size	Number	Percentage (%)
1.	4 m^3	16	40
2.	6 m^3	10	25
3.	8 m^3	14	35
	Total	**40**	**100**

Source: *Field Survey,* 2018

Figure 4.11: Size of Bio-gas Plant



Source: Based on the table 4.11

4.12: Problems about the Use of Biogas Plant

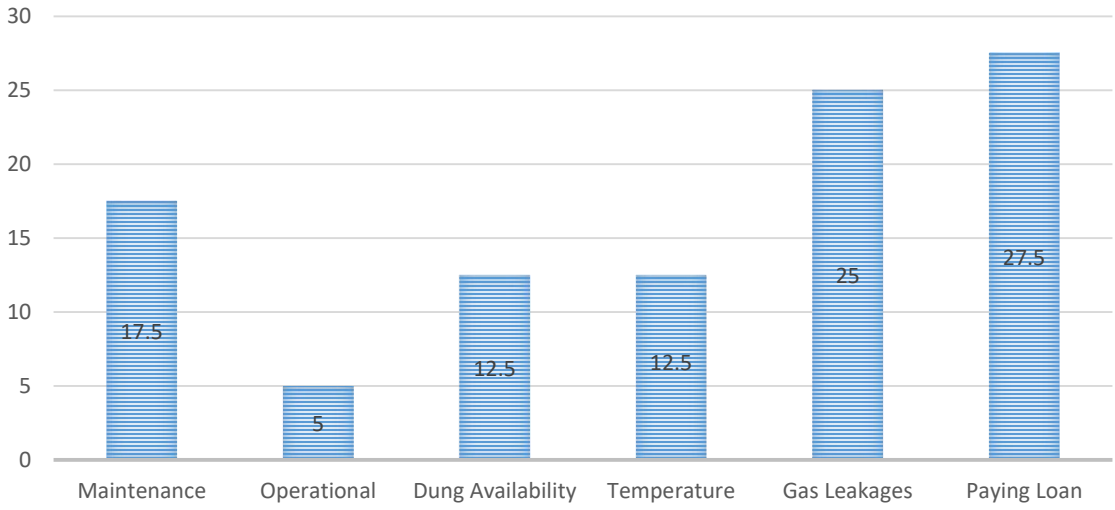
There are so many problems of the use of biogas plant. The main problem is less gas production from plant especially in winter seasons. The other major problems are maintenance, operational, dung availability, temperature, gas leakages and paying loan. In this section perception of respondents also have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

Table 4.12: Problems of Bio-gas Plant

S.N.	Problems	No. of Households	Percentage (%)
1.	Maintenance	7	17.5
2.	Operational	2	5
3.	Dung Availability	5	12.5
4.	Temperature	5	12.5
5.	Gas Leakages	10	25
6.	Paying Loan	11	27.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.12: Problems of Bio-gas Plant



Source: Based on the table 4.12

Table 4.12 and figure 4.12 shows that about 27.5% respondents out of total interviewed reported that they have problem of paying loan, followed by gas leakages 25%, problem of dung availability 12.5%, problem of maintenance 17.5%, operational problem 5% and also temperature problem especially in winter season 12.5%.

4.13: Main Objective of Installing Bio-gas

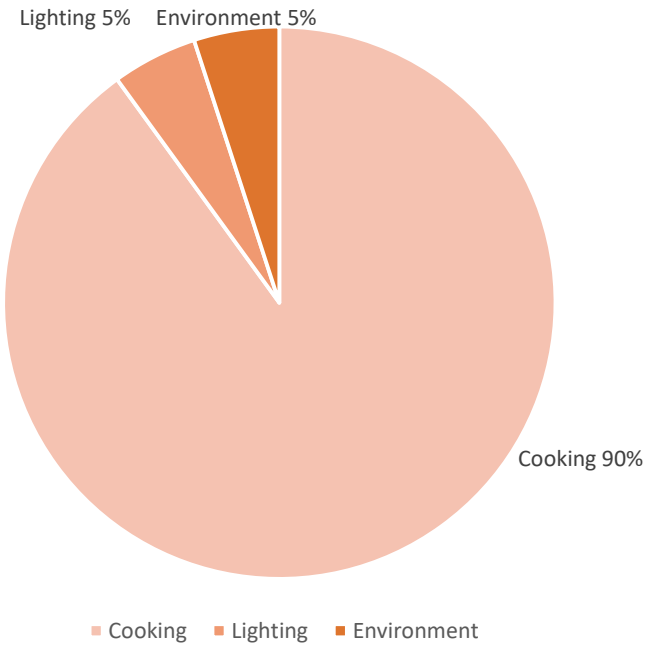
Though most of the people consider bio-gas only as a source for cooking purpose, it has multiple of other uses and benefits, which could also be the objectives of installing it at home. Among the surveyed 40 house most of the respondents gave the answer that they have installed the bio-gas with the goal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

Table 4.13: Main Objective of Installing Bio-gas

S. N.	Objective	Number	Percentage (%)
1.	Cooking purpose	36	90
2.	Lighting purpose	2	5
3.	Environment benefit	2	5
	Total	**40**	**100**

Source: *Field Survey,* 2018

Figure 4.13: Main Objective of Installing Bio-gas



Source: Based on the Table 4.13

Before installation of bio-gas, the people of the study area mainly used firewood and LP gas for cooking purpose. In the study area among 40 households, 35 households used to use firewood for the cooking purpose whereas 5 of the houses used LP gas for the cooking purpose. The energy use pattern seems to have changed significantly after the installation of bio-gas which has resulted in relief of women with respect to their health and sanitation. Kitchens have been in improved condition with less smoke and clean and new energy use pattern has brought behavioral change in user′s livelihood.

4.14 Reduction in Workloads

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

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

Table 4.14: Reduction in Workloads

S. N.	Category of work	Average time taken hrs/day		Reduction in workload (saving in time) hrs/day
		Before Installation	After Installation	
1.	Firewood collection	3.1	0.23	2.87
2.	Cooking activities	2.2	1	1.2
3.	Washing utensils	1.1	0.6	0.5
	Total	**6.4**	**1.83**	**4.57**

Source: *Field Survey,* 2018

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

4.15 Saving of Firewood

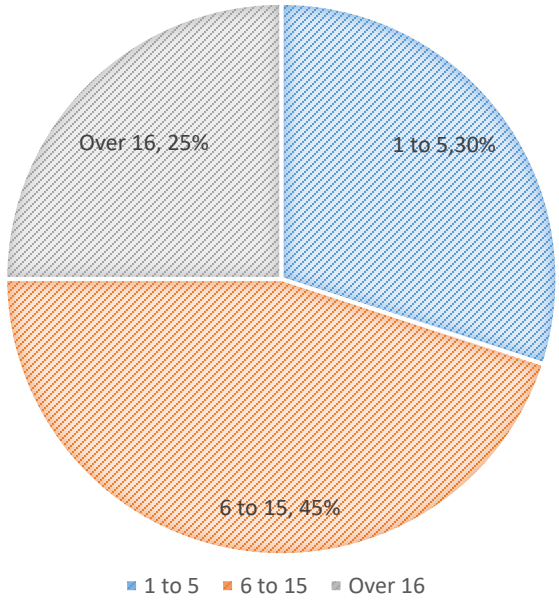
Considerable amount of firewood was found to be saved after the installation of biogas plants, which definitely help economically to the households and assist a great deal in the environmental improvement as well.

Table 4.15: Saving of Firewood

S. N.	Amount Saved in bhari/month	Number	Percentage (%)
1.	1 to 5	12	30
2.	6 to 15	18	45
3.	Over 16	10	25
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.15: Saving of Firewood



Source: Based on the table 4.15

As only 40 households used to use firewood as their fuel, only 40 households are taken in total in this case. Most of the respondents 45 percent were found to saving firewood ranging from 6 to 15 bhari, 30 percent of the households save 1 to 5 bhari of firewood whereas 25 percent of the households save firewood over 16 bhari per month. The maximum quantity of firewood saved was recorded to be 22 bhari whereas the minimum quantity saved was noted to be 4 bhari. The normal rate of firewood in local area is rupees 80 per bhari, so the above data clearly signifies that there is a saving of substantial amount of money.

*1 Bhari is approximately equivalent to 30 kgs.

4.16 Utilization of Advantaged Time

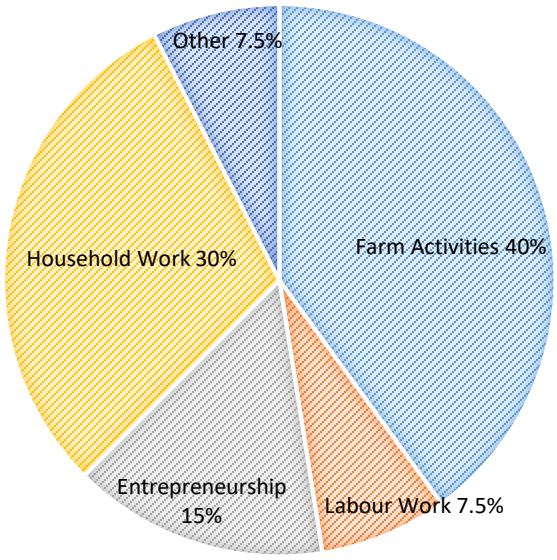
Undoubtedly, after the installation of bio-gas a significant amount of time is saved and there is a good opportunity for the households to make the most of the gained time. Since, Nepal being very much agriculture dominated country, the majority of the households of the study areas is also found using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

Table 4.16: Utilization of Advantaged Time

S. N.	Category	Number	Percentage (%)
1.	Farm Activities	16	40
2.	Labor work	3	7.5
3.	Entrepreneurship	6	15
4.	Household Work	12	30
5.	Others	3	7.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.16: Utilization of Advantaged Time



Source: Based on the table 4.16

4.17 Use of Latrine

One of the major pull factors for construction of bio-gas was the opportunity to construct the toilet, in the study area and lots of people took full advantage of this opportunity as well. Among the surveyed households, 97.5% of the households had built latrines whereas 2.5% households were devoid of latrines.

Table 4.17: Use of Latrine

S.N.	Have Latrine	No. of Households	Percentage (%)
1.	Yes	39	97.5
2.	No	1	2.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

4.18: Reduction in Diseases

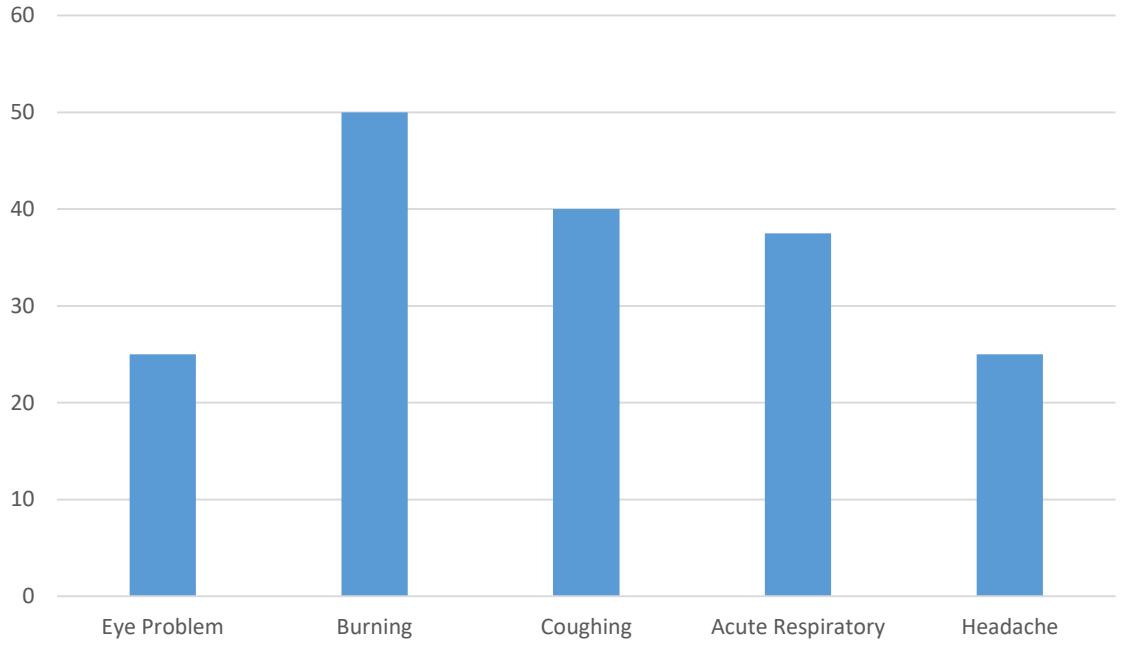
One of the most positive benefits of the bio-gas plant is the betterment of the health condition of the households as well. We have well witnessed that lots of housewives in the rural areas of Nepal are suffering from respiratory, burning, headache, eye problems due to the smoke and flames of firewood,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

Table 4.18: Reduction in Disease

S. N.	Problem	After Installation	Before Installation	Reduction in Disease Percentage (%)
1.	Eye Problem	12	9	25
2.	Burning	6	3	50
3.	Coughing	5	3	40
4.	Acute Respiratory	16	10	37.5
5.	Headache	20	15	25

Source: *Field Survey,* 2018

Figure 4.18: Reduction in Disease



Source: Based on the table 4.18

Table 4.18 and figure 4.18 shows that the most relief of the people found was in the case of burning as 50 percent answer consisted that they burning problem has been reduced. 40 percent are satisfied with the reduced coughing problem, followed by 37.5 percent acute respiratory problem, 25 percent eye problem and 25 percent headache problem.

4.19 Slurry and Its Use

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

4.19.1 Effect of Slurry

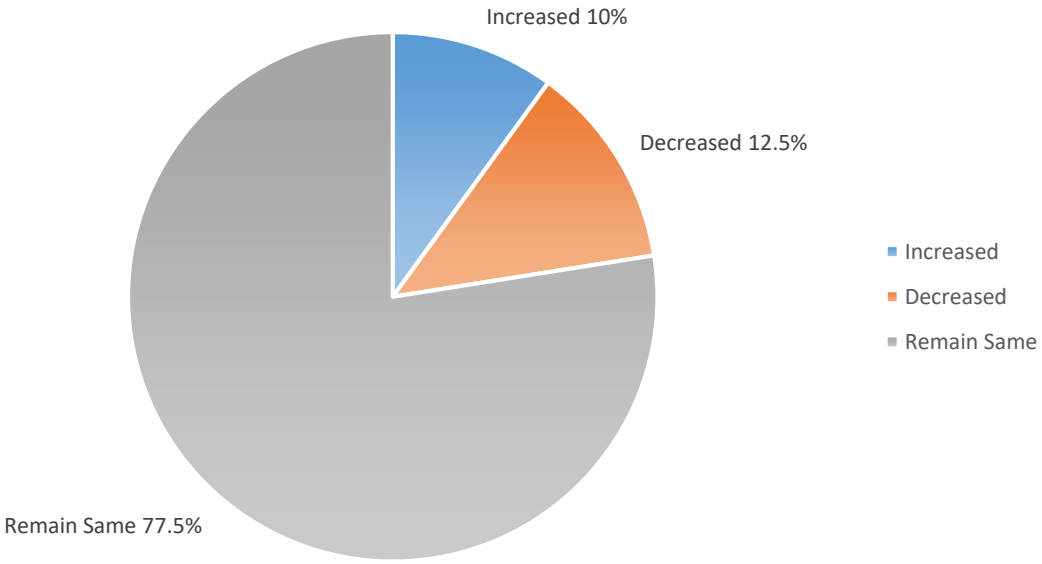
Fertilizer or manure is the most essential input for any crop. The slurry is said to be rich in various plant nutrients such as nitrogen, phosphorous, potash etc. Well fermented bio-gas slurry improves the physical, chemical and biological properties of the soil resulting qualitative as well as quantitative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

Table 4.19.1: Effect of Slurry

S. N.	Agriculture production	Number	Percentage (%)
1.	Increased	4	10
2.	Decreased	5	12.5
3.	Remain same	31	77.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.19.1: Effects of Slurry



Source: Based on the table 4.19.1

Against all the speculations and writings in favor of the use of slurry, all those proved to be wrong in the study area proved. A huge majority of the respondents 77.5 percent said that there was no change in the production of crops before and after the use of slurry as manure. Only a slender 10 percent revealed that the use of slurry have enhanced the production of crops whereas 12.5 percent did not enjoy the use of slurry as they witnessed the decrement in the production of crops after its use.

4.19.2 Effect on Insect, Fly and Mosquito Prevalence

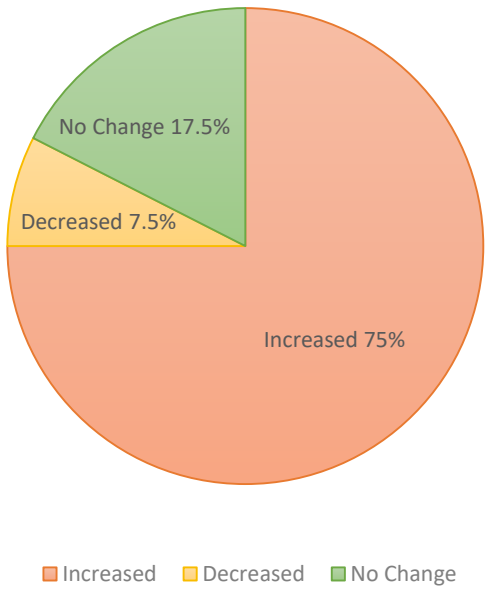
Increase in the prevalence of insects was one of the drawbacks of bio-gas installation witnessed in the study area. Most of the respondents said that the concentration of the insects was very high in the outlet of the bio-gas plant and the deposited pit of slurry provides a big breeding space for insects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

Table 4.19.2: Effect on Insect, Fly and Mosquito Prevalence

S. N.	Insect/Fly/Mosquito Prevalence	Number	Percentage (%)
1.	Increased	30	75
2.	Decreased	3	7.5
3.	No Change	7	17.5
	Total	**40**	**100**

Source: *Field Survey*, 2018

Figure 4.19.2: Prevalence in Insects



Source: Based on the table 4.19.2

The above figure shows that 75 percent of the respondents argued that the prevalence of the insects and mosquitoes have been amplified after the installation of bio-gas plant.

Only a slender 7.5 percent observed the decrease of insets and mosquitoes whereas 17.5 percent of the respondents experienced no change in this respect before and after the installation.

4.20 Applications of Bio-gas

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

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

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

 Bio-gas for Electricity Generation

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

4.21 Benefited Family Members of the Plant Owners

After installation of bio-gas plant almost all of the members of the family were found to be benefited. Workload of the family members, especially of the women was found to be reduced. A great positive view towards the reduction of workloads due to the installation of bio-gas was observed among the plant owners. Due to big flame and smokeless stoves,

time has been saved in considerable amount in cooking, cleaning etc. The women were feeling quite relived by getting rid from the hectic way of creating fire by blowing it. The smokeless environment led to better health of the family. Most of the housewives expressed great satisfaction particularly with the cooking aspect of bio-gas. About 48 percent respondents said that female members of the households are benefited from bio-gas whereas rest of the 52 percent claimed that not only female members but all the family members are benefited from the bio-gas.

4.21.1 Impact of Bio-gas Plant in Raising Social Status

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

4.21.2 Impact of Bio-gas Plant in Financial Sector

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

4.21.3 Benefits from Bio-gas

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

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

Environmental Benefits: The introduction of bio-gas plants has reduced the consumption of fuel wood. BSP estimates that an average rural household uses about 2 tonnes/year of fuel wood for cooking, so the plants installed up until 2005 save a total of about 250,000 tonnes/year. There is visible evidence of forest re-growth in Nepal, brought about mainly by an active programme of tree planting, but also by the reduction of fuel wood use through the bio-gas programme. There are substantial savings in emissions of greenhouse gases, including CO2 from avoided fuel wood and kerosene use, and N2O from synthetic fertilizer. However there is a small net increase in methane emission, because the unburned methane from cooking and minor leaks is slightly greater than the avoided emission of methane from manure disposal. Taking all of these into account, BSP estimated a net saving of about 3 tonnes/year of CO2 equivalent per plant, or a total of 370,000 tonnes/year for the plants installed up until 2005.

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

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

4.21.4 Negative Effects of Bio-gas

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

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

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

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

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

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

- The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.
- The biogas households comprised of 5 ethic group dominated by Brahman (40%), Chhetri (35%), Magar (15%), Dalit (5%), and others are (5%). This reveals that Brahman and Chhetri who are considered as high class have adopted this technology at high level.
- There is considerable reduction in workloads of the family member, especially for women. The household save 2.87 hrs/daily firewood collection. 1.2 hrs/daily for cooking activities and 0.5 hrs saving for cleaning utensils.
- Majority of sampled household reported that time has been saved and majority of respondent saved time has been used for farm activities (40%) and income generation activities (30%).
- Most of sampled households have saved firewood on each cooking time. The average saving for firewood by the installation of biogas plant per household is accounted rs. 720 per month.
- Fuel saving in summer is high compare for winter in the monetary valve. It is because of the insufficiency of gas in winter due to low temperature factor.
- The literacy percentage of the respondents was found very high (over 95%), but the level of education of most of this percent is under the secondary level.
- Most of the household have toilet facility (97.5%).
- Medical expenses also have been reduced after the installation of biogas plant.

- Indoor air pollution of smoke or kerosene fumes has been reduced.
- Majority of biogas households were engaged in farming (65%). They also engaged in other occupation like service, business and social work.
- Majority of households were medium from income point of view. About 50% biogas user household's annual income is medium rs.100000-120000.
- Government subsidy given was very encouraging factor for installation of biogas plants.
- The women in social organizations have been increased after the installation of biogas plants.
- Most of the people (95%) realized the reduction in the effect of diseases like respiratory problem, headache, burning, coughing, eye problem etc.
- Breeding of Mosquito has increased significantly in 75% of the sampled household. It is one of the negative impact of bio-gas plants.
- The cleanliness of household as well as environment was improved and intestinal diseases have been reduced after the installation of biogas plants.
- All of the households were found to be using the digested slurry for the manure purpose.
- Biogas user had installed biogas plant as a substitute to firewood and due to clean and comfortable cooking.
- Sizes of $4m^3$ and $8m^3$ biogas plants are more popular in this area as compared to other size of plants ($6m^3$, $10m^3$).
- The main sources to inform the installers about biogas were the respective biogas companies (42.5%), followed by the neighbors (37.5%).
- The main problems of plant owner are paying loan (27.5%), gas leakages (25%), Dung availability (12.5%), and maintenance (17.5%) which is also negative impact of biogas plant.

5.2 Conclusion

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

The main objective of the installation of the biogas plant was found to be for the cooking purpose. Some of the biogas users were also found to be enjoying the light facility from the biogas. Housewives/women are the main beneficiaries of the installation of biogas plant and they were found to be quite content as it made their work lot easier. Ample amount of time was found to be saved through biogas for the reasons like collection of firewood, cooking food and cleaning up of the utensils. In addition, illness through the smoke emitted during cooking in firewood was found to be reduced in satisfactory level. Biogas helped a great deal to keep the interior parts of the houses clean with contrast to firewood, from which the emitted smoke used to make the house dirty. Also, the surrounding environment condition of the home was found been better as the emission of smoke was controlled and the heap of firewood as well as pieces of firewood were not seen scattered around.

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

5.3 Recommendations

- Maintenance training to all the biogas users should be given compulsorily so that they do not have to see the way of Biogas Company for days to maintain it.
- Though the different experts through research have suggested a great manure value of slurry which has not been the case in the study area, so the technical way of utilization of slurry should be suggested by the concerned agency.
- Insufficiency of the gas in winter season has been the major problem for the biogas users. So proper alternative design of biogas plant suiting that condition is urgent.
- The cause of increased prevalence of mosquito and other insects should be studied. It might happen that proper composting of slurry would reduce the chance of breeding of mosquito and reduce their prevalence.
- Training should be given to suggest the technical way of mixing the dung or bio degradable matters to get the maximum output from the limited available resources.
- Biogas is a boon for rural areas as an alternative source of energy in this time of energy crisis, so it should be promoted all around by giving ample subsidies to economically poor groups.
- It was found that unfair competition of the biogas companies have resulted in the poor construction of the biogas plant making the users its victim, so government should formulate some terms and conditions against the biogas companies.
- It is found that all the plant owners have used the gas only for cooking purpose. Thus it is necessary to conduct further studies about the uses of gas to other income generation activities.

ANNEX 1

QUESTIONNAIRE

Socio-Economic Impact of Biogas on User

(A Case Study of Hungi VDC in Palpa District)

2018

Household Questionnaire No.

1. General Information:-

1.1 Name of the household head/ Respondents:

1.2 Sex: M/F

1.3 Caste/Ethnicity:

1.4 Ward number:

1.5 Occupation:

1.6 How much agricultural land do you have (in Ropani)?

a) Below 10 ☐ b) 11-20 ☐ c) 21-30 ☐
d) 31-40 ☐ e) 41 and above ☐

1.7 What is your family occupation?

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

1.8. Family Size and education

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

2. Information on Biogas

2.1 Do you have biogas plant?

a) Yes ☐ b) No ☐

2.2 Size of that plant m^3 ☐

2.3 Type of Gobar gas plant?

a) Dome ☐ b) Drum ☐

2.4 What is the name of your biogas company?

2.5 What are the reasons behind the installation of biogas plant?

a) Easy and smokeless cooking ☐ b) Toilet ☐
c) Environmental protection ☐ d) Get rid of firewood collection ☐
e) Resource conservation ☐

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

Total cost	Source of investment	Govt. subsidy amount

2.7 When did you install this plant?

Year: …… Month: …….

2.8 Have you attached toilet with this plant?

a) Yes ☐ b) No ☐

2.9 If not, why?

a) Due to the concept of unholy ☐ b) Dirty ☐
c) Separate toilet ☐ d) Sufficiency of gas ☐
e) Others (specify) …….

3. Livestock

3.1. Dung production

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

3.2. Dung feed per day ……..kg

3.3 Water used for mixing ……..liters

3.4 Uses of biogas

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

3.5 Source of water

a) Well b) River

c) Hand pump d) Canal

e) Tap water f) others

4. Alternative Energy Source, Consumption and Saving

4.1 Source of energy used before biogas installation

a) Firewood b) Agriculture residue g) L.P. gas

c) Electricity d) Kerosene

e) Dung cake f) Others

4.2 Source of the energy used after installation

a) Firewood b) Agriculture residue

c) Electricity d) Dung cake

e) L.P. gas f) Others

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

a) Yes ☐ b) No ☐

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

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

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

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

4.6 In which activity, do you utilize this saved time?

a) Farm activities ☐ b) Child care ☐

c) Gardening ☐ d) Physical labour for wages ☐

e) Income generating activity ☐

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

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

c) Market ☐ d) others (specify) …….

5. Health and Sanitation:

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

a) Yes ☐ b) No ☐

5.2 If yes, which type of disease?

a) Eye illness ☐ b) Lung disease (T.B.) ☐

c) Respiratory problem ☐ d) Asthma ☐

e) Headache ☐ f) All of the above ☐

g) Others (specify) …….

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

a) In health ☐ b) In hygiene ☐ c) In sanitation ☐

d) All of above ☐ e) 0thers (specify) ……

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

a) Decrease ☐ b) Increase ☐ c) Remained same ☐

6. Do you use the biogas slurry for farming?

a) Yes ☐ b) No ☐

6.1 How much has it increased agricultural production?

a) Increased ☐ b) Decreased ☐ c) Remain same ☐ d) Can't Say ☐

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