CHAPTER I

INTRODUCTION

1.1 Background of the Study

Nepal is a landlocked and sovereign independent country situated at South Asia bordering the Republic of India and China. India in the east, south, west and China in the north of Nepal. Ecologically, Nepal is divided into three main regions Himalayan, hill and Terrain. It is located between $26^0$22" to $30^0$27" north latitudes and $80^0$4" to $88^0$12" east latitudes. It covers an area of 1,47,181 sq. km which accounts 0.03 of land areas of earth and 0.3% of Asia. The altitude range from 59 meters to 8848 meter and the climate varies from tundra to polar. The country stretches from east to west with mean length of 885 km and widens from north to south with mean breadth of 193 km average (DoI, 2074). Its population is 26,494,504 (CBS 2011). About 82.93% of total population is living in rural areas and 21.6% people are below poverty line. The per capita income of Nepalese people is 1004 $ annual (MoF, 2018). The inequality between poor and rich has been increasing rapidly. The country has been divided in to 7 province, 77 district, 753 local level and 6743 wards. Nepal is rich in natural resources having more than 6000 rivers and rivulets. Nepal has high possibility of renewal energy. The feasibility study of wind energy has been started in different parts of the country like Achham, Mustang etc.

Renewable energy is energy from sources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time (www.eia.gov). Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished. For example, sunlight or wind keep shining and blowing, even if their availability depends on time and weather (www.nrdc.org).

Renewable energy can contribute to "social and economic development, energy access, secure energy supply, climate change mitigation, and the reduction of negative environmental and health impacts". Under favorable circumstances, cost savings in comparison to non-renewable energy use exist.

All countries of the world are affected by the world energy crisis in many times. Rising cost of petroleum products, there is negative impact on socio-economic condition of the country. People have to face to face many problems such as scarcity and high cost of petroleum products, now a day we are facing such kind of problems. Shortage of energy is a serious constraint for the achievement of sustainable development. The large proportion of the population from rural areas and their massive dependence on traditional energy resources show that the rural sector is the most important sector for the implementation of the concentrating development programs to accelerate the country's development index. The low consumption level of imported energy shows that the industrial activity is very low whereas household energy dominates the major energy portion of the market. Due to the geographical terrain, it will cost massive investment and time to link rural areas with the national grid. Based on this fact, the government started to promote locally available environmentally friendly renewable energy resources in Nepal, which are more affordable to those rural populations, helping to raise the rural economy (Shrestha, 2010).

The Government of Nepal has established the Alternative Energy Promotion Centre (AEPC) in November 3, 1996 to make renewable energy mainstream resource through increased access, knowledge and adaptability contributing to the improved living conditions of people in rural area of Nepal. The main programmes are micro hydro, solar and biomass (bio-diesel, cooking stoves, and biogas). Currently, AEPC is coordinating with Ministries, GoN, donors, NGOs, INGOs, the private sector and stakeholder / user groups to make policy recommendations to the government. There are different programs under AEPC funded via unilateral, bilateral donor organizations (AEPC, 2010) which will be discussed in detail in different journals and booklets. Other intuition is the Renewable Energy for Rural Livelihood (RERL) which is works the sector of renewable energy. It is funded by Global Environmental Facility (GEF) and the United Nations Development Programme (UNDP). RERL has been developed as an integral part of Alternative Energy Promotion Centre (AEPC)'s National Rural and Renewable Energy Programme (NRREP) and thus, has been assisting in fulfilling its ambitious targets. The main objective of RERL is to support AEPC to remove barriers for scaling up of interventions, which promote less disseminated larger renewable energy systems such as mini hydro, large micro hydro

and large solar PV systems. RERL has been supporting development of sustainable implementation modalities such as demonstration projects, private sector involvement for financing and attainment of financial sustainability through promotion of productive energy uses.

The GoN has subsidized almost all of these renewable energy technologies through the "Rural Energy Policy 2006" revised in 2006 and 2009. The supporting policies are "Subsidy Policy for Renewable (Rural) Energy" and Renewable (Rural) Energy Subsidy Delivery Mechanism" (AEPC, 2010). The Subsidy Policy defines objectives as well as the types, level of subsidy and the delivery mechanism. Since the programme is running since last 15 years, there is a need for the evaluation and Analysis of the Impacts of Subsidies on Small Scale Renewable Energy Technologies Dissemination in Nepal (AEPC, 2010).

In Nepal, 82.03% of the total population live in rural areas and are meeting their energy needs from traditional resources (78%), such as fuel wood, agricultural residue, cattle dung etc. (CBS, 2011). Energy supply and balance statistics show that the major consumption of energy in Nepal is in the domestic sector, whereas the major supply of energy comes from biomass, of which fuel wood is the dominant energy source, as it covers 77 percent of the total biomass energy supply in Nepal. One of the interesting facts is that although Nepal is blessed with natural resources and a steep gradient topography, it has harnessed only 990.5 MW of 43,000 MW (2.3%) of technically and economically feasible potential of hydropower. The total electricity production (till 2075 asar) is 1044.6 MW, Where 990.5 MW from hydroelectricity, 53.4 MW from thermal plant, 0.7 from solar energy (MoF, 2018).

Nepal is the highest traditional fuel consuming country in Asia because of its high dependency on traditional biomass fuels, mostly firewood, limited extent of charcoal and crops and animal residues (Bhattarai, 2004).

Maximum population of Nepal use traditional cooking stove. The traditional cooking practice in Nepal uses a "three-stone" cooking stove. Only 20%-25% of the households in Nepal use fossil fuels such as kerosene or liquefied petroleum gas for cooking. The majority uses a mix of agricultural residues, twigs, leaves, cow dung and fuel wood. The combustion of some of this biomass in the traditional cooking

stoves generates a variety of gases including carbon dioxide (CO2), carbon monoxide and other particulate matter. The replacement of traditional stoves by improved cooking stoves (ICS) improves heat transfer, which reduces the total amount of fuel required for cooking and the amount of emissions. Altogether, the improved cook stoves have other many benefits.

1.2 Statement of the Problem

In developing countries, indoor air pollution far outweighs the outdoor air pollution. The main indoor source is the incomplete combustion of solid fuels as wood, charcoal, cow dung and agricultural residues in open fires or in traditional cook stoves. This is estimated to cause 2 million premature deaths annually. Worldwide, more than three billion people are still dependent on the burning of solid fuel for cooking and heating of their houses (WHO, 2009).

Nepal is a technically backward country as regard to fuel. Energy sector is backbone of the nations and it is one of the major issues of the developing countries. Nepal has been facing energy problems such as the high prices of fossil fuels and high rate of depletion of the forest resources. More than 70.47 percent of the Nepalese populations are still using firewood as a source of fuel. High consumption of the fuel wood causes indiscriminate destruction of the forest wealth. Forest area of Nepal is decreasing at the rate of 1.7 percent per annum. If the forest declining rate is not controlled; after 27-30 years, Nepal will be changed into the desertification. It is well known that the deforestation results into natural calamities such as landslides, floods and soil erosion etc. Improved Cooking Stoves save forest from minimum use of firewood. The people in rural area are using conventional form of energy like fuel wood, animal dung and agricultural residue. This conventional method of energy consumption is not suitable for rural people as it has many negative impacts on the life of rural people. Firstly, the rural people have little access to the source of energy like hydroelectricity. In addition to this, looking at the economic status of the country, it seen hard to install plants for the production of the energy. The geographical structure of the country also seem to be obstacle for the installation of the infrastructure to enable the rural people to meet the needs of energy, the renewable source of energy which can be installed through fewer budgets and can be affordable by the rural people should be given more importance.

The problem of cooking over an open Traditional Cooking Stoves (TCS) is the increased health problems brought on from the smoke, particularly lung and eye ailments, but birth defects. According to the World Health Organization, "Every year, indoor air pollution is responsible for the death of 1.6 million people, that's one death every 20 seconds." Replacing the traditional 3-rock cooking stove with an improved one and venting the smoke out of the house through a chimney can dramatically improve a family's health (WHO, 2009).

Deforestation and erosion are often the result of harvesting wood for cooking fuel. The main goal of most improved cooking stoves is to reduce the pressure placed on local forests by reducing the amount of wood the stoves consume. Additionally, the money a family spends on wood or charcoal translates into less money being available to be spent on food, education, and medical care; so an improved cooking stove is seen as a way of boosting a family's income.

Similarly, a rural person's in my study area heavily depends on biomass such as fuel wood, agriculture residues, cattle dung etc. to meet their domestic energy needs. The traditional stoves has been observed over consume these low grade but cheap and readily available biomass fuels resulting into excessive pollution of the indoor environment (air and sanitation) and poor family health especially those of women and children.

Every morning and evening, women in Nepal spend an hour or two cooking their rice, Dal, Curry, and Roti or other flat bread. Most will prepare their meals over a smoky, 3-stone open fire or traditional clay or brick cook stove called a *Chulho*. The stoves burn a mix of wood, hay, or cow dung that the women collect from around their homes or, at times, far from the safety of their villages. The old-fashioned *Chulho* cook slowly, imparting a delicious flavor to the food that many Nepalese love. But everyone from the women cooking their meals to international health experts knows the smoke from the fires has a dark side, literally and figuratively. In this context, ICS can play important role for efficient utilization of fuel wood in terms of saving the quantity of fuels and cooking time reduction in health hazards and lowering the pressure on forest for fuel wood extraction.

This study focused on these problems of Bannigadhi Jayagadh -1 of Achham

District, which are as follow,

i. What are the health and other impact on woman, senior citizens & children after installation ICS of the study area?
ii. What is the current situation of ICS in Ganjra village?
iii. What are the financial requirements and benefits of ICS?

1.3 Objective of the Study

The major objectives of this study are to assess the status and impact of ICS at Bannigadhi Jayagadh R.M.-1, Achham among the users. The specific objectives of this study are given below:

a. To identify the current situation of Improved Cooking Stoves (ICS) in Ganjra village in Achham.
b. To examine health impact on woman, children and senior citizen.
c. To examine financial requirements and benefits of ICS.

1.4 Significance of the Study

Rural Nepal villages cook with the traditional method that consists of three-stones placed in a triangular formation. The three-stone method has drawbacks resulting from the practical yet, inefficient design. Since the stones do not create a barrier, heat constantly escapes requiring constant fuel replenishment. Women and children, who are primarily responsible for gathering fuel wood, spend two to three days each week collecting and then carrying wood on their backs or heads. The cumulative effect of fuel wood collection by this substantial number of people destroys the forest resource base on which this population literally depends on for existence. The growing scarcity of firewood and other consequences resulting from forest depletion, the search of alternative energy source is seen very crucial. As forest resources become scarce, the balance between what people need and what they can obtain would shift. As a result, people has to struggle to survive that becomes harder.

The study is very important for understanding and identifying the changes in the status, way of living and activities of ICS user household in the study area Ganjra.

Assessment of the impacts of ICS users, their activities, their capacities and understanding on utilization of ICS will certainly be helpful in Clean Development Mechanism. The outcomes of the study will be of great importance to policy makers to formulate appropriate plan for further development of the appropriate technology that better sots the rural people needs from is and every aspects. Improved cook stoves (ICS) particularly mud-brick ICS with and without chimney is one of the most simple, inexpensive and widely used technologies designed to improve combustion efficiency of biomass and reduce exposure to indoor air pollution. The benefits of ICS includes increased thermal efficiency, conservation of forests by reducing fuel wood consumption, reduction in women's drudgery, reduction in indoor air pollution and hence smoke-related health disorders, and prevention of fire hazards. Traditional stoves used in B.J. R.M.-1 were simple structures, made from clay or having stone or metal tripods. These stoves are very inefficient because they have poor airflow and insulation. As a result, they consume a lot of biomass and produce high levels of indoor air pollution.

1.5 Limitation of the Study

Due to the various constraints, so it is not a comprehensive study and it focused to analysis the certain impact and current situation of ICS at study area. Having outlined the objectives, statement of the problem and methodology of the study, there are some limitations, which are as follows:

- This study is focused on the ICS installed in B.J. R.M. -1, Ganjra of Achham district.
- This study deals the current status and socio-economic impact of ICS only so the technical aspect of the ICS is lacking in Ganjra village.
- The study has focused on health of women and children, fuel wood consumption, saving of cooking time, impact on environment after using ICS.
- This study has based on both primary and secondary data. Primary data will collect by the questionnaire, interviews, field observation and secondary data will collect from previous book, researches, journals, publications and related materials of ICS.
- Information and data was collect by sampling methods so always sampling may

not be represented the population thought.

- In this study, general limitation was considered time constraint, financial problems, lack of my experience and lack of recent information.

1.6 Organization of Study

This Study is divided into five chapters. The first chapter includes introduction / background of Study, statement of the problem, objective of the study, signification of the study, limitation of study and organization of study. Likewise, the second chapter of study includes review of literature. Similarly, the chapter three includes research methodology that deals source of data and information, method of data collection, data processing and method of analysis. The chapter four deals description of study area, educational condition of house holders, current status, impacts and problems on improved cooking stove in the study area. Finally, the chapter five deals findings, conclusion and recommendations.

CHAPTER II

REVIEW OF LITERATURE

2.1 Energy

Energy is sources of power. It is one of the basic needs of people. It is very important for our daily life particularly for the economic and overall development. Energy is one of the essential drivers for social and economic development. A sustainable energy supply, both in the short and the long term, is needed for enhancing economic development, people's quality of life and protecting the environment. Availability of quality energy could augment the productivity and the effective supply of physical and/or human capital services. Advanced industrialized countries are able to use modern machinery and techniques for increasing the capital-labour ratio and productivity of the workers because of the availability of required amount of energy (WECS, 2013).

Energy is an important development indicator, which provides vital inputs for survival and economic development. Energy supply and consumption is still in a traditional state in Nepal. At present, renewable energy generation, capability of the country is still significantly very low due to technological and economic barriers. However, the average efficiency of the renewable energy technologies is good in performance and environmentally safe (DDC Achham, 2015).

Nepal is fully dependent on traditional energy sources such as biomass. For commercial purpose the country is reliant on imported fossil fuels like petrol, diesel, kerosene and LPG for running vehicles, stationary engines, boilers, cooking, lighting etc. Heavy dependence for energy on biomass resources has accelerated the depletion of natural resources and contributed to the degradation of natural environment. The country spends about 40 per cent of its foreign currency reserve on the import of petroleum products. On the other hand, the country's vast resource of renewable hydropower energy remains virtually unexploited. Nepal needs to harness its vast hydropower potential and reduce its dependence on biomass in order to check the further degradation of the environment and reduce country's

dependence on fossil fuel based energy. The power so generated can be used for setting up clean energy based industries that will significantly contribute to the economic development of the country (Shrestha , 2016).

2.2 Present Energy Situation in Nepal

Nepal is one of the least developed countries in the world (GDP-1004 $) with 83% of the population living in rural areas. Nepal is predominately an agricultural country where this sector contributes to 33% of the national GDP. Despite being an agricultural based economy, majority of the peasants are subsistence farmers where the production is limited to consumption at the household level (CBS, 2011; MoF 2012, 2018). Still, approximately 21.8% of the populations live below the poverty line.

Nepal is poor in fossil fuel resources, and thus has to import all its non-renewable energy resources, such as kerosene, diesel, petrol, liquefied petroleum gas (LPG) and coal, from its neighboring country, India. The prices for these fossil fuels are strongly dependent on the global economic and political conditions. But what Nepal is rich in are renewable energy resources, such as biomass, water, sunshine and also wind in some particular areas. The great benefits of these energy resources are, that they are free and renewable, and therefore do not incur ongoing fuel costs. Further, a great advantage is Proceedings of the International Conference on Renewable Energy for Developing Countries that these renewable energy resources are locally available, and thus can be part of the local community's economy and lifestyle.

In Nepal, the production of electricity is 1044.6 M.W. (from hydroelectricity 990.5 M.W., from thermal plant 53.4 MW and from solar energy is 0.7 MW) at fiscal year 2074/075 (first 8 months report) and the customer of electricity users are 3,532,000 in that period. The difference between electricity demand and supply is 463.6 M.W., where demand of electricity is 1508.2 MW. 18% users of total population are using electricity from renewal energy. At that time, total number of biogas plant are 8346, solar plant are 16,572, improved water mill are 203 and Improved Cooking Stoves are 10,018 installed (MoF, 2018).

2.3 Renewable Energy

Renewable energy is energy from sources that are naturally replenishing but flow-limited. It is collected from renewable/natural resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services.

The large proportion of the population from rural areas and their massive dependence on traditional energy resources show that the rural sector is the most important sector for the implementation of the concentrating development programs to accelerate the country's development index. The low consumption level of imported energy shows that the industrial activity is very low whereas household energy dominates the major energy portion of the market. Due to the geographical terrain, it will cost massive investment and time to link rural areas with the national grid. Based on this fact, the government started to promote locally available environmentally friendly renewable energy resources in Nepal, which are more affordable to those rural populations, helping to raise the rural economy. The National Planning Commission (Nepal National Planning Commission 2008) stated in its report that there is technically feasible potential of 50MW micro hydropower, 1132.7 MW of solar energy (considering 5% of the area potentially suitable @ 4- 5 kWh/sq.m/day) and 1.9 million biogas plants (AEPC, 2010).

The demand and supply of energy generated from renewable resources such as solar, micro-hydro and biogas is gaining momentum as over 15 percent of the total population in the country now use them for lighting and cooking purposes. Even though hydropower has been considered a key energy resource for economic prosperity, developing low cost, decentralized and environment- friendly renewable energy technologies have given new impetus to meet the growing energy needs of scattered settlements living in diverse topographies. “One of the biggest achievements from the installation of renewable and alternative energy sources is that it has promoted energy equity where the poor and rural communities living in harsh topographical regions now have access to clean energy source for lighting and

cooking purposes," said Jagannath Shrestha, an energy expert with the Institute of Engineering, Pulchowk. While using hydropowers to generate electricity is over a century old practice, the renewable energy technologies (RETs) were first adopted by the 7th five year plan (1985-1990).

Due to ever increasing dependency on imported energy sources, particularly fossil fuel, the environment and public health hazards associated with traditional practices in the use of biomass as a source of energy is on the rise. A decentralized, efficient, low cost and environment-friendly energy supply based in diverse indigenous renewable resources is the present need of the scattered households, a report on the Current status of renewable energy in Nepal: Opportunities and Challenges, published in 2011, said (Kathmandu Post, Nov. 10, 2014).

The Government of Nepal (GoN) has established the Alternative Energy Promotion Centre (AEPC) in 1996 for the promotion of renewable energy technologies in Nepal. The main programmes are micro hydro, solar and biomass (bio-diesel, cooking stoves, and biogas). Currently, AEPC is coordinating with Ministries, GOs, donors, INGOs, NGOs, the private sector and stakeholder/user groups to make policy recommendations to the government. For the small scale RE deployment, it acts as a one door channel for the mobilization of funds. There are different programs under AEPC funded via unilateral, bilateral donor organizations (AEPC, 2010) which will be discussed in detail in different journals and booklets.

The GoN has subsidized almost all of these renewable energy technologies through the "Rural Energy Policy 2006" revised in 2006 and 2009. The supporting policies are "Subsidy Policy for Renewable (Rural) Energy" and Renewable (Rural) Energy Subsidy Delivery Mechanism" (AEPC, 2010). The Subsidy Policy defines objectives as well as the types, level of subsidy and the delivery mechanism (AEPC, 2010). Since the programme is running since last 15 years, there is a need for the evaluation and analysis of the impacts of subsidies on small-scale renewable energy technologies dissemination in Nepal (www.aepc.gov.np).

2.3.1 Resources of Renewable Energy

The country's economy does not provide enough economic bases for large-scale investment for the exploitation of hydro potentials, laying transmissions and distribution network in the rural areas in the immediate future. Alternative energy resources like solar, biomass and biogas, micro hydro and wind can play a catalyst in rural development by providing modern form of energy.

- ***Hydropower Resources***

Nepal is the major contributor to the Ganga Basin in the north of India. The annual discharge of out flowing rivers from Nepal to India is about 236 billion m^3 from over 6,000 rivers, with many rivers losing a potential height of about 4,000 meters within a north – south distance of 100 km. This creates a theoretical hydropower potential of 83,290 MW. The harsh terrain and difficult access to many areas limits the theoretically exploitable hydro power potential to a more realistic technically and economically profitable potential. Therefore, the realistic realizable, economically and technically feasible, hydropower potential has been estimated to be 42,130 MW. With this figure, and an assumed capacity factor of 80% the annual energy potential of Nepal's rivers can be estimated to be around 300 TWh (Alex,Kimber & Komf, 2016).

Nepal is a country with enormous water resources. The theoretical hydropower potential has been estimated to be 83,000 MW of which 42,000 MW is technically feasible. Hydropower utilization is currently about 2.5 % of the proven potential. The total installed electricity generation is about 1044.6 MW Of this total generation of electricity. At present about 15 companies manufacture and install micro-hydro plants in Nepal. So far, about 13.6 MW of power has been generated from about 2046 micro-hydro plants including peltry sets. Most of these turbines are installed solely for agro-processing. Some of the units are also couples with electric generators. Micro hydro plant consists of civil and electro-mechanical components. (RECAST, 2016) .

- ***Solar Energy***

Solar energy is the power derived from the sun. Radiant light and heat from the sun can be harnessed by different solar technologies. If solar energy is converted into electricity by using solar cells or panels, it is called Solar PV applications and if solar energy is converted into heat rather than light, it is called solar thermal applications. Open air-drying is a traditional drying method in Nepal for storage of agricultural products such as paddy, wheat, maize, fruits, vegetable and herbal medicines. Besides natural sun drying, cabinet type, rack type and tunnel type solar dryers are also used in some places in Nepal. A few manufacturers and NGOs have attempted to promote a few designs of solar dryers in the country. A modified rack type solar dryer developed by RECAST is also used for drying fruits and vegetables. The government has been trying to encourage the use of solar dryers by providing subsidies. A 50% subsidy on the cost of solar dryer was announced by AEPC in 1998.

The development of solar energy technology is thus reasonably favorable in many parts of the country. Solar energy is traditionally used for drying crops, clothes, fuel wood crop residues etc. The technological intervention started only in the sixties with the production of domestic solar water heaters. The use of solar water heaters are mainly in the urban centers and in the trekking route. In fiscal year 2074/075, there are around 16,572 solar heaters installed in the country (MoF, 2018).

Development of solar cookers in Nepal started in 1997 with the parabolic cooker brought in by RECAST. Later on RECAST developed box type solar cookers locally. A number of demonstrations and training sessions were conducted on these devices and some cookers were distributed. The government also provides an amount Rs. 3500/- as subsidy for a parabolic solar cooker which cost Rs. 10,000/- in the present market price.

- ***Biogas***

Biogas is produced out of organic waste and can be used for thermal (heating) and electrical end-use. The slurry that is a by-product of the plant is used as organic fertilizer. Biogas has positive impact on household health, sanitation and plays a

crucial role on sustainability of clean environment In Nepal. Biogas technology was introduced in 1955 and the Government has been engaged in biogas programme since 1975. More than 305,000 domestic biogas plants are installed in Nepal so far. 1992-2014 A.D. Biogas has been proven as an alternative solution for the growing energy crisis. Alternative Energy Promotion Center (AEPC) has been promoting various biogas technologies to mainstream renewable energy solution in Nepal to address poverty, gender and social inclusion and regional balance issues (www.aepc.gov.np). There are 8,346 biogas plants are installed at the 1st eight month of fiscal year 2074/075.

- ***Biomass***

With still around 80% - 85% of the population living in rural areas, the primary energy source used to provide most of the necessary daily energy services in Nepal since centuries, has been fuel wood, often supplemented by crop residues and animal manure, dependent on the prevailing local customs, cast, altitude and geographical zone.

Biomass is the densification of loose materials (agricultural residues, forestry wastes, etc.) to produce compact solid composites of different sizes called briquettes. Densification is the general process of compressing the raw materials to a certain form using a mould and pressure. In 1982, two different briquetting technologies were introduced in Nepal, namely paralyzing and extrusion technology. Nearly 20 enterprises registered with the Ministry of Industry for the installation of briquetting plants. However, about 65% of them have not yet started operating due to poor profitability and marketing problems, as well as shortage of rice husk. Only one manufacturer has continued to produce rice husk briquettes in Nepal. Many other plant owners have closed the plants due to technical and marketing problems. This briquette is not used in household cooking. It is mostly used in institutional cooking. It is quite successfully used for space heating in urban areas. High initial investment, increase price of raw material and frequent repair of extruder are problems associated with it. This technology has gained wide scale popularity through the Community Forestry Users Group (FECOFUN) and has been disseminated throughout the country (Shrestha, 2016).

- ***Wind Energy***

Wind is still unharnessed energy resource in Nepal. Due to its diverse topography and the consequent variation in the meteorological conditions, it is difficult to generalize wind conditions in the country. Although there are some indications of some potential of wind energy and geothermal energy, their magnitude as well as feasibility is not yet established. A 30 kW wind power generator was installed by the Nepal Electricity Authority (NEA) in Kagbeni, Mustang, but the unit was heavily damaged by high winds during operation. At present, NEA is implementing a wind power development project and a few private workshops are involved in the fabrication of wind pumps for irrigation purposes.

- ***Improved Cook Stove (ICS)***

ICS was introduced in Nepal in 1950s and continues to be relevant in the present context. AEPC/NRREP, together with other government, non-government and private organizations, is involved in developing and promoting different types of ICS in Nepal and so far more than 700,000 improved cook stoves have been installed in 63 districts (www.aepc.gov.np).

Improved cook stoves (ICS) particularly mud-brick ICS with and without chimney is one of the most simple, inexpensive and widely used technologies designed to improve combustion efficiency of biomass and reduce exposure to indoor air pollution. Cook stoves are commonly called “improved” if they are more efficient, emit less emission or are safer than the traditional cook stoves or three-stone-fires. The term usually refers to stoves which are burning firewood, charcoal, agriculture residues or dung. A stove is the combination of heat generation and heat transfer to a cooking pot. Cook stoves are commonly called “improved” if they are more “efficient” than the traditional cook stoves. “Efficient” mean Energy efficiency. The core question concerning the efficiency of two alternative stoves is: “With which of the two stoves do I use less fuel to prepare my meal?’’ These stoves may be built under ground or over ground. Heat transfer to the cooking pot is very low, resulting into low efficiency. Improved cook stove (ICS) is a device that is designed to consume less fuel and save cooking time, convenient in cooking process and creates smokeless environment in the kitchen or reduction in the volume of smoke produced

during cooking against the traditional stove. The direct and indirect benefits of ICS includes: increased thermal efficiency, the conservation of forests by cutback in firewood consumption, reduction in women's labour, reduction in indoor air pollution and hence smoke-released health disorders, prevention of fire hazards, reduction of cooking time. Improved cook stoves are a promising measure for sustainable and efficient use of fuel wood (Paudel, 2010).

Improved cookstoves have been part and parcel of rural development in Nepal since the 1950's. Distributed with the goal of saving forests, protecting the environment, and to a certain extent, for health reasons, improved cookstoves, like toilets built by sanitation projects, have been an entry pass into the community for various development projects. Occasionally some 'gender-related activity' is integrated in such projects. But these approaches have not shown sustainable results. Improved cookstoves have never completely replaced traditional cookstoves. Moreover, 'improved' cookstoves have not been improved over time, in that communities have not gained access to newer and better technology.

In keeping with global initiatives, the government plans to install improved cooking stoves throughout Nepal by 2017. On January 20, 2013, the Government of Nepal announced an ambitious mission of 'Clean Cooking Solutions for All by 2017' (CCS4ALL). The government has requested all concerned stakeholders to recognize that achieving this mission requires stronger collaboration. We do not have to start from zero, because many NGOs and INGOs are already involved in ICS projects, and forums, workshops and seminars on the subject are being held every now and then.

Indeed, what is needed is strong political will at the national and local levels, a concerted effort from related stakeholders, as well as inter-linkages between policies and programmes of all sectors and line agencies. The health sector has a crucial role to play in this regard, as the issue of air pollution no longer remains just an environmental concern but also a health concern requiring immediate attention (The Kathmandu Post, July 15 2014).

With the support of Community Forestry Development Project (CFDP), assisted by Food and Agriculture Organization (FAO) in 1981, RECAST carried out research works for the development of designing of improved cook stoves suitable for Nepal.

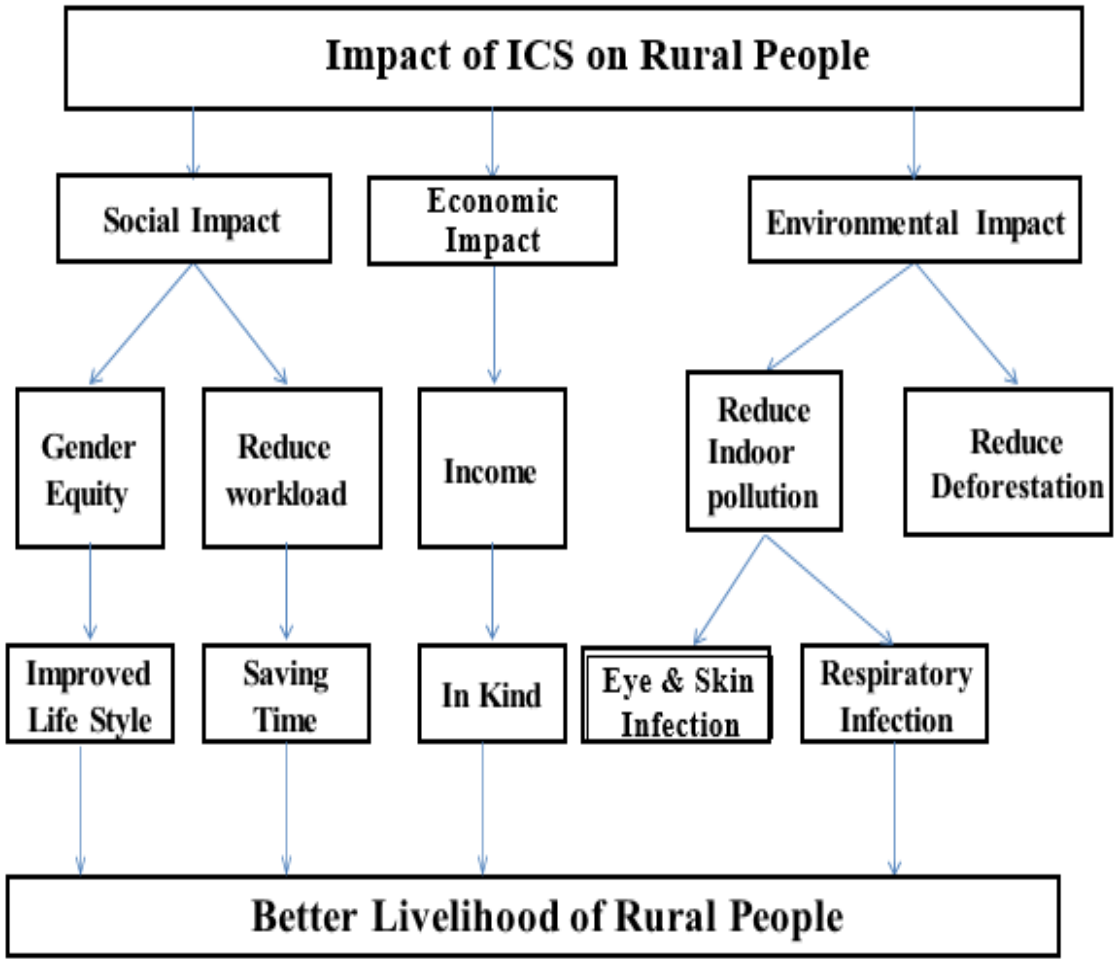
This is the first undertaking in the country with specified commitments for the development and dissemination of improved cook stoves in a large scale. As a result of the project activities, there has been a notable advance in the identification of suitable stove design and also in the dissemination of the improved types to the field in a sizable number. The government of Nepal accorded high priority to increase ICS installation in the country in the 9th plan. The national ICS programme (2002 - 2006) funded by Energy Sector Assistance Programme (ESAP) of DANIDA and executed by AEPC has disseminated about 300,000 ICS till June 2008, in 44 mid-hill districts by more than 2500 trained promoters out of which 50% are women. There are more than 90 local NGOs involved in the program and about 50,000 ICS is being disseminated every year. This has been perceived as a strong platform for the commercialization of ICS in the rural household of Nepal. Within the 10th plan period (2002-2007), the government of Nepal disseminated additional 250,000 numbers of ICS in the rural areas of the country. Government of Nepal is promoting ICS in the mid-hills without direct subsidies. However, in the high mountain districts, 50 per cent subsidy, not exceeding Rs. 2500/- is being provided on metal stoves (RECAST, 2016).

ICS promotion in Nepal is on the cross-roads of prospective future characterized by the following opportunities:

- The use of ICS is estimated to save 25-40% of fuel wood, plays great role to reduced smoke. Create hazards free health and sanitation situations at individual, family, community levels.
- The existence of the Network among ICS promoting organizations has helped in the process of institutionalization of the affiliated NGOs, which is also encouraged by the government.
- The Programme is primarily focused to the rural women with the appropriate strategies to build capacity at local level.

The following figure shows impact of ICS on Rural people:

Figure 2.1: Impact of ICS on Rural People



2.3.2 History of ICS in Nepal

In Nepal, biomass energy: fuelwood, agri-residue and animal dung is used for cooking and heating purposes. Use of traditional stoves such as "agenu" (open fireplace) and "chulo" (rudimentary stoves) consumes more fuel wood and increases the burden on women. Women are mainly responsible for cooking and collection of biomass, mainly fuelwood from the forest. Use of biomass energy and low-grade biomass fuels lead to excessive levels of indoor smoke/air pollution. Women and children in particular are exposed to the smoke emission. This is one of the reasons for higher rates of infant mortality and morbidity and other unhealthy living conditions. Release of incomplete carbon gas and other harmful particles in the atmosphere due to poor combustion of biomass fuels in rudimentary stoves results in

the emission of Green House Gas (GHG). More than 80% of the energy needs are met by fuelwood thus exerting immense pressure on the forest resources of the country with negative impacts on environment.

The history of Improved cooking stoves (ICS) programme is not long. ICS program started in early 1950s in Nepal. At that time "Hyderabad and Magan stoves" (an Indian model of ICS) were implemented as part of Village Development Services of the "*Tribhuvan Village Development Program*". That program was ended in the early 1960s. After that number of organizations such as UNICEF, Peace Corps etc. have integrated ICS dissemination in their other development activities during 1970s.

Large parts of the world population still rely on traditional biomass for their primary energy needs for cooking. Talking about the same case for developing Asia, 51 % of total populations residing there use traditional biomass as supplier of energy for cooking. About two-third of the total households (about 64 %) use Firewood as the usual source of fuel for cooking followed by LPG (21.03 %), cow dung (10.38 %). Bio-gas and Kerosene is used for cooking by 2.43 and 1.03 % of the total households respectively (CBS 2011). Attempts have been made for the proper utilization through the efficient and high-tech cookstoves which can bring significant positive impact on the environment, health and economic spheres of modern life. Nepal is a good testing ground for ICS adoption due to the prevalence of cooking technology that uses wood as the primary fuel source, since Nepal is plentiful in forests and scarce in natural gas, electricity and coal. Further, Nepal has experimented with ICS since the early 1980s (Manibog 1984), and the learning from its initial mistakes is paying dividends in the form of appropriate local designs and some success in implementing use of the ICS. We think studies that document the failure of the ICS reveal that successful learning from one context has not been transferred to others, and that the same mistakes are being repeated elsewhere. As the previous example indicates, large scale dissemination programs have met with low rates of success. Nepal shows the potential for success from a ground up strategy. Much may therefore be learned by other countries from Nepal's experience in this area. In 1980s the National Planning Commission included ICS in a Plan document in attempt to address the pressing fuel wood problem. In 1981 [[Community Forest

Development Project]] (CFDP) developed prefabricated ceramic ICS. In 1982, prefabricated ceramic stoves were tested, and after some modification, RECAST developed Ceramics Insert Stoves. During 1985 Small Farmer Development Project (SFDP) of Agriculture Development Bank (ADB/N) distributed Ceramic Insert Stoves. Other major organizations and projects which took up further ICS dissemination efforts include United Mission to Nepal (UMN), [Terai Community Forestry Development Project] (TCFDP), Nepal-Australian Forestry Project, [Resource Conservation and Utilization Project] (RCUP), CARE/Nepal etc. RECAST developed a new model of a stove known as "Improved Tamang Stove". They tried to make the stove with cheap readily available local materials. Since early 1990s, new initiatives from various NGOs, INGOs and GOs, for ICS dissemination have been underway. Most of the organizations working on ICS programs concentrate on mid hill and Terai regions, and they are mainly working on Mud Stoves.

According to Alternative Energy Promotion Centre (AEPC), there are no subsidies in ICS programs now. There used to be subsidy programs on ICS a few years ago, but now they only give training on building stoves using local resources and materials.

The development of mud brick stove by Research Centre for Applied Science and Technology, Nepal (RECAST) in early nineties relaunched the stove program. Indeed, since early 1990s, new initiatives for ICS dissemination create new stoves design, which can be built completely from cheap readily available local materials. The target-oriented approach was abandoned and replaced by a subsidized bottom-up and demand-driven approach. ICS was promoted and disseminated by various organizations with different financial arrangements such as with and without subsidies, equity participation by users etc. ICS became an important and integral component of development initiatives and was supported by quite a number of programs, donor agencies and promoting/disseminating organizations. The collective efforts of over 25such organizations together promoted about 40,000 improved stoves of various types (mud, metallic) in different districts of Nepal. In 1995, ICS network supported by Asia Regional Cook Stove Program (ARECOP) and managed by Centre for Rural Technology, Nepal (CRT/N) was established. The network has concentrated

its effort in bringing uniformity among approaches of various organizations involved by advocating a bottom up and subsidy less approach. The network is aimed at bringing together various organizations working in ICS promotion and dissemination and expanding the utilization of ICS. His Majesty's government of Nepal (HMG/N) provided policy guidelines to encourage development and application of energy saving devices as well as promotion and dissemination of alternate energy technologies from 9th plan (1997– 2002). HMG/N set a target of promoting 250,000 ICS during the plan period through the collective efforts of government, non-government organizations and the private sectors. However very little of the target was achieved. Within the framework of the 9th plan, the National ICS program has been initiated in Nepal from early 1999 with the support from Energy Sector Assistance Program (ESAP) of DANIDA and Alternative Energy Promotion Center (AEPC) of the HMG/N. Many district level NGOs and CBOs like the Centre for Rural technology (CRT/N) implement this programme. The general objective of this program is to establish a sustainable framework and strategy to make available technically and socially appropriate ICS in rural communities based on local capacity building and income generation. This program has been currently promoting ICS in 33 mid-hill districts of the country. Within the present 14th three year plan (2073/074-2075/76, GON) has further emphasized ICS dissemination with target to install 10,65,000 ICS as well as the development of research and development activities (14th three-Year Plan, GoN) . According to economic survey, the total number of ICS installed is 10,018 in the FY 2074/075 (during 8 month) in Nepal.

The history of the ICS is not new in Nepalese context. The development of Improving Cooking Stoves (ICS) can be divided into three phase. The first phase started in the 1950s by introducing "*Magan Chulo*" which originated in India. At that time, the village development services, "*Gramin Vikash Sewa*" started promoting ICS in some rural areas of Nepal. The program has aimed at uplifting the living conditions of the people and reducing exposure to smoke. However, the program was unsuccessful in terms of wider dissemination because of easy accessibility to the forest nearby as well as the low price of firewood.

The second phase started in the early 1970s and focused on improving fuel efficiency. Technological expertise about large mud stoves with a number of rings,

known as the “Lorena” stove, came from South America (Guatemala). The Women"s Training Centre of Nepal was involved in training women in the construction of Lorena Stoves. The main objective during this period was to find a solution to the fuel wood crisis and accompanying deforestation. In the late seventies, RECAST became involved in the improvement of these stoves and renamed them Nepali *chulo*.

The third phase, which began in the early 1980s, has taken up by research and development (R&D) and laboratory-based work. This included a detailed assessment of cooking-stove performance, standardized procedures for testing, and design methodologies to obtain higher performance and efficiency. The Lorena Stoves replaced by ceramic insert and Double Wall Stoves. These cooking stoves were design by RECAST under a contract with the HMG/UNDP/FAO Community Forestry Development Project (CFDP). Large-scale distribution has carried out by the CFDP. After some years, with support from UNICEF the ceramic cooking stoves and the new Nepali chulo were also introduced through the Agricultural Development Bank, Nepal (ADB/N), the Small Farmer's Development Project (SFDP) and the Women Development Division (WDD) through their Production Credit for Rural Women (PCRW) Program. Thousands of these stove were distributed some modifications to ceramic Tata Energy Research Institute (TERI) models were made, especially on the second ring and its size. Distribution was limited and confined only to the field trail. As in the first phase, socio-economic issues once again occupied the center- stage of activities. ICS Production had reviewed and planned for a self-propelling distribution process. (WECS, 2004).

Later the Tamang Stove (Improved Village Stove) introduced. It consist of a mud-brick or mudstone ICS with an iron tripod, which has driven into the combustion chamber to form a better foundation. It is a two-ring stove with a chimney (ceramic or mud-brick). The stove can withstand excessive force, Such as that exerted during cooking maize porridge. The chimney has modified for easy cleaning.

Laboratory based work, ceramic insert and double wall stoves replaced the Lorena stove. These stoves were design by RECAST under a sponsorship with the GON, UNDP, FAO, and CFDP. The ceramic cooking stoves and the new Nepali chulo also

introduced through the agriculture development bank. New modification stoves called Tamang completely from cheap readily available local materials stoves dissemination have been underway (CRT/N, 2003).

ICS is the reformed device of traditional cooking stove. Comparatively it consumes less fuel wood; it is easy to cook food, keeps the clean environment in kitchen room, and reduces the indoor pollution than the traditional cooking stove. Technically, it is simple and acceptable than the other stove like as LP gas, biogas, kerosene stove etc. the use of low-grade biomass fuel in traditional stoves leads to excessive levels of indoor air pollution. Women and children of rural and poor families are particularly exposed to the smoke emission. This is one of the reasons of higher rates of infant mortality in rural area. Release of incomplete carbon products in the atmosphere due to poor combustion of biomass fuel results greenhouse gas emission too (AEPC, 2000).

2.3.3 Present Status of ICS in Nepal

Despite more than forty years of ICS programme development implementation and research; ICS programs in rural Nepal have been of limited success. Presently, some national and international organizations are still rather reluctant to enhance ICS programs, and ICS related activities are given relatively low priority by development planners, managers and practitioners as well as by the rural communities themselves.

However, ICS development has had a comeback on the development agenda among NGOs in Nepal, and there is now consensus about the importance of ICS and the need of a new innovative approach to ICS dissemination, among potential stakeholders. Generally, the attitude and approach to ICS implementation has changed over the years from a supply-oriented, quantitative 'hardware' oriented approach, to more demand-oriented, qualitative 'software'-oriented approach. The expected achievement of Government of Nepal (GoN) is 1,425,980 ICS were installed until fiscal year 2075/076 (MoF, 2018).

HMG gives priority to a national ICS programme. AEPC came in the picture as Various NGOs/INGOs felt need from a national body being overall responsible for ICS co-ordination and dissemination. Hence, AEPC was mandated to work in ICS

when the Danida's Sectoral programme for Energy came in 1999 (Basnyat and Shrestha, 2003).

The following table shows total ICS installed at five years:

Table 2.1: ICS Installed at Last Five Years

Fiscal year	**2070/071**	**2071/072**	**2072/073**	**2073/074**	**2074/75 (First 8 month)**
Number of ICS installed	1,40,662	3,10,281	51,211	60,555	10,018

Source: Economic Survey 2074/075, MoF

2.3.4 Benefits of ICS

ICS is the new technology for cooking in rural villages of Nepal. It is reliable and cheapest sources of energy for the context of Nepal. So must of the people of village use for cooking. Nepal has not more energy sources as other developed countries. In the current context of the energy crisis, ICS is one of alternative sources of energy. ICS helps to save energy as use of traditional cooking stove waste energy while cooking food about 90 percent energy waste and only 10 percent energy is used in cooking food. Therefore, ICS help to save energy it also help to reduce pollution and save our environment .It is also easy to use than traditional cooking stove .It is affordable too. It does not need more cost for installation .Even it can be made by village woman by using local material after simple training.

It helps to minimize the consumption of firewood and keep the kitchen atmosphere safer and relatively smoke free, it certainly contributes to create a better rural environment. As a result, women and girls are spending less time and effort on gathering firewood, cooking, washing blacked utensils and heating water in inefficient ways. The time saved by women can be productively used in learning skills that help generate additional income for themselves and to get together in groups to save money, begin small individual or group enterprises and more importantly, to either talk about and participate in community social development work. Nowadays, use of ICS for water heating by attaching a back boiler on the side or around the chimney pipe is increasing in the mid hills and mountain regions of

Nepal. The materials required for the construction of ICS are locally available and includes stones/bricks, mud etc. In addition to the domestic ICS, promotion of institutional improved cook stoves in hotels, teashops, schools, hotels and barracks is being carried out (www.aepc.gov.np).

Aryal & Baral, (2004) described the role of ICS in the participatory Biodiversity conservaton. ICS were not of innovated concepts that contribute to the reduction of fuelwood use for house hold purpose. This study further found that ICS contribute to reduce the fuelwood consumption by 50%. This reduction of fuelwood use lessens the pressure on the community forest by fifty percent. This means more wild flora and fauna are conserved.

2.4 Traditional Cooking Stoves (TCS) and It's Problems

Traditional stove is a common stove that is widely used in rural areas to cook food and animal feed. The traditional method of cooking is on a three-stone cooking fire, tripod, mud stove with one or two holes, etc. The three-stone fire is the cheapest stove to produce, requiring only three suitable stones of the same height on which a cooking pot can be balanced over a fire. These stoves are inefficient; they consume a lot of firewood and fill the kitchen with smoke. These stoves are built in open space and fire is distributed widely even outside the stove. Therefore, pot could not absorb the heat so that takes more time to cook food. As a result, fire wood is used more and takes more time to cook. Due to this, women has to spend a lot of time collecting firewood and suffer from lung diseases and eye problems which are common in the rural areas. This also causes deforestation and imbalance in environment (REDP, 2003). Traditional stoves used in Nepal are simple structures made from clay or having stone or metal tripods. These stoves are very inefficient because they have poor air flow and insulation. As a result, they consume a lot of biomass and produce high levels of indoor air pollution.

Problems: Smoke is vented into the home, instead of outdoors, causing health problems. 3.8 million People a year die prematurely from illness attributable to the household air pollution caused by the inefficient use of solid fuels and kerosene for cooking. Among these 3.8 million deaths, 27% are due to pneumonia, 18% from

stroke, 27% from ischemic heart disease, 20% from chronic obstructive pulmonary disease (COPD), 8% from lung cancer (WHO, 2018).

However, this traditional cooking method also has problems:

- Fuel is wasted, as heat is allowed to escape into the open air.
- Only one cooking pot can be used at a time.
- The use of an open fire creates a lot of risk of burns and scalds. Oxygen may discharge burning e members and cause eye injuries.

2.5 Contextual Literature Review on ICS

The introduction and uptake of Improved Cook stoves (ICS) have been part of the wider development agenda since the 1940s to tackle the plethora of health, environmental, gender and safety issues surrounding traditional cooking methods (Anhalt and Holanda 2009). It can be claimed that many studies initially associated ICS with the improved efficiency and performance of biomass cookstoves however, fuel use and emissions testing have more recently also been used to investigate the broader health gains associated with ICS use (Albalak et al 2001). For example, (Grieshop et al 2011) looked at the health and climate benefits of several cooking options, including firewood, charcoal, kerosene and LPG based solutions and (Singh et al 2014) compared traditional and improved cookstoves in relation to indoor air pollution (IAP) in Northern India, finding that ICS usage leads to considerable reductions of both fuel usage and indoor air pollution. Other studies, however, have found that unless multiple 'low-cost, long-term and inconspicuous monitors' are used to measure daily stove usage, measurements of how stoves "affect outcomes such as health will be subject to unknown biases. These biases will also reduce our ability to understand what interventions might reduce harms from household air pollution" (Harrell et al 2016).

There have been several papers which have studied the emissions and fuel performances of different cooking options using different metrics and at the adoption barriers for ICS technology. Limited literature is also available on techno-economic models for the comparison of cookstoves and for estimating the costs of achieving regional, national and global cooking access targets. For instance, (Vaccari et al 2012)

compared cooking costs for a limited number of improved stoves in the Logone Valley (Chad – Cameroon). (Ekholm et al 2010) developed a cooking energy choice model and implemented it as the MESSAGE-Access model. Also, used the 'MESSAGE– Access' model to evaluate the policy trade-offs between climate mitigation and clean cook-stove access in South Asia. (Malla et al 2011) looked at possible rates of returns for different interventions on households cooking systems in Nepal, Kenya, and Sudan and included improved stoves, smoke hoods and LPG-based solutions. (Fuso Nerini et al 2015) created an optimization cost model comparing cooking solutions for a rural village in East Timor. Those techno-economic analyses generally found, depending on local characteristics, that modern firewood cooking could potentially result in decreased costs, while cooking with modern fuels such as electricity and LPG could potentially increase costs compared with traditional cooking.

However, there is a lack of easy-adoptable quantitative techno-economic models for comparing cooking solutions within the existing literature. This is in line with (Foell et al 2011), which urged for increased research in energy-economic models for cooking energy access and for targeted case studies applying those models.

Finally, several metrics have been (and are being) developed to measure access to cooking solutions. Two are predominant in the current cooking energy access dialogue, the International Organization for Standardization (ISO) standards for cook stoves proposed in the International Workshop Agreement (IWA) and the multi-tier Global Tracking Framework (GTF) for cooking energy access (IEA and the World Bank 2015). The first was developed in an International Workshop Agreement where a community of specialists worked to develop a tiered set of exposure, efficiency, and safety standards for clean cook stoves. In 2012, at the International Workshop in The Hague conveyed by the Partnership for Clean Indoor Air (PCIA) and the Global Alliance for Clean Cookstoves (GACC), more than 90 stakeholders from 23 countries reached a consensus on the tiers and indicators. This consensus takes also into consideration the latest World Health Organization guidelines on indoor pollution (WHO 2014). This metric was adopted in the paper for its unique detail in categorizing cooking solutions. The International Organization for Standardization (ISO) is currently developing the updated global standards for clean cooking

solutions, which were not released yet at the time of writing this paper (World Health Organization 2016). The multi-tier Global Tracking framework (GTF) for cooking energy access adopted some of the indicators agreed in the IWA tiers for their categorization of levels of energy access. This metric was adopted in the paper for its comparability to the IWA standards, and as a number of ongoing efforts promote the use of the Global Tracking Framework for monitoring country progress towards Sustainable Energy for All (Fuso Nerini 2016). Several other metrics are available, however none provide the combined technology detail and the reach of the two described above. For instance, a recent paper (Cameron et al 2016) also defined 3 "fuel tiers" of cooking energy access. Other metrics consider cooking in the overall metric, without however focusing on it. The Energy Development Index, developed by the International Energy Agency consider the share of modern energy use in the total final consumption by the residential sector as indicator for cooking energy access (IEA 2012). The Multidimensional Energy Poverty Index also consider cooking, using survey data on the type of used cooking fuel and indoor air pollution (Nussbaumer et al 2013).

2.6 Polices Review on ICS

- **Rural Energy Policy, 2006**

There are huge possibilities of producing energy in Nepal. Availability of enormous water resources and topographic situation gives rise to a potential for 83,000 MW of hydropower of which about 43,000 MW of power production seems to be economically and technically feasible. Till now, where only about 1044.6 MW has been harnessed which is mainly consumed in urban areas, the rural and remote areas of the nation has no access to reliable and clean energy. In the other hand, in spite of enough possibility of producing energy in rural areas in the form of biogas, solar energy, wind energy, improved water mill, micro and mini hydropower, it has not been used as per the needs.

According to the Rural Energy Policy, 2006 –Rural Energy‖ means energy that is environmental friendly and used for rural households, economic and social purpose such as Micro and Mini Hydro, Solar Energy, Wind Energy, Biomass Energy, etc. Rural energy is also known as renewable energy. The overall goal of this policy is to

contribute to rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in the rural areas. In order to achieve this goal, the "Rural Energy Policy" will have three objectives. First one is to reduce dependency on traditional energy and conserve environment by increasing access to clean and cost effective energy in the rural areas. Then second is to increase employment and productivity through the development of rural energy resources. Last one is to increase the living standards of the rural population by integrating rural energy with social and economic activities.

- **Subsidy Policy for Renewable Energy 2069 B.S.**

It was felt necessary to make adjustment in the existing subsidy policy for increasing the access to more remote part of the country and to the poorest and socially disadvantaged people. In addition, this subsidy policy should encourage private sector to commercialize the renewable energy technologies, and focus on better quality and service delivery in rural areas. The current subsidy policy is not smart and addresses the pro poor. The subsidy should link with the credit and it should be gradually replace by the credit in the long-term. Considering the subsidy to promote the technologies, and reduce the initial upfront cost so that the low-income households can afford the technologies to make the current subsidy policy equitable, inclusive and effective, this Renewable Energy Subsidy Policy, 2013 has been formulated. According to this policy

- No direct subsidy will be provided for the promotion of household mud improved cook stoves. But local bodies are encouraged to provide some financial support to install mud ICS to household with single woman, backward, disaster victim, poor and endangered ethnic group as identified by the Government of Nepal.
- The subsidy amount of Rs. 3,000 and Rs. 4,000 will be provided for household metallic improved cook stove for less than or two pot hole, and three pot hole types respectively. But such subsidy amount will not be more than 50percent of the total cost.
- The subsidy amount of Rs. 20,000 but not more than 50percent of the stove cost will be provided for the metallic improved cook stove to be installed in

public institutions like public school, hospital/health post, police and army barracks, religious places, and orphanage homes.

- The subsidy amount of Rs. 2,000 but not more than 50percent of the stove cost will be provided for the metallic rocket stoves less than or two pot hole.

2.7 Reviews of Related Studies

In this part I have reviewed few of old dissertation in related to improve cooking stove which will be helpful for the further my study.

According to sulpya 1986, "The ICS save firewood about 18-42percent and efficiency is 25-40percent".

The quake-hit folks of Langtang in Rasuwa district have been provided with the improved clay oven that saves cooking time, consumes less firewood and is smoke-free.A total of 116 smoke-free clay ovens were distributed to the locals with support from the non-governmental organisations managed after social initiatives. The ovens were taken to the village in a Fishtail Air helicopter, Sennurpu Tamang, a local resident said.With the distribution of the improved ovens, the life in the Himalayan region is expected to become easier due to better health of the folks and warm houses. It is learnt that the energy efficient stoves were imported from Lhasa of China (The Rising Nepal; Jan 5, 2018).

REDP (2000) studied on the application of biogas and ICS for forest saving showed that from biogas about 14,268 tons of biomass per year had been saved which was equivalent to 8,917 ha of forest and from ICS 420 tons of biomass per year equivalent to 262 ha of forest area. This study further identified that both biogas and ICS are important alternative energy techniques for sustainable supply of biomass energy in the country like Nepal.

BSP (2002) conducted the survey and found that carbon emission saving was 1419g-c and 3160g-c equivalent of carbon emission per day per households in summer and winter with the replacement of TCS by biogas in Terai.

Aryal & Baral (2004) described the role of ICS in the participatory Biodiversity conservation. ICS were not of innovated concepts that contribute to the reduction of

fuel wood use for house hold purpose. This study further found that ICS contribute to reduce the fuel wood consumption by 50%. This reduction of fuel wood use lessens the pressure on the community forest by fifty percent. This means more wild flora and fauna are conserved.

Banskota and Sharma (2005) studied the impact of a project “Capacity Building of Women for Energy and Water Management in the Himalayas” and found that ICS reduced 35% reduction in fuelwood consumption.

Aryal (2007) studied the fuelwood consumption pattern of mid hills and terai community and found that ICS and biogas technology play very effective role in the participatory conservation of forest and biodiversity in the community forest since they are effective for reducing the fuelwood demand. He further found that in the situation of fuel wood they have positive role in reducing the pressure in the forest by reducing the demand of fuel wood.

The problem of cooking over an open fire is the increased health problems brought on from the smoke, particularly lung and eye ailments, but also birth defects. According to the World Health Organization, "Every year, indoor air pollution is responsible for the death of 1.6 million people that’s one death every 20 seconds." Replacing the traditional 3-rock cooking stove with an improved one and venting the smoke out of the house through a chimney can dramatically improve a family’s health (WHO, 2009).

Pradhan (2006) has studied on impact of improved cooking stove on rural livelihood; A case study of siwalik area of chulachuli VDC of Ilam. The general objective of the study is to assess the impact of Improved Cooking Stoves on the rural livelihoods of Chulachuli VDC of Ilam District that includes the fuel wood consumption at the household level and impact on the health of women and children, time saving (collection of fuel wood and cooking), kitchen management and natural resource conservation and the specific objectives are to assess the social impact of Improved Cook Stoves, to assess the efficiency of ICS in terms for energy consumption and time saving, to assess the impact of ICS on health and environment. The research technique included household survey, interview with key informants and field observation. A total of 90 respondents were selected and of which 50 percent

respondents were female and 50 percent were male. The people of Chulachuli VDC have accepted improved cook stoves. Majority of them have been using two holes type since 2-3 years. The staffs of the organizations were seen as main motivators to construct ICS in Chulachuli. Most of the respondents said that maintenance was not required since the installation of ICS. Impact of ICS is visible in Chulachuli VDC. Time is also saved from improved cooking stoves. The average time saved during cooking was 0.44 hour compared to the traditional stoves. The ICS also helped to reduce frequency of fuel wood collection since the fuel wood consumption has reduced. The health problems were reduced resulting less medical expenses. Reduction in fuel wood collection, illegal tree felling and decreased in fire wood sale and forest was seen denser in Ilam Siwaliks. The pots do not get black due to smoke and takes less time to clean. Thus, the impact of the ICS is seen very positive in Chulachuli VDC.

Another study undertaken by Roshma Karki has studied on impact analysis of ICS in livelihood of rural women: a case study of sindure VDC, Lamjung district, Nepal. The study revealed that the impact analysis of the improved cooking stove over the traditional cooking stove and presents the facts and situation. It has been expected that the problems of cooking over an open fire such as health problems, lung and eye ailments, deforestation and saving of waste fuel as well as time saving of rural women have been solved. In addition, time consumption by using ICS compared to TCS is almost half. The workplace becomes smoke free and neat. All materials used in the ICS can be used again and again. Operation is convenient and easy. ICS needs regular, but easy maintenance.

Social acceptance and adoption easier compared to disseminating totally alien technologies. Financial, economic and risk analysis establishes the fact that both TCS and IICS are not financially feasible, but ICS has a financial benefit over TCS.

Likewise another study conducted by Jeewan panthi,on renewable Energy technology for reducing greenhouse gas emission and sustainable fuelwood harvesting: a case study of phenapati community forest, Bardia, Nepal.from this studies,the energy consumption scenario in this area is more or less similar to the national level. Most of the people are using biomass especially fuelwood burning in traditional cooking stoves. The use of efficient cooking stove is decreasing due to lack of proper

knowledge and people are shifting towards biogas. The other reason for the failure of the ICS was not an appropriate model in the site as there was a high chance of firing being the stack very short. Electricity is used in very less quantity and almost all the households are using it only for lighting purpose. Fuel wood, the major source of energy is collected only from nearby community forest in routine basis. Biogas users consume about 60.68% less than TCS while ICS users are using 38.12% less than TCS. Biogas has significantly reduced the fuelwood consumption at 95% confidence level but not significantly by ICS. The total use of kerosene in the area is 3,963 liters per year which is in decreasing order because traditional kerosene consuming lamps are being replaced by electric Tukimara lamp.

The another scholar Rupakheti (2014), has studied on improved cooking stove is a device that is designed to consume less fuel and save cooking time convenient in cooking process and create smoke less environment in the kitchen or reduction in the volume of smoke produced during cooking against the traditional stove the direct and indirect benefits of ICS were increased thermal efficiency, the conservation of forest by less fire wood consumption reduction in woman's labour, reduction in indoor air pollution and smoke released health disorder prevention of fire hazards, reduction of cooking time .

His study was conducted in Dhading district with specially focused to Jiwanpur VDC the main objectives of the study was to access the present situation of ICS on Dhading district to, to analysed the potentiality of improved cooking stove in Dhading district and find out problems and challenges of improved cooking stove in Jiwanpur VDC for this study descriptive and analytical research design have been adopted to obtain necessary information.

From above studies, ICS is most important technology in rural area of Nepal. There are many benefits of ICS in our daily life. It helps our life easier in health, socio-economic, time reduce etc. sector. So, government should be started ICS and Biomass technology in rural area of Nepal.

CHAPTER THREE

RESEARCH METHODOLOGY

Methodology is the backbone of the study. The research methodology is a systematic way of conducting the research is an effective and practical, so that it can explain how the research is done. The whole study will be carried out the basis of primary and secondary data. Reliable and relevant study can be made possible only by applying scientific methods. Hence the primary purpose of this chapter will discuss and design the framework of research. Different procedures of research methodology will be applied which are as follows:

3.1 Research Design

As the ultimate goal of the study was investigated the impact and current status of ICS in Ganjra, Achham. This was followed the combination of exploratory, descriptive and diagnostic research design. This research design was helped to interpret the quantitative as well as qualitative data and finding. My research have been the blueprint for the collection of data. I was looked into the problem by exploring the views of different set of respondents, as well as by exploring different literatures related with the research.

3.2 Rational of the Selection of Study Area

Last two year, ICS has emerged as an important source of alternative energy in B.J.R.M-1, Ganjra of Achham district. Therefore, the present study has been carried out in Ganjra village. As I am local inhabitant of the same district, so this place is familiar for me with the local culture and practices. The another reason is, it is easily accessible for me in data collection and field study of ward no.-1 of Bannigadhi Jayagadh rural municipality. It was well convinced that by the selection of this VDC, it could get more accurate information to fulfil my objectives easily and effectively under any circumstance than any other study area.

3.3 Nature and Sources of Data

Data is a set of fact. In this study, both primary and secondary data was used for required. Nature of data has been qualitative and quantitative for this research work. So Primary and secondary data is used in this study. Primary data and information were collected from field visit, household survey, focus group discussion, questionnaires, key informant interview by researcher himself similarly secondary data and information were collected mainly through VDC, DCC, NGOs, INGOS, Government reports, book, newspaper, articles, published and unpublished books and articles, online sources and so on.

3.4 Population, Sample size and Sampling Procedure

The total household of research place Ganjra is 334 households, where the number of men is 705 and the total number of women is 894. Among then, 40 male and 26 female (20% of total household) will be used at age 15-60 years who were the responds of this study. In research population of the study refers that population or number of people which was been directly involve to the study.

Any research study needed sampling procedure, so that I was selected to ward no 1 of Bannigadhi Jayagadh R.M. by purposive method. There are 334 households in Ganjra. Among them, I was selected 20% of total household by using simple random sampling method. Women are directly affected more than men from ICS. Women are too much busy in the kitchen for the purpose of cooking more than men. Therefore, I was selected 40 female and 26 male (20% of total household) will be used at age 15-60 years who were the responds of this study who represent all geography of study area.

3.5 Data Collection Technique and Tools

Primary data from households of Study area has been collected. To generate the primary data the household survey and focus group discussion techniques were applied. For the collection of the primary data structured questionnaires and checklist were applied.

3.5.1 Household survey

A household survey is research method & questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents who were ICS users. Questionnaire for this research study includes the questions related to the socio-economic status of the people, age, caste group, family size. Similarly, questions includes related to the ICS and health related issues. A face-to-face technique of data collection method of interview was applied to retrieve data from the respondents. Questionnaire survey for qualitative data collection methods is most helpful in getting the story behind a participant's experience and the interviewer can pursue in-depth information around this topic.

3.5.2 Focus Group Discussion (FGD)

The focus group discussion was held in two group with 8 & 10 participation per group discuss with aama Samuha & other users of ICS/stockholders (include with ward chairman) respectively at study area. This discussion was based on the impact of ICS on health of women, senior citizen and children and current status of ICS which was recorded in my mobile and noted in notebook.

3.6 Data analysis and Interpretation

The data obtained from different tools and techniques have been used according to requirement. At first I edited of founded data and coded them. Then the coded data have been converted into tables with numbers, averages and percentage through computer office programs as MS word and Excel. Different statistical measures like diagrams charts and tables were used in presenting the data. Statistical methods like percentage analysis were used to analyze the quantitative data. The study is based on qualitative description and explanations to analyze the quantitative data. Basic statistical tool and methods have been utilized to analyze results and interpret the concepts, results and discussions.

CHAPTER IV

DATA ANALYSIS AND INTERPRETATION

This chapter is based on analysis and data generation through questionnaire, observations & discussion of the ICS consumers. The data taken from field visit are presented in tabular forms and they are analyzed in different point of view in order to find the objectives of the study.

4.1 Introduction of the Study Area

4.1.1 Achham District

Achham District lies in the Sudurpaschim province of Nepal whose headquarter is Mangalsen. It's located at 29°6'40.95" Northen latitude and 81°17'55.78" East longitude. Its total area is 1,692 km². This hilly district is situated at far-western part of capital Kathmandu. Its shares Kalikot, Doti, Bajura, Surkhet & Dailekh. There are 6 rural municipalities and 4 municipalities at Achham. According to National Population and Housing Census 2011, the total population of the district is 257,469 with male 137,469 and female 120,008. The major occupations of people are agriculture.

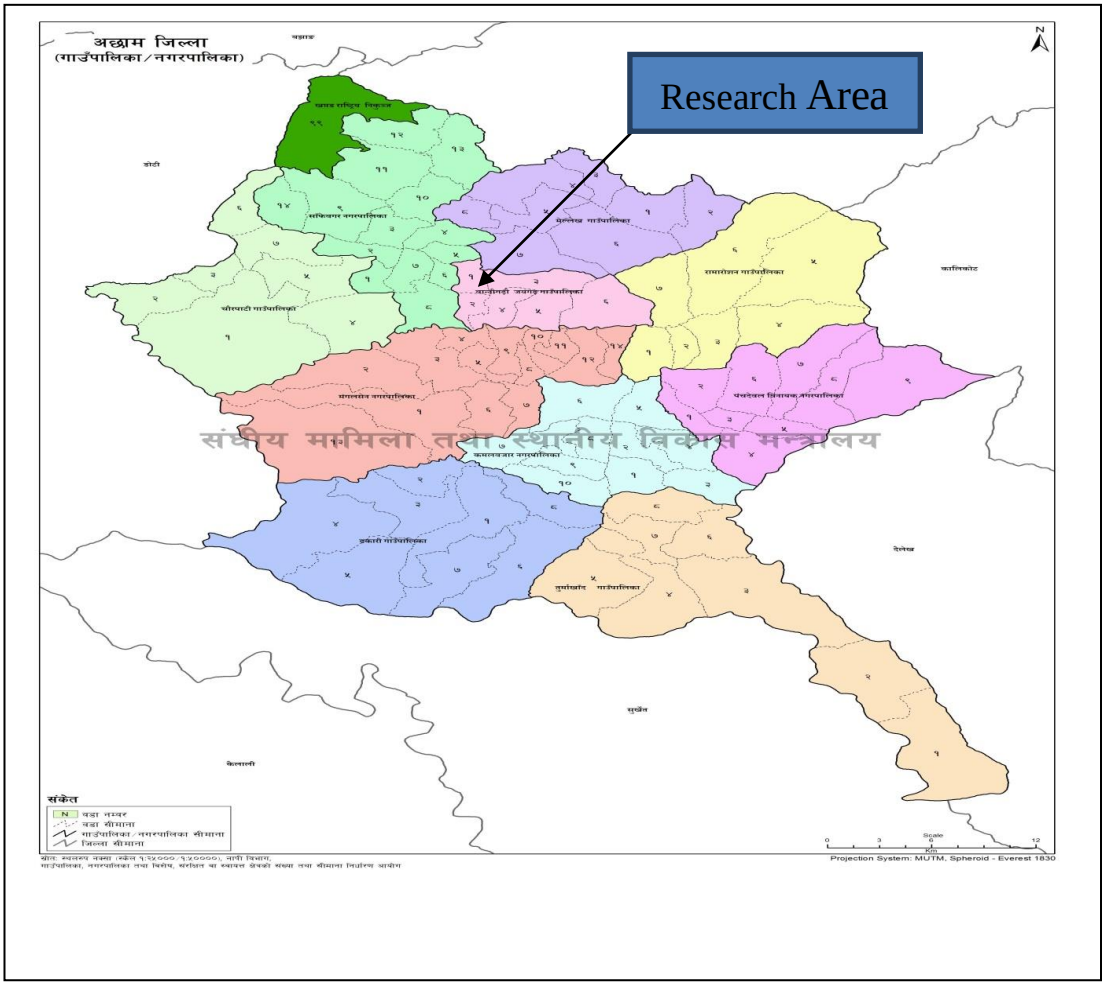
4.1.2 Ganjra Village

Bannigadhi Jayagadh Rural Municipality lies in north part from the Mangalsen (District Headquarter), Achham. Its total area is 58.26 km^2 and total population of this R.M. is 17,359 (CBS, 2011). It is 21 kilometres far from main business center Sanfebagar 20 K.M. far from Mangalsen. My research area is Bannigadhi Jayagadh Rural Municipality ward no 1, Ganjra which lies in 29°12'40.5" North and 81°15'27.5" East latitude and 1066 m. height from sea level. The total population of B.J.R.M. - 1, Ganjra according to the village profile 2070, was 1599 (705 male and 894 female). The numbers of households are 334. This B.J.R.M. - 1, Ganjra consists of various ethnic group but the dominating groups are Chhetri, Brahmin, Newar and Dalit. Nuclear family system represents the main basis of social structure (RUDEC, 2070).

Agriculture represents the main source of income of B.J.R.M. -1, Ganjra. The average farm size is so small and highly fragmented.The agricultural production consists of food grains such as wheat, maize, paddy and cash crops; livestock consists of cow, buffalo, goat and sheep; literacy estimated at out of 60 percent. There are two primaries, and one high school in B.J.R.M. -1, Ganjra.

There is one health post and five schools in Ganjra village. Transport and communication linkages on this village are somehow well because various parts of the village are moterable now. In addition, there are some public telephone booths and Nepal Telecom has provided mobile services too, which serves all the population of the Ganjra. Most of the population is benefitted from the electricity in the village. Out of 334 households, more than 285 households have installed ICS in their houses.

Figure 4.1: Map of Bannigadhi Jayagadh R.M. -1, Ganjra with Achham Map



Source: www.mofaga.gov.np

4.2 Occupation of the Respondent

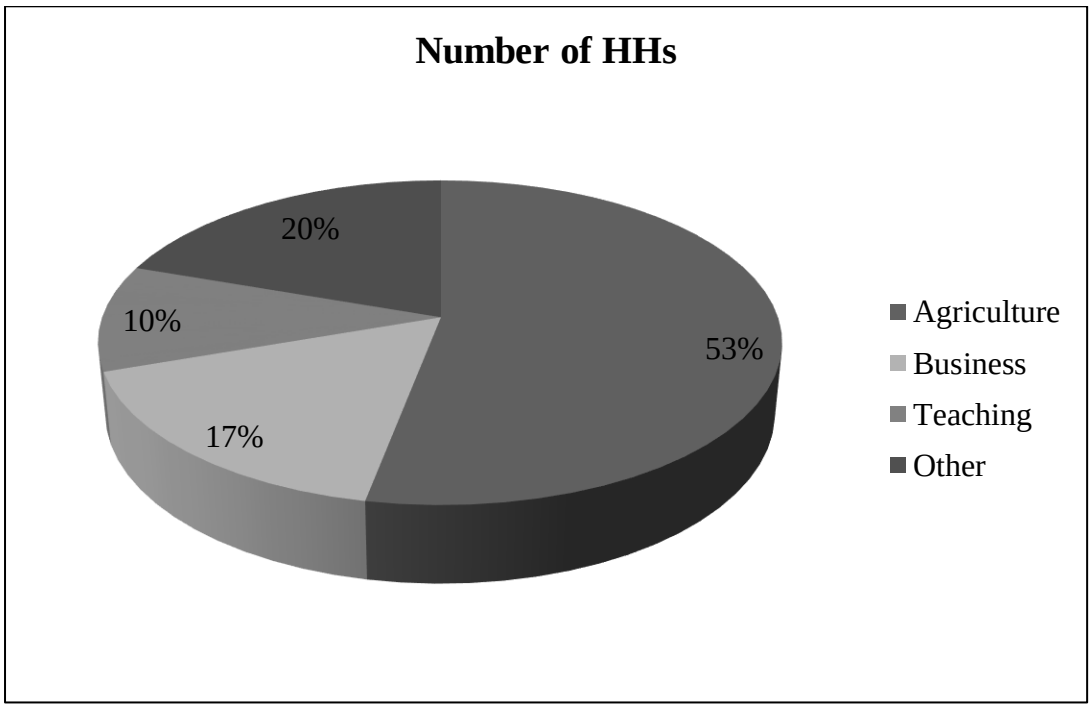
Occupation play a vital role in the technology installation and the informal utilization of any new trends of technology depends up on the occupation. In the study area most of the respondents are involved in agriculture occupation. So most of the farmers have installed ICS because they get fuel from their farm. Beside this teacher and business men also installed ICS in the study area.

Table 4.1: Occupational Status of Respondent

Occupation	Number of HHs	Percent of HHs
Agriculture	35	53
Business	11	17
Teaching	7	11
Other	13	19
Total	66	100

Source: Field survey 2018

Figure 4.2: Occupation of Respondent



From the above table 4.1 and figure 4.2, 53 percent respondents are involved in agriculture, 11 percent respondent has teaching occupation, 17 percent respondents have business occupation and 19 percent respondents are involved in other occupation. Most of the respondents of the study area are involved in agriculture. It can be also shown from column chart. The figure below presents the major occupation of the respondents.

4.3 Caste Affiliation

There are different castes and ethnic groups in Nepal. The people having different castes are inhabited in different localities with different professions and activities. The majority of Chhetries and Brahmins is mainly seen in mid-hills area.

Table 4.2: Caste Affiliation of the ICS Holders

Caste	Number of HHs	Percentage
Chhetri	41	62
Brahmin	2	3
Dalit	21	32
Newar	2	3
Total	66	100

Source: Field Survey, 2018

Among the total sampled households, Chhetries are the leading adopter of the ICSs (62%), followed by Brahmins (3%), Dalits (32%), Newars (3%) and very few belong to other castes. The other castes are socially and economically still backward in each sector.

4.4 Monthly Income of Respondents

Prosperity of the house-hold depends upon the source of income and its extent. Higher the income better will be the household status. The annual income of most Nepalese people based on agriculture. But here we need annual income from other sources like services, business and other sources. The power of purchasing capacity

also depends up the income of family.

Table 4.3: Monthly Income of Respondents

Monthly Income	Number of HHs	Percent
lesss than 1000	1	2
Rs. 1000-5000	15	23
Rs. 5000-10000	12	18
Rs. 10000-15000	16	24
Rs. 15000 & above	22	33
Total	66	100

Source: Field Survey, 2018

The data presented on above table no. 4 shows that diverse income range was observed among the respondents where majority of 2% house-hold have income less than one thousand per month, 23% respondents have monthly income above 1000-5000 ,18% respondents have monthly income 5000-10,000, 24% respondents have monthly income 10000-15000, 33% respondents have monthly income 15000 and above.

4.5 Duration of ICS Installed

In my survey area, all the people did not installable ICS in same time. So different people install ICS in different time depend on their willing.

Table 4.4: Duration of ICS Installation

Duration of ICS installed	Number of HHs	Percent
0 to 1 year	48	73
1 to 2 year	10	15
2 to 3 year	4	6
3 to 4 year	2	3
More than 4 year	2	3
Total	66	100

Source: Field Survey, 2018

This table shows of the ICS (73%) were constructed more less than one year. 15% percent respondents have installed it before 1-2 years. 6 percent constructed ICS before 2-3 years. 3 percent respondents have installed it before 3-4 years and again 3 percent respondents have installed it before more than 4 year . This shows that use of ICS is accepted by the people in Bannigadhi R.M.-1, Ganjra of Achham.

4.6 Type of ICS Installed

ICS may of various types. For example one hole, two hole and three hole. In study area some respondents have installed one hole ICS and some installed two hole.

Table 4.5: Types of ICS installed

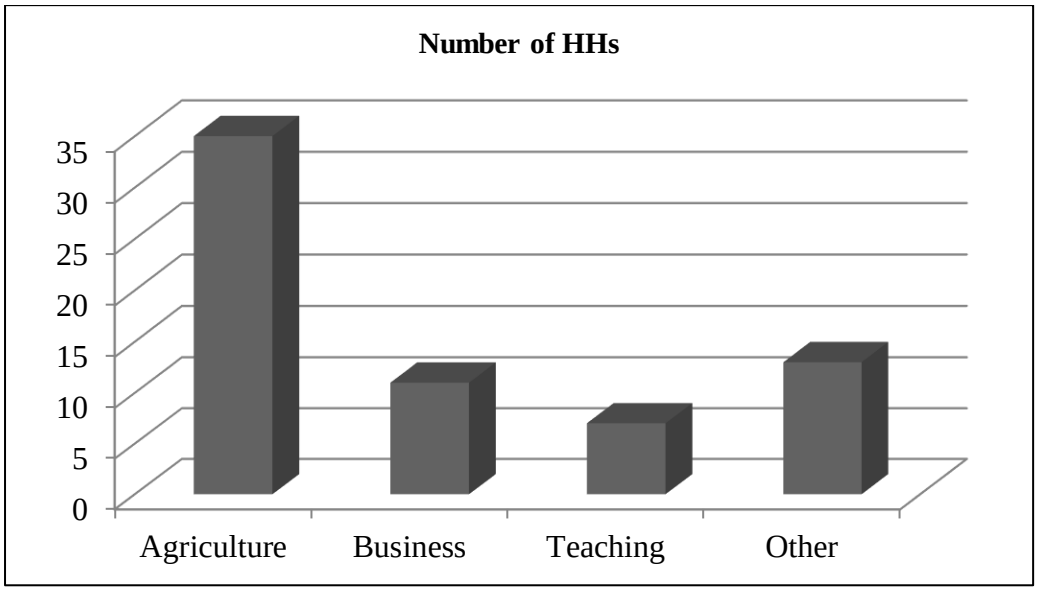
Type of ICS	**No. of HHs**	**Percent**
One hole	5	**8**
Two hole	59	**89**
Three hole	0	**0**
Other	2	**3**
Total	66	**100**

Source: Field Survey, 2018

From above table most of the respondents have installed two hole ICS, i.e. 89 percent, 8 percent respondents have installed one hole ICS, 3 percent of users have installed other ICS and no respondents have installed three hole ICS.

The following figure shows that types of ICS installed in Ganjra village.

Figure 4.3: Types of ICS Installed in Study Area



4.7 Motivation for ICS Installation

At my study area, most of people do not install ICS before. Then motivator provides information and knowledge about ICS and its benefits. Also Organization play vital role of motivator in installing ICS. Friends and groups members can also inspiring to install ICS.

Table 4.6: Motivators to Install ICS

Motivator to install the ICS	No. of HHs	Percent
Promoter/NGOs	40	61
Neighbor	13	20
Friends	6	9
Mother Group	7	10
Total	66	100

Source: Field Survey, 2018

From above table 61% users installed ICS inspired by promoter, 20% respondents installed it inspired by their neighbors, 9% respondents installed it inspired by friends

and 10% respondents installed it inspired by group member. It shows that role of Promoters, motivators, neighbor, friends and mother group have significant role in installation of ICS in my study area.

4.8 Money Spent in ICS Installation

ICS installation requires some cost. In past years it requires less money but now a day its cost is increasing slowly**.**

Table 4.7: Money Spent in ICS installation

Money spent	**No. of HHS**	**Percent**
Below 1000	5	8
Rs. 1000-2000	41	62
Rs. 2000-3000	17	26
Above Rs. 3000	3	4
Total	66	100

Source: Field Survey, 2018

From the above table 8 percent respondent answered ICS installation require Below Rs. 1000, 62 percent respondent answered ICS installation require Rs. 1000-2000, 26 percent respondent answered ICS installation require Rs. 2000-3000, 4 percent respondent answered ICS installation require above Rs. 3000 .

4.9 Use of Installed ICS

In my study area, the total numbers of ICS installed are 285 households. They are using of ICS for different purpose.

Table 4.8: Use of ICS

Use of ICS	No. of HHs	Percent
Cooking	60	91
Make animal food	3	4.5
Boiling water	3	4.5
Total	66	100

Source: Field Survey, 2018

From the above table majority of the respondents, i.e. 91 percent are using ICS for cooking purpose, 4.5 percent respondents use ICS to make animal food and 4.5percent respondents use ICS to make liquor. From this, we can conclude that the perception towards ICS has been changed and people are accepting the improved technology.

4.10 Source of Firewood Collection for Fuel

Firewood is important for ICS as fuel. There are different source of firewood. People may manage firewood from community forest, private forest, from own farmland, where as some people buy firewood and etc.

Table 4.9: Source of Fire Wood

Source of firewood	No. of HHS	Percent
Community forest	51	77
Private forest	5	8
From own farmland	10	15
Buy	0	0
Total	66	100

Source: Field Survey, 2018

From above table 77 percent respondents answered they brought firewood from community forest, and there is no government forest, 8 percent respondents answered they brought firewood from private forest, 15 percent respondents answered they

brought firewood from their own farm land and zero percent respondents answered from buy. We can conclude that most of the respondents brought fire wood as fuel from community forest.

4.11 Impact and Benefit of ICS

The impact of ICS will be analyzed on firewood consumption, saving in cooking time, impact on health of women, senior citizen, children and environment etc. They are as follows:

4.11.1 Amount of Fuel Wood Save Using of ICS than TCS

Both TCS and ICS require fuel wood. That means fuel wood is very important for these stoves to perform work. Fuel wood consumption by these stoves may differ. One stove may consume more fuel wood and another may consume little fuel wood.

Table 4.10: Amount of Fuel Wood Saved when Uses of ICS than TCS in a Week

Amount of Fuel Wood save when using of ICS in a week	**Number of HHs**	**Percent**
1 *Bhari*	10	15
1.5 *Bhari*	13	20
2 *Bhari*	35	53
2.5 *Bhari*	8	12
Total	66	100

Source: Field Survey, 2018

From the above table 15 percent respondents answered amount of fuel wood save 1 *bhari* when using of ICS than TCS in one week. 20 percent respondents answered amount of fuel wood save 1.5 *bhari*, 53 percent respondent answered amount of fuel wood save 2 *bhari* and 12 percent respondents answered amount of fuel wood save 2.5 *bhari* when using of ICS than TCS in a week. From these answer of respondents we can conclude that TCS require more fuel wood in comparison to ICS.

4.11.2 Saving Time in Collection of Firewood

Before installation of ICS, they used average 2.3 bhari of fuel wood. For the collection of such quantity of fuel wood, they have to allocate 3.45 hrs per week. But after installation of biogas, they used only 1.16 bhari fuel wood in a week, for the collection of such fuel wood. They have spent 1.74 hrs per week. Thus the net saving time after installation of ICS was (3.45 before – 1.74 after) 1.71 hrs per week per household or 0.24 hrs per family/day.

4.11.3 Time Consumption for Cooking

It was not that easy to identify time utilization by respondents in terms of direct benefits. Normally people do not record time for any work they do in the rural areas. Every activity is seen as routine work that is not recorded in their memory too. However, respondents mentioned that there has been decrease in cooking time after installation of the ICS.

Table 4.11: Time Taken by Traditional Stove and ICS

Cooking Time	TCS		ICS	
	No of HH	**Percent**	**No of HH**	**Percent**
Less than 1 hour	5	7	19	29
1-1.5 hour	11	17	35	53
1.5-2 hour	33	50	9	14
2-2.5 hour	17	26	3	4
Total	66	100	66	100

Source: Field Survey, 2018

From the above table 7 percent respondents answered less than one hour time required for cooking food by TCS where as 29 percent respondents answered less than one hour time was enough for cooking food in ICS, 17 percent respondents answered 1-1.5 hour time require for cooking food in traditional stove where as 53 percent respondent answered 1-1.5 hour time is enough for cooking food in ICS, 50 percent respondents answered 1.5-2 hour time is required for cooking food in TCS where as 14 percent respondents answered 1.5-2 hour time is required for cooking

food in ICS and 26 percent respondents answered 2-2.5 hour time is required for cooking food in TCS where as 4 percent respondents answered 2-2.5 hour time is required for cooking food in ICS . From above table we found that less time is required for cooking food in ICS than Traditional Cooking Stove (TCS).

4.11.4 Health Problem in Women and Children before Installation of ICS

There was many health problem due to smoke comes from traditional stove. Smoke may cause different health problem like respiratory problem, eye problem, cough and cold, chest pain, asthma, headache etc**.** Indoor air pollution is a significant threat in households using TCS. Many people living in rural areas of Nepal, burn biomass for cooking and heating. Specifically, indoor air pollution affects women, senior citizen and children far more than any other sector of society. Women typically spend three to seven hours per day by the fire, exposed to smoke, often with young children nearby. This survey also revealed that significant proportion of the households were suffering from various health problems before ICS installation because of smoky environment resulting from TCS.

Table 4.12: Health Problem in Women, Children and Senior Citizen

Health Problems	No. of HH before Installation of ICS	Percent
Respiratory	12	18
Cough and Cold	19	29
Asthma	6	9
Eye problem	9	14
Headache	20	30
Total	66	100

Source: Field Survey, 2018

From above table 18 percent respondents were suffered from respiratory problem, 29 percent respondents answered they were suffered from cough and cold, 9 percent respondents answered they were suffered from asthma, 14 percent respondents answered they were suffered from eye problem and 30 percent respondents answered they were suffered from headache. It shows that there were many health problems from use of TCS.

4.11.5 Money Spend in Health Checkup of Women and Children Before and After ICS Installation

There found many health problem from smoke comes by use of stoves. But traditional stove produces more smokes than ICS. Woman and children will be fall sick if the stove produces more smoke and require more money for their health checkup. Similarly woman and children will fall less sick if the stove produces little smoke and require less money for their treatment.

Table 4.13: Money Spent in Health Checkup

Money spend in health checkup annually	TCS		ICS	
	No. of HH	Percent	No. of HH	Percent
Less than Rs. 1000	5	7	35	53
Rs. 1000-3000	11	17	15	23
Rs. 3000-6000	33	50	5	7.5
Rs. 6000 and above	10	15	1	1.5
No idea	7	11	10	15
Total	66	100	66	100

Source: Field Survey, 2018

From above table, 7 percent respondents answered less than 1000 rupees spend in health checkup annually while using TCS where as 53 percent respondents answered less than 1000 rupees spend in health checkup annually while using ICS, 17 percent percent respondents answered 1000-3000 rupees spend in health checkup annually while using TCS where as 23 percent respondents answered 1000-3000 rupees spend in health checkup annually while using ICS, 50 percent respondents answered 3000-6000 rupees spend in health checkup annually while using TCS where as 7.5 percent respondents answered 3000-6000 rupees spend in health checkup annually while using ICS,15 percent answered 6000 & above rupees spend in health checkup annually while using TCS where as 1.5 percent respondents answered 6000 & above rupees spend in health checkup annually while using ICS and 11 percent respondents answered no idea in health checkup annually while using TCS where as 15 percent respondents answered no idea in health checkup annually while using ICS. From the

table we found more money spend in health checkup annually while using TCS in comparison to ICS.

4.11.6 Improvement on Health After Installation of ICS

I found significant improvement in health of women, senior citizen and children after installation of improved cook stoves in the rural areas.

Table 4.14: Health Status after Installation of ICS

Improved health after ICS installation?	No. of HHS	Percent
Health condition is same as before	7	11
Yes but not serious as before	26	39
No problems at all	33	50
Total	66	100

Source: Field Survey, 2018

From the above table 11 percent respondents answered there exist health problem same as before ICS installation, 39 percent respondents answered there exist health problem but not serious as before ICS installation and 50 percent respondents answered there is no problem at all after installation of ICS.

4.11.7 People Suffered from Different Type of Disease Cause by Smoke in Bannigadhi Jayagadh R.M. Ward no. 1 from the Year 2016 to 2018.

Traditional Cooking Stove (TCS) produce more smoke, which influence the health of stove user mainly women, senior citizen and children. Smoke may cause different types of disease like respiratory problem, headache, eye problem, asthma etc. Data on, people (of B.J. R.M.-1, Ganjra village) suffered from disease caused by smoke collected from Bayalpata Hospital are tabulated and analyzed below.

Table 4.15: People Suffered from Smoke Over 3 years

Disease	Number of People of Ganjra village suffered from Smoke		
	Year 2016	Year 2017	Year 2018
Eye problem	5	2	0
Asthma	8	5	3
Head ache	14	10	5
Respiratory Problem	6	7	4
Total	33	24	12

Source: Field survey, 2018 / Bayalpata Hospital, Achham.

From the above table we found no. of patient due to smoke is decreasing in study area from 2016 to 2018.Total no of patient due to smoke are 33, 24 and 12 in year 2016, 2017 & 2018 respectively. This shows that decreasing the number of patient due to smoke. That means people of this area are became more health conscious and start to use less smoke producing stove like ICS, LP gas etc.

4.11.8 Impact on Environment

The study also tried to find the impact of ICS on environment which was completely based on the general perception of respondents. As ICS produce less smoke in comparison to TCS, so ICS is environment friendly stove.

Table 4.16: Impact on Environment of ICS

Impacts	No. of HHS	Percent
Compared to 3 years back, forest looks thick	10	15
Illegal tree falling is reduced	10	15
Minimized firewood sale	5	8
Firewood collection load is reduced	33	50
Others	8	12
Total	66	100

Source: Field Survey, 2018

From the above table 50 percent respondents answered reduced in firewood collection load, 15 percent respondents answered reduced in illegal tree falling, 8 percent respondents answered minimized in firewood sale, 15 percent respondents answered forest look thick as compared to 3 years back and 12 percent respondents answered other. We can conclude that reduction in illegal tree felling from the forest and decrease in firewood sale supports conserving the forest. So, ICS helps to conserve of forest and support bio-diversity.

4.12 Current Status of ICS

4.12.1 Maintenance of ICS

Operation and maintenance is one of the vital aspects in the successful dissemination of ICS. The frequency of maintenance here means not repairing but frequent maintenance like chimney cleaning. As smearing with cow dung and mud is a daily job, this is not accounted under maintenance category. Even though ICS needs maintenance than the traditional stoves.

Table 4.17: Number of ICS Maintenance

Frequency of ICS Maintenance	No. of HHs	Percent
Once	9	14
Twice	4	6
Thrice & above	3	4
Not yet repaired	50	76
Total	66	100

Source: Field Survey, 2018

From the above table majority of the respondents i.e., 76 percent respondents have not yet repaired their ICS. 14 % of users have repaired their ICS only once time, 6 percent respondents have done maintenance twice from the installation, 4 percent respondents have done maintenance 3 times & more from its installation. This shows that ICS users do not have to spend more time and cost in repair and maintenance.

4.12.2 Problem facing ICS

There are some problems of ICS users when use of ICS at their home. These are the problem of ICS users in my study area.

Table 4.18: Problems Facing by ICS Users

Problems from ICS	Number of HHs	Percent
Direction of chimney against wind direction	2	3
Does not burns wood properly	4	6
Consumes more firewood	3	5
Cook food slower than traditional stove	2	3
No one of above	55	83
Other	0	0
Total	66	100

Source: Field Survey, 2018

From above table 3 percent respondents facing problem like direction of chimney against wind direction, 6 percent respondents answered does not burns wood properly, 5 percent respondents answered consumes more fire wood than in traditional stove, 3 percent respondents answered cook food slower than traditional stove were the problem faced by using ICS, 83 percent respondents replied no one of above and they like use of ICS and zero percent respondents answer they are facing other type of problems.

4.12.3 Number of Drop out Respondents out of 66 Households

There were 66 sample households. All the HHs we take do not use ICS continuously that means few of these HHS have been left it to use.

Table 4.19: Number of Drop out Respondents

Respondents	No. of HHS	Percent
Dropper	3	4.5
Non dropper	63	95.5
Total	66	100

Source: Field Survey, 2018

From the above table 95.5 percent respondents were continuously using ICS from its installation where as 4.5 percent respondents have been left it to use or dropper.

4.12.4 Causes of Drop Out

In my field study I found some drop out respondents who have been use ICS in past but due to certain reason they left it to use and now a days they use other types of stove.

Table 4.20: Causes of Drop Out

Causes	No. of HHS	Percent
Smoke not pass out	2	66.67
Consume more fuel wood	1	33.33
Total	3	100

Source: Field Survey, 2018

From the above table out of ICS dropper respondent, 33.33 percent drop out respondents answered ICS consume more fuel wood was the cause of their drop out, 66.67 percent drop out respondents answered smoke not pass out while using ICS was the cause of their drop out.

4.13 Level of Satisfaction from ICS

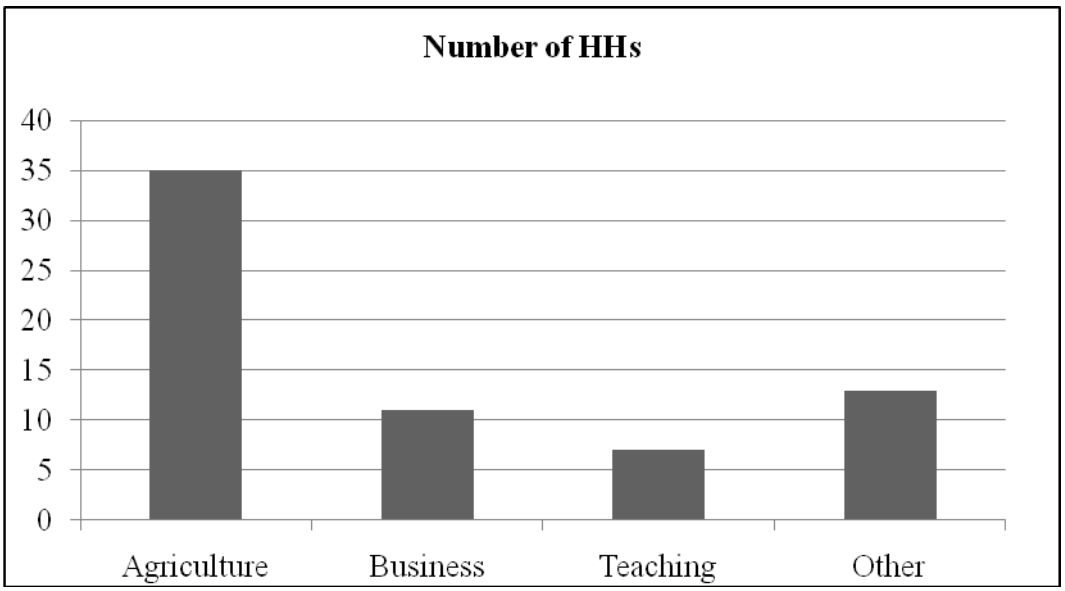
All people didn't satisfy from ICS in my study area. The level of satisfaction from ICS given below.

Table 4.21: Level of Satisfaction from ICS

Level of Satisfaction from ICS	Number of HHs	Percent
Fully Satisfied	25	38
Satisfied	33	50
Neutral	5	8
Dis-Satisfied	3	4
Total	66	100

Source: Field Survey, 2018

Figure 4.4: Level of Satisfaction from ICS



This table 4.21 & figure 4.4 shows that most of the people satisfied from ICS. 38 percent people are fully satisfied, 50 percent people are satisfied, 8 percent people are neutral & 4 percent people are dis-satisfied from ICS. From this data we can say effect of ICS in my study area is very well.

CHAPTER V

FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter is final and last chapter of this research study which has been divided into Major Findings, conclusion and recommendations.

5.1 Major Findings

ICS is becoming popular in the rural area of Nepal as a renewable energy for daily life. In this context, the present study on the socio-economic impact and current status of ICS in the Bannigadhi Jayagadh R.M. -1, Ganjra of Achham district. The study was based on a sample of 66 households which was about 20% of the total ICS users of the study area and they were selected by applying judgmental sampling procedure. The main objective of the study was to assess the impact and current status of ICS installation. This included both positive as well as negative impacts.

The study has shown how the ICS helped to save firewood, reduced workloads, saved time and improvement on the health and sanitation. Use of slurry in regard to agriculture production is also been dealt. Following are some of the highlights of major finding/summary:

- The study shows that various caste's people are living at my study area, i.e. Brahman, Kshetri, Dalit and Newar and all caste people has installed ICS at their home.
- All these 66 HHs who are the users of ICS taken as sample HHs.
- Average household size of study area is 4.8.
- Major occupation of the sample HHs, Agriculture 53%, Teaching 11%, business17% and others19%.
- In the study area 61% HHs installed ICS after getting information from promoter/NGOs while 20% household installed ICS inspired by neighbor.
- 8 percent respondent answered ICS installation require Below Rs. 1000, 62 percent respondent answered ICS installation require Rs. 1000-2000, 26 percent respondent answered ICS installation require Rs. 2000-3000, 4

percent respondent answered ICS installation require above Rs. 3000 .

- In the study area 2% house-hold have income less than one thousand per month, 23% respondents have monthly income above 1000-5000 ,18% respondents have monthly income 5000-10,000, 24% respondents have monthly income 10000-15000, 33% respondents have monthly income 15000 and above.
- Majority of the ICS (73%) were constructed at 0-1 year. 15 percent respondents have installed it before 1-2 years. This shows that use of ICS is accepted by the people of my study area.
- In the study area most of the respondents have installed two hole ICS i.e. 89 percent and 8 percent respondents have installed one hole ICS and 3% respondents have installed other ICS.
- In the study area 91 percent respondents are using ICS for cooking purpose, 4.5 percent use to make animal food and 4.5 respondents use ICS for boiling water.
- In my study area 77 percent respondents answered they brought firewood from community forest, and there is no government forest, 8 percent respondents answered they brought firewood from private forest, 15 percent respondents answered they brought firewood from their own farm land and zero percent respondents answered from buy. We can conclude that most of the respondents brought fire wood as fuel from community forest.
- There is 15 percent respondents answered amount of fuel wood save 1 *bhari* when using of ICS than TCS in one week. 20 percent respondents answered amount of fuel wood save 1.5 *bhari*, 53 percent respondent answered amount of fuel wood save 2 *bhari* and 12 percent respondents answered amount of fuel wood save 2.5 *bhari* when using of ICS than TCS in a week. From these answer of respondents we can conclude that TCS require more fuel wood in comparison to ICS.
- The net saving time after installation of ICS was 1.71 hrs per week per household or 0.24 hrs per family/day.
- In my study area 7 percent respondents answered less than one hour time required for cooking food by TCS where as 29 percent respondents answered less than one hour time was enough for cooking food in ICS, 17 percent

respondents answered 1-1.5 hour time require for cooking food in traditional stove where as 53 percent respondent answered 1-1.5 hour time is enough for cooking food in ICS, 50 percent respondents answered 1.5-2 hour time is required for cooking food in TCS where as 14 percent respondents answered 1.5-2 hour time is required for cooking food in ICS and 26 percent respondents answered 2-2.5 hour time is required for cooking food in TCS where as 4 percent respondents answered 2-2.5 hour time is required for cooking food in ICS .

- There are 7 percent respondents answered less than 1000 rupees spend in health checkup annually while using TCS where as 53 percent respondents answered less than 1000 rupees spend in health checkup annually while using ICS, 17 percent percent respondents answered 1000-3000 rupees spend in health checkup annually while using TCS where as 23 percent respondents answered 1000-3000 rupees spend in health checkup annually while using ICS, 50 percent respondents answered 3000-6000 rupees spend in health checkup annually while using TCS where as 7.5 percent respondents answered 3000-6000 rupees spend in health checkup annually while using ICS,15 percent answered 6000 & above rupees spend in health checkup annually while using TCS where as 1.5 percent respondents answered 6000 & above rupees spend in health checkup annually while using ICS and 11 percent respondents answered no idea in health checkup annually while using TCS where as 15 percent respondents answered no idea in health checkup annually while using ICS. From that data we found more money spend in health checkup annually while using TCS in comparison to ICS.
- 11 percent respondents answered there exist health problem same as before ICS installation, 39 percent respondents answered there exist health problem but not serious as before ICS installation and 50 percent respondents answered there is no problem at all after installation of ICS.
- 50 percent respondents answered reduced in firewood collection load, 15 percent respondents answered reduced in illegal tree falling, 8 percent respondents answered minimized in firewood sale, 15 percent respondents answered forest look thick as compared to 3 years back and 12 percent respondents answered other. We can conclude that reduction in illegal tree

felling from the forest and decrease in firewood sale supports conserving the forest. So, ICS helps to conserve of forest and support bio-diversity.

- In Ganjra village 3 percent respondents facing problem like direction of chimney against wind direction, 6 percent respondents answered does not burns wood properly, 5 percent respondents answered consumes more fire wood than in traditional stove, 3 percent respondents answered cook food slower than traditional stove were the problem faced by using ICS, 83 percent respondents replied no one of above and they like use of ICS and zero percent respondents answer they are facing other type of problems.
- 95.5 percent respondents were continuously using ICS from its installation where as 4.5 percent respondents have been left it to use or dropper where 33.33 percent drop out respondents answered ICS consume more fuel wood was the cause of their drop out, 66.67 percent drop out respondents answered smoke not pass out while using ICS was the cause of their drop out.
- In my study area, 38 percent people are fully satisfied from ICS, 50 percent people are satisfied, 8 percent people are neutral & 4 percent people are dis-satisfied from ICS. From this data we can say effect of ICS in my study area is very well.

All the surveyed ICSs are in good running condition. The promoter, NGOs, Government office had provided short trainings to the households, therefore users could do minor repair works by themselves whenever needed.

5.2 Conclusion

The outcomes of the study suggested that the main benefit of ICS to its owner was cooking facility that saved a considerable amount of money if the plant and appliances worked smoothly. Besides this, other benefits such as time saving, convenient in cooking, reduction of indoor air pollution resulting is several health benefits were also cited. This study deals with the general impacts of the ICS on the users and its current status. In general, ICS were found to have very positive impacts on the user, which is well appreciated by them the total time saving of 0.79 hrs per day family or an average from the installation of ICS suggests that it has been successful to lower the family workload.The study shows that respondents are accepting the improved technology by

knowing its benefits and efficiency. *Malika Vikash Sangh Nepal*,local governance are working actively to motivate people for installation of ICS. Generally, in the rural areas new technologies are not accepted due to lack of proper information, lack of money, tedious to maintain after installation etc. However, in the case of *Ganjra* village, some respondents reported that maintenance was done 1-2 times after the construction. This shows that, maintenance was not a great problem while usingICS. Greatest percentage of houses spent big money for heath checkup before installation of ICS whereas there was very lower percentage of houses who were spent large money for health checkup after installation of ICS. It reflects the benefit of ICS.Smoke not pass out was the major cause of being dropped out after installation of ICS among other causes therefore there must be concerned while installing the ICS. There should be concentration regarding the technique of maintenance after installation, direction of air and so on. On this matter, technician should aware about this technology and must inform the proper information related to ICS uses to the people. Overall, the findings of the study showed that ICS is effective in reducing forest pressure. It not only save energy but also save money.Fuel wood collection and cooking are two major activities which directly showed the saving of time after installation of ICS however fuel wood collection and consumption was higher before installation of ICS. The women and children do not have to go to forest for collection of fuel wood. The time can be used to another activities like income generating activities, agriculture, caring livestock and cleaning house and most importantly health is being well day after day as compared to that of before installation. Therefore it is necessary to make a reliable policy to install ICS properly and must spread this technology throughout the rural area of Nepal which will be beneficial for poor people and health cost will be reduced and people will be more productive which is effective in country's economy. Conservation of forest has a greater part in the protection our surrounding environment. Forest plays or important role in the formation and conservation of soil, and affect rainfall. ICS has been proved very useful especially for the women members of the family.

5.3 Recommendations

This study reveals that there is a need for a lot of improvement in the present role of promoters and method of ICS construction and maintenance to achieve a qualitative product and provide more benefits to the ICS users. Based on the study following recommendations are made for its wider applications.

- The subsidy, which have been providing by the government should be increased and focused to those section of people who were neglected or marginalized.
- Due to the lack of resources and manpower, the promoters may not be able to send technical manpower to all constructed stoves but this problem can be solved if the respective ICS users are provided with an operation and maintenance training. This will be more useful because ICS users can easily repair and maintain ICS themselves.
- Supervision which has been conducting by local government should be regularizing because low quality construction may bring negative impacts on the users. Effective monitoring and evaluation of various institutions and programs on ICS should be done in regular basis.
- The promotional activities is required both at local as well as national level. At local level companies should distribute the pamphlets with picture, some documentary and arrange workshops which can easily aware local people. Besides these, they should give some advertisement, through newspapers, radio and television.
- Although government has given some space for ICS promotion in its 14th three year plan, implementation in the field is negligible. ICS program is seen as the program of development agencies only. Thus, this should be integrated with ward level programme. This also helps to sustain the programme in the long run.
- It has been that farmers do not know proper utilization of slurry from ICSs therefore training for better management of slurry should be given to them.
- Most of the ICS owners were male but most of the users were females so the training should be given for users but not for owners.

- ICS is necessary for all rural people, so that the government considerably in maintained and manage in the above recommended point as well as local government should be involved in implementation.

ANNEX I (Questionnaire)

1. General Information of the Respondents

   a) Name: b) Sex:

   c) Address: d) Age:

   e) Occupation:

2. Monthly income of your family from your occupation is…..

   a) Less than 1000 b) Rs. 1000-5000

   c) Rs. 5000-10000 d) Rs. 10000-15000

   e) Rs. 15000 & above

3. Where do you collect firewood from?

   a) Community forest b) Private forest

   c) Own farmland d) Buy

   e) other ….....

4. When did you install ICS at your home?

   a) Less than 1 year b) 1 to 2 year

   c) 2 to 3 year d) 3 to 4 year

   e) more than 4 year

5. How much time do you spend to collect fuel wood?

……. Mins/hour

6. How much time did you require to prepare food in Traditional stoves?

   a) Less than 1 hour b) 1-1.5 hrs.

   c) 1.5 - 2 hrs. d) 2 - 2.5 hrs.

7. How long it takes to prepare food in improved cooking stoves?

   a) Less than 1 hour b) 1-1.5 hrs.

   c) 1.5 - 2 hrs. d) 2 - 2.5 hrs.

8. Which type of stove have you installed?

   a) One hole b) Two hole

   c) Three hole d) Other

9. Who motivated you to install ICS?

   a) Promoter b) Neighbor

   c) Friends d) Mother Group

d) Other (Specify if any)...

10. For what purpose do you use ICS?

a) Cooking b) Boiling water

c) Make animal food d) Heating room

e) Other

11. How often have you done maintenance after installing ICS?

a) Once b) Twice

c) Thrice & above d) Not at all

12. What type of problems are you facing in using ICS?

a) Problem of smoke outlet

b) Direction of chimney against wind direction

c) Does not burn wood properly

d) Consumes more firewood

e) Cooks food slower than TCS

f) Other (Specify if any).....

13. Amount of fuel wood save when using of ICS in a week.

a) 1 Bhari b) 1.5 Bhari

c) 2 Bhari d) 2.5 Bhari

14. What kind of health problems that woman and children have been facing while using TCS?

a) Respiratory b) Cough and cold

c) Chest pain d) Asthma

e) Eye problem f) Headache

g) Other (Specify if any).....

15. Do you still have those problems?

a) Yes, same as before

b) Yes, but not serious as before C) No

16. How much money do you save on health check-up of woman and children while using ICS in a year?

a) Less than 1000 b) 1000-3000

c) 3000-6000 d) 6000 and above

e) No idea

17. What impacts are seen in forest conservation after the use of ICS?

a) Reduce in fire wood collection

b) Illegal tree felling has been minimized

c) Minimized fire wood sale

d) Compared to 5 years back, forest looks dense

e) Other (Specify if any).....

18. What are the causes for dropped out of ICS?

a) Back fire

b) Consume more fuel wood

c) Smoke not passed out

d) Take more time for cooking food

e) All of the above

19. Are there any houses who have constructed ICS but not using them?

a) Yes b) No

If yes, what might be the reason?

.....

20. How much money do you spent in ICS installation?

a) Below 1000 b) Rs. 1000-2000

c) Rs.2000-3000 d) Above Rs. 3000

21. Do you feel reduced in fuel wood cost of ICS than in traditional cooking stove?

a) Yes b) No

c) Same cost in both

22. Have you been able to save your cooking and cleaning time after use of ICS?

a) Yes b) No

If yes, how much time?

..... Mins/hour

23. What do you do to utilize your time?

……

24. Level of satisfaction from ICS……

a) Fully satisfied b) Satisfied

c) Neutral d) Dis-satisfied

ANNEX II

Checklist – Focus Group Discussion

1. **Location**

   District:

   Rural Municipality:

   Ward No. : Village: Tole:

2. Date: Time:

   Facilitator:

3. List of Participants:

S. N.	Name	Sex	Age
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

4. General Information
5. Impact of ICS

5.1. Time Consumption for Cooking

5.2. Amount of Fuel Wood Consumption

5.3. Source of Fire Wood collection for Fuel

5.4. Health Problem in Women, senior citizen and Children Before and after Installation of ICS

5.5. Money Spend in Health Check-up of Women and Children Before and After ICS Installation

6. Current status of ICS in Ganjra.

7. Sustainability

7.1 Acceptability of the technology

7.2 Good heath after installation.

7.3 Reduction in fuel wood.

Thank You

ANNEX III

Name of Focus Group Discussion (FGD) participations In Study Area

A) Name of participations of FGD with AAma Samuha in study area

Name	Age
1. Basanti Khadka	49
2. Sita Khadka	30
3. Baijanti Khadka	27
4. Sharada Khadka	40
5. Sita Devi Khadka	38
6. Debu Devi Sunar	46
7. Nirmala Shah	27
8. Paban Khadka	38
9. Rambha Tiruwa	30
10. Bhajan Bhul	36

B) Name of participation of FGD with stakeholders in study area

Name	Age
1. Dipak Khadka	35
2. Jhankar Bohara	39
3. Chakra Nagarji	29
4. Purna Bahadur Joshi	36
5. Siddha Thapa	38
6. Dhanbire Tiruwa	42
7. Parwati Sunar	25
8. Hirenda Khadka	51

REFERENCES

AEPC (2000). *An introduction to alternative energy technology in Nepal*. Lalitpur: Alternative Energy Promotion Center.

AEPC (2010). *Renewable energy hand book*. Lalitpur*:* Alternative Energy Promotion Center.

Anhalt J. and Holanda S. (2009). *Implementation of a dissemination strategy for efficient cook stoves: Policy for Subsidizing Efficient Stoves in Northeast Brazil*. Vienna: IDER and REEEP publication.

Aryal, S. (2007). *Adoption of renewable energy technology towards sustainable harvesting of fuelwood from community forest.* Kathmandu: Central Department of Environmental Science, Tribhuvan University.

Basnyat , S. (2017). *Status of Improved Cooking Stoves (ICS) in rural Nepal : A case study of Nareshwor VDC of Gorkha, District.*Kathmandu*:* An unpublished thesis submitted to Central Department of Rural Development, Tribhuvan University.

Bhattarai, T.(2004). *Efficient biomass fuel combustion for economy health and environment.* Kathmandu: CES, IOE / TU.

BSP. (2002). *An integrated environment impact assessment.* Lalitpur: Biogas Sector Partnership-Nepal.

CBS(2011). *Census of Nepal.* Kathmandu: Center Beaurau of Statistics.

CTR/N (2003). *Renewal energy in Nepal.*Kathmandu*:* Centre for Rural Technology, Nepal.

DDC (2015). *District development plan handbook*, Mangelsen Achham: District Development Committee Achham.

DOI (2017). *Nepal Parichya*: Department of Information, Kathmandu.

GoN(2015). *14th Three year plan document.*Kathmandu: National Planning Commission

Harrell S., Beltramo T, Blalock G, Kyayesimira J (2016). *What is a "meal"? Comparative methods of auditing carbon offset compliance for fuel-efficient cookstoves Ecol*. Econ. 128 8–16

Malla, M. B., Bruce, N., Bates, E., & Rehfuess, E. (2011). *Applying gloabal cost-benefit analysis methods to indoor air pollution mitigation interventions in Nepal, Kenya and Sudan: Insights and Challenges.* Policy , 39 (12), 7518-7529

MoF(2018), *Econonic survey, F.Y. 20* .nmandu:Ministry of Finance, Nepal

Nussbaumer, P., Fuso Nerini, F., Onyeji, I., Howells, M., 2013. *Global Insights Based on the Multidimensional Energy Poverty Index (MEPI)*. Netherland: Elsevier Limited.

Panthi Jeewan (2011). *Renewable energy technology for reducing greenhouse gas emission and sustainable fuelwood harvesting: A Case Study of Phenapati community forest, Bardia, Nepal.* Kathmandu: An unpublished thesis submitted to Central Department of Environmental Science,Tribhuvan University.

Paudel, S. (2010). *Comparison of improved and traditional cooking stove user in terms of firewood consumption. A study of Chhekampar VDC, Gorakha District, Nepal.* Kathmandu, Nepal: National College, Kathmandu University.

Pradhan, Sheela (2006). *Impact of ICS on rural livelihood: A case study of Siwalik Area of Chulachuli VDC of Ilam District*. Kathmandu: An unpublished thesis submitted to Central Department of Rural Development, Tribhuvan University.

RECAST, (2016). *Renewable energy report in Nepal: A consultancy assignment given by the Asian and Pacific Centre for Transfer of Technology (APCTT).* Kathmandu: Centre for Applied Science and Technology (RECAST) Tribhuvan University.

REDP (2003). *An impact study of REDP programme*. Kathmandu, Nepal: Renewable Energy Development Program (REDP).

Rupakheti, A. (2014). *Impact of improved cooking stove on rural women: A case study of Dhading District.* Kathmandu, Nepal: An unpublished dissertation on Central Department of Rural Development, Tribhuvan University.

Shrestha, A. (2010). *Prospects of biogas in terms of socio-economic and environmental benefits to rural community of Nepal: A case of biogas project in Gaikhur VDC in Gorkha District.* Kathmandu: College of Applied Sciences (CAS), Tribhuvan University.

Shrestha Dr. Krishna (2016). *Renewable energy report.* Kathmandu, Nepal, Research Centre for Applied Science and Technology (RECAST) Tribhuvan University.

Sigdel, T.S. (2004), *A Study of Biogas Energy in Relation to Environmental Conservation and Social Development* .Kathmandu: A Submitted for Central Department of Rural

Development, Tribhuvan University.

RUDEC (2070), *Village profile of Ganjra V.D.C*. Achham: Prabidhi Vikas Kendra Mangalsen.

WECS (2004). *Energy report,* Kathmandu: Water Energy Commission Secretariat.

WECS, (2013). *National energy stratigy of Nepal report.* Kathmandu: Water and Energy Commission Secretariat.

websites

www.aepc.gov.np

www.bannigadhijayagadhmun.gov.np

www.eia.gov

www.iea.org

www.kathmandupost.ekantipur.com

www.moen.gov.np

www.nrdc.org

www.therisingnepal.org.np

www.who.int