COST EFFECTIVENESS ANALYSIS OF ELECTRIC AND DIESEL PUMP SET (A CASE STUDY OF TRIBHUWANBASTI VDC, KANCHANPUR DISTRICT, NEPAL) Atindra Subedi 2013

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A Thesis Submitted to

The Central Department of Economics, faculties of humanities and social science, Tribhuvan University, Kirtipur, Kathmandu

in partial fulfillment of the requirements for the Degree of the

Master of Arts (M.A.)

in

Economics

By

Atindra Subedi

Central Department of Economics

Tribhuvan University, Kathmandu

December, 2013

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LETTER OF RECOMMEDATION

This thesis “COST EFFECTIVENESS ANALYSIS OF ELECTRIC AND DIESEL PUMP SET” has been prepared by Mr. Atindra Subedi under my supervision for the partial fulfillment of the requirement for the Master of Arts in Economics.

I hereby, recommend this thesis for evaluation committee as a partial fulfillment of requirements for the degree of Master of Arts in Economics.

……………………………………..

Naveen Adhikari

Lecturer

(Thesis supervisor)

Date 2070-09-02

APPROVAL LETTER

We certify than this dissertation “COST EFFECTIVENESS ANALYSIS OF ELECTRIC AND DIESEL PUMP SET” submitted by Mr. Atindra Subedi to the Central Department of Economics, Faculty of Humanities and Social Sciences, Tribhuvan University, in partial fulfillment of the requirements for the degree of Master of Arts in Economics has been found satisfactory in scope and quality.

Therefore, we accept this thesis as a part of the said degree.

Dissertation Committee

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Associated Prof. Dr. Ram Prasad Gyanwaly

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Date 2070-09-08

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Date 2070-09-02 Atindra subedi

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ABBREVIATION/ACRONYM

GRDB	: Ground Water Resources Board
APP	: Agricultural Perspective Plan
VDC	: Village Development Committee
FAO	: Food and Agricultural Organization
WB	: World Bank
DOI	: Department of Irrigation
IWMI	: International Water Management Institute
CBS	: Central Bureau of Statistics
NPC	: National Planning Commission
ILC	: Irrigation Line of Credit
NGWA	: National Ground Water Association
ADB	: Asian Development Bank
ADB	: Agriculture Development Bank
GON	: Government of Nepal
IMP	: Irrigation Management Project
ISSP	: Irrigation Sector Support Project
ISP	: Irrigation Sector project
BNP	: Basic Needs Program
IR	: Irrigation Regulation
DTIP	: Deep tub well/Shallow tube well Irrigation Project
GWIP	: Ground Water Irrigation Project
CGISP	: Community Groundwater Irrigation Sector Project
NISP	: Nepal Irrigation Sector Project
CSTIP	: Community Shallow Tube well Irrigation Project
DFID	: Department for International Development

CHAPTER I

INTRODUCTION

1.1 Background of the Study

Agriculture is the back bone of the Nepalese economy which contributes 33% share in the Gross Domestic Product (GDP) and more than 75% people are engaged on agriculture as main occupation (Bista, 2011).There is almost no possibility of extension of the arable land. The only way to increase the agricultural production is through increased productivity through the provision of irrigation system, improved seeds, access to credit and technology.

Agricultural development largely depends on availability of modern inputs such as hybrid seeds, fertilizer, pesticides, irrigation etc. irrigation has not only the direct impact on the plant growth on the field providing adequate water but also increase the effectiveness of other inputs such as fertilizer. Irrigation has both direct and indirect role to increase agricultural output. Hence for good agricultural production, irrigation is one of the major inputs.

Irrigation is the supply of water to fields that lack moisture: it provides an optimal water regime within a root zone for the development of agricultural crops, and is one of the main methods of reclamation. It consists of a complex of engineering, agronomic, and organizational-economic activities based on hydraulic engineering techniques of rationed water supply to soil to provide soil moisture. Irrigation is required when there is a lack of natural moisture for crops, either for the whole vegetation period or at different stages of development. Without it the highly productive use of agricultural land is impossible. Because of irrigation, favorable moisture and other related soil regimes are established. These are necessary for enhancing fertility, obtaining a high and steady harvest, and the essential improvement of farming production quality. Irrigation makes it possible drastically to improve the soil conditions of dry zones and make them suitable for agricultural use, and to make more productive use of those regions that are adequately wetted. In the latter case irrigation is an indispensable prerequisite of the development of cotton and rice growing, grain production (with the creation of guaranteed grain harvesting zones), fodder crop and vegetable growing, horticulture and livestock breeding fodder crops on irrigated land, and the creation of pastures and hay land.

There are different systems of irrigation, each with its advantages and disadvantages. Natural application is through the rain, rivers, snowmelts, etc. The artificial application is through the construction of engineering works. (Dams, canals, channels, pump sets etc). The overall functions involved in the delivery of water from the source to the field are called irrigation system. The total arable land in Nepal is constant & only the way to increase the production only through extension in irrigated land. Therefore the government is giving high priority over the irrigation and considered itself as the important component of green revolution (http://www.eolss.net/Eolss).

Irrigation farming in comparison with upland farming under similar conditions leads to a production of higher gross returns per hectare, with the basic possibilities being the achievement of higher yields per hectare of a particular crop; production of several harvests in a year; growing of crops that produce comparatively high yields per hectare and it is possible to have continuous rice cultivation thus extending the area under cultivation of rice (Ruthenberg, 1983).

This in turn leads to increased yield per hectare which helps to boost the food security of a country. In addition to that, irrigation farming allows the permanent use of land. For rice cropping for example, it is possible to carry out permanent agriculture for long periods realizing high yields per unit area and the soil fertility is not impaired (ibid-irrigation board for irrigation development). In other cases of farming, the yields continue to diminish as you continue farming the same piece of land due to depletion of the soil fertility. Similarly, irrigation farming leads to a reduction in yield fluctuations from year to year.

When the water supply is reliable, there is some independence between production and the weather. Hence the yearly fluctuations of yield are less than the fluctuations in upland farming. This means that under irrigation farming even the dry areas that experience inadequate rains can be assured of constant yields with a reliable water supply. Irrigation farming also leads to a more continuous production process in the sense that there is an improvement in the regular household supply of food and cash incomes emanating from the production process. This helps to boost a country’s food security and contributes to the improvement of a country's economy. Furthermore, in irrigation farming some limiting factors like the amount of rainfall which determines the range of possible crops to be grown in upland farming are less compelling, thus enabling irrigation to facilitate diversification in production.

In developing countries particularly, irrigation farming leads to employment creation in that a relatively large number of workers per hectare are employed, enabling a relatively high income to be earned without the use of expensive equipment. Thus through irrigation, some developing countries have been able to transform themselves from food deficit to food surplus nations and also to improve their economies. Irrigation also leads to utilizing land that would otherwise not have been used in the upland areas (Thairu, 2010).

Agricultural perspective plan (APP) has estimated only 459 thousand hectors of land have year round irrigation in the implementation year in which 57% of arable land in Terai & 76% arable land in hill & mountain are non-irrigated (APP, 1995). Keeping the above figure in view government has given top priority to the irrigation component & considered irrigation as vehicle of green revolution, and aimed to increase agricultural production & productivity by extending irrigated land to 1126 thousand hectors of total irrigable land by the end of agricultural perspective plan (APP-1995).

In Nepal there is different irrigation method according to the different geographical regions, in hilly area channels, lifts,' GARA' methods are used & tube-well, boring, canal are used in Terai& inner Terai region.

Kanchanpur is one of the fertile districts of the Terai region which is located in far west development region & it is marginalized by government. Although Kanchanpur is fertile district of Nepal, but irrigation facility is not found satisfactory in this area, some of VDC's are irrigated by canal but more of them are using pump set.

Tribhuwanbasti VDC is also one of them which are highly irrigated by pump set method; there might be many limitation of pump set method although there are no alternatives for farmers. Only one source for canal in Kanchanpur district is Mahakali River, tough there is remote possibility for canal in Tribhuwanbasti VDC because of elevation and distance, and it will be possible only when government invest in large amount.

1.2 Statement of the Problem

Nepal is a small country with geographical area 147,181 sq. km but it is known as one of the richest country in the world for water resources. It has more than six thousand rivers out of which more than thousand rivers are eleven km long & about hundred rivers are one hundred sixty km long. Data shows that 2.27% of the total water resources of the world are in Nepal, however only small area of land has facility of systematic irrigation (Pokharel, 2068). Out of total land 2,641,000 hector lands estimated to be suitable for arable agriculture. Of this land, the potential irrigable area under surface and ground water sources is about 1,766,000 he. But at the end of the tenth plan the country has only 1,194,144 hectors irrigated land which is only 67.6 percent of potential irrigable area (NPC, 2008). It revel critical situation of irrigation facility.

Monsoon controlled agricultural activities and farmer's behavior and decision has become a threat to crop productivity and growth and then higher economic growth of aggregate economy. Access to irrigation has also been observed to be major factor for rural poverty. Land productivity of non-poor households is nearly two times higher than that of poor households, mainly because of access to irrigation and better situated farms. The risk of poverty is more pronounced among farm households that do not have access to irrigation. As access to irrigation and the share of irrigated area increases, the poverty gap between farm households with and without irrigation grows. Despite large investments in the sector, only 50% of arable land presently has irrigation facilities. Furthermore, only 30% of the area having irrigation facilities gets year round irrigation while the remaining 70% receives only seasonal irrigation. Agricultural practices are still highly dependent on rainfall due to inadequate irrigation infrastructure or facilities. This dependency on rain fall not only affects yields but also significantly influences the sowing and harvesting time, approximately 66% crop land follows traditional irrigation from monsoon rain. (Timilsina and Sijapati, 2011).

In Nepal, the irrigation potential is estimated about 1.4 million hector from the major rivers and about 0.7 million hector from the minor rivers and ground water sources in Terai and about 0.5 million hector in hill. Total irrigation potential is about 2.65 million out of which irrigation development is only 22.89 percent that is 606,588-hector, according to the eighth plan (Bista, 2011). Least exploitation of the irrigation potential has been a constraint of higher crop productivity and production.

For agricultural development, irrigation has been given top priority since the beginning of the plan development and Agricultural perspective plan (APP) that is a 20 year long plan to achieve the economic development has given top priority on the irrigation facility. In Nepal canal irrigation system is in highly practice, due to various constraints in Terai, APP has emphasized on the shallow tube wells for the irrigation system. In reality achievement on irrigation development & extension was less than the stated target in the plan and resource allocation.

Canal irrigation development project needs the construction of medium and big dams. This engineering project to conduct feasibility study and construction pre requires a huge investment. Financial problem is constraint to initiate the feasible irrigation project. In this context in Terai region pump set irrigation method is only one alternative for irrigation. In Terai there are two types of pump set in practice, one is Diesel pump set and another is Electric pump set. In comparison to Pump set based irrigation system, canal irrigation system is cost effective for farmers, but due to unavailability of canal irrigation system farmer are using pump set based irrigation for the convenience to install. In general, now days it needed around one lakh fifty thousand for both Electric and Diesel Pump Set, which is more expensive for farmer. Due to limited availability of required three phase’s electric power in farm area, farmer is escaped to install Electric pump set, and they have to invest themselves for infrastructure. For Electric Pump Set heavy power cut became a great problem and brain technicians are not available in rural area for maintenance, so it creates problem to the farmer and it needs large amount for maintenance than Diesel Pump Set.

Here can have a serious and valuable question, why Nepal cannot develop irrigation although national plan has given top priority on it.

1.3 Objective of the Study

The general objective of the study is to analyze the cost effectiveness of ground water irrigation facility provided by pump set in Thibhuwanbasti VDC Kanchanpur. The specific objectives are:

I) To examine the cost effectiveness of Diesel and Electric Pump Set based irrigation system in study area.

II) To analyze the problems associated with each in the study area.

1.4 Significance of the Study

In Nepal it is found that more than 75% people are engaged in agriculture. However, it imports heavy amount of food from rest of the world especially from India. This is due to lack of commitment & investment in development of Agricultural sector. Better production & productivity depends upon Agricultural inputs especially it depends on irrigation; in Nepal development of irrigation is very poor. So it is necessary to develop irrigation system for Agricultural development & as a whole economic development. Which needs huge amount of investment; for which this study will be useful for government sector & private sector to make investment in irrigation sector especially in pump set irrigation system in Terai belt.

As there are only few studies on related field so the data and information of this study will give meaningful guidelines for sustainable environment friendly and economic project in related field. This research has significance as it gives figures the existing irrigation system of Tribhuwanbasti VDC. This study will useful to economists, planners, interested irrigation institutions and other interested persons. This study will helpful for further researcher. And finally this study will be practically helpful to develop irrigation system to develop agricultural sector of related area.

1.5 Limitation of the Study

As this is an academic exercise and limited to an area with four questions, the study has been the following limitations:

- The study has covered only one VDC of Kanchanpur district i.e. Tribhuwanbasti VDC.
- This study is based on relatively low sample size of 61 Households.
- This study focuses on cost effectiveness and does not aim at impact evaluation or cost benefit analysis.

1.6 Organization of the Study

This study has been organized in seven chapters. First chapter includes background of the study, statement of the problem, objectives of the study, significance of the study, limitation of the study and organization of study. Second chapter is literature review which deals with world history of irrigation and related studies. Third chapter discuss research methodology adopted in this study which includes research design, and selection of the study area, nature and sources of data, sampling procedure, tools and technique of data collection, and method of data analysis. Fourth chapter describes about irrigation in Nepal and concept of ground water irrigation. Fifth chapter deals about the presentation, interpretation and analysis of data. This chapter also presents major finding of this study. The study ends with the summary, conclusion and recommendation of the study.

CHAPTER II
LITERATURE REVIEW

In this chapter available documented article, books and reports literature regarding irrigation has been reviewed. This chapter provides the details of history of irrigation and review of related studies.

2.1 Brief History of Irrigation in the World

Agriculture is the oldest occupation in the world. Irrigation in agriculture is not a recent phenomenon. The accurate origin of irrigated is not known though; it has been noticed since thousands of years in region of Asia, Africa and America. when people left their stone age then practice agriculture farming then it began in many parts of the arid and semi-arid of the world. The fact data about irrigation of ancient period is not available. Nobody can give the answer when and how the irrigation system has started. But there were many kinds of irrigation methods were in practice since ancient period such as wells, channels, canals etc.

Chisholm (1911), ancient Egyptians practiced basin irrigation using the flooding of the Nile to inundate land plots which had been surrounded by dykes. The flood water was held until the fertile sediment had settled before the surplus was returned to the watercourse. There is evidence of the ancient Egyptian pharaoh Amenemhet III in the twelfth dynasty (about 1800 BCE) using the natural lake of the Faiyum Oasis as a reservoir to store surpluses of water for use during the dry seasons, the lake swelled annually from flooding of the Nile.

The Ancient Nubians developed a form of irrigation by using a water wheel-like device called a Sakia. Irrigation began in Nubia sometime between the third and second millennium BCE. It largely depended upon the flood waters that would flow through the Nile River and other rivers in what is now the Sudan.

In sub-Saharan Africa irrigation reached the Niger River region cultures and civilizations by the first or second millennium BCE and was based on wet season flooding and water harvesting.

Terrace irrigation is evidenced in pre-Columbian America, early Syria, India, and China. In the Zana Valley of the Andes Mountains in Peru, archaeologists found remains of three irrigation canals radiocarbon from the 4th millennium BCE, the 3rd millennium BCE and the 9th century CE.

These canals are the earliest record of irrigation in the New World. Traces of a canal possibly dating from the 5th millennium BCE were found under the 4th millennium canal. Sophisticated irrigation and storage systems were developed by the Indus Valley Civilization in present-day Pakistan and North India, including the reservoirs at Girnar in 3000 BCE and an early canal irrigation system from circa 2600 BCE. Large scale agriculture was practiced and an extensive network of canals was used for the purpose of irrigation.

Ancient Persia (modern day Iran) as far back as the 6th millennium BCE, where barley was grown in some areas where the natural rainfall was insufficient to support such a crop. The Qantas, developed in ancient Persia in about 800 BCE, are among the oldest known irrigation methods still in use today. They are now found in Asia, the Middle East and North Africa. The system comprises a network of vertical wells and gently sloping tunnels driven into the sides of cliffs and steep hills to tap groundwater. The Noria, a water wheel with clay pots around the rim powered by the flow of the stream (or by animals where the water source was still), was first brought into use at about this time, by Roman settlers in North Africa. By 150 BCE the pots were fitted with valves to allow smoother filling as they were forced into the water.

The irrigation works of ancient Sri Lanka, the earliest dating from about 300 BCE, in the reign of King Pandukabhaya and under continuous development for the next thousand years, were one of the most complex irrigation systems of the ancient world. In addition to underground canals, the Sinhalese were the first to build completely artificial reservoirs to store water. Due to their engineering superiority in this sector, they were often called 'masters of irrigation'. Most of these irrigation systems still exist undamaged up to now, in Anuradhapura and Polonnaruwa, because of the advanced and precise engineering. The system was extensively restored and further extended during the reign of King Parakrama Bahu (1153–1186 CE).

The oldest known hydraulic engineers of China were Sunshu Ao (6th century BCE) of the Spring and Autumn Period and Ximen Bao (5th century BCE) of the Warring States period, both of whom worked on large irrigation projects. In the Szechwan region belonging to the State of Qin of ancient China, the Dujiangyan Irrigation System was built in 256 BCE to irrigate an enormous area of farmland that today still supplies water. By the 2nd century AD, during the Han Dynasty, the Chinese also used chain pumps that lifted water from lower elevation to higher elevation. These were powered by manual foot pedal, hydraulic waterwheels, or rotating mechanical wheels pulled by oxen. The water was used for public works of providing water for urban residential quarters and palace gardens, but mostly for irrigation of farmland canals and channels in the fields.

Chisholm (1911), in 15th century Korea, the world's first rain gauge, uryanggye, was invented in 1441. The inventor was Jang Yeong-sil, a Korean engineer of the Joseon Dynasty, under the active direction of the king, Sejong the Great. It was installed in irrigation tanks as part of a nationwide system to measure and collect rainfall for agricultural applications. With this instrument, planners and farmers could make better use of the information gathered in the survey. In the Americas, extensive irrigation systems were created by numerous groups in prehistoric times. One example is seen in the recent archaeological excavations near the Santa Cruz River in Tucson, Arizona. They have located a village site dating from 4,000 years ago. The floodplain of the Santa Cruz River was extensively farmed during the Early Agricultural period, circa 1200 BC to AD 150. These people constructed irrigation canals and grew corn, beans, and other crops while gathering wild plants and hunting animals. In the middle of the 20th century, the advent of diesel and electric motors led for the first time to systems that could pump groundwater out of major aquifers faster than it was recharged. This can lead to permanent loss of aquifer capacity, decreased water quality, ground subsidence, and other problems. The future of food production in such areas as the North China Plain, the Punjab, and the Great Plains of the US is threatened.

At the global scale, 2,788,000 km² (689 million acres) of agricultural land was equipped with irrigation infrastructure around the year 2000. About 68% of the area equipped for irrigation is located in Asia, 17% in the Americas, 9% in Europe, 5% in Africa and 1% in Oceania. The largest contiguous areas of high irrigation density are found in North

India and Pakistan along the rivers Ganges and Indus, in the Hai He, Huang He and Yangtze basins in China, along the Nile River in Egypt and Sudan, in the Mississippi-Missouri river basin and in parts of California. Smaller irrigation areas are spread across almost all populated parts of the world. Only 8 years later in 2008, the scale of irrigated land increased to an estimated total of 3,245,566 km², what is nearly the size of India.

Mygeologypage (1999), the major success stories for civilizations based on agricultural irrigation are Egypt and China. The major stories of failure are happening right in front of us. In present-day California, a giant industry is trying to maintain an irrigation economy with a diminishing supply of poor-quality water, on clay soils with very poor natural drainage, in an almost landlocked plain with poor or non-existent regional drainage, applying water that has been stripped of its natural load of silt. Ancient Irrigation: Egypt and the Nile-Ancient irrigation styles depended very much on the physical geography and geology of the area, and the engineering skills available. Four different styles of irrigation were developed very early in agricultural history. All irrigation systems depend on taking water from natural sources and diverting it to artificial channels or ponds where it is applied to crops. The Nile valley is rainless and extremely fertile. Herodotus wrote more than 2000 years ago, "Egypt is... the gift of the river." Egypt depends on the Nile in a way that no other nation does. 97% of Egyptians live on 2.5% of its area. The prosperity of the Nile valley civilizations has depended throughout recorded history on the efficiency with which the central government has organized the best use of the river water. Crops could be stored after years of abundance, for example, and irrigation schemes could be both built and maintained.

At first, Egyptian agriculture along the Nile was based on growing winter crops after the annual floods had subsided. Egyptian irrigation was based on several facts. There was only one water source (the river) which was too powerful to control. Irrigation works therefore had to be passive in construction, and built relatively high along the river bank so that they dealt only with the peak of the flood. The river valley is flat-floored, but narrow and steep-sided, never more than 25 km wide until it reaches the Delta below Cairo. Irrigation schemes could therefore not carry water any great distance away from the river.

The ancient Egyptians built large flat-bottomed basins for growing crops along the river banks, and simple sluices that diverted water into them at the peak of the flood. It was easy in engineering terms, if not in labor, to arrange for good water flow through several basins in succession, controlled by simple gates. Water was allowed to stand in the fields for 40 to 60 days, and then was drained off the crops at the right moment in the growing cycle, downstream back into the river. There was always plenty of water, so salts never built up in the soil; and the flow in the canals and ditches was strong enough to avoid silting. (Silt that settled in the basins was beneficial in two ways: it made the floors of the basins evenly flat, and it brought a lot of nutrients with each year's flood.) Ditches and canals were short, and the typical irrigation scheme was very local. The design of the irrigation system depended critically on knowing in advance the height of the annual flood, and the Egyptians developed a system of "Nilometers" at various points along the valley. Rapid communication and early warning of the height of the flood as it rolled downstream from the south made a great difference to the size of the harvest. Herodotus wrote that the Egyptians "get their harvests with less labor than anyone else in the world." Early irrigation was rather local and primitive, and food was not stored efficiently, so the early civilizations were vulnerable to long-term fluctuations in the Nile floods. There was no significant attempt at water storage: since all the water came from the Nile, any storage would have meant damming the river, which was far beyond the capability of the ancient Egyptians. Therefore their irrigation system was passive, and early Egyptian civilization depended largely on one winter crop per year. After it was harvested in the spring, the land lay fallow until after the next flood. Only in a few places with very wet soil was there any chance of a second crop, and among these areas were Abydos, Memphis, and Thebes, the great centers of ancient Egyptian civilization. They lay along the river, upstream from the Delta. The Old Kingdom, the Middle Kingdom, and the New Kingdom were periods in Egyptian history when strong central government flourished in times of prosperity, followed by periods of stagnation in economy and population, often accompanied by social, military, and artistic decline. It's not clear whether strong central government resulted in effective irrigation and good crop production, or whether strong central government broke down after climatic changes resulted in unstable agricultural production.

Diversion Dams-Irrigation problems are completely different in dry hilly country. Rivers and springs are smaller, and do not have the perennial flow of the major rivers in Egypt and Mesopotamia. Water storage must be built into any sophisticated system, but some simple irrigation can still be practiced. Even so, irrigation systems must be active, rather than passive on the Egyptian pattern. Most likely, irrigation systems began with small springs and in small drainages, and as engineering techniques were developed, they could be applied to larger rivers and to larger areas of plains. Perhaps the earliest successful technique was to build a diversion dam. The structure is built right across the bed of the stream, and is not merely a cut in the river-bank that takes off some of the water into a canal. Stream valleys with only seasonal flow are the best places to learn dam-building. The dam can be built during the dry season, allowing engineers to learn how to build a successful dam, without having to master also the technique of diverting the stream. The dam can also be maintained or repaired during dry seasons. If the dam fails in flood, it does no more than restore the old flow, and is not catastrophic. It's probably not a coincidence that all the most ancient dams are built across intermittent streams, or wades. Perennial rivers are much more difficult to dam because there is no access to the dry river bed unless the river is diverted. One of the most impressive dams of ancient times is near Marib, the ancient Sabaean capital in the Yemen, and was built about 600 BC.It is 500 m long, and is built of carefully worked masonry, strengthened by copper fastenings. The dam was not meant to be a reservoir filled with usable water. It was more a giant weir, to hold back some of the annual flood waters coming down the valley, and to divert some of that water, under control, out of sluices and into a canal system. The same sort of diversion dam system evolved independently in the Hohokam culture of Arizona.

Mesopotamia: Canals on the Plain-Irrigation has been an important base for agriculture in Mesopotamia (what is now Iraq and part of Iran) for 6000 years. But Mesopotamia is very different from Egypt. Mesopotamia has low rainfall, and is supplied with surface water by only two major rivers, the Tigris and the Euphrates. Although they are much smaller than of the Nile, they have much more dramatic spring floods, from snowmelt in the highlands of Anatolia, and they carry more silt. Furthermore, the plains of Mesopotamia are very flat, and poorly drained, so that the region has always had persistent problems with poor soil, drought, catastrophic flooding, silting, and soil salinity.

Mygeologypage (1999), Mesopotamian engineers had to worry about water storage and flood control as well as irrigation. Silt built up quickly in the canals, threatening to choke them. This could be overcome by constant dredging as long as organization and manpower were available. The other problem was more insidious, and could not be overcome by the engineering available at the time. It was difficult to drain water off the fields, and there was always a tendency for salt to build up in the soil. Although the plain of Mesopotamia is very flat, the bed of the Euphrates is higher than that of the Tigris; in fact, Euphrates floods sometimes found their way across country into the Tigris. Engineers used this gradient as soon as irrigation schemes became large enough, using the Euphrates water as the supply, and the Tigris channel as a drain.

Mesopotamia has had times of successful irrigation, and times of silt and salinity crises: the latter around 2000 BC, 1100 BC, and after 1200 AD. The first crisis may have been caused by water politics. In any irrigation system, the farmers most downstream are those most likely to be short of water in a dry year, or to receive the most polluted water. In Sumeria, the city of Lagash was rather far downstream in the canal system based on the Euphrates. Apparently Entenmanns of Lagash decided that he would instead cut a canal to tap Tigris water, but the addition of poor-quality water led to rapid salinization of the soil. Sumeria-the earliest city-states of Mesopotamia, those of Sumeria, lay in the lowest, most water-rich areas of what is now southern Iraq. Irrigation could be fairly simple in this region, with each city-state probably building one irrigation system. The cities may have originally been administrative centers, marketing centers and defensive centers related to local irrigation schemes: in other words, they were "irrigation cities. Mesopotamian engineers built very large weirs and diversion dams, to create reservoirs and to supply canals that carried water considerable distances across the flat countryside. The scale of their irrigation was larger than in Egypt, and Mesopotamian irrigation was interventionist and active. Almost certainly the idea of diversion dams was brought to Mesopotamia from the hills, since the rivers are mostly perennial. Mesopotamian tradition suggests so: Sargon of Assyria probably learned it from the ancient nation of Urartu. The scale and ambition of early Iron Age Mesopotamian projects was matched only in China and Egypt. The Abbasside-After the wave of Moslem expansion broke over Mesopotamia, the Abbasside Caliphate was based on Baghdad from 762 AD until its demise in 1258. Existing irrigation schemes were renovated and greatly extended in very large projects. Abbasside engineers drew water from the Euphrates at five separate points, and led it in parallel canals across the plains, watering a huge area south of Baghdad. This system provided the basis for the enormously rich culture of Baghdad, which is still remembered in legend

(Scheherezade, the Caliph of Baghdad, and the Arabian Nights) as well as history. But it required a lot of physical maintenance, and there was a lot of salinization in the south. As central government began to fail in the 12th century (mostly from extravagant overspending), the canals became silt-choked, the irrigation system deteriorated, and the lands became more salinized. The deathblow to the system was natural: massive floods about 1200 AD shifted the courses of both the Tigris and the Euphrates, cutting off most of the water supply to the Nahrwan Canal and wrecking the whole system. The Abbasids were too weak (or bankrupt) by now to institute repairs, and the agricultural system collapsed. By the time the Mongols under Hulagu devastated Iraq and Baghdad in 1258 AD, they were finishing off a society that was already a wasteland. Iraq has remained a desert for more than 600 years.

Majumdar (2000) says irrigation is an age - old practice and in fact as old as man's first attempt at crop growing. Irrigation has dictated and decided largely pace and the progress of the agricultural development. The irrigation area in India is in 1996 was only 33.59% of the total arable land and land under permanent crops in the country (FAO, 1997). The area under irrigation in the world in 1996 amounted to only 241.5 million hectors which was 15.98% of the total arable land and land under permanent crops in the world (FAO, 1997). The country like Japan, Korea, Kyrgyzstan and Pakistan are in comfortable position having 60 to 82 percent of their lands irrigated Australia, Brazil, Canada and Russian federation have irrigated area less than five percent of their arable land and under permanent crops, while Algeria, Argentina, Kazakhstan, South Africa, Sudan and U.S.A. have facilited to irrigate only six to fifteen percent of their lands. Egypt is the only one country in the world that could bring fully arable land and under permanent crops under irrigation.

According to Huffman (1935), irrigation agriculture was also flourished in America before Christ. In Peru, a great size civilization was developed whose future included large irrigation structure of considerable ingenuity. Similerly eveidence of advance agriculture civilization based on extensive and skillful irrigation is also found in Chile and Mexico. It has been estimated that in yhe salt river valley of Arizona for example more than 2,50,000 across of land were irrigated by more than 1000 miles of canal and ditches.

Modi (2000), states that irrigation is an age-old art. as old as civilization. in india also the irrigation gas practiced since hitorical times. the first effort of irrigation development under the British rule began in the beginning of the nineteenth century (1800–1836), which were directed towards improvements and utilizaation of old indiginious works, rather than the construction of new irrigation works. three importance irrigation works-Western Delta System were renovated and opened for use. The beginning of the 20th century was marked by an important event on the history of irrigation in India, namely the appointment of the first Indian irrigation commission. nIn the early fourties just before independence India was a large irrigated country in the world. With potential nearly one third of the irrigation area of the country went to pakistan. Thus, at the time of independence the total gross irrigated area that remained on India after partition was 22.6 million hector. Soon after independence India was facing sever food shortage and hence much attention was paid to irrigation to increase agriculture production in the plans that were formulated.Accordingly a large number of irigation and multi purpose projects were taken up since independence are Bhakra–Nagal, Gandak, Gandhi Naha, Ramganga etc with the completion of the various project the gross irrigated area had increased from 22.65 million hectors at the beginning of 1951 to 63.4 million hectars up to the end of 1983.

Agricultural trend is directly related with irrigation sector and production pattern is determined by it, so, whole world's concern is how to develop irrigation system. The development of irrigation is not satisfactory its motion is very slow.139 hector was irrigated till 1961, and after decade only 32 million hector additional lands was facilitated. According to FAO till June, 2005 only 277.831 million hector of whole world has irrigated. Out of total irrigated area nearly about 50% of it is occupied by China, India, America and Pakistan (Sapkota, 2068).

2.2 Review of Related Studies

There have been conducted many researches about irrigation in the world and Nepal too. Likewise many studies have been conducted about ground water irrigation in Terai belt of Nepal. But there is no any research in study area about ground water irrigation. Some literature reviewed about irrigation is given here:

Khatri (2001) has studied the impact of Ground water Irrigation project in Nepal. His study is concerned with Sitapur water irrigation projects of Banke district. The project began to provide the irrigation facility since 2053 B.S. Before 2053, crop cultivation depends upon monsoon rainfall. And paddy cultivation covered in only 46 percent of the catchments area. After the facility of irrigation, paddy cultivated area about 78 percent of the catchments area. Crop production was 14.79 quintal per bigha before the projects. Now its production is 35.87 quintal per bigha. The crop production yield has also been raised to 36 quintal per bigha in 2052. Similarly farmers are more oriented towards the cash crop and also changed in the food habit of the people after the augmentation facility. People have been migrating to the study area due to the irrigation facilities, which helped to increase the economic conditions. In this way irrigation has helped to raise crop production and to change in cropping pattern and to uplift socio-economic activities in the study area.

Panta (2002) has made a study of the impact of rain aster irrigation project on agriculture production in Dhamilikuwa VDC, Lamjung. He comes into the end that after the initiation of irrigation facility the irrigated land of command area (with project) has 202 percent of cropping intensity was 39 percent higher than that of control are (163 percent). Cropping intensity in rain fed land on command area (200 percent) and control area (without project), (182 percent) was almost same. In the command area can be seen the change in cropping pattern. Irrigation facility in command area increased winter crop such as wheat, oilseeds, Potato etc. But in control area most of the land remained follow during winter. High value crops like paddy, wheat etc. were cultivated in command area in place of millet and upland paddy. After the getting irrigated facility on the cultivated land the marginal productivity of land was very high as compared to others production inputs such as human labors, fertilizer, bullock labor, seeds etc.

Availability of water also plays a vital role on the performance of an irrigation project and also indirectly influences the cost of the project. Innocence et al used annual rainfall and conjunctive use of surface water and underground water as a proxy for water availability and found that in Sub Saharan Africa, the irrigation projects located in areas with more water available have a tendency of being smaller in size and don’t require storage facilities. However, there is need to govern water use, as Bardhan found that water reform was crucial in building community institutions of cooperation. In his study of farmers in India, he found that Indian farmers set formal water rights opposed to customary rights which in turn increased their probability of cooperation. In addition, water availability also has an influence on the types of crops chosen and corresponding varieties and which has an impact on the performance of the irrigation project (Bardhan, 2002).

Khanal (2003), he has studied on engineering participation in water management. He mentions that irrigation systems are socio-technical systems and technology of the system shapes and is shaped by ecology and society. Design should thus begin considering both the human and the physical dimension of irrigation systems. The strength of participatory design depends first on what people, both users and designers know about the system, and its opportunities and constraints.

According to DFID (2003), irrigated agriculture has the potential to be the single most effective means of creating and sustaining rural livelihoods in the least developed countries, thereby contributing substantially to poverty reduction. Chambers (1983, 1995) suggest that the poor achieve substantial benefits from irrigation, particularly in terms of increased employment opportunities and food security, notably in remote areas. Unlike other users of water, the direct financial benefits to the farmers often form a small proportion of the total benefits to society of using water in irrigated agriculture, (Bhatia, 1997). However, irrigation can be criticized for inefficient water use, high capital and recurrent costs, lack of sustainability, and inequity in distribution of land and water. Developing governments and other stakeholders need better knowledge of the effects of irrigation, to improve decision making on support policies vise a via rain fed agriculture; liberalization of trade and markets; investment in systems; water allocation to sustain resources and livelihoods; and the potential for improving irrigation performance in the face of competition for supply from other sectors of the economy. Experts in Nepal and Bangladesh indicate that the proposed research will be valuable in guiding national policies. 80% of the population of developing countries is rural, depending on agriculture. Despite recent improvements in some national economies, the total number of poor people is raising, yet governments and funding agencies are reducing finance for irrigation. A WB policy paper states that poverty will persist in Nepal unless agricultural performance is improved. DFID's Bangladesh strategy paper states that priority will be given to projects which improve rural livelihoods, promote environmentally sustainable production and replicate successful initiatives. Nepal and Bangladesh are low income developing countries (WB, 1999). For example, on average 50% of the population of Nepal has less than $1/day and 87% has less than $2/day (WB, 1999). This enabling project also includes research aimed predominantly at the rights, interests and needs of the poor, addressing issues of equity and barriers to participation of people. It aims to identify the direct and indirect benefits of irrigation to the livelihoods of men, women and children, and cross-cutting issues - finance, institutions, access to common property, crop per drop, technology and markets, political rights, societal and cultural perceptions, gender relations, workloads and nutrition levels.

IWMI (2006) has written the relationship between poverty reduction and irrigational development has become a topical issue amongst academics and policy makers alike. A ministerial Bonn Conference on fresh water management declared that, “combating poverty is the main challenge for achieving equitable and sustainable development and irrigation water plays a vital role in relation to human health, livelihoods, economic growth as well as sustaining ecosystems". There is a general consensus that irrigation development particularly in agricultural countries help reduce poverty significantly. The direct benefits of irrigational development operate at local and households level with higher production, higher crop yields, and reduce risk of crop failure, all year-round and non- farm employment opportunities and food security. Globally, 17 present of global irrigated land contributes to about 40 present of world cereal production (Lipton, 2002). On the production side of poverty-irrigation relationship, irrigation development creates localised demands for both farm and off-farm income generating economic activities indirectly. It is well established that, due to the prominent of agricultural sector and adaptation of green revolution in low income countries agricultural growth rate of 4-6 per cent adds immense purchasing power.

The World Bank (2008), has refereed Nepal has abundant water resources capable of irrigating 8 to 10 million hectares and providing 43,000 MW of hydropower. About 40 percent of the nation's 2.6 million ha of potentially irrigable lands are developed. Less than one percent of the hydropower potential is utilized and these supplies 85 percent of national demand, l3 percent Water for domestic consumption is drawn from springs and streams in the hilly areas and from river diversions and groundwater in the Kathmandu valley and elsewhere. Water quality is poor in and around Kathmandu because of extensive pollution of rivers; and in parts of the Terai because of the high arsenic content of groundwater. Development of Nepal's rivers for irrigation is costly because of the large diversion structures needed to manage the annual floods, exacerbated by the large quantity of sediment these waters carry. India needs to agree to any diversion of these trans-boundary rivers-a further complication. Consequently, groundwater-based irrigation has proved to be an attractive option in the Terai for both the private and public sectors. Irrigation in Nepal is broadly categorized according to ownership and Management (public versus private schemes), to location (Hills versus Terai), and to source of irrigation water supply (surface versus groundwater). Private irrigation schemes have long been developed and managed by private farmers, and are classified as Farmer-Managed Irrigation Systems (FMIS). The rest of the irrigation schemes are publicly developed and managed by the Department of Irrigation (DOI).

By 1990/91 the crop sector contributed about 60 percent of agricultural GDP. With all land potential fully developed growth was driven mainly by increased use of fertilizer and irrigation. Fertilizer accounted for about 44 percent of the growth in agricultural GDP, irrigation 15 percent and varietal improvement less than one percent. 'Officially reported fertilizer use grew at the rate of 12 percent per year from 1980/81 to1992/93." Even so, in per hectare terms the level of application is low compared with other countries in the region: one-third to one-quarter that of Bangladesh, Pakistan, and Sri Lanka and 10 percent that of China. ‘At present yields, rice, wheat and maize alone are estimated to be removing 700,000 tons of nutrients annually”. Two Commercial fertilizers were replacing little more than 10 percent of that annual loss.

K.C. (2008), he has conducted a research on "Role of irrigation to reduce poverty: A study on effect of deep tube well on reducing poverty on Dang". On his study he has tried to show role of irrigation to reduce poverty. He has said that, to reduce poverty it's necessary to develop the irrigation in agriculture sector which provide employment opportunity and income for peoples. He has shown that before tube well irrigation system out of total economically active population, 58.76 % people were engaged in agriculture as main occupation, but after deep tube well irrigation (the research is done after 4 years later after installment) it decreased and reaches to 53.14% the above percent show that after irrigation facility people participation has decreased by 5.62% in both period (before and after) the participation percent in the services are not satisfactory respectively 1.84% and 2.88%. The same case in business sector, the particularly percent's of the people are 1.41% before and 2.09% after. Toward services and business sector, people are attracted slightly. Likewise he has shown the fact that production & productivity has increased after tube well irrigation. Annual production of the paddy, maze, pulses and oilseeds are 9011muri, 553muri, 292.55muri, 163.6muri respectively before irrigation and after irrigation facility the production has increased as paddy 9943muri, maze 553muri (the irrigation cannot affect the production of maze), pulses 561.3muri, oilseed 220.1muri.

Shah (2009), has studied in 1947, British India-the part of South Asia that is today's India, Pakistan, and Bangladesh-emerged from the colonial era with the world's largest centrally managed canal irrigation infrastructure. However, as vividly illustrated by Tushaar Shah, the orderly irrigation economy that saved millions of rural poor from droughts and famines is now a vast atomistic system of widely dispersed tube-wells that are drawing groundwater without permits or hindrances. Taming the Anarchy is about the development of this chaos and the prospects to bring it under control. It is about both the massive benefit that the irrigation economy has created and the ill-fare it threatens through depleted aquifers and pollution. Tushaar Shah brings exceptional insight into a socio-ecological phenomenon that has befuddled scientists and policymakers alike. In systematic fashion, he investigates the forces behind the transformation of South Asian irrigation and considers its social, economic, and ecological impacts. He considers what is unique to South Asia and what is in common with other developing regions. He argues that, without effective governance, the resulting groundwater stress threatens the sustenance of the agrarian system and therefore the well-being of the nearly one and a half billion people who live in South Asia. Yet, finding solutions is a formidable challenge. The way forward in the short run, Shah suggests, lies in indirect, adaptive strategies that change the conduct of water users. From antiquity until the 1960s, agricultural water management in South Asia was predominantly the affair of village communities and/or the state. Today, the region depends on irrigation from some 25 million individually owned groundwater wells. Tushaar Shah provides a fascinating economic, political, and cultural history of the development and use of technology that is also a history of a society in transition.

Pariyar (2010), has said the basic purpose of this study is to understand the impacts of socio-economic heterogeneity, and existing aged-old caste system, and the ways these factors influence in defining property rights, and formation of local level institution for irrigation water management in Nepalese context. Both irrigation water and infrastructures are common pool resources, due to their low excludability and a high rivalry nature and demonstrate higher probability of over-exploitation and inequitable resource distributions (Cheung, 1970, Adhikari, 2003). The occurrences of the latter case, however, are due to existing heterogeneity amongst user groups, lack of appropriate institutional arrangement, and absence of well-defined property rights for using common pool resources. In this research, the methodological approach utilises insights from new institutionalism and theoretical and empirical literature from new institutional economics and developmental studies that underscore the role of formal and informal institution for natural resource management. The perspective on institutions adopted here follows the approach of North (1990) who defines institutions as humanly devised constraints that shape human interaction that ultimately affects the performance of economy by their effects on the costs of exchange and production. In the Context of irrigation development in Nepal, the role of castes system is of paramount importance. It affects directly or indirectly, in institution formation, defining property rights, and other associated formal and informal regulations for resource management. Call for institutional changes are made due to propensity to achieve equity and efficiency in resource allocation (Ostrom, 1992). Failures of the existing institutional structures and governing rules and regulations results into inequitable and inefficient resource allocation and call for evolutionary institutions capable of responding to underlying economic circumstances of the community are inevitable (Bardhan, 1993). This study seeks to understand how institutionalised social differentiation can result in inefficient use, inequitable allocation, and unsustainable use of irrigation canal water in Nepal. The crux of the arguments in this study is that social system and, socio-economic heterogeneity play a prominent role in distribution and sustainable use of irrigation water. Furthermore, this study seeks to understand ways and means of creating institutional durability and long term management of irrigation resources at local level.

However, research on the relationship between irrigation and poverty involves aggregate macro level analysis. Furthermore, although much work has been done in relation to the implications of local level socio-economic heterogeneities on forest management (Adhikari, 2003) very little work has been done in irrigation development. The growth aspects of irrigation are well accepted. Despite the close inter linkages between irrigation development and poverty reduction there is still a considerable polarisation on equity dimension. Head and tail inequity, also known as upstream-downstream inequity has been well documented. A growing body of literature argues that growth can lead to a skewed income distribution raising questions about the anti-poverty strength of irrigation development. Sceptics argue that it is naïve to assume that irrigation development is distribution neutral. Also, since the distribution of irrigation water is land based, irrigation development is inherently biased against the landless and land poor. In his synthesis studies of 307 irrigational systems during 1970-89, Freebairn (1995) found that both inter-farm and interregional inequalities widened in 80 of the studies. However, these studies suffered from fundamentally methodological sampling in their study of natural resource endowments and poverty in a tribal belt of Chhotanagpur Plateau (India) demonstrated significant differences in the benefits accruing to higher landholding households from higher social strata as compared to those from lower caste affiliations.

Since, Nepal exhibits a highly skewed land distribution (as mentioned in the policy relevance section below), the probability for unequal water distribution is high. Furthermore, existence of caste system with dominance of higher castes in policy domains, and disproportionately higher land distribution amongst them has meant that the same group are deriving much of the benefits from the irrigational development in Nepal. Ethnic minorities, indigenous people, and Dalits, who represent a significant number of landless households marred with poverty, have tended to lag behind in benefiting from irrigational development in Nepal. Much work needs to be done to inform policy makers, about the trajectories through which the benefits of irrigation development trickle down in a caste based society such as Nepal. Since 1960, South Asia has emerged as the largest user of groundwater in irrigation in the world. Yet, little is known about this burgeoning economy, now the mainstay of the region’s agriculture, food security and livelihoods. Results from the first socio-economic survey of its kind, involving 2,629 well-owners from 278 villages from India, Pakistan, Nepal Terai and

Bangladesh, show that groundwater is used in over 75% of the irrigated areas in the sample villages, far more than secondary estimates suggest. Thanks to the pervasive use of groundwater in irrigation, rain-fed farming regions are a rarity although rain-fed plots within villages abound. Groundwater irrigation is quintessentially supplemental and used mostly on water-economical inferior cereals and pulses, while water-intensive wheat and rice system dominates canal areas. Subsidies on electricity and canal irrigation shape the sub-continental irrigation economy, but it is the diesel pump that drives it. Pervasive markets in tube well irrigation services enhance irrigation access to the poor. Most farmers interviewed reported resource depletion and deterioration, but expressed more concern over the high cost and poor re-liability of energy supply for groundwater irrigation; which has become the fulcrum of their survival strategy.

After viewed above literature reviews I understood, there have been many studies on irrigation in the world and Nepal too. Some of them I have taken here in my study (thesis) for literature review. Many of them are based on productivity and production. They have tried to show impact and role of irrigation on land productivity, crops production, poverty reduction and increasing in living standard of farmer. They have also discussed about irrigation system how the irrigation is conducted from past to present. But different from them my research is striving to compare cost effectiveness and annual rental income of Diesel pump set and Electric Pump Set irrigation system, how they are installed the pump set, which are the main sources of money for pump set instalment, what they want for improvement on pump set irrigation system and they are satisfied or not from the existing pump set irrigation system. Hence, this study find out the significance, impact on agriculture output and socio-economic condition of pump set irrigation system having households on the study area.

CHAPTER III
RESEARCH METHODOLOGY

This chapter explained how data were collected, which tools and technique has used, Selection of study area, Research design, Nature and Sources of data and how data has processed and analyzed.

3.1 Research Design

The research study has been carried out with comparitive, descriptive as well as exploratory approach. It is comparitive because the study aims to compare the cost effectiveness between two types of existing pupm set irrigation system, i.e Diesel pumpset and Electric pumpset. It is exploratory because the study aims at exploring the socio-economic condition, problems of pump set irrigation system and its impact on agricultural output due to Tube well irrigation system in Tribhuwanbasti VDC.

3.2 Selection of Study Area

Tribhuwanbasti VDC is the remote VDC of Kanchanpur district and it is marginalized. There are 2,724 households, 14,168 total population, 6,482 male and 7,686female in the study area (CBS 2011). The main occupation of the people is agriculture, few of them are in service and small business but now day's flow of youth for overseas has increased. Main crops in all nine wards are paddy, wheat, and maze; accordingly now a days farmer are attracted towards cash crops like vegetable, sugarcane and banana. Most of the farmer is the medium farmer with total land three bigha. Though main occupation is agriculture and land is arable but there is no any project and program on irrigation by government expect a little subsidy on countable Diesel pump sets. Diesel pump set is highly in practice than Electric Pump Set in Tribhuwanbasti VDC, but it has not been studied its cost effectiveness**.**

The pump set based irrigation system has been only one alternate for irrigation to the Tribhuwanbasti VDC in Kanchanpur district. Due to lack of canal irrigation system and limit availability of electric power for pump set conduction diesel pump set irrigation system has been prioritized than Electric Pump Set for water supply in the farm of Tribhuwanbasti VDC of Kanchanpur.

3.3 Nature and Sources of Data

Both qualitative and quantitative data has been used in this study. Both primary and secondary sources of data are used in this study. Primary data were collected through field visit with different techniques such as observation, interview, Secondary data were collected from the journals, books, articles, newspapers, unpublished reports and documents, VDC office, district irrigation office and Ministry of irrigation, Government of Nepal.

3.4 Sampling Procedure

The study has only covered Tribhuwanbasti VDC of Kanchanpur district where 243 households (pilot survey, 2070) are having pumpset and among them 61 HHs has selected as sample, which is approximetly 25% of the total. The HHs has been choosen by following systematic sampling.

At the beginning the list was obtained from VDC and is kept as recorded in VDC record. Out of 2740 household by dividing by sample number 61 we get 45 as sample interval for systematic sampling and the first household was chosen randomly with in interval which was ninth household, and rest was chosen based on sample interval. During sampling if the sampled house hold was not having Pump Set then nearest house hold has taken as sample house hold.

3.5 Tools and Techniques of Data Collection

There were many tools and techniques for data collection. Here in this study I have taken Household Survey and Key Informants Interview. Structured Questionnaire was prepared to collect necessary information by doing interview in selected households. The questions were filled up by taking interview with the household head or member of households to collect the required information. Focus group discussion has used to collect the ideas and views of the people on problems and solution of pump set. Accordingly key information interview has used while doing pilot survey, elder peoples of the village, VDC secretary, teachers and active farmer were also interviewed to collect initial information regarding Pump Set.

3.5.1 Key informant interview

Key informant interview is also used using checklist. Elder peoples of the village, VDC secretary, teachers and active farmer were also interviewed to collect initial information regarding Pump Set. Form these person information on the status of Pump Set installation, people's attitude and perception about irrigation, problem faced by the user and support needed for promoting irrigation was collected.

3.6 Processing and Analysis of Data

After finishing the field survey, the collected data were first edited, coded and numbers were entered in computer, with the help of Microsoft Word, Excel and Stata, data were processed. The collected data analyzed by using simple statistical tools such as percentage, table, graph etc. charts and map have also been used to make clear presentation of the findings. The Quantitative data were analyzed using simple statistical tools such as percentage, average whereas Qualitative data have been analyzed through content analysis.

CHAPTER IV
IRRIGATION IN NEPAL

4.1 Irrigation in Nepal

Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growing in grain fields and helping in preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming. Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area.

Neplease economy, as mentioned earlier, is highly dependent in agriculture. Hence government has put especial effort for the development of agriculture in its every five year plan. However, before the time of constructing Chandra Canal (1926) in Saptari, all the irrigation development activities were carried out through indigenous traditional Canal system. At that time Rajkulos were famous as the indigeneous irrigation system. Fedual lords Anshuvarma and Jinsu Gupta made a number of Rajkulos. Several other

Rajkulos were construted during Malla regime. 'Naikes' were appointed for regulating, governing, maintenance and operation of Rajkulos (Shrestha, 1986).

Irrigation has since long been contributing as a key input for farm production, household income and food security in Nepal. Since time immemorial the farmers of Nepal have constructed and managed traditional canal systems, many of which are still functional. However, these Farmer Managed Irrigation Systems (FMIS), about17000 in hills and 2000 in Terai, cover about quarter of the total arable land and serve mainly to supplement irrigation during wet season. Most irrigation is done by diverting small rain-fed streams that have high discharge variability and no water during dry season. Moreover, these systems are built by using local materials and indigenous knowledge and require a lot of manual labor input which is increasingly being scarcer. Water use efficiency and reliability of most FMISs is very poor.

The Government of Nepal (GON) has also fully recognized the need and importance of irrigation. It has been making continuous efforts for the development of the irrigation sector of the country over the past five decades. However, irrigation facility expansion through conventional methods is severely limited by topographical constraints. Snow melt is largely inaccessible because rivers draining it have deep cuts and are usable only with very long canals or by pumping, which is often prohibitively expensive. Moreover, the challenge is mounting as relatively easy and economically more viable projects have already been taken up. Access to irrigation has also been observed to be a major factor for rural poverty.

Land productivity of non-poor households is nearly two times higher than that of poor households, mainly because of access to irrigation and better situated farms. According to the latest "Nepal Living Standards Survey", the risk of poverty is more pronounced among farm households that do not have access to irrigation. As access to irrigation and the share of irrigated area increases, the poverty gap between farm households with and without irrigation grows. Despite large investments in the sector, only 50%of arable land presently has irrigation facilities. Furthermore, only 30%of the area having irrigation facilities gets year round irrigation while the remaining 70%receives only seasonal irrigation. Agricultural practices are still highly dependent on rainfall due to inadequate irrigation infrastructure or facilities. This dependency on rainfall not only affects yields but also significantly influences the sowing and harvesting time (Mr. Timilsina and Mr. Sijapati, 2011).

Department of Irrigation (DoI) is a government organization, with a mandate to plan, develop, maintain, operate, manage and monitor different modes of environmentally sustainable and socially acceptable irrigation and drainage systems - from small to larger scale surface systems and from individual to community groundwater schemes. Its ultimate aim is to provide year round irrigation facilities and increase the irrigable area of the country to higher limits. This giving a primary input in increasing the productivity of the land and providing a major input to the GDP and eventually improve the standard of living of the beneficiary farmers. Apart from this the DoI also has to carry out river training activities to protect the floodways, floodplains and agricultural lands in the form of river bank protection such that the loss of properties caused by flooding is reduced.

Although the construction of modern irrigation system started in Nepal in 1922 during Rana regime with Chandra Nahar, the Department of Canal was formally established in 1952 under the ministry of Construction and Communication. The department then passed different stages working under different ministries and finally ended up as Department of Irrigation in 1987. Since the establishment of Ministry of Irrigation (MoI) in 2009, DoI has been working under it. DoI is one of the departments under the MoI of Government of Nepal (GoN). The Director General (DG) of DoI is supervised by Secretary of MoI. There are four divisions under the umbrella of DG in DoI. Apart from these divisions, administrative branch, financial branch and legal branch are also directly administered by DG. There are five Regional Irrigation Directorates in each region under the supervision of DG. Twenty six irrigation development division offices and twenty irrigation development sub-division offices in all regions work under the supervision of respective irrigation directorates. Besides, there are eight irrigation management divisions and 3 mechanical divisions in the structural organization of DoI. Out of the total 14.718 million hectare area of the country only 2.641 million hectare area is arable and 1.766 million hectare land is irrigable. 76% of potential irrigable area lies in the Terai region of Nepal.

The history of irrigation in Nepal before 1922 were all developed, operated and maintained by farmers called Farmers Managed Irrigation System (FMIS). From 1922 to 1957, Government made little effort to develop irrigation infrastructures in Nepal. Chandra Nahar, JuddhaNahar, Jagadispur Jalasraya (Banganga), are few examples of the projects developed during that period. However, irrigation infrastructure development has got high priority since 1957, the milestone of the beginning of periodic plan in Nepal.

The minor irrigation program was introduced in the second three-year development plan (1962-65) to provide low-cost-irrigation facilities to farmers within a short period of time. The program included the construction of small wells, irrigation tanks, reservoirs, pumps (lift) and other low cost irrigation facilities. Although it was planned to provide irrigation facilities to 4,455 hectares by the end of the Plan period under this program, the actual achievement was insignificant.

The Third Plan Period (1966-70) saw the countrywide implementation of the minor irrigation program with the emphasis on the participation of the beneficiaries. The government investment in irrigation development - especially in the large-scale irrigation systems in the Terai increased tremendously from 1970 onwards. This was due to the increase in the borrowing of international capital in the form of loans and grants for the country's overall economic development. This is clearly reflected in the surge of irrigation development targets in the subsequent five-year development plans-from the Fourth Plan (1970-75) onwards.

Until the middle of 1980s, irrigation development by the government focused largely on the construction of physical infrastructure of canals and structures, and very little attention was given to the effective management of the completed systems. Attention began to be paid to the improved management of government-operated irrigation systems from 1985 onwards. This is reflected in the implementation of a number of management-oriented projects in 1985-89: the USAID-funded Irrigation Management Project (IMP) in 1985, the Irrigation Line of Credit (ILC) in 1988 financed by the World Bank, the irrigation Sector Project (ISP) in 1988 financed by the ADB, and the Irrigation Sector Support Project (ISSP) in 1989 under the co-financing of the UNDP, the World Bank and the Asian Development Bank (ADB). All these projects have specifically emphasized the participatory approach to irrigation development and management of irrigation facilities. Further, following the introduction of the Basic

Needs Program (BNP) in 1987, the working Policy on Irrigation Development for the fulfillment of Basic Needs' was formulated in the early 1989.

This was immediately followed by the promulgation of the Irrigation Regulations (IR) in April 1989. These Regulations placed emphasis on the greater collaboration with water users in all phases of irrigation projects-planning, construction, operation and maintenance. The strategy of increasing farmer participation was mainly based on the recognition that government resources alone were inadequate to meet the country's irrigation development objectives and sustain the management of government irrigation systems after their completion. The government expected to increase the rate of irrigation development and develop maximum farmers'/water users' responsibility in the operation and maintenance of completed irrigation systems. The Irrigation Regulations gave water users, for the first time, a legal mandate to form water users' associations in accordance with the 1976 Association Registration Act. It institutionalized the participation of actual water users in irrigation. In 1989, the action plans and policies for the turnover of small irrigation systems and the participatory management of large irrigation systems were formulated.

This was followed by the promulgation of Water Resources Act and Irrigation Policy in 1992 with the clear vision of irrigation development. Later this policy was amended in 1997 and now Irrigation Policy 2004 is in practice. Similarly Irrigation Master Plan 1990, Agriculture Perspective Plan 1995, Water Resources Strategy 2002 and National Water Plan 2005 are other few documents which guide irrigation development in Nepal. At present, DoI is involved in the development of many irrigation projects. Sikta, Ranijamara Kulariya, Mahakali III, Babai, IWRMP, CMIASP and MIP are few examples of major activities in the implementation. DoI is equally responsible for development of new irrigation projects and O&M of developed schemes. For the last couple of years, DoI has been working with marginalized farmers in remote areas under the program of Non-Conventional Irrigation Technology Project (NITP). Similarly it has given high priority to IWRM principles while planning and developing new projects. Having realized the importance of year round irrigation, it is underway to start multipurpose inter basin water transfer project, diverting water from water surplus river to water deficit river and Bheri Babai diversion project is the first one to be implemented. In the course of development, DoI has arrived at the stage of inter basin water transfer and which is the new milestone of its achievement. However this will not be the full stop and it keeps on moving with the aim of expanding irrigation area and improving irrigation efficiency for the food security of the nation (MoI, 2009).

Table: 4.1 Progress of Irrigation in Plan Periods (2013-18 to 2064-67)

Planning's	Expanding of Irrigation (He.)	Percent of Total Irri. Land
Before first plan	6228	0.5
1st Plan	5200	0.4
2nd Plan	1035	0.1
3rd Plan	52860	4.2
4th Plan	37733	3.1
5th Plan	95425	7.7
6th Plan	172649	14.0
7th Plan	179337	14.5
8th Plan	293895	23.8
9th Plan	121900	9.8
10th Plan	208110	16.8
3yr Interim Plan	57848	5.1
Total	1232220	100.0

Source: Sharma, (2012).

Groundwater Investigation Program started in the country in F.Y.2026/27. USAID was the first to conduct primary groundwater investigation program in Nawalparasi, Rupandehi, Kapilvastu, Banke, Baridya, Kailali and Kanchanpur districts through construction of deep tube wells. Afterward, with the help of UNDP, GON carried out shallow aquifer investigation project covering whole districts of the Terai. From then onwards, GWRDP has been continuously conducting investigation programs by constructing deep and shallow tube wells, and by carrying out geophysical survey, water level monitoring of existing tube wells and water quality analysis programs. The project also aims to start hydro-geological study of Kathmandu Valley, mountains and Karsts aquifer of the surrounding area.

Community Shallow Tube well Irrigation Project (CSTIP)**-**Community Shallow Tube well Irrigation Project, with the loan assistance of International Fund for Agriculture Development (IFAD) was implemented in drought and flood affected five districts of Terai region namely Sunsari, Saptari, Siraha, Sarlahi and Rautahat. The project started its implementation work in F.Y. 1994/95 and was completed in December 2000. Through manual and machine drill shallow tube well irrigation scheme, the project provided irrigation facility for 4855 ha. of land. Around 60,000 populations are benefited directly or indirectly by this project. Bhairahwa-Lumbini Groundwater Project (BLGWP)**-**The project started its implementation work in Rupandehi District under the loan assistance of World Bank in F.Y. 1976/77. The project constructed 181 deep tube wells, 272 km of farm road, 287 km of electrification and provided irrigation facility for 20,309 ha. of land. Nepal Irrigation Sector Project (NISP)-Ground water component, irrigation Line of Credit (ILC) with the assistance of World Bank had been launched as a pilot project since F.Y. 047/046 and completed in F.Y. 053/054. All total 14602 ha. was the target to irrigate, out of which about 4960 ha. of land irrigated in 8 Terai districts (Navalparasi to Kanchanpur) through shallow tube wells and deep tube wells. The remaining irrigable area and the additional potential area are developed under Nepal Irrigation Sector project.

Nepal Irrigation Sector Project (NISP) - NISP started in F.Y.054/055 with the loan assistance of World Bank was implemented in 8 western districts of Terai namely Nawalparasi, Rupandehi, Kapilvastu, Dang, Banke, Bardiya, Kailali and Kanchanpur. Out of the total target of 7,500 ha.the project provided irrigation facility to 6482 ha. of land.

Community Groundwater Irrigation Sector Project (CGISP)**-**CGISP started in F.Y.054/055, the project was implemented in 12 Terai districts of eastern and central development region of the country with the loan assistance of ADB. The main aim of the project was to develop 15,000 shallow tube wells to irrigate around 60,000 ha. of land. The project installed 19767 numbers of shallow tube wells providing irrigation to 37685 ha. of land.

Groundwater Irrigation Project (GWIP) **-** GWIP is principally guided by 20 years (055/056 to 074/075) Agriculture Perspective Plan (APP) and conducts program with close consultation with other program. The project is implemented in 20 district of whole Terai. To date, the project has provided irrigation for 18225 ha. through shallow tube wells and 2,240 ha. through deep tube well.

Deep Tub well/Shallow Tube well Irrigation Project (DTWIP)**-**DTWIP (farmer managed DTW irrigation systems) is being implemented in Jhapa, Sunsari, Saptari and Siraha districts in the Eastern Development Region of Nepal under the immediate relief package for drought affected areas with grant assistance of the Government of India. The main activity of this project is to develop 22 DTW irrigation systems in order to irrigate around 880 ha. of land. The project started in F.Y. 061/062. The project has completed 10 numbers of DTW irrigation systems and has provided irrigation to 240 ha. of land. Similarly, Shallow tube well Irrigation Project is being implemented in this F.Y. 064/065 under the grant assistance of Government of India in Dhanusha and Mahottari. This project shall provide irrigation facility to 1,000 ha. of land in the region.

Nepal adopted poverty alleviation as the national priority from its Tenth National Development Plan. This resulted in a reorientation in the country’s irrigation sector. Irrigation was already recognized as the key input for farming that enhanced farm productivity, household income and food security. However, targeted intervention approach for the poor shifted the drive from the previous focus of expanding the irrigated area through construction of large irrigation schemes to the aim of enhancing irrigation efficiencies, delivering year round irrigation and conserving land and water. A substantial portion of the rural poor have small plots which are insufficient to provide full employment or income and the agricultural outputs are hardly adequate to support the family economy. In this context, Nepal’s shift towards pump set, shallow tube well and water lifting technologies in Terai plain areas and micro irrigation technologies in hilly areas has been found to offer a positive impact for poverty alleviation and conservation of land and water.

4.2 Concept of Groundwater Irrigation

Groundwater is water located beneath the earth's surface in soil pores paces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. Typically, groundwater is thought of as liquid water flowing through shallow aquifers, but technically it can also include soil moisture, permafrost (frozen soil), immobile water in very low permeability bedrock, and deep geothermal or oil formation water. Groundwater is hypothesized to provide lubrication that can possibly influence the movement of faults. It is likely that much of the Earth's subsurface contain some water, which may be mixed with other fluids in some instances. Groundwater may not be confined only to the Earth. The formation of some of the landforms observed on Mars may have been influenced by groundwater. There is also evidence that liquid water may also exist in the subsurface of Jupiter's moon Europe (Waller, 1982). Groundwater is the water that fills cracks and other openings in beds of rocks and sand. Each drop of rain that soaks into the soils moves downward to the water table, which is the water level in the groundwater reservoir. Groundwater does not normally occur in underground streams, lakes, or veins. Groundwater is found in soils and sands able to retain the water-much like a sponge holds water. Some 2.78 million trillion gallons of groundwater, 30.1 percent of the world's freshwater, are estimated for the entire planet of Earth. Of the total 349 billion gallons of freshwater the United States withdraws each day; groundwater is estimated to be 79.6 billion gallons, or 26 percent (NGWA, 2013). In the Nepal, ground water irrigation system is being practiced since last four decades. Several literatures on such irrigation system are found which reflect the true scenario of the results of such types of irrigation. Theoretical context regarding the subject matter of the research work as well as the empirical findings in Nepalese context and in the context of other countries are mentioned in this chapter:

CHAPTER V

DATA ANALYSIS AND INTERPRETATION

This chapter includes analysis and interpretation of collected data; furthermore presentation has done using table, graph and chart.

5.1 Socio-Economic Characteristics

5.1.1 Population

The total number of households of the Tribhuwanbasti VDC was 2,724 and total population was 14,168. Out of total population male number was 6,482 and female number was 7,686 (CBS, 2011). The average household size in the VDC is 5.56 which are higher than the national average (4.3). The population density of the VDC is high.

5.1.2 Age and Sex Composition of the Respondent

Age and sex composition are the basic demographic characteristics, which play vital role in the population analysis because those matters directly influence the incidence of birth, marriage and deaths. On the basis of economic activity, population distribution of sampled households has been classified into four age groups the age and sex composition is given in table.

Table 5.1: Sample Population Distribution by Age and Sex

	Male	Female	Total

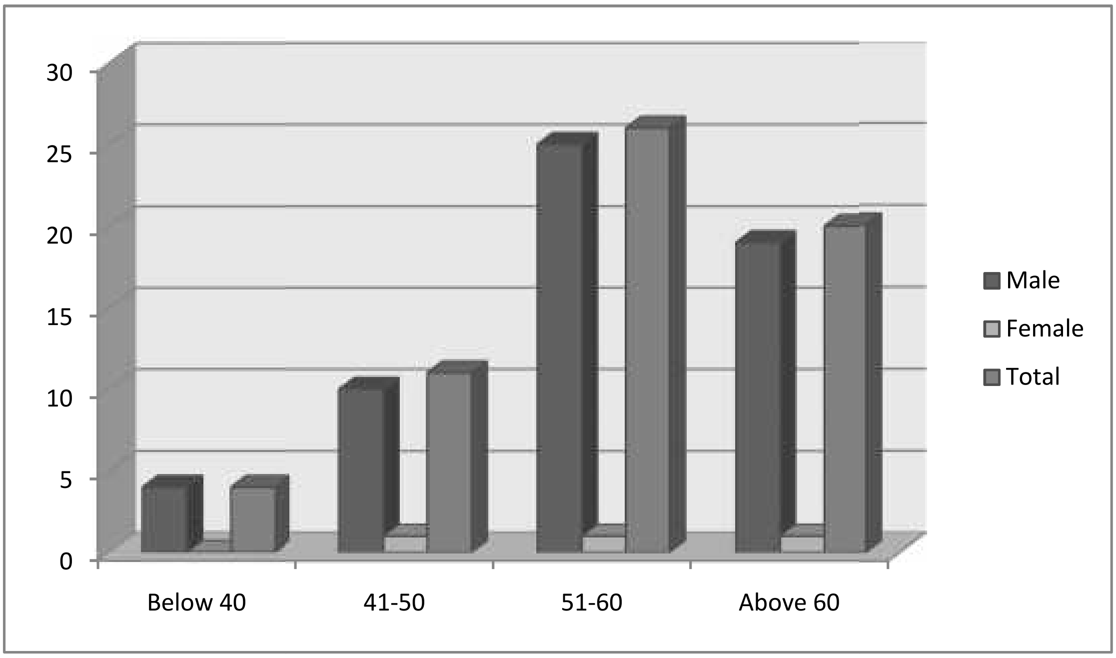
Below 40	4(6.89%)	0	4(6.55%)
41-50	10 (17.24%)	1(33.33%)	11(18.03%)
51-60	25(43.10%)	1(33.33%)	26(42.62%)
Above 60	19(32.27%)	1(33.33%)	20(32.78%)
Total	58 (100%)	3(100%)	61(100%)

Source: Field Survey, 2013

Generally the age group of economically active man power is considered to be 15-60 years. Thus, economically active respondent are estimated to be about 67.21 percent and the rest 32.79 percent of the respondent are dependent. Out of total respondent 95.08 percent are males and 4.91 percent are female (Table 4.1).

People below 15 years and above 60 years fall under dependent population. But in this area, due to rural agro-based economy, they are involved in various types of household works such as cattle rearing, looking after children, water collecting, cooking, grass cutting, wood collecting, poultry etc.

Figure 5.1: Sample Population Distribution by Age and Sex



Source: Field Survey, 2013

5.1.3 Education Level

In the study area, there are three primary schools, five secondary schools four higher secondary schools and two colleges; among them some are boarding schools. In this study, we broadly divided the sample population above 6 years, into two groups i.e. literate and illiterate. The literate group is also sub-divided into different groups according to the classes as literate without formal education, primary (1-5 class), lower secondary (6-8 class), secondary (8-10 class SLC also), higher secondary (+2 level) and above. Those people who can read and write but not have formal education in school are placed under literate class. The following table shows the educational status of the study area.

Table 5.2 Educational Status of Sample Population

Level	Frequency	Percentage
Illiterate	16	26.22
Literate without formal education	8	13.11
Primary	4	6.55
Lower secondary	14	22.95
Secondary	11	18.03
Higher secondary	3	4.91
Above	5	8.19

Source: Field Survey, 2013

From the Table 4.2, we find that the literacy rate of the study area is higher than that of national average which is 60.9%, (NPC, 2011) and Kanchanpur district's average which is 72.79%, (DDC, 2013). Only 26.22% of total populations are illiterate and rest of them is literate in the study VDC.

Among the sub division of literate as the percent of informal literate (13.11), primary level (6.55%), lower secondary level (22.95%), secondary level (18.03%), higher secondary level (4.91%) and above is (8.19%).lower secondary level is higher than others levels and secondary level is in 2^{nd} position. The table shows lower secondary level educated people are good number in study area.

5.1.4. Caste

The sample households have been divided on the basis of three cast groups like privileged group, ethnic group, and Dalit. In the Nepalese society, according to the cast of people, their occupation, education, economic status and lifestyle used to be determined. The cast structure of sample households is presented in the following table.

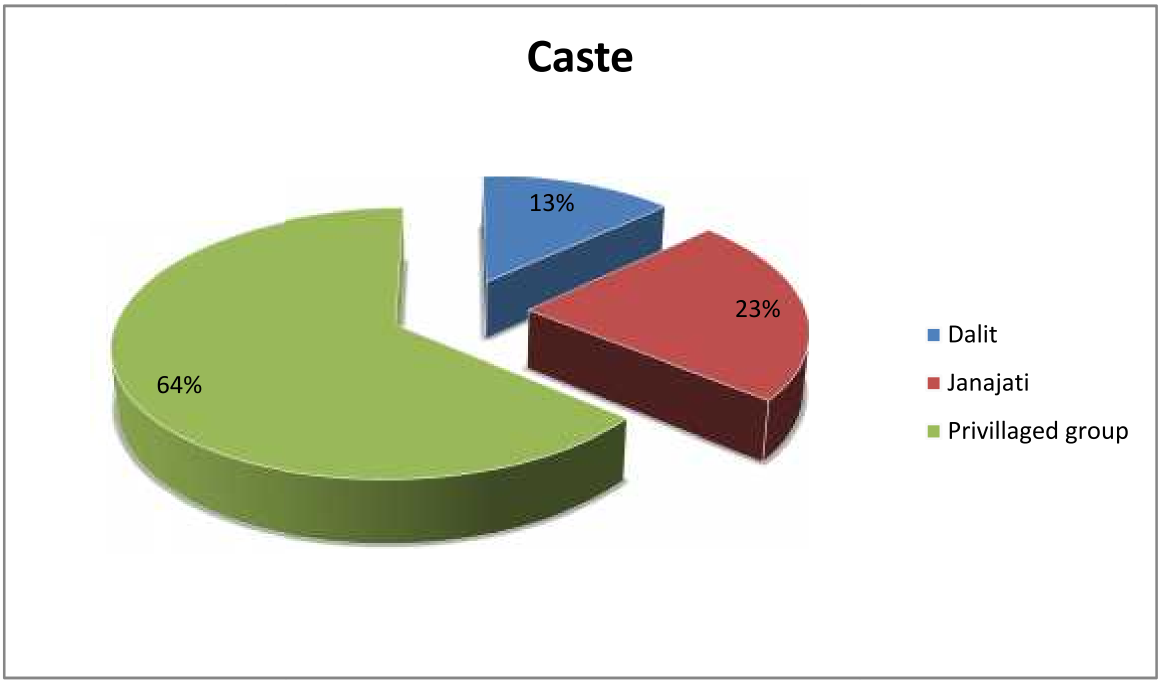
Table 5.3 Caste Distribution of Sample Households

S .N.	Caste Group	Number	Percentage (%)
1.	Dalit	8	13.11
2.	Janajati	14	22.95
3.	Privileged group	39	63.93
Total		61	100.00

Source: Field Survey, 2013

The Table 4.3 shows that out of total sample households 63.91 percent households of Brahmin, Chhetry and Thakuri is recorded; Janjati household is 22.95percent, which includes Tharu, Gurung, Magar, Shrestha and Garthi. Similarly the smallest household's size is Dalit consisting of 13.11 percent, which includes B.K., Sarki and Sunwar.

Figure 5.2 Caste Distributions of Sample Households



Source: Field Survey, 2013

5.1.5 Religion

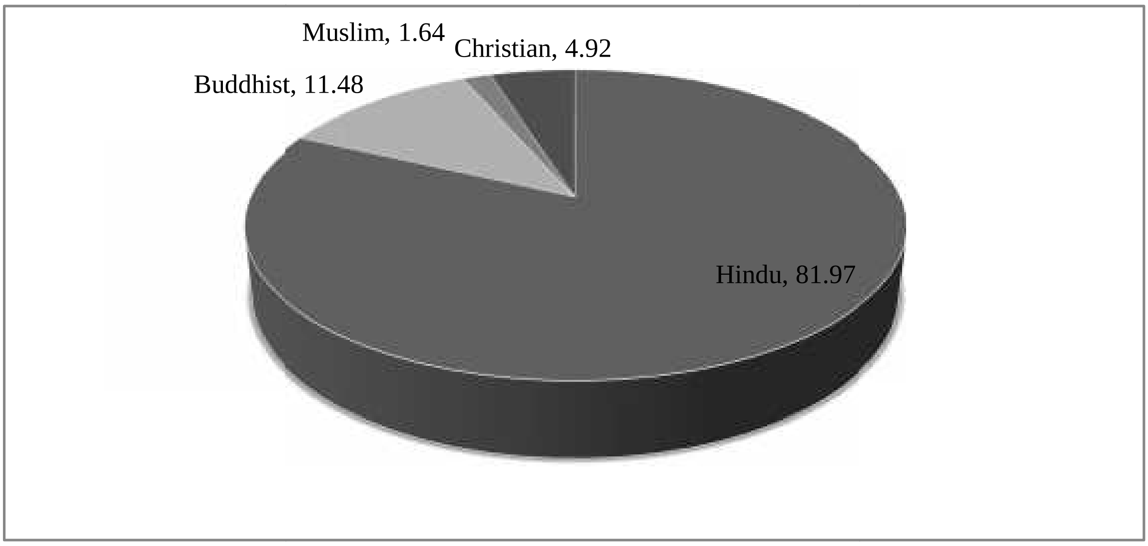
The sample households have been divided on the basis of five religious groups like Hindu, Buddhist, Muslim, Christian and others. The cast structure of sample households is presented in the following table.

Table 5.4: Distribution of Sample Householdsby Religion

Religion	Frequency	percentage
Hindu	50	81.97
Buddhist	7	11.48
Muslim	1	1.64
Christian	3	4.92
Total	**61**	**100**

Source: Field Survey, 2013

Figure 5.3 Religious Distributions of Sample Households



Source: Field Survey, 2013

5.1.6 Land Holding

Land is very important natural resources for practicing agriculture. It is also the most important factor for employment and income generation. Due to the failure of land reform program, land is unequally distributed in the rural areas. The average size of agricultural land holding in Nepal was reported to be 1.08 hectors (CBS, 2002).

The size of land holding almost in the study area is unequally distributed. The sample households are divided into three classes according to their size of land holding. Small farmers are those who have own land up to one bigha (20 kattha), medium farmers are those who have own land between one-three bigha and those who have own land above three bigha comes under large farmers.

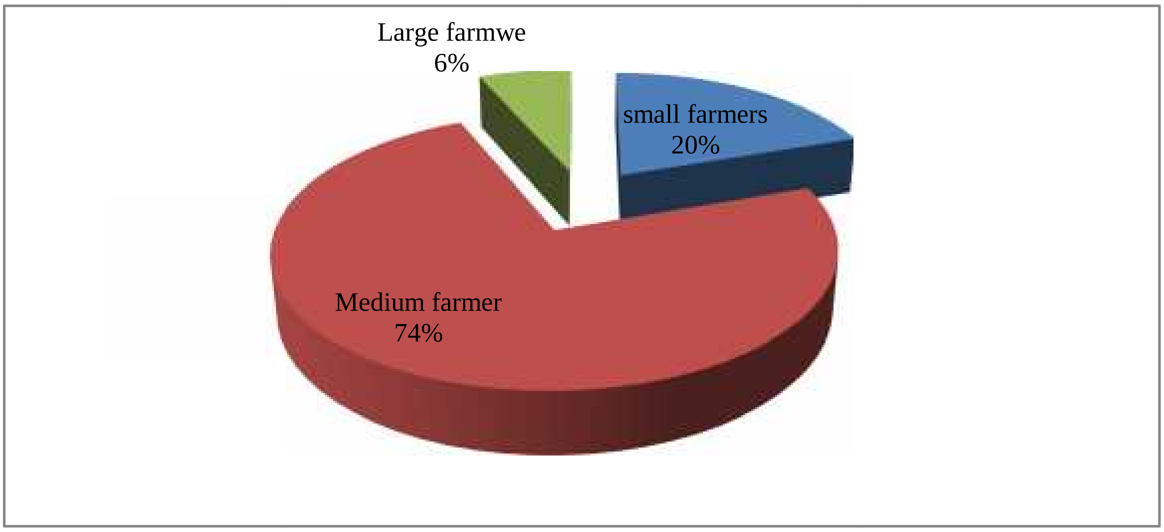
Table 5.5: Distribution of Sample Households by Size of Land

Category of Farmers	Numbers	Percentage (%)
Small Farmers (Up to One Bigha)	12	19.67
Medium Farmers (One-Three Bigha)	45	73.77
Large Farmers (Above Three Bigha)	4	6.55
Total	61	100.00

Source: Field Survey, 2013

In the study area, 19.67 percent of the households are small farmers, 73.77 percent households are medium farmers and 6.55 percent are large farmers. It shows that the medium class farmers are in large numbers in the study area. The total sample land holding is 139 bigha (2780kattha).The average size of the land holding per households of the study area is 2.27 bigha (45.57kattha).

Figure 5.4: Distribution of Sample Households by Size of Land

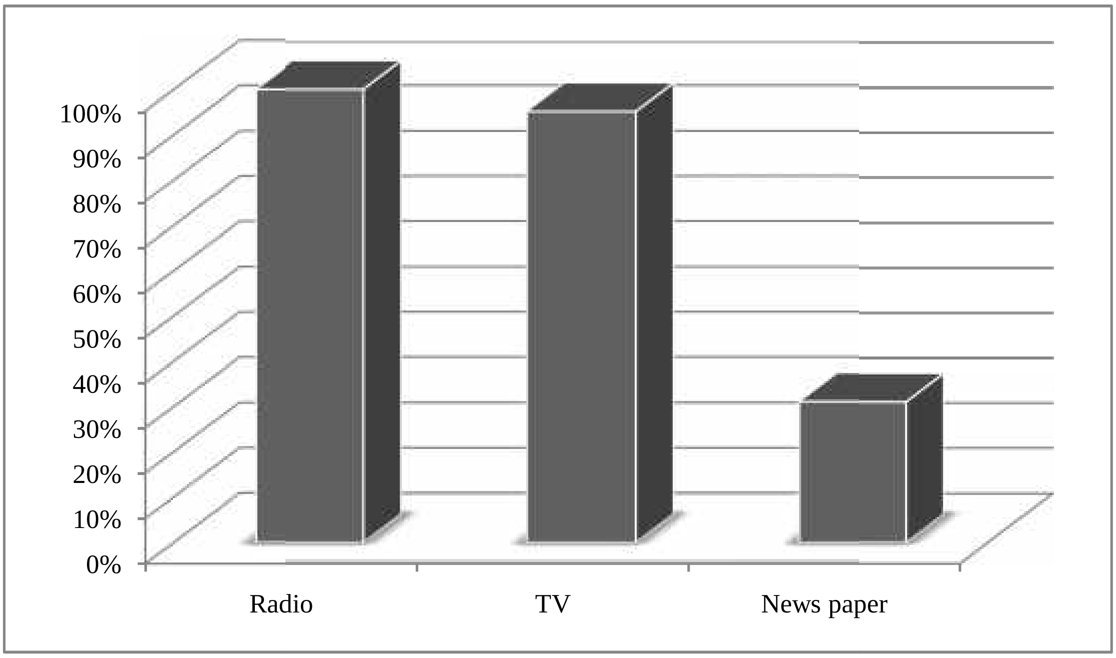


Source: Field Survey, 2013

5.1.7 Excess to Communication

Though study area is rural and marginalized excess of communication was found satisfactory. Every households listen radio, out of total sample household 95.08 percent has TV and 31 percent household red newspaper. It has presented in the following bar graph.

Figure 5.5 Excess to communication



Source: Field Survey, 2013

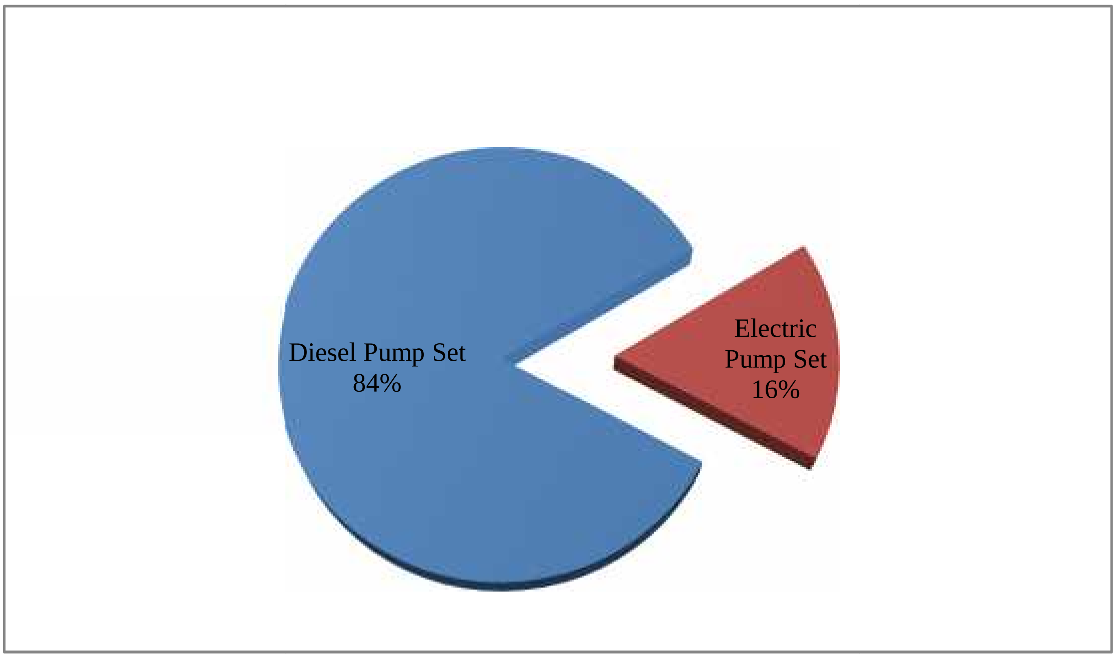
CHAPTER VI

6.1 Choice of Irrigation: A cost effectiveness Analysis

6.1.1 Distribution of Pump Set

Choice of pump set is influenced by various factors like education, awareness and basic requirement. It was found that out of total sampled household only 10 was found Electric pump set and remaining 51 was Diesel pump set. Due to limit availability of three phase's electric power in farm area, farmer was compelled to choose Diesel pump set, so during the data collection frequency of Diesel Pump Set was found more than Electric Pump Set. Distribution of pump set is shown in below chart.

Figure 6.1 Distribution of Pump Set



Source: Field Survey, 2013

6.1.2 Relation between land holding size and pump set

There were many factors which affect choice of household for pump set. Among various variable some variable are directly related and other indirectly. Land holding is one of them which influence on choice of pump set. Here we have described the pump set having household by size of land holding.

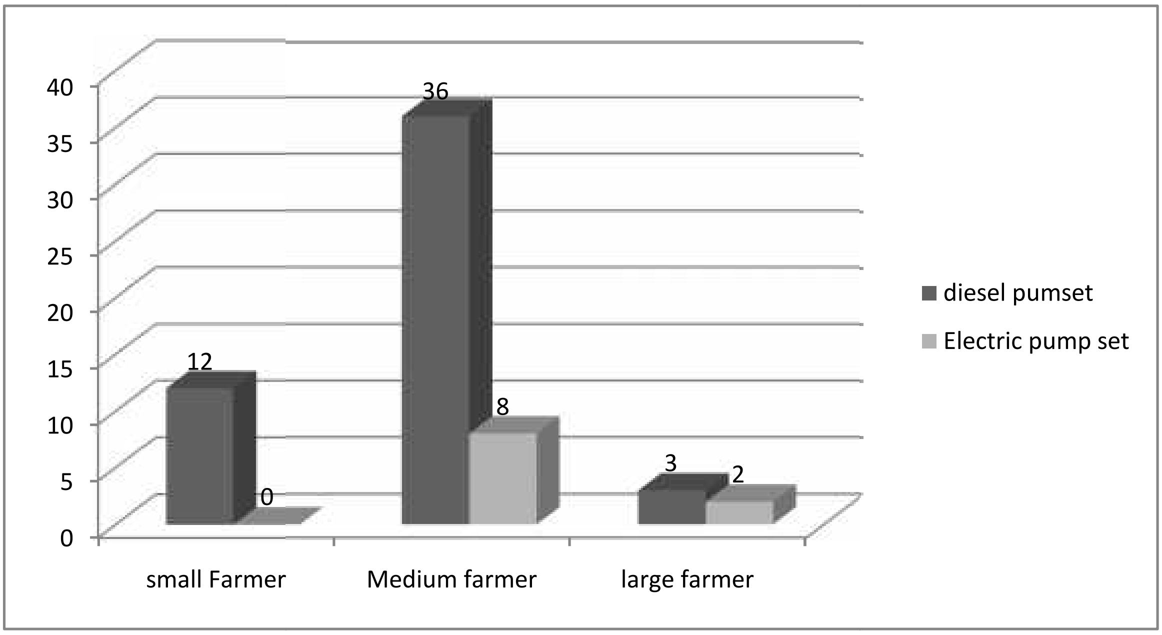
Table 6.1 Relation of pump set with size of land holding.

Total Land holding	**pump set**	
	Diesel pump set	Electric pump set
small farmer (0-20 Katha)	12 (23.52%)	0
Medium farmer(20-60 Katha)	36 (70.58%)	8 (80%)
Large farmer (more than 60 Katha)	3 (5.88%)	2 (20%)
Total	51 (100%)	10 (100%)

Source: Field Survey, 2013

The data shows that out of total diesel pump set having household 23.52 percent pump set having household are small farmer, 70.58 percent pump set having house hold are medium farmer and only 5.88 percent pump set having house hold are large farmer. This shows that the frequency of diesel pump set having households is high in medium farmer. Similarly out of total Electric Pump Set having house hold 80 percent households are medium farmer and 20 percent household are large farmer. This shows that the frequency of pump set having household of medium farmer is high than small and large farmer.

Figure 6.2 Relation of pump set with size of land holding



Source: Field Survey, 2013

6.1.3 Use Detail of Pump Set by Land Category

In the study area it was found the land has been categorized as Upland Khet, Bari and Loland Khet. Upland Khet describes for the land which is situated in a little bit higher area which needed more irrigation than Loland Khet, Bari is a little piece of land which is generally used for cash crop and vegetables, situated near the house. And the Loland Khet is the main land with high productivity than other land. The use detail of pump set by land category is shown in the table.

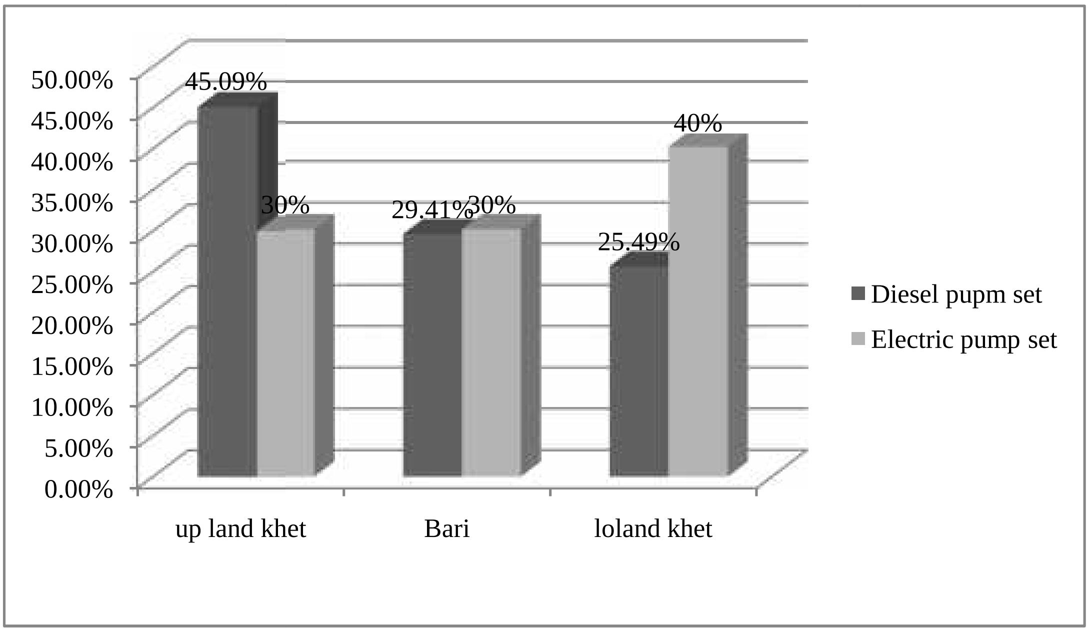
Table 6.2 Use Detail of Pump Set by Land Category

Use plot	Diesel pump set	Electric pump set	Total
Upland Khet	23(45.09%)	3(30%)	26(42.62%)
Bari	15(29.41%)	3(30%)	18(29.50%)
Lowland Khet	13(25.49%)	4(40%)	17(27.86%)
Total	51(100%)	10(100%)	61(100%)

Source: Field Survey, 2013

The data shows that out of total (Diesel + Electric) pump set 42.62 percent pump set has installed in Upland Khet, 29.50 percent pump set has installed in Bari and 27.86 percent pump set has installed in Lowland Khet.

Figure 6.3 Use Detail of Pump set by Land Category



Source: Field Survey, 2013

6.1.4 Investment on Pump Set

Out of total Pump set having farmers of the study area many of them have taken loan for pump set from governmental and non-governmental institutions, creditors, relatives and others and rest of them have invest himself without taken any loan. So the sample households of the study area are divided in three groups according to the investment of money for pump set. The groups are: Loan from government institution, Loan from others (non-government institutions, co-operatives, creditors, relatives and others) and Self investment (without loan).

Table 6.3: Sources of Investment

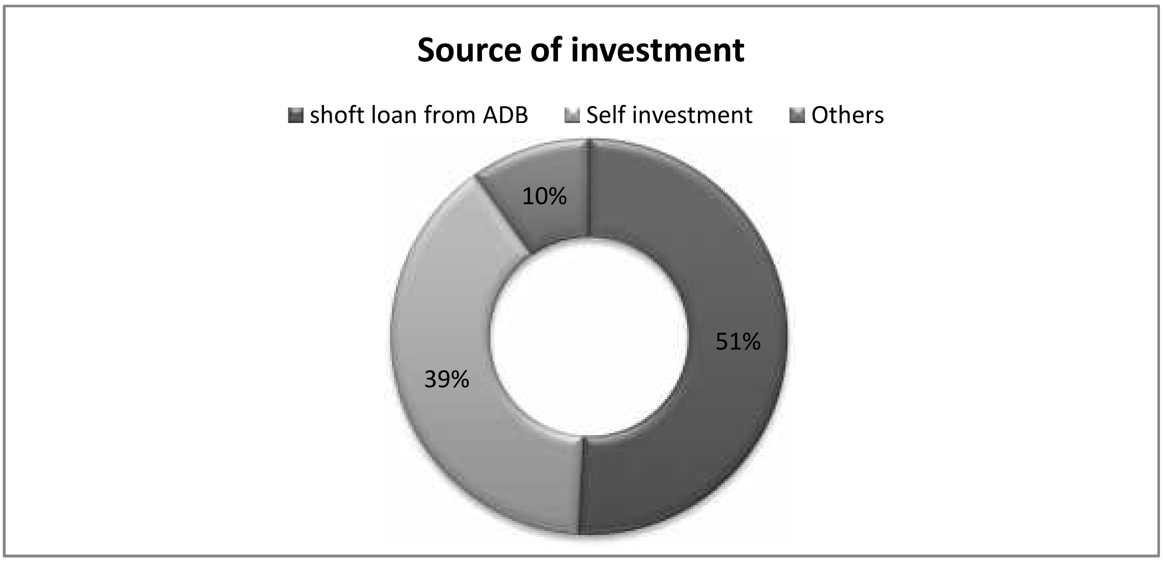
Sources	Number of Electric pump set	Number of Diesel pump set	Total Pump Set	Percent (%)
shoft loan from ADB	3	28	31	50.81
Self-Investment	7	17	24	39.34
Others	-	6	6	9.83
Total	10	51	61	100.00

Source: Field Survey, 2013

The table shows, how the farmers have managed the investment of money for pump set. From the above table we know that 50.81 percent farmers have taken loan for pump set from government institutions, 39.34 percent farmers have invest themselves (without loan) for pump set and rest of them 9.83 percent farmers have taken loan for pump set from other sources such as non-governmental institution, co-operatives, creditors, relatives and from others.

We can say that the government institutions have played good role for pump set install in study area but even 9.83 percent farmers have taken loan from other sectors like non-government institution, creditors, relatives, neighbors etc. which is very expensive to them in interest rate.

Figure 6.4 Distributions of Sample Households by Investment on Pump Set



Source: Field Survey, 2013

6.1.5 Average Use of Pump Set by Season

It was found that the average use of two types of pump set of the study area is influenced by various factors such as seasonal shortage of fuel, load shedding etc. So there has unequal use of both types of pump set on different season. The average use of both pump set has shown in the below table.

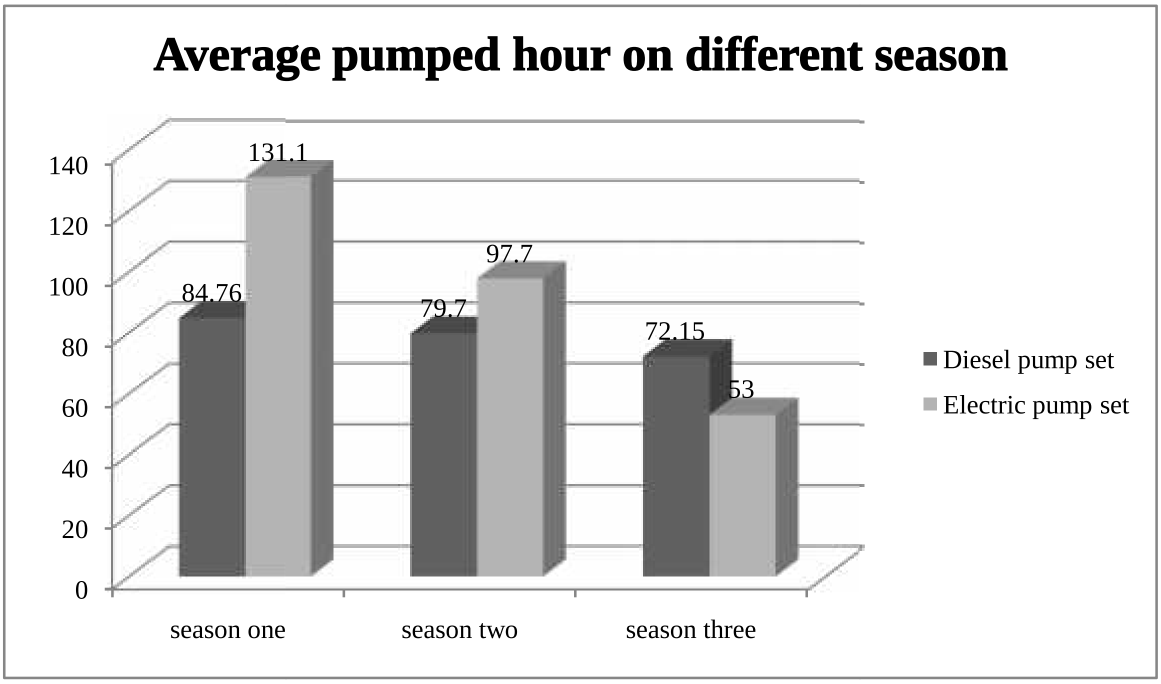
Table 6.4 Average Use of Pump Set by Season

Pump set	Average pumped hour on season 1st (Ashad to Kartik)	Average pumped hour on season 2nd (Manghsir to Falgun)	Average pumped hour on season 3rd (Chaitra to Zestha)
Diesel pump set	84.76	79.7	72.15
Electric pump set	131.1	97.7	53

Source: Field Survey, 2013

The table shows that both pump sets have been used much more in first season, season second is in second position and third season is in third position. The average pumped hour of diesel and Electric Pump Set in first season is 84.76 hour and 131.1 hour respectively, similarly 79.7 hour diesel and 97.7 hour Electric Pump Set has used in second season. And then in third season average use of diesel and Electric Pump Set was 72.15 hour and 53 hour respectively. The data shows that the Electric Pump Set has been used much more than diesel pump set in first and second season but in third season diesel pump set has used more than electric pump set.

Figure 6.5 Average use of pump set by season



Source: Field Survey, 2013

6.2 Calculation of Cost

6.2.1 Fixed Capital

Out of total sample 51 was diesel pump set and remaining 10 was electric pump set. Many of them were installed in different year so there was variation in initial cost. Coz of variation it is impossible to analyze the initial cost distinctly. That's why we have analyzed average initial cost in the following table.

Table 6.5 Initial Capital Cost

Pump set	Average initial cost (Rs.)
Diesel pump set	81607
Electric pump set	81700

Source: Field Survey, 2013

The average initial cost of diesel pump set has seen Rs 81607 and that of Electric Pump Set is Rs81700. The data shows that there was negligible difference on installation cost; it means the initial cost of electric pump is not expensive than diesel pump set so it is positive aspect to the farmers to install the electric pump set. This information clears them who think the Electric Pump Set is much expensive than diesel pump set.

6.2.2 Operation Cost

It was found that there was vast difference in per hour operational cost of diesel and electric pump set. In general diesel pump set needs 1 liter diesel per hour and 2 unit electricity is needed per hour for electric pump set. Latest market price of diesel is Rs 103 per liter and that of electricity is Rs 7 per unit. The average operational cost of both pump set has shown in below table.

Table 6.7 Operating cost

Pump set	Average pumped hour on season 1st	Operation cost	Average pumped hour on season 2nd	Operation cost	Average pumped hour on season 3rd	Operation cost
Diesel pump set	84.76	8730	79.7	8209	72.15	7431
Electric pump set	131.1	1835	97.7	1367	53	742

Source: Field Survey, 2013

The table shows that the operational cost of diesel pump set is very high than electric pump set. Electric Pump Set is more than 7 times cost effective than diesel pump set. fuel cost of Electric Pump Set is countless in comparision to diesel pump set.

6.2.3 Maintenance Cost

During the data collection it was found that there were no any sequal relationship on maintenance cost and its frequency. mainly the frequency of maintenance depends upon its uses and when was it installed. Generally it was found that diesel pump set nedded to maintain two times in a year and it cost Rs.500-1000 per episode. on the other hand, expect negligable terms, Electric Pump Set need not maintain yearly, but it cost much more than that of diesel pump set. Electric Pump Set needed Rs.3000-4500per episode in three or four years. Here surfacely maintenance cost of Electric Pump Set seems costly than diesel pump set but when we calculate, it is not so.

6.2.4 Income from Pump Set Rent

Farmers use to sell the pump set water in per hour rent after using on their own farm. They use to take per hour pump set rent about Rs 60-100. The rent is different in different villages. According to the pump set’s annual rental income of the farmers we have divided them four groups: Rs 0-10,000 income having group, Rs 10,000-20,000 income having group, Rs 20,000-30,000 income having group and more than 30,000 per year income having group.

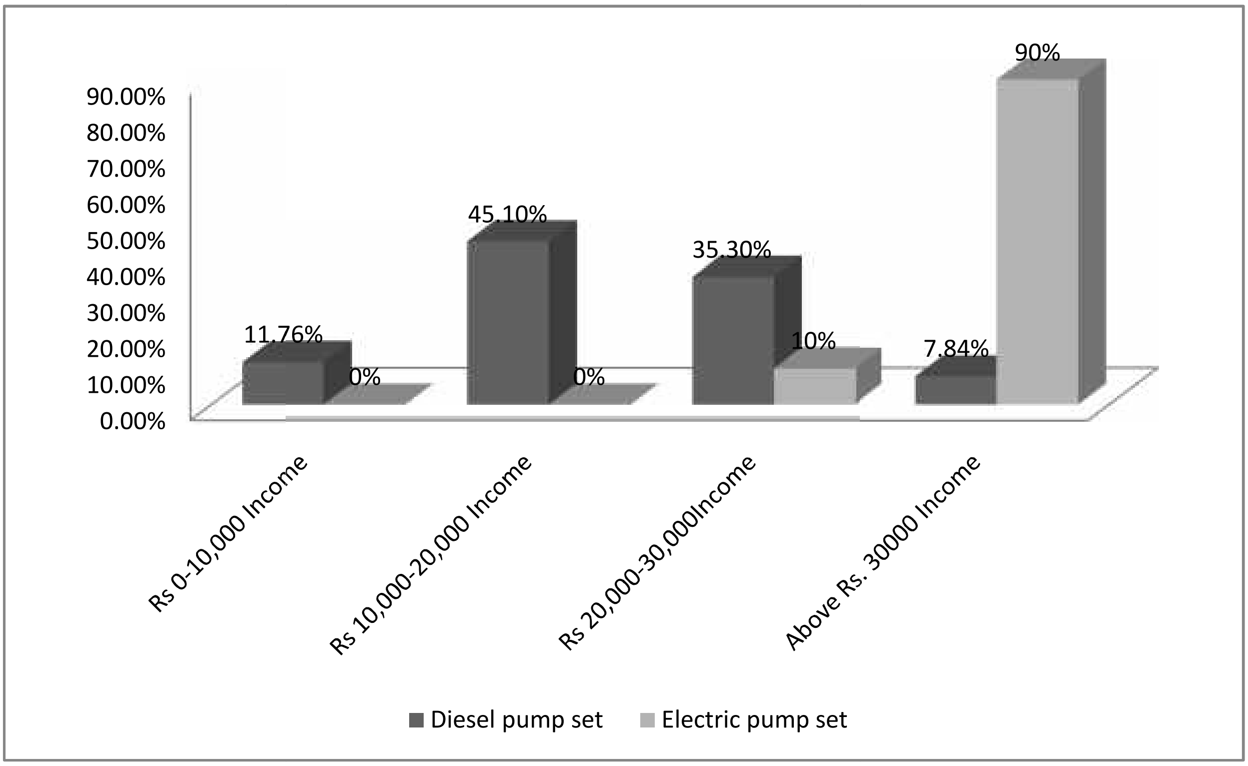
Table 6.8: Distribution of Sample Households by Pump set Income

Income	diesel pump set	percent(%)	electric pump set	Percent (%)
Rs 0-10,000 Income	6	11.76%	0	0
Rs 10,000-20,000 Income	24	45.1%	0	0
Rs 20,000-30,000 Income	18	35.3%	1	10%
Above Rs. 30000 Income	4	7.84%	9	90%
Total	51	100%	10	100%

Source: Field Survey, 2013

The table shows that out of total sample diesel pump set having households 4 (7.84 %) households earns more than Rs 30,000 amount per year, 18 (35.3 %) households earns Rs 20,000-30,000 amount per year, 24 (45.1%) households earns Rs 10,000-20,000 and rest of them 6 (11.76 %) households earns only Rs 0-10,000 amount per year through the pump set rent.simillarly out of total sample Electric Pump Set having household 1 (10%) households earns Rs 20,000-30,000 amount per year, and rest of them 9 (90%) households earns more than Rs 30,000 amount per year. Above data clearly shows that per year rental income of Electric Pump Set is higher than diesel pump set.

Figure 6.6 Distribution of Sample Households by Pump set Income



Source: Field Survey, 2013

6.3 Cost Effectiveness Analysis

After doing analysis of collected data it was found that Electric Pump Set is cost effective than Diesel Pump Set. There is no significant difference on initial capital cost of both pump set. Beyond this Electric pump set is much more cost effective than Diesel Pump Set in terms of fuel cost. Electric Pump set needed Rs. 14 per hour to operate whereas Diesel Pump Set needed Rs. 103 per hour. Similarly in terms of maintenance for Diesel Pump Set much more time is required to maintain twice in year which also needed money in heavy amount and it also interrupt irrigation. In comparison of life Electric pump set can give more service than Diesel Pump set and it also needed time to time services and cure than Electric Pump Set. In terms of life Electric Pump set gives service continuously for six to seven year where as Diesel Pump set only runs for four to five year without maintenance, besides this annual rental income from Electric Pump Set is higher than Diesel Pump Set because, for the farmer who do not have pump set they prefer Electric Pump Set for irrigation due to minimum operating cost. Where farmer have to pay only Rs. 100 to 120 per hour for Electric Pump set besides this for Diesel Pump Set they have to pay rent separately to the owner of Pump Set and have to buy fuel also. Therefore for rental irrigation farmer have to invest up to Rs. 200 for Diesel Pump Set.

6.4 Problems and suggestionfor Pumpset Irrigation System

6.4.1 Problems of Diesel Pump Irrigation System

The farmers are investing themselves for their pump sets by their own cash or loan. Now about Rs 100,000 amount is necessary for pump set so it is very expensive for small and poor farmers. In terms of fuel, Diesel is used for fuel in diesel pump set but it is very expensive (now Rs 103 per/ltr), there is no any subsidy on diesel for farmers and it has also seasonal shortage problem. The pump sets used to install in edge of land or far from the house so there is much possibility of theft. Besides this Diesel pump set irrigation system requires experienced and knowledgeable technician for its maintenance and Limited life of pump sets are the major problems.

6.4.2 Suggestions to Improve Diesel Pump Set

Some suggestions are given here, which were collected with respondents here given below: Provision of new engine, which can operate by both diesel and electricity, Time to time maintenance of pump set parts, Trainings for farmers who have pump set, Provision of pump set parts on subsidy, Provision of qualified technician and Provision of loan without any deposition in low interest. For all this, farmer said that government should be responsible.

6.4.3 Problems of Electric Pump Set irrigation system.

Well trend technician are not available in rural area for maintenance and it needs large amount then Diesel pump set for per episode maintenance. Unscheduled power cut is also another problem to the farmer.

6.4.4 Suggestions to improve Electric Pump Set irrigation system

Some suggestions are given here, which were collected with respondents here given below: provision of rural electrification, provision of new engine, which can operate by both diesel and electricity, time to time maintenance of pump set parts, trainings for farmers who have pump set, provision of pump set parts on subsidy, provision of qualified technician and provision of loan without any deposition in low interest,

CHAPTER VII

SUMMMARY, CONCLUSION AND RECOMMENDATION

7.1 Summary

The overall purpose of this study was to measure cost effectiveness of the existing pump set irrigation system of Tribhuwanbasti VDC of Kanchanpur.

Nepal has still sufficient ground water level that can be used for irrigation basically in rural areas. Generally Terai belt can take lots of advantages from groundwater. But due to several reasons groundwater is not being optimally used as in the project area Tribhuwanbasti VDC. If proper action is taken recently farmers of the Tribhuwanbasti VDC can take more benefit that could raise their living standard from farming.

Income has increased not only in the form of wage and employment but total production has also increased due to irrigation. Total output of all type of crops that is grown in the study area was found to increase after irrigation. Similarly those land which are not cultivated before irrigation is now being cultivated. In other words irrigation has also increased the opportunity of using available resources more efficiently. Irrigation has also encouraged farmers to grow nontraditional crops such as banana, sugarcane etc. that can generate cash income instantly. Although the share of income from banana and sugarcane is not very big, lots land having farmer are taking part in the banana and sugarcane production which has very benefited to them side of money and using of land.

But many people are not adopting pump set irrigation system due to expensive and seasonal shortage of diesel, unavailability of electricity, low powered electricity, only two phases having electric connection system in many wards and many other problems. some of them are adopting diesel pump set irrigation system which is costly, it is making high price of farm output and only few are adopting Electric Pump Set due to unavailablity of requre electric facility. High production cost is reducing competitive capacity of local farmers to compete with Indian agriculture production that is easily available in Nepalese market. Similarly local people can earn high income when they migrate for labor work in foreign country. So people are not interested less profitable agriculture activities. This may be another reason for low rate of adaptation of irrigation facility or pump set irrigation system.

7.2 Conclusion

This study shows one side pump set having more household are privileged groups (Brahmin, Chhetri and Janajati), Hindu religious, and literate or educated family member having households and another side those people have pump set who are rich and who have good accessed for loan to governmental and nongovernmental institution and money lender. It means those people are not leaving their own countryside cause of many reasons, cultural rules and regulations so they are investing on agriculture or irrigation.

Finally, in conclusion we found that Electric Pump Set have more positive benefits than diesel pump set for rural farmers and Electric Pump Set is much more cost effective than diesel pump set. Both pump set need equal capital cost for installation and fule cost of electric pumpset is very low than diesel pump set, thats why many of the farmer choses Electric Pump Set but due to unavaibility of electric facility they are bound to install diesel pump set. Pump set has been a reason to change on their income, increasing production, intensify the use of agricultural land and diversification of crops. All of these finally improve the livelihood of rural farmers. Howeverthe farmers having pump set facing several problems such as Investment, Security, Fueling, maintenance etc. So, the government either has to provide canal irrigation or have to give some subsidies for the installation, maintenance, fueling etc.

By this cost effectiveness analysis we can conclued that Rural electrification would be effective prograame and a milestone for agricultural development of not only Tribhuwanbasti VDC but whole country and finally it would be helpful for agro based national economy.

7.3 Recommendation

On the basis of aforementioned findings following recommendations were made for this study.

- Government should provide electricity in each agricultural area with needed phase's electric convection system with subsidized rate.
- Government should provide subsidy on pump set parts such as engine, motor, pipe etc.
- Government should provide loan for farmers in low interest rate and without deposited any fix property for pump set installation.

This study shows the cost effectiveness of pump set and socio economic condition of pump set having households of the study area but there is others more sector which are related with irrigation sector such as canal irrigation system, and community managed irrigation system. Those sectors will be a good sector for the further study. Except those many others untouched sector are there which will be the proper sector for study for anyone.

Surface irrigation potentiality will be a good topic for the further study because there is lack of surface irrigation system which is invested by government and also long term, cheap than pump set irrigation system.

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