Impact Assessment of Rooftop Rain Water Harvesting: A Case Study of Bagh and Battagram Districts

By

Ajaz Ahmed

Dissertation Submitted in Partial Fulfillment of Master of Philosophy (MS/M.Phil) Degree in Environmental Economics

Centre of Environmental Economics and Climate Change (CEECC), Pakistan Institute of Development Economics (PIDE) Islamabad, Pakistan

Signature Head of Department____________________________________

Signature Supervisor____________________________________

Signature External Examiner____________________________________

AKNOWLEDGEMENT

First and foremost I offer my sincerest gratitude to my Supervisor, Dr Usman Mustafa, who has guided me throughout my thesis with his patience and knowledge whilst allowing me the room to work in my own way. I attribute the level of my Masters in Philosophy degree to his encouragement and effort and without him this thesis, too, would not have been completed. Indeed he is very dedicated, committed,and friendly personality. I am especially thankful to the Head Department of Environmental Economics Dr Rehana Siddiqui, for her kind support and guidance. Without her support and encouragement I might not be able to submit my research work before the due timings.

I am heartily thankful to Dr Wasim Shahid Malik, Dr Arshad Khan, Dr Idrees Khawaja, Mahmood Khalid, Nasir Khan, Abdul Samad, Shujat Farooq, Muhammad Mehraj, Ayaz Ahmed for support from the initial to the final level enabled me to develop an understanding of the subject. I am greatly appreciative of Syed Zaheer Hussain Gardezi and all the staff of WatSan Section in ERRA, who have supported me in conducting primary survey. I am indebted to Rizwan Ali Shinwari who has spared his precious time and helped me in data collection throughout the survey. I am also thankful to my survey team at both sites yielding a high rate of response rate.

In my daily work I have been blessed with a friendly and cheerful group of class fellowsand junior students from Master and M.Phil at PIDE. I offer my regards and blessings to all of those who supported me in any respect during the completion of the project, as well as expressing my apology that I could not name them individually. Finally, I thank my parents for unconditional love and support throughout all my studies at PIDE.

Table of Contents

LIST OF GRAPHS

LIST OF MAPS

LIST OF TABLES

ABSTRACT

Water is a basic necessity for all living beings, and without it life is not possible. Water availability remains a serious issue in both urban and rural areas in the developing world particularly, in earthquake prone and hilly areas. Majority of the population of Pakistan is living in rural areas, where access to safe drinking water is very serious issue. In order to resolve the water crisis in Pakistan, government as well as number of private agencies (NGOs) is working on water management. Different approaches, including Rooftop Rain Water Harvesting (RRWH) technology are being taken up for supplying water to the population. In this regard, a project of RRWH technology was initiated by Earthquake Rehabilitation and Reconstruction Authority (ERRA) Pakistan in Bagh, Azad Jammu Kashmir (AJK) and Battagram, Khyber Pakhtunkhwa (KPK), Pakistan. There was need to evaluate the socio economic impact of this technology. Present study is the assessment of RRWH technology with special reference to women health and time allocation. Analysis was carried out using statistical and econometric techniques. Specifically, study has used Negative Binomial Regression (NBR) and Ordinary Least Square (OLS) techniques to quantify the results. Moreover, financial appraisal of the technology using Net Present Value (NPV), Economic Rate of Return (ERR)and Pay Back Period is also carried out in this research. The findings of the study revealed that RRWH technology is viable, profitable, women friendly and sustainable source of water supply.

CHAPTER I

INTRODUCTION

Water is a prerequisite for life and without it there will be no living thing. Its availability remained a serious issue in both urban and rural areas in developing as well as developed countries (Tripathi and Pandey, 2005andDwivedi, 2009). Particularly, its significance is further enhanced in earthquake prone, hilly, and rural areas where access to water is difficult, expensive and tiresome (Kumar, 2004). According to United Nation water is the basic right of human beings. Millennium Development Goals set forth for 2015 have focused on the availability of safe drinking water (UN, 2003). It is often said that quality of life depends on the quality of water we are using. Besides its importance and necessity, water is becoming scarce commodity on whole earth.

Since, the last few decades, water demand has increased with alarming pace, whereas, the availability of fresh water is drastically decreasing (Liaw and Tsai, 2004andLehmann and Tsukada, 2009). This is mainly due to the higher population and industrial growth, intensive agriculture production, fast urbanization, etc. (Kumar, 2004 and UNEP, 2009). This surge in water demand is putting enormous pressure on existing water supply sources with serious consequences for environment. United Nation Environmental Program highlighted the gap between the supply and demand of water as the most critical issue of present age (UNEP, 2009).Although, there are number of water supply schemes initiated by governments and international agencies, but still millions of the poorest people are suffering from acute water shortage.

The growing scarcity of water in low income countries, where majority of the poor reside in the rural sector, creates lots of problems in water allocation (Xinshen et al., 2005).Given the grim situation of water, there is a dire need to formulate some water conservation strategies. In this regard many prudent approaches to conserve water at domestic as well as commercial level are being adopted. Rain Water Harvesting (RWH) is one among them to conserve, store and utilize rain water. RWH is very old but useful approach to channel and use the rainwater in productive manners (Li et al, 2000 and UNEP, 2009).

It has been used by almost all societies in all parts of the world to provide water for drinking, livestock, irrigation etc. RWH is also very useful for soil conservation which otherwise erode due to flash flow of rains (UNEP, 2009). Mainly there are two types of RWH; Surface Rainwater Harvesting (SRWH), and Rooftop Rainwater Harvesting (RRWH). Both are equally important and used as water conservation strategies.

This technology has special importance for Pakistan because country is also facing acute water shortage. World Bank reported that Pakistan is a water stressed country in South Asia(World Bank, 2005).Population distribution of Pakistan is such that, more than 60 percent of total is living in rural and hilly areas, where it is very difficult to provide water supply schemes, because of high cost and very low success ratio. Moreover, in hilly areas supplying water is time consuming, hazardous, and costly business with numerous risks involved in it (Baguma et al, 2010).World Bank further endorsed that this technology is the most suitable and viable approach for hilly areas of Pakistan (World Bank, 2005).

RRWH system is simple, economical, and based on indigenous resources. Local people can easily be trained and mobilized to implement such technologies (Helmreich and Horn, 2009).Construction material is readily available and system is convenient in the sense that it provides water at the point of consumption, and family members have full control of their own systems. It greatly reduces operation and maintenance problems because it is installed at each dwelling unit. Due to which there is no stress of users on it and owner also try to maintain it. Water collected from roof catchments is usually of acceptable quality as of other available water sources (Kumar, 2009).

Most important aspect of RRWH is the reduction in time and fatigue of women, which is needed for collection of water from water sources. The available save time can be used for productive purposes like; domestic work, agriculture and livestock activities, children brought up etc. Studies found that technology reduces cost incurred on health as well as time allocation for curing the sick people, which could be used for profitable activities (Lehmann and Tsukada, 2009andBaguma et al, 2010). Similarly, young children (boys and girls both) can go to school who are otherwise busy in fetching water. Furthermore, this system improves the sanitation and hygiene of rural population by providing them water at home on sustainable basis (Thomas and Martinson, 2007).

Provision of water through RRWH technology has special importance for women wellbeing because; being the direct beneficiaries, they can harness number of benefits out of this. Although, substantial work on economics of RRWH has been done in many countries but unfortunately, no ample attention was devoted to research on impact of this technology in Pakistan.

1.1 Objectives

Overall objective of the study is to analyze the impacts of RRWH in hilly sites of Bagh, and Battagram, districts. Specifically, the study has following objectives:

1. To highlight the scope and prospects of RRWH in hilly and earthquake prone areas.
2. To analyze the impact of RRWH on women health and women time allocation with special reference to water fetching in hilly and scattered helmets.
3. To investigate the Net Present Value (NPV), Economic Rate of Return (ERR), and Pay Back Period (PBP)for financial analysis of RRWH project.
4. To formulate the policy recommendations for sustainable use of rain water and its implications for wellbeing of rural population.

1.2 Organization of the Study

The study consists of six chapters. After the introduction and objectives of the study in the first chapter, second chapter deals with the review of literature. It presents the status of research work which has been done on the topic. Mainly literature is based on the analytical and empirical findings of research. The first section of literature review is about the potential of RRWH system in terms of per annum water supply. Second section emphasizes on the impact of RRWH technology with special reference to water fetching on women health and time allocation. Last section presents review on financial aspect of the facility.

Third chapter provides the description of the site of the study areas, where the present research has been carried out. It includes the brief introduction of the study areas, culture, population, natural resources and socio-economic status, etc. Fourth chapter deals with data and methodological framework followed by the study. Specifically, it discusses the data, construction of variables, their theoretical underpinnings, and econometrics models to examine the overall impact of RRWH technology in Bagh and Battagram.

Fifth chapter presents detailed discussion of results of the statistical and empirical work done in order to investigate the potential benefits of the project. Overall conclusion and policy implications are presented in the last chapter.

CHAPTER II

LITERATURE REVIEW

Rainwater harvesting is well recognized and practiced technology to collect, conserve and sustainably use the rain water. It is especially more suitable for the earthquake prone, scattered and hilly areas, where the success ratio of traditional water schemes is very low. The RRWH plays significant role in soil conservation because it reduces the loss due to rain water runoff.

2.1 Scope of Rooftop Rain Water Harvesting (RRWH)

Kumar (2004) used the secondary data sources to analyze the hydrological opportunities and economic cost of RRWH in India. According to the findings of study, supply of water to a hilly population cost Rs. 25/ m^3 for a supply level of 50 lpcd. Whereas, the marginal cost would be Rs.22/ m^3 in order to raise the supply level to 100 lpcd. The high marginal cost was due to proportional increase in cost of pumping equipment, which forms a significant component of the capital cost and operation and maintenance costs, respectively. But in the case of rooftop water harvesting the unit cost (Rs. 25/ m^3) remains more or less the same. The marginal cost production of water through rooftop water harvesting system also works out to be very close to the unit cost. This is because the cost of the system heavily depends on the storage capacity of the rooftop water collection tank and starts from nearly thousand rupees (for the channel and gutter pipe). Author concluded that RRWH system is more suitable for scattered and hilly population particularly where there is high rainfall and large rooftop catchment areas. But, it is not very effective and economical in urban areas. Author has not highlighted the overall potential benefits of the project for rural areas.

Yie et al. (2009) analyzed the RRWH as an innovative approach to saving energy in hilly communities at Hua-Chan Community in northern Taiwan. Authors have used the secondary data to conduct marginal analysis and economic feasibility analysis. Study has also calculated the optimum storage volume for different dwelling units. It indicates that the optimum rainwater tank volumes range from 5 to 10 m^3 according to the type of dwelling. RRWH systems are economically unfeasible for either water-saving purpose (Benefits/Cost=0.60) or energy-saving purpose (Benefits/Cost= 0.55). However, it becomes economically feasible when using RRWH for both energy savings and water savings. Results of this study suggest that water conservation and energy conservation should be considered together in hilly communities. Moreover, the unit energy-saving cost of RRWH is 6.4 NT$/ kWh, i.e., more cost effective than the investment of solar PV systems in Taiwan. Overall, study is has unique approach of integrating two things (water and energy) in to rain water conservation, but authors have not mentioned unit energy saving due to water.

Tripathi and Pandey (2005) have examined the potential of RRWH using the primary data for Zura village in Kuch District, Gujrat, India. Apart from survey they have also used the secondary information. They calculated the potential of technology for some households. Their findings yielded that mean annual rainfall in Kutch village is less than 500 mm. Analysis of 23 year rainfall data of Bhuj Taluka of Kutch district reveals 292 mm mean annual rainfall with 70% probability. Study proposed that RRWH system can resolve the problem of drinking water in drought prone areas of Kutch district. Although, study has calculated the potential of RRWH but specifically it has not focused the total amount of water which could be saved. Furthermore, it is also not clear that to what extent this facility is making ease for the community.

Fayez and Shareef (2009) observed the potential of this technology for household water supply in Jordan. They used data on rainfall, water supply, population, and number and area dwellings in each governorate. The potential rainwater harvesting volume was estimated based on the total roof area, the average annual rainfall, and the runoff coefficient. Potential saving percentage is calculated by dividing the potential volume of harvested rainfall by the annual domestic demand. Results revealed that a maximum of 15.5 Mm^3/y of rainwater can be collected from roofs of residential buildings if all rain falling on the surfaces is collected. This was equivalent to 5.6% of the total domestic water supply of the year 2005. The study also claimed that harvested water fulfill the WHO standards of drinking water.

Liaw and Tsai (2004) investigated about the optimum storage volume of rooftop rain water harvesting systems. They have analyzed the cost and utility functions by using the data and empirical techniques. Mainly they did the optimizations of the size of rooftop rain water harvesting system in which they found that optimal point of the given water supply reliability can be determined from the rooftop area storage capacity/reliability curve and the cost function. This study also presents a simple method based on the concept of marginal rate to determine the reliability of a water supply for RRWH systems. The point at which the marginal rate of substitution between total annual cost and reliability equals the average value determines the reliability of the water supply. Authors have applied very interesting approach but their methodology and findings are ambiguous.

All above studies have analyzed the scope and potential of RRWH technology with different angles. Most of these have tried to examine it as a cost effective water supply source. There is no such evidence found of its inefficiency or poor performance. Studies have emphasized that this water conservation approach is useful to avoid supply shortage in hilly areas.

2.2 Health and Time Allocation of Water Fetching Women

Lehmann and Tsukada (2009) examined the effect of rainwater harvesting on poverty using primary data. The study developed the correlation between RRWH and poverty by adopting the opportunity cost principle. Study cited that it reduces cost incurred on health as well as time allocation for curing the sick people, which could have other resourceful uses. Furthermore, health could also improve due to improved water quality and labor supply. They calculated that households holding a cistern spend no more than 30 hours per month for collecting water. A significant share of households without a cistern spends up to 50 hours per month. The results of the study are very useful and provide way forward for further research but health issues were not quantified with reference to RRWH technology.

Thomas and Martinson (2007) found that by adopting RRWH system household water consumption and hygiene were directly, whereas, health related benefits were indirectly improved. Study argued that there are some health related issues like back strain, injury and falling, while carrying water and some other problems like nonattendance of children left at house associated with water fetching. Furthermore, study has claimed that water fetching has relatedness with some other issues like bringing water from dangerous locations where risk of attacks from wild animals always remains there. Study has touched upon almost all of the major hazards which caused by the laborious and tiresome job of water fetching but, these are just theoretical claims and hypothetical situation which ought to be empirically tested in order to precisely report their individual contribution to overall sufferings of water fetching.

DfidKar Report R1 (2002) while discussing some case studies reported that, in Uganda people were covering 4 to 11 km distance in search of water, with a return journey time of between 5 to 7 hours. There were many hazards associated like attacks by wild animals, sharing of water source with livestock, falls while carrying water, and personal assaults. In Uganda and Ethiopia vendors services are most widely used during the dry season (June to September) when it is tiring to walk long distances for fetching water, or when water is urgently needed. Households have to purchase water daily during severe dry periods when prices become double. The water sources of vendors are either their own water storage tanks or they collect from the lake or spring by bicycle. Daily water collection is time consuming and costly business. Report further revealed that almost all respondents were tired due to fetching water. Moreover, long distance and associated problems (such as children drowning in the well, children developing bad habits from others, women and girls being raped, and attacks by snakes and other wild animals) were also highlighted.

Reviewed studies with reference to the impact of RRWH on women health and their time allocation were interesting and provided good insights for future research. All of the above discussed studies have claimed that this water conservation approach increasing the welfare of people and specifically it has created ease for the women of poor communities by providing water for domestic consumption on sustainable basis.

2.3 Financial Analysis

Tang (2009) carried out a study to examine the net benefits of RRWH by adopting different approaches. For evaluating the villagers' opinion towards rainwater harvesting, various questions were asked. Almost all respondents were in favor of the RRWH system. Study found that on average, each household spends Rs. 1800 (USD 36) to purchase water from private vendors per year. The amount was Rs. 216,510 (USD 4,353) per year for entire village. The study analyzed that net benefits of RRWH were positive under the three scenarios: 1) Analysis without discount rate, 2) Baseline scenario with a 30% discount rate, and 3) Worst case scenario or sensitivity analysis. The study did not analyze the socio economic impact like women health and time allocation.

Dwivedi and Bhadauria (2010) analyzed the domestic RWH in India. Authors have collected data of 30 Households and examined the size of rooftops, storage capacity and cost of water. The unit cost of the water which can be harvested from rooftop area was calculated by considering the 30 years of serviceable life of RRWH system and water tank at 7% rate of interest. The salvage value of the DRWH system was assumed 25% and annual maintenance and repair cost as 0.5% of the capital cost. In this study authors have calculated the unit cost of water but without indicating the type of analysis.

Literature of financial appraisal of the RRWH technology argued that, it is suitable, viable and profitable approach of water supply. This system has very less monetary cost of installation and maintenance. Moreover, it saves their time which they can use for other productive activities like agriculture and livestock.

CHAPTER III

DESCRIPTION OF THE STUDY AREAS

This chapter provides the detailed description of study areas, where pilot phase of RRWH project was initiated by ERRA and implemented by two NGOs (Maqsood Welfare Foundation (MWF) and Save the Children). Maqsood Welfare Foundation (MWF) is Bagh based local NGO which implemented the pilot of RRWH in one village of Bagh district. Save the Children is an international NGO operating in different areas of Pakistan and it has played the role of implementer in one village of Battagram to implement this technology.

The descriptions include mainly the characteristics of the areas like demographic and cultural information, geography, climate, agriculture, and natural resources etc. First of all study will present the general information about both districts and then remaining sections will explained. In order to highlight the differences of both areas study will explain each characteristic of the areas side by side.

3.1 Introduction of the Districts

3.1.1 Battagram

Battagram is a district of Hazara division of the Khyber Pakhtunkhwa province in Pakistan. The district covers an area of 350,172 acres (excluding the 930 sq. km unsettled area of Chor pastures) (Battagram 2007). The district is mostly mountainous with peaks rising above 4000 meters with thick forests. However, fertile plain areas exist in Nindhyar, Tijri Deshan, Batamori, Banna and Rashang valleys. The estimated population of Battagram district in 2004-2005 was

361,000. The average household size of the district is 6.6personsThe main language of the district is Pashto, but Hindko and Gojri are also spoken. Apart from that English and Urdu are spoken and understood in offices. Battagram obtained the status of district in July 1993 when it was upgraded from a tehsil and separated from Mansehra district. Before Battagram obtained the status of district, it was a tehsil of the Mansehra district. The district was badly affected in massive earthquake of 2005. The whole infrastructure including water supply system was partially or fully damaged.

The project of RRWH has been executed in Saroona, a village of Allai. It is one of the two Tehsils, or subdivisions, of Battagram district. Allai contains 8 union councils which include Banna, Bateela, Batkul, Biari, Jambera, Pashto Rashang, and Sakargah. The Allai valley is bounded by Kohistan on the north and east, by the Kaghan valley, Nandhiarh and Deshi of Deshiwals on the south, and by the Indus river on the west. The valley of Allai is divided from Kohistan on the north by a range of mountains rising to over 15,000 feet, and from Nandhiar and Deshi by another range running from the Afghanistan border to the Indus above Thakot (Battagram 2007).

The valley was ruled by Khans (tribal rulers) until 1949, when it signed the ‘Instrument of Accession′ with Pakistan. Allai was merged into Pakistan as an administrative part of the Battagram sub-division in 1971 while, Battagram was upgraded to the status of a district and Allai become one of the sub-divisions of Battagram district in 1993. Allai valley was badly affected by the Kashmir earthquake on October 8, 2005 which also destroyed the 'cable way' a way to allow residents to cross the Indus river.

Pilot project of RRWH system was implemented in Saroona which is one village of union council Allai. According to the estimates provided by Save the Children in year 2010 total no of households of Saroona village are 330 and total population of the village is 5000, whereas, the average household size is 8. Population distribution with regard to their professions in Saroona, Battagram is given in appendix Table 5.1.

Map 1: Study Area in District Battagram

3.1.2 Bagh

Bagh is one of the eight districts of Azad Jammu and Kashmir (AJK),Pakistan. The district, which had been part of Poonch district, was created in 1988. The total area of the district is 1,368 square kilometers. Bagh district was created with three sub-divisions, namely Dhirkot, Bagh and Haveli, with its headquarters at Bagh. It is said that a *Bagh* (garden) was set up by the landowner of the area, where the premises of the forest department are now located. As a result, the area that is now the district headquarters was named “Bagh”. Bagh was badly affected by the Earthquake on October 8, 2005 which destroyed the overall infrastructure of the district.

Map 2: Study Area in District Bagh

3.2 Detailed Descriptions of the Study Areas

3.2.1 Climate Information

The altitude of Battagram district is 728 meters, while general elevation of Bagh is between 1500 and 2500 meters above sea level. Both sites are touristed with mountaineers, anglers, hunters, hikers, naturalists and anthropologists. The holidaymaker flavor in each year is from June to

October. Climate of these districts varies with altitude. The average temperature of Battagram Survey of this study has been carried out in Chitra Topi, which is the project site of RRWH. It is a village of union council Topi in district Bagh. This village is situated in the North East of main Baghcity at an altitude of 7000 feet above from sea level and on a distance of 18 KM. The village is linked with Bagh city with a melted road (Map 2). Topography of the area is hilly. Number of the households in this village are 274. Total population of the village is 1918 in which males are 940 and females are 978. Overall literacy rate of the village is above 80% (Bagh 2007). The main clans of the Chitra Topi are Suddhen, Mughal, Qureshi. Suddhen is the most influential clan that take the lead and dominate in taking decisions at the local level.

In Bagh maximum and minimum temperatures during the month of June are about 40 °C and 22 °C respectively. December, January and February are the coldest months in Bagh. The maximum temperature in January is about 16 °C and minimum temperature is 3 °C respectively. Annual precipitation is about 1500 millimeters (Bagh 2007). Forest and vegetation cover is average, but comparing Battagram, Bagh has more area under forest. In Bagh mountains are generally covered with coniferous forests. This enormous forest cover is one major factor that is contributing to the huge rain fall through respiration effect in both districts. The annual precipitation is about 1500 millimeters (Bagh and Battagram 2007). This high rainfall is the main cause of initiating and implementing the RRWH project in these areas. Topographically, the districts area is mountainous with different slopes.

In some areas of Battgram extreme cold weather is observed and in other areas it is moderate. Maximum and minimum temperatures in Bagh during the month of June are about 40 °C and 22 °C respectively. December, January and February are the coldest months. The maximum temperature in January is about 16 °C and minimum temperature is 3 °C respectively. The annual precipitation is about 1500 millimeters. Forest cover and vegetation is average, but in Bagh it is more than Battgram. In Bagh mountains are generally covered with coniferous forests.

This enormous forest cover is one major factor that is contributing to the huge rain fall in both districts. The annual precipitation is about 1500 millimeters. And this happened due to respiration effect of the forests. This high rainfall is the main cause of initiating and implementing the RRWH project in these areas. Topographically, the districts area is mountainous with different slopes.

3.2.2 Geographical Information

Bagh and Battagram districts are far from each other and have different geography like Bagh is touching its border with Indian occupied Kashmir and Battagram have Afghanistan on its North. Battagram is 90 km away from Abbottabad and 240 km from the capital Islamabad (Battagram 2007). It has geographical borders with Kohistan district, the Tribal Area of Kala Dhaka (Black Mountain of Hazara), Shangla district and Malakand division. Bagh lies in lesser Himalayan zone and situated 46 km from Rawalakot. The main range in district is Pir Panjal. The district is bounded by Muzaffarabad to the north, Poonch to the south, and Poonch of the Indian-administered Jammu and Kashmir to the east; it is bounded by the Rawalpindi district and Abbottabad district to the west. Bagh district is linked to Muzaffarabad by two roads. One is via Sudhan Gali which is 80 km and other is through Kohala which is 97 km (Bagh 2007).

3.2.3 Agriculture and Livestock Information

The land of Bagh and Battagram is very fertile and suitable for agriculture and livestock. Due to high rainfall and soil fertility agriculture is the main source of income for the people of these areas. Mostly, there is subsistence farming in these areas but still most of the households are self-sufficient in grains. Because of high rainfall and land fertility kitchen gardening is very successful in these areas, specifically in Bagh.

The main source of irrigation in Battagram are the Nandeharh ,Landay, Allai river and Arivulet in Chappargram. The river Nandeharh mainly irrigates, Batamori, Romai, Shumlai and Tamai. It also receives a Rivulet from Chappargram village at Narazturn (Narazamorh).The River Lanady come from Kuzabanda and Trand region and falls in Thenandeharh. Then the Nandeharh river runs through the villages of upper Shingli, Lowershingli, Peshora, Kotgala, Hotal and Thakot. At the Thakot the Nandeharh falls in the river Indus. The irrigation sources also include many small rivulets and the natural springs.

Table: 3.1 Agriculture and Livestock in Bagh

Agriculture 2005-06		
Major Crops	**Area (Acres)**	**Production (Yield Per Acre)**
Maize	28000	7.39
Wheat	8800	6.24
Potato	193	50.00
Orchards	1426	5.75
Rice	680	6.00
Livestock 1998 (in numbers)		
Cattle		61,532
Buffalo		610,41
Sheep & Goat		108,484
Domestic Poultry		408,226

(Source: ERRA, Pakistan 2007)

The home grown vegetables which are being cultivated includes cauliflower, tomato, onion, peas, potato, mung bean, garlic, chili pepper, raddish, tinda, pumpkin, spinach, green bean, etc.

Among the fruits the main fruits are apple, walnut, plums, oranges, and pears. The walnut and pears are the main fruits of Battagram.

Table: 3.2 Agriculture and Livestock in Battagram

Agriculture 1998	
Major Crops	**Area (Acres)**
Maize	46359
Wheat	19902
Rice	5821
Livestock 1998 (in numbers)	
Cattle	106882
Sheep	59885
Goat	24482
Horse	126420
Mole	739
Donkey	1230
Poultry	457353

(Source: ERRA, Pakistan 2007)

3.2.4 Cultural Information

Living style of people in Bagh and Battagram is very undemanding and hospitable. Their foods are very simple, pure and healthy. Mainly, their foods are comprised of wheat, rice and maize which they use domestically, but homegrown vegetables are also the necessary part of their foods. Due to livestock holding dairy products are easily available in purest form. And they are using these to fulfill the nutrition requirement.

People of Battagram wear simple dress of Qamez Shallwar and women take Abaya (Burqa) because of the Parda which is their custom. Men in Bagh also wear the same dress of Qamez Shallwar but women usually not take Burqas. This scheme of dress is uniform in whole region homogenously. The culture, history, customs and traditions of both districts are not entirely same but there are few things which are common in both districts.

CHAPTER IV

DATA DESCRIPTION AND METHODOLGY

The major objective of the study is to evaluate RRWH technology with special reference to its potential of water supply, impact on women health and time allocation and financial appraisal. Therefore,in order to achieve these objectives mainly study has adopted three broad approaches; first approach which used in quantification of impacts is descriptive analysis, second is based on econometric techniques like Ordinary Least Square (OLS) and Negative Binomial Regression (NBR). Third and final approach is the investigation of financial aspect using Net Present Value (NPV), Pay Back Period (PBP), and Economic Rate of Return (ERR).Chapter has three sections based on the given approaches.

4.1 Descriptive Analysis

In this section, study adopted some tools of descriptive analysis like cross tabulations, graphs, and frequency tables etc.to analyze the impacts. This approach is used to provide the detail explanation of the potential benefits of technology on the lives of beneficiaries. Moreover, it is the in depth investigation of different aspects of the RRWH system.

4.1.1 RRWH Potential

Following Tripathi and Pandey (2005) the supply of the water through RRWH system was estimated by the following equation:

$$S = R \times A \times Cr \qquad (1)$$

Where:

S= Supply of water by RRWH system

R= Mean Annual Rainfall in millimeters (mm)

A=Catchment's Area in meter squares (m^2) and

Cr =Coefficient of Runoff of rooftop

Coefficient of Runoff varies with the material and nature of roofs. Coefficient of Runoff for different types of roof is given in appendix (Table: 4.1.1).

4.2. Models Specification and Econometric Analysis

Study is based on estimated econometric models. These models are regarding the health and time allocation of water fetching women. In order to estimate women health model study has taken up the Negative Binomial Regression technique. Because this model has count dependent variable and its data is discrete. Normally, Poisson Regression is the used for this kind of model but in this case, the condition of Poisson regression is not being fulfilled. Because mean and variance of dependent variable are not equal this is the prerequisite for this technique.

In other words, when variance exceeds mean, the count variable is over dispersed and when mean exceeds the variance, it will be a situation of under dispersion. These two phenomena are collectively called extra dispersion. So in order to avoid this problem Negative Binomial Regression technique is used. The second model is of women time allocation in which study analyzed the impact of RRWH technology on women time allocation. This model is estimated using OLS technique. Following is the details of both models.

4.2.1 RRWH and Women Health

In order to capture the impact of RRWH on women health Bourne et al. (2009) model was adopted. The impact was estimated using the following equation:

$$Illness = \alpha_0 + \alpha_1 Rrwh + \alpha_2 Edu + \alpha_4 Ages + \alpha_5 Pdtwf + \alpha_6 Dws + \alpha_7 St + \alpha_8 Sat + \alpha_9 Region + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Illness is dependent variable and data on this variable is "number of times a women became ill in last 6 month". Following are the independent variables with their justification of inclusion and expected sign.

Rrwh= This is the focused or main explanatory variable of the study, which was included to examine the impact of facility on women health. It is a dummy and constructed as; "1" is for those who are doing RRWH (treated group) and "0" for those who are not (control group). Expected sign of the variable is negative. Following are the control variables of this model. Keeping other factors constant study examined the overall impact of this technology on women health.

Edu=Education is used to analyze the impact of women education on their health. Variable is constructed using data on "years of schooling". This variable was included because; it plays crucial role in determining women health. The expected sign of the variable is negative.

Ages = Study used this variable to observe the impact of ages of water fetching women on their health. Variable was engulfed into model due to its crucial importance with reference to women health and their workload. The expected sign of this variable is positive.

Dws = Distance from water source (in kilometers) is that distance which women cover while fetching water from spring. It is included in model because it determines the fatigue involved in water fetching. The expected sign of the variable is negative.

St=Sleeping time of women (in hours) is taken into analysis of women health because sleep and rest has great contribution in human health. The expected sign of the variable is negative because with the increase in sleep there it is assumed that women illness will decrease.

Sat = Social activities time (in hours) is that time of women in which they meet and interact with relatives, friends and neighbors. Mostly, when women encountered with any problem they share with other colleagues and offered by them with help. So in a way it is a source of easing out the emotional and physical pressures, which is good for their health. That is why it is included into analysis and its expected sign is negative.

Pdtwf = Per day time of water fetching (in hours) is a time of women which they spend to collect water from the source. Literature on RWH emphasized that with the increase in time of water fetching women health will deteriorate. Expected sign of this variable is positive.

4.2.2 RRWH and Women Time Allocation

In order to capture the impact of RRWH on women time allocation Fernandez et al. (2002) model was adopted. The impact was estimated using the following equation:

$$Twt = \beta_0 + \beta_1 Rrwh + \beta_2 Ages + \beta_3 Edu + \beta_4 Inc + \beta_5 Dws + \beta_6 Sat + \beta_7 + \mathrm{Re}gion + \varepsilon ......(3)$$

Where 'Twt' is total work time of women which is dependent variable in women time allocation model. It is calculated this by adding up their full day activities time from morning to evening. The intention of using total work time as dependent variable is to study the impact of RRWH facility on overall work time of women. Explanatory variables are same except household income which is new variable in this model. Focused variable in this model is also the 'Rrwh'. Keeping all other variables constant, study analyzes the impact of technology on women time allocation.

4.3 Financial Analysis of RRWH

This is the third part of study in which financial tools are presented to study the viability and sustainability of RRWH. The purpose is the demonstration of the value of the project to the economy in general and community in special. In this regard study attempted to assess the overall benefits of the facility using Net Present Value (NPV), Economic Rate of Return (ERR), and Pay Back Period (PBP).

In financial analysis first tool to study the net benefits of the project is NPV which compares the value of a currency today to the value of that in the future, taking rate of returns into account. If the NPV of a prospective project is positive it means project is profitable and it should be initiated or scaled up. However, if NPV is negative, the project is not profitable and it should not be imitated or extended rather it should be excluded because its cash flows are negative. In case of zero NPV which is a specific case where there is, neither the gain, nor the loss of the project, its execution depends on the nature of the project and circumstances.

Next tool which study has used in project appraisal is ERR. It is the discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero or it is the rate of growth a project is expected to generate. Normally economic rate of return is compared with the prevailing market interest rate which is the opportunity cost of investment in any project. Higher the projects economic rate of return, the more desirable it is to undertake. The third and last technique which study has used is PBP. It refers to the period of time required for the return on an investment to repay the sum of the original cost of investment.

For example, a $10000 investment which returned $5000 per year would have a two year Pay Back Period. It is comparatively weaker tool to evaluate the investments in projects because time value of money is not taken into account. Pay Back Period intuitively measures how long something takes to "pay for itself." All other thing remains equal, shorter Pay Back Period are preferable to longer Pay Back Period. This analysis provided the relevant ex-post evidence within the frameworks of discounted cash flows and Benefit Cost Analysis (BCA).

Study used primary as well as secondary information in order to examine the financial aspect of the project. Data on cost of the project of RRWH was provided by the implementers (Maqsood Welfare Foundation and Save the Children Pakistan) of the project. Main components of the cost include; capital cost, labor cost, administrative cost, and operational and maintenance cost.

Benefits of the system are reckoned using the primary information, which is collected through survey. In order to compute the benefits study has monetized them using the actual or estimated monetary value of each individual benefit. And then study aggregated their monetary values to assess the overall benefits of the project.

Total benefits of the project are comprised of three things. First is monetary value of water fetching time which is being saved due to this facility. In order to estimate this study has used the proxy of prevailing women wages in the area. In order examine the use of saved time, study asked from respondents that how much time they are using out of total saving. They reported that almost 30 to 40 percent time they are using out of that which is being saved due to RRWH facility. Based on this information two scenarios of total benefits are made. One is under the assumption of 20% usage of the saved and second is when 30% of the saved time is being used. Second is annual saving of medical expenditures on women health which was calculated by comparing the annual medical cost of water fetching women in control and treated groups. Third is the annual saving of kitchen gardening in terms of monetary value, because otherwise they have to purchase these vegetables from bazaar which now they are getting from home grown vegetables. This calculation is made after investigating about the weekly and monthly saving of beneficiaries due to home grown vegetables.

Financial analysis was conducted on the basis of twenty years of time period. The reason of using this time period was that, it is the minimum life time of each installed unit of RRWH technology. This time period which is also called the life of the system is defined by the technical staff involved in this project. Moreover, factors which were considered while defining the life of the system were mainly the quality of material, equipment and conditions of site.

Discount rates are widely used in the public sector to assess policy proposals where costs and benefits accrue over long time periods. Socially optimal policy choices require an appropriate choice of discount rate. It reflects the opportunity cost of the funds committed to the projects. The opportunity cost depends upon what other options are available to us given our own situation and current market conditions. Discount rate is a rationing device to efficiently allocate the scarce resources in competitive environment. The underlying assumption is that these funds could be used for other projects with a specific percentage of national rates of return. Following (Estrada 2003) is the mathematical formulation of discount rate for a particular project.

$$E(ri) = Rf + \beta i\,(E\,(rm) - Rf) \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$E(ri)$ = return required on financial asset i

Rf = risk-free rate of return

βi = beta value for financial asset i

$E(rm)$ = average return on the capital market

In order to calculate the net benefits of RRWH technology, present study has used 13 percent discount rate. Mainly there were two main determinants which were considered while taking this particular rate of discount. First, this project of RRWH was initiated and financed by government, and in public sector discount rate is 13 percent. Second and logical argument to justify this discount rate is that, it is based on current market conditions and prevailing rate of return which is the opportunity cost of these funds. A key feature of both approaches is that they have an element of opportunity cost underlying them.

There are few assumptions which are used in financial analysis of the projects like; markets are clear, there is one market interest rate, perfect information and all aspects are covered by markets. Under these assumptions the market clears at a rate where the time preference for consumption equates to the opportunity cost of capital. The opportunity cost of capital is the rate of return the capital must pay back to investors in order to make investment decision right. In this case the market-clearing rate would be the discount rate.

4.4 Data Description

To conduct the empirical analysis study had required primary as well as secondary information. Main sources of the data to evaluate the potential benefits were implementers of the project. But they were unable to provide enough relevant information because they did not conducted any pre or post intervention survey of beneficiaries. Due to this present study has conducted a primary survey of the beneficiaries of the project. Data was collected through probabilistic and non-probabilistic methodologies. The detail of all data collection tools used in primary survey is given in appendix Table: 4.5.Mainly primarily data was collected through personal interviews of respondents using a detailed questionnaire which covered wide range topics. Broadly questionnaire has following main sections: personal information of HH, water information (fetching and consumption both), time allocation in different activities including water fetching, water sources and distance etc. Under each head there were further questions to collect the information of all individual variables with each possible dimension.

4.5 Sampling Methodology

4.5.1 Selection of the Villages

The villages in both districts (Bagh and Battagram) were selected by the ERRA and its implementing partners (Maqsood Welfare Foundation and Save the Children) to test the RRWH technology in pilot. The villages were selected on the basis of their vulnerability with regard to water supply. Based on this criterion, two villages (ChitraTopi from Bagh, and Saroona from Battagram) were taken up to provide RRWH systems.

4.5.2 Population of the Study

Population of the study is comprised of two groups, one is treated group which is provided with RRWH systems, and second is control group that is using the traditional water supply sources and have no provision of RRWH technology. Treated population in both villages was 45 households whereas in control group there were175 households from Chitra Topi, Bagh and 375 households Saroona, Battgram.

4.5.3 Sample Size and Methodology

In order to conduct the analysis study has picked the total population of treated group which was 45 households. Study has chosen the proportional sample of 75 households of control group from ChitraTopi, Bagh and 120 households of control group from Saroona, Battagram. Random Sampling methodology was employed to pick the sample from control population.

Table: 4.1 Distribution of Sample across the Regions

Region	Treated HH	Control HH	Total
Bagh	45	75	120
Battgram	45	120	165
Total	50	195	285

The population in control group was homogenous with respect to water supply. Technique was suitable provided the resource limitation, location, and facilitation. The optimum sample is the one which maximizes precision per unit cost.

4.6 Questionnaire

Study has used different probabilistic and non-probabilistic sources of data collection. Probabilistic source of data collection is personal interviews of beneficiaries through questionnaire and non-probabilistic data collection tools were also used which includes PRA tools like; key informants survey, focused group discussions etc. But mainly the data has been collected through personal interviews of respondents. Study used a detailed questionnaire to gather all relevant information. Overall target of the questionnaire was to collect the information about water situation in both communities, but to examine the socio economic impact of RRWH, some other relevant information was also necessary. So, in addition to water information there are some other sections in questionnaire like demographics, women health, time allocation, and agriculture and livestock etc.

Personal information of the household includes the members of the households, their education, ages, and income status. Water information was based on water issues like supply sources, consumption and demand of water, and water fetching and RRWH system. Health information was specifically with reference to water fetching women, which significantly affected due to water situation. Similarly, daily women time allocation was also included due to the fact that women have to spend time for water fetching. Lastly, as agriculture and livestock is the economy of rural households, it is affected by water situation. Detailed questionnaire is attached in the appendix (Appendix B) of the study.

CHAPTER V

RESULTS AND DISCUSSIONS

This is very crucial chapter of the present study that yields the results of analysis which were carried out using statistical and econometric tools. Reckonings were made using both, primary as well secondary information. Mainly there are four sections of this chapter. First section deals with results of descriptive analysis. It includes the potential of the RRWH technology, characteristics of the sample, and summary statistics of the variables etc. While the second section is based on the econometric techniques, in which study estimated two models; the first one examined the impact of RRWH technology on the health of the women, whereas, second deals with women time allocation. Third section make available the findings of financial analysis of RRWH technology which includes NPV, ERR, and PBP. Last part includes results based on PRA tools like Key Informants Survey (KIS), Focused Group Discussions (FGDs) and Case Studies.

5.1 Descriptive Analysis

In order to study the socio economic profile of the areas, study will present the descriptive statistics. These include the results of calculated RRWH potential and summary statistics of some of the important variables used in analysis of the present study. The purpose of presenting this section of results is that, the empirical findings will be easy to interpret and understand. Moreover, these statistics will support in explaining the subsequent sections of findings.

5.1.1 Potential of RRWH

Potential of the RRWH technology was estimated for the number of houses with different rooftop areas ranging from 500 squares feet as a minimum, to 5000squares feet as maximum catchment area. With 500 squares feet area, annually 675 thousand liters of water could be harvested with the availability of 1500 mm annual rainfall(Table: 5.1.1). While when catchment area is 5000 square feet, annually 6750 thousand liters of water could be harvested. In order to make the results out of the ordinary and more clearer study have converted the initial potential (which is in thousand liters) into locally used standard measures like Gallons and Pitchers (Table: 5.1.1).

Table: 5.1.1. Potential of RRWH with respect to Catchment Area (Square Feet)

Rooftops Area(sq feet)	Harvested Water in Thousand Liters/Year	Harvested Water in Thousand Gallons /Year	Harvested Water in Thousand Pitchers /Years	Per Day Pitchers
500	675	67.5	135	370
1000	1350	135	270	740
1500	2025	202.5	405	1110
2000	2700	270	540	1479
2500	3375	337.5	675	1849
3000	4050	405	810	2219
3500	4725	472.5	945	2589
4000	5400	540	1080	2959
4500	6075	607.5	1215	3329
5000	6750	675	1350	3699

*The calculation of harvested water is based on the mean annual rainfall (which is 1500 mm for Bagh and Battagram districts) and respective catchment area of Galvanized Iron Sheet (GIS).

5.1.2 Sample Characteristics

Sample of the study was collected from two sites, which had different socio economic, and demographic characteristics. Some indicators were developed and used to examine the socio economic status of study areas. First of all is education which varies across the regions. Maximum Years of Schooling (MYOS) of a household is used as a indicator of education. Based on this indicator, reckoning showed that on average MYOS was 7 years in overall sample. But at district level the situation was totally different, because Bagh had on average 11 MYOS while, in Battagram it was 3 i.e (Table: 5.1.2).

Table: 5.1.2.Average Value of Maximum Years of Schooling of Household, Household Income, Distance from Nearest Market

Villages	Maximum Years of Schooling of Household	Household Head Income (Rs.)	Distance from Nearest Market (Kms)
Bagh	11	14600	11
Battagram	3	8000	15
Overall	7	11300	13

There are several reasons of this phenomenon of less education in Battagram which includes less amount of attention devoted to primary education, lack of awareness of community, no motivation of tribal elders and political leaders for masses to take keen interest in education. Second and very crucial variable of study areas is household's income. It also varies across the regions which explain the financial discrepancy across the districts. Average income in Bagh is Rs.14600, while in Battagram it is Rs.8000(Table: 5.1.2).

This may be due to level of education that helps individuals in getting access to employment and business opportunities which enhance the individuals and households income. Without having required basic education or skills and knowledge of job market nobody can get a proper job. Agriculture and livestock which is the economy of rural household and provide job opportunities to many people, is poor in Battagram as compare to Bagh.

Distance from Nearest Market is a variable which always play a vital role in socio economic status of the rural population. Because their mobility and access to urban areas enable them to adopt some means of support. Moreover, access to education becomes easy if distance from market is less. This is indicated by the above table that the distance from nearest market is high in Battagram as of Bagh. Keeping in view its impact on household income and level of education, this variable is also a big determinant of backwardness of Battgram region.

5.1.3 Livelihood Sources of Household Heads (HHs) in Sample Area

Following is the overview of livelihood patterns in the study areas based on the in formation of professions of the Household Heads (HH).Survey reveals that; vast majority of people from sample are just laborers, and large part of them are from Battgram (Table: 5.1.3). As explained earlier it is because of poor skills and education, less exposure to cities, and less mobility. All willing people with require fitness can offer their services in local job market. The second densest sector, which provides job opportunities to many potential workers, is private job which includes clerks, salesmen, waiters, drivers and some other jobs of managerial nature.

The reason of having private jobs second big sector of employment is that, there is very less effort and skill required to get these jobs. Study also found that public service (civil as well as army men)is also one source of livelihood to many people in study areas. And the main reason behind this is job security because low skilled people prefer less risky jobs, even if those are less paid. It is worthy to mention that due to comparatively higher education, people from Bagh are dominating in public sector jobs.

Table: 5.1.3 Livelihood Sources of Household Heads (HHs) in Sample Area (%age)

Villages	Agric ulture	Labor er	Govt. Service	Private Service	Business	Foreign Service	Pension er	Zakat	Any other
Bagh	8	17	27	25.2	8	3	3	1.7	9.3
Battagram	10	47	5	30.4	2	1.2	1.2	1.8	2.3
Overall	9	32	16	27.8	5	2.1	2.1	1.75	5.8

Agriculture stands at fourth in absorbing mass labor in Bagh and Battagram. Private business is positioned at fifth as a source of livelihood. Only few people reported that member of their household working out of the country, which indicated that there is very less inflow of remittances from outside into these areas and it could be one possible reason of low income in study areas. Findings yielded that there are only few samples of pensioners and zakat takers in study areas. Overall depiction shows that people in Bagh are more associated with formal sector. And their quality of life is much better due to horizontal distribution of workers in different fields.

5.1.4 Summary Statistics of Women Water Fetching and Time Allocation

In summary statistics some of the important variables like Water Fetching Women Ages, Education, Social Activities Time, Sleeping Time, Distance from Water Source, Per Day Time for Water Fetching, Persons Involved in Water Fetching, Daily Saved Time due to RRWH and its spending is included. In addition to overall sample results, statistics of the both regions are also presented separately (Table: 5.1.4 a).These summary statistics are clearly indicating the variations in sample across the villages. Moreover, these are providing support in overall interpretation and understanding of the results.

Table: 5.1.4 (a)Average of Women Ages, Education, Distance from Water Source (Km),Social Activities Time (Hrs),and Sleeping Time (Hrs)

Villages	Women Ages (years)	Women Education (YOS)	Distance from Water Source (kms)	Social Activities Time (hrs)	Sleeping Time (hrs)
Bagh	34	7	0.6	0.7	7
Battagram	33	0	1	0.5	7
Overall	33.5	3.5	0.8	0.6	7

Average Age of Water Fetching Women is 33 years in the overall sample of the study as well as at village level. Ranging from12 years as minimum and 65 years as maximum age across the sample. This information shows that on average water fetching women in both regions are young, which is understandable because it is a tedious job and old women cannot perform it. On the other hand it is the most potential age group which has comparatively higher opportunity cost of time. The water fetching time of women could be productively used by adopting this alternative technology for water supply.

Women Education is very crucial variable of the study, because it affects the overall socio economic conditions of women like their employment, time allocation in domestic activities, maternal health, sanitation and hygiene, and their medical checkups etc. The difference of education and its impacts are highlighted by the present study, because women education is totally different across the two regions (Table: 5.1.4 a). Average education of women in Bagh is 7 years of schooling, whereas in Battgram almost all women have zero education. Furthermore, in Bagh maximum years of schooling was 16 years but in case of Battgram there was only one individual which had 7 years of schooling, and it was the highest in that area.

Distance from water source is the average distance women have to walk while carrying the water. This variable has special importance with reference to women health and their time allocation. Survey of present study revealed that average distance from water source is 0.6 kilometer in Bagh while it was one kilometer in Battagram. This means that on average women have to walk more in Battagram, so they will be more vulnerable to water fetching hazards. Minimum distance reported in Bagh was 0.1 kilometers and maximum was 2 whereas, in Battagram it was 0.2, and 3 kilometers, respectively.

In rural areas, women often interact with their neighbors, relatives and close friends during the usual routine, which come under their social activities time. So, study has investigated their social activities time in order to analyze its pattern and impact on women comfort in both communities. Overall per day average time allocation for social activities is one hour, among both villages, it is higher in Bagh and lesser in Battagram. Because culturally, women are not allowed to go outside their homes. The minimum per day average time allocation for social activities is zero and maximum is 3 hours for both communities (Table: 5.1.4 a). This is the social capital of rural women which help them in easing out the stress managing daily life problems.

Sleeping time of women is very crucial indicator with reference to women wellbeing. On average reported sleeping time of women was 7 hours in both villages (Table: 5.1.4 a) whereas, minimum and maximum time was 5 and 9 hours, respectively. This shows that there was no such dilemma of sleep shortage in these regions, as people go earlier for sleeping due to tiresome work routine. And in mountainous areas, people avoid working and moving in late evening and prefer to sleep early. Moreover, in the sample areas there are no such activities like cable etc. where people can engage themselves after evening in these communities.

(Table: 5.1.4 b) Average of Per Day Time for Water Fetching, Persons Involved in Water Fetching, and Daily Saved Time

Villages	Per Day Time for Water Fetching (hrs)	Persons Involved in Water Fetching	Daily Saved Time (hrs) Due to RRWH System
Bagh	4	2	4
Battagram	6	2	6
Overall	5	2	5

Per Day Time for Water Fetching is an important variable with regard to women time allocation. It is determined by the distance of water source. Average water fetching time in Bagh and Battagramwas4 and 6 hours, respectively. The average water fetching time in Battagram was higher by 2 hours, which was due to the higher average distance from water source (Table: 5.1.4 b).Minimum time for water fetching reported in Bagh was 0.25 hour whereas; in Battagram it was one hour. Similarly, maximum time allocated to water fetching in Battagram was 12 hours a day while, in Bagh it was 10 hours.

Another important variable regarding water fetching is Persons Involved in Water Fetching. Study revealed that on average in each household there were 2 individuals who were fetching water in both regions. Single person in fetching water reflected as minimum number of water fetching individuals in both villages (Table: 5.1.4 b). Maximum number of water fetching individuals was4 and 5 in Bagh and Battagram respectively.

Daily Saved Time in hours is a crucial variable of the present study. It is based on women saving of time due to the use of RRWH System in treated group. Study revealed that in both villages women save on average 6 hours of daily water fetching time due to this facility(Table: 5.1.4 b).Notably, minimum time saving was 2 and maximum was 10 hours in both study areas. It is worthwhile to mention that, this saving of time due to RRWH technology was being invested in productive activities by the women.

The saved time is being utilized by the women of communities who are using RRWH technologies in different resourceful activities like, entertainment and social activities, agriculture and livestock, domestic work, education and awareness etc. (Table: 5.1.4 c). Findings yields that women from Bagh are spending 20 percent of their saved time in entertainment and social activities which indicates that they have the social capital and they are doing investment to enrich it. Social capital plays a vital role in women welfare because, they discuss their daily life problems and get and offer help within their networks.

Contrary to Bagh, women in Battagram are not spending the saved time in social activities. Study shows they have zero social interaction with other women in communities on regular basis. The reason behind this is that culturally women in Battagram are not allowed to go outside, so they cannot form such networks with other community members as of Bagh. This is important finding of the study because it indicates the strength of social networking in both regions.

Table: 5.1.4 (c) Saved Time Utilization by Women

%age of average Saved Time Allocated for Different Productive Activities at Each Location				
Villages	Entertainment and Social Activities	Agriculture and Livestock	Domestic Work	Education and Awareness
Bagh	20	26	34	20
Battagram	0	25	70	5

Agriculture and livestock is the main sector of rural economy everywhere in the world. Because it provides food, fiber and livelihood sources to rural population. Moreover, due to having enough available land and less off farm income opportunities, rural household prefer to cultivate crops for their sustenance. Study shows that women are utilizing almost 25 percent of their time saving in agriculture and livestock in both regions(Table: 5.1.4 c). It means that agriculture and livestock is getting almost equal attention of people in Bagh and Battagram.

In domestic work women from Battagram are dominating over women of Bagh in allocating saved time. Study estimated that they are spending 70 percent of their saved time in domestic activities which is almost double of that in Bagh. The reason is that women from Battgram had zero time allocation for social activities which is being used in domestic work. Moreover, they have less education and mobility out of their houses. Education and awareness includes time allocation in getting formal or informal education, children tuition, or other awareness related activities at household level. It also grabs more attention of women in Bagh, because level of women education is higher in this area. They are spending 20 percent of their saved time in education and awareness activities whereas; in Battagram it is 5 percent.

5.2. Econometric Analysis

This is the second section of this chapter in which study estimated two models to examine the impact of RRWH technology on women health and women time allocation. Negative Binomial Regression (NBR) technique was employed to estimate the women health impact of RRWH technology. OLS was used to investigate the impact of technology on women time allocation. The results of the models are depicted in (Tables: 5.2.1and 5.2.2).

5.2.1 Women Health Model

To examine the robustness of different variables, study applied regressions for several models with alternative specifications and variables. Estimating women health, study has taken model 1 as the baseline model that includes all relevant variables. In this model Rooftop Rain Water Harvesting 'RRWH' is the first variable (Table: 5.2.1).

'RRWH' is a focused variable of the model and present study. It is a dummy where '1' is for treated group and '0' for control group. It was included as the main variable to quantify the impact of technology on women health. RRWH have negative relationship with dependent variable 'Illness' which means that, illness decreases with the provision of RRWH facility. In quantitative terms the coefficient of women illness shows that there is 18 percent less probability of water fetching women from treated households as of those households, who were in control group.

This is out of the ordinary finding of the study and we can conclude from this that RRWH brings improvement in the health of water fetching women, particularly in rural areas, where women use to collect water far from their dwelling units. This betterment in women health can be either due to the decrease in fatigue of water fetching, or due to improved sanitation and hygiene condition. This could be investigated separately, but it was not the focus of the present study rather, this study aimed to find out the overall impact of RRWH technology on women health.

Table: 5.2.1. Negative Binomial Regressions Model of Women Health

Variables	Model1	Model 2	Model 3	Model 4
CONS	1.775 (11.25) ***	1.789 (20.49) ***	1.799 (23.52) ***	1.797 (23.49) ***
RRWH	-0.192 (-3.34) **	-0.190 (-3.46) **	-0.189 (-3.48) **	-0.189 (-3.49) **
REGION	-0.099 (-1.44)	-0.099 (-1.44)	-0.098 (-1.43)	-0.119 (-2.43)*
SAT	-0.029 (-2.09) **	-0.029 (-2.09) **	-0.029 (-2.08) **	-0.029 (-2.08) **
DWS	-0.054 (-1.18)	-0.053 (-1.21)	-0.052 (-1.20)	-0.052 (-1.20)
ST	0.002 (0.10)			
AGES	0.0003 (0.22)	0.0003 (0.22)		
PDTWF	0.006 (0.89)	0.006 (0.88)	0.0005 (0.87)	0.006 (0.92)
EDU	-0.003 (-0.45)	-0.003 (-0.45)	-0.003 (-0.45)	
Observations	367	367	367	367
WALD ($\chi 2$)	27.65	27.57	27.34	27.22

Note: Robust z statistics in parentheses. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Furthermore, estimated impact is cumulated, and it is difficult to isolate each aspect of health which is being affected by RRWH. The study revealed that RRWH system has profound impact with reference to women health. Result of the present study was consistent with the Bourne et al. (2009) and Pandey et al. (2009).

In order to study difference between two regions of the study, dummy variable of 'REGION' was included in analysis where '1' is used for Bagh and '0' for Battagram. Coefficient value of this variable is significant and indicates that there is 9 percent less probability of women illness in Bagh as of Battagram. The sign of the variable is negative which was expected. This is very attention-grabbing finding of the analysis and there are multiple reasons of sign and significance of this variable across the two regions.

Following could be the main causes of this variable; First and foremost is sanitation and hygiene which was comparatively poor in Battagram which may be due to the fact that education level among women in Battagram was nearly zero. Second factor of this difference across the regions was women level of education, which was quiet high in Bagh whereas; it was almost zero in Battagram. The third and most important factor was access to medical and other services, which was easy and efficient in Bag has compare to Battagram.

Social Activities Time 'SAT' variable was taken in model because it has strong correlation with women health in terms of emotional wellbeing. The result showed that it has negative relation with dependent variable that is theoretically justified in terms of health. The value of the coefficient of this variable is 3 percent which means that holding all other variables constant each one hour increase in social activities time decrease the probability of women illness by 3 percent. Women save time due to RRWH and that time is being used for leisure and work. Leisure included meeting friends, relatives and neighbors which help them in releasing the mental stress caused by domestic work load. We can say this facility has indirectly positive impact on women health through social activities time which increased with the provision of water at consumption point.

Distance from Water Source 'DWS' was encompassed in model to figure out the relationship between 'DWS' and women illness which was insignificant. This might be due to the shorter distance of water source. As the average distance of water source from dwelling unit is one kilometer that is reasonable for the people of hilly area. Moreover, there is no such variation in distance from water source. Due to which it is not significant. There may be the impact of variable on women health but dominant sample is from Battagram where it is one km that is consistent. But, considering the goal of the study it captured overall impact in order to precisely report the findings.

Sleeping Time 'ST' was incorporated in model, and intuition of bringing this variable into model was to examine its relationship with women health. The finding shows that it was insignificant and not affecting women health. There could be number of possible reasons of this result. First of all, variance of sleeping time was very low and due to low variation of the variable it has no impact. Secondly, as agriculture and livestock is the economy of rural households, people have to work hard in their fields and they walk for long distance in sloppy terrain to ensure their livelihood. Due to which they get tired and sleep early.

Third reason of their early sleeping habit is that, sun set early in hilly areas, and when light disappears they do not prefer to move to avoid all types of risks. Fourth factor which may contribute to their early sleep is that, they have no access to cable and other media which can engage them in wasting time of sleep. Insignificance of this variable proved that sleep deficit is not the cause of disease but it may be due to work load. Women work load is the composition of their domestic tasks. And among those tasks collection of water from water source is the most tedious and time consuming job.

Per Day Time for Water Fetching ‘PDTWF’ was used to examine its relationship with dependent variable illness. The sign of the variable is positive which is expected but coefficient value is not significant. There are two reasons of insignificance of this variable. First of all as mentioned earlier the average distance of water source is not very long and it has negligible variations. Due to which it is not a significant predictor of dependent variable. Second reason is that when women visit the water source, they also meet with their friends and relatives which are coming under the social activities time.

So perhaps ‘PDTWF’ is not purely that time which they spent for fetching water rather it is overlap of PDTWF and SAT. That is why it is not affecting women health significantly. There are two demographic variables in model 1, Ages of water fetching women ‘AGES’ and their Education ‘EDU’. The value of the coefficient of first variable is not significant, but its sign is expected. Insignificance of this variable is may contributes to specific age group of water fetching women which comprised of more young people who were comparatively healthy and less vulnerable to diseases (Table: 5.1.4 a).

Education ‘EDU’ is incorporated in model to probe its relation with dependent variable. However, variable is insignificant in the model. Insignificance of this variable is because women education is almost zero in Bttagram region. And present study has dominant sample from Battagram. Due to this fact women education is insignificant in model. Secondly, irrespective of level of education all women have to fetch water from water source because it is primary need and without water they cannot perform the important domestic tasks like cooking, washing, cleaning and livestock holding etc.

After estimating baseline model which is model 1, study estimated the three more models with alternate specifications and different variables in order to test the robustness of results in original model. Since 'ST' sleeping time was the most insignificant variable in model 1 we have dropped it and estimated model 2 without this variable. Dropping out the sleeping time variable from model did not affect the sign or significance of any variable in model 1. Furthermore, overall significance of the model remains same which means that this variable was not a good predictor of dependent variable illness.

Similarly, few other insignificant variables were excluded from model 3 and 4 to analyze their influence on other variables. In model 3 we have excluded women ages which were the next insignificant variable in our original model. Exclusion of this variable caused no change in sign or significance of other variables. RRWH, Region, and SAT remained significant with consistency in their signs. Overall goodness of fit of the model also remains significant which shows that our results are still same.

Last dropped variable from the model was 'EDU' which was also insignificant in our previous models. The reason of consistent insignificance of this variable is explained above. Exclusion of this variable from model 4 does not bring change into sign or significance of any variable except the 'Region' whose value is slightly increased. This increase in the value of variable is happened which is explained earlier that level of education across the region is totally different. Value of Wald test is still significant in model 4 which shows that overall results are not changed.

5.2.2 Women Time Allocation Model

Using OLS technique study analyzed the impact of RRWH technology on women time allocation. Dependent variable is Total Work Time 'TWT' of water fetching women from early morning to night. Study computed several models for women time allocation form model 1 to 5 with different specifications in order to check the robustness of the results. Model 1 is the baseline model that includes relevant variables.

Amongst explanatory variables Rooftop Rain Water Harvesting 'RRWH' is a dummy which is focused or key variable of the study was included in model to look into its impact on women total work time. Sign of variable is positive which was expected and its value is significant in model 1. It is very prominent finding of the study, which means that total available work time increase due to saving of time which otherwise invested in water fetching. Now, that time is being utilized in productive activities like children brought up, agriculture and livestock, social activities and entertainment, and domestic work. It is important to mention here that might be total saved time was not being fully utilized, but even if women are using part of that time saving, still it's resourceful.

Region 'REGION' is also a dummy variable, included in analysis to investigate the regional difference of time allocation. It is significant with negative sign which was expected. The reason of negative sign is that, both regions of the study are different with respect to socio economic and cultural aspects. For instance, as explained above education level is different in both districts. Second reason of difference across the regions is that, in Bagh women has better access to health, education, and market as of Battagram. Third factor of regional difference is income disparity which has various determinants like; level of education across the regions and on and off farm job opportunities which cause the income disparity at personal as well as household level.

Table: 5.2.2 OLS Model of Women Time Allocation Model

Variables	Model 1	Model 2	Model 3	Model 4
CONS	13.294 (31.88)***	13.287 (32.00)***	13.287 (24.50)***	13.221 (33.11) ***
RRWH	1.910 (6.74)***	1.907 (6.88)***	1.913 (6.88)***	1.921 (6.78)***
REGION	-0.984 (-3.16)**	-0.982 (-2.42)**	-0.864 (-2.40)**	-0.902 (-2.92)**
AGES	0.018 (1.57)	0.018 (1. 57)	0.018 (1. 58)	0.021 (1.63)
HHINC	-6.09e-06 (-0.47)	-6.09e-06 (-0.47)	-6.09e-06 (-0.47)	
SAT	0.112 (0.67)	0.112 (0.69)	0.110 (0.67)	0.111 (0.68)
EDU	0.017 (0.38)	0.017 (0.38)		
DWS	-0.007 (-0.02)			
NO OF OBS	370	370	370	370
R^2	0.1285	0.1285	0.1281	0.1277

Note: Robust t statistics in parentheses. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Women Ages ‘AGES’ was included in model to identify the impact of women age on women time allocation. The variable was found to be insignificant with expected sign. The reason of insignificance of this variable could be the less reported variation in ages of women, because sample of the study comprised of more young people. Secondly, women who were young and comparatively less vulnerable to disease could manage their domestic work easily. So women age has no effect on total work time.

Household Income 'HHINC' is very important variable which was included in model 1.It is almost insignificant with negative sign which was expected. Since there are no such employments opportunities for women, where they can offer their services to market, they cannot avoid the household jobs. Secondly, there is no trend of hiring house maids and servants in those communities, due to which a women from household having higher income cannot use the services of someone else to reduce the time for domestic work. Thirdly, we are in a male dominant society, where women have very less share in decision making. And they follow the set norms of society and do not demand more than what they have.

Social Activities Time 'SAT' is highlighted as a predictor of total work time. But this variable is also insignificant having lowest value of its coefficient. Reason of insignificance of this variable is that, when women go out of their homes for some work they get the company of other women, which is their SAT as well as work. Like when they go for shopping, water fetching or herding the animals in range lands, they meet with their friends and neighbors. Due to this reason SAT cannot exactly isolated from their work time and not significant in model.

Education of Women 'Edu' was taken in to model to analyze its impact on overall women time allocation pattern. Women education is insignificant in model and it has two reasons. One is that study have dominant sample from Battagram where there is almost zero education of women as compare to Bagh. Secondly, since all women in our sample are either housewives or the most responsible member of their household which cannot avoid domestic work even if they are educated. Thirdly, over there women did not have such employment opportunities as of urban, so they prefer to manage their domestic work because culturally every potential woman in rural household has to share the burden of family.

Distance from Water Source ‘DWS’ is comprised in model to examine its impact on time allocation. This variable is not significant because of shorter distance of water source. As the average distance of water source from dwelling unit is 1 kilometer that is not large for the people of hilly area. Second is that it is not the sole determinant of time allocation to water fetching and total work, but there are some other factors like nature of tracks and travel hurdles which determine the women time allocation.

R^2 shows the overall goodness of fit, which is significant in case of model 1. In model 2 study excluded the ‘DWS’ which has the lowest value of its coefficient and is not explaining the dependent variable. Exclusion of this variable has not altered the sign or significance of any variable. All other variables are remained same. In model 3 study dropped the ‘EDU’ which was also insignificant. Dropping this variable out of model, make no change in the sign or significance of any other variable in the model 4. So, we can say that this variable is also not a predictor of the women time allocation. Study eliminated the ‘HHINC’ from model 4 due to its insignificance. Elimination of this variable is also justified because still all variables are same with their sign and significance.

5.3 Financial Analysis

The third section of this chapter presents the results of financial analysis of RRWH project, which includes the Net Present Value (NPV), Economic Rate of Return (ERR) and Pay Back Period (PBP). Basically, this part is the continuation of analysis which was carried out in order to evaluate the RRWH technology. Primary as well as secondary information was used in order to examine the financial aspect of the project. As explained in the Data and Methodology (Chapter III), per unit economic cost of RRWH system was provided by the implementers of the project, while the benefits were computed by the study using primary information.

Study presents the findings of financial analysis in two scenarios. These scenarios were formed using the assumption about the contribution of time in overall benefits. When aggregate benefits of the project were computed, one determinant of benefits was saved time of women which was invested for water fetching before. To estimate that time, study has used the proxy of wages based on the prevailing market wage. But in real life it is the domestic savings of women time which have very less or no opportunity cost. Because, women are neither investing their whole saving of time in productive activities, nor they offer their services in job market. Moreover, we had asked from respondents that how much of the saved time they are using. Based on these facts we have used the assumption of 30% and 20% use of save time.

5.3.1 First Scenario of 30 % Saved Time

In this scenario study has used assumption that women are using 30% of saved time in productive activities. Based on this assumption net cash flow were calculated for NPV, ERR, and PBP. First of all findings of NPV are presented with their interpretations. Next step explains the outcomes of ERR and PBP which further highlights the scope of the project.

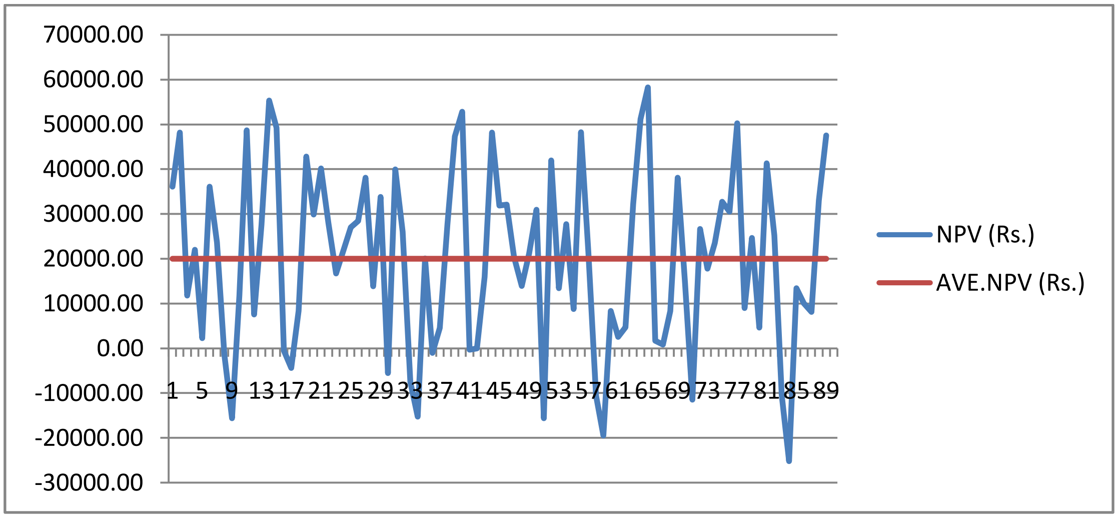
5.3.1 (a) Net Present Value (NPV)

NPVs of each individual beneficiary of the project are represented in Graph 5.3.1 (a). The vertical axis demonstrates the different values of NPV (in Rs.) while horizontal axis shows the number of beneficiaries which is 89. The straight horizontal line in graph presents the average

NPV and the second line which apparently fluctuates is showing the actual values of NPV for all treated households. In case of project assessment, rule of thumb is that, NPV should be positive which is true in case of RRWH project. Considering the results presented in Graph 5.3.1 (a) there are few households which have negative NPV, otherwise majority of the households are lying above the horizontal axis.

The average value of NPV is 58255.48, which is a relatively higher figure for any successful project. The highest value of NPV is 19975.98while the lowest is -25208.29. The fluctuation in value of NPV is due to the fluctuations in benefits of RRWH system for individual households. In case of high value of NPV, we can say that the households are using the facility properly and getting the maximum benefits (like suing more timesaving, getting higher yields of kitchen gardening, more health benefits etc.) out of it. When, value of NPV is low, it means that those households are not optimizing their benefits from the potentials of RRWH. And perhaps they need more awareness about the efficient use of the system.

Graph 5.3.1 (a) Actual and average NPV assuming 30% use of saved time

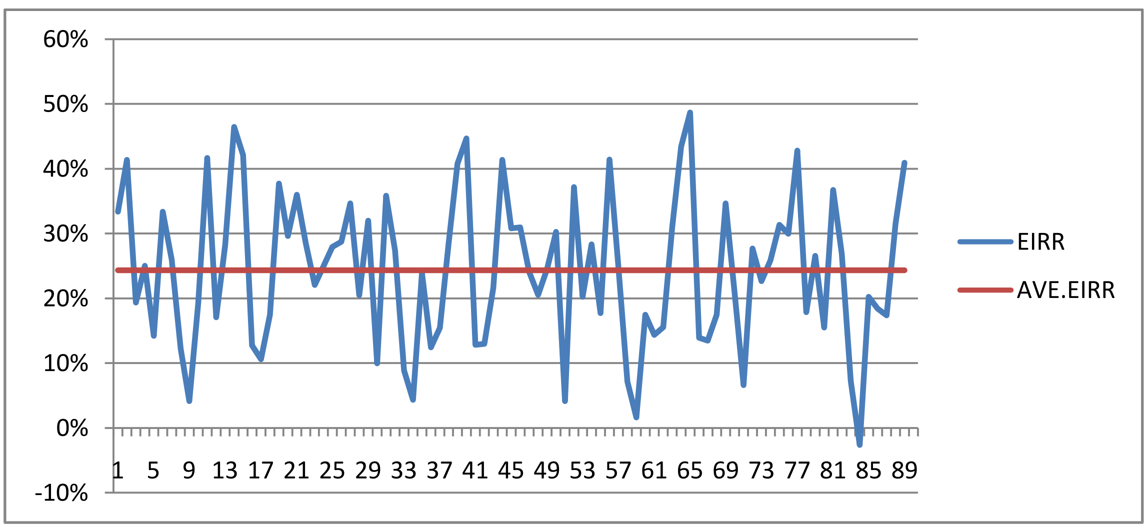


Keeping in view the NPV of RRWH system, it shows that it is most viable, profitable and sustainable project for the rural areas of Bagh and Battagram districts. Furthermore, it is clear from the results that this project has huge potential and it can give maximum returns to its beneficiaries.

5.3.1 (b) Economic Rate of Return (ERR)

Study has estimated ERR for each individual facilitated household taking the assumption of 30% use of save time. In Graph 5.3.1 (b)straight horizontal line is showing the average ERR for whole sample while, the fluctuating line demonstrates the actual values of ERR for individual households. Average value of ERR is 24% which is reasonably good for project considering the rate of return and market interest rate. All samples have positive ERR and lie above the horizontal line except one sample. The reason of variation in ERR across the households is variation in benefits as it was in case of NPV.

Graph 5.3.1(b) Actual and average ERR assuming 30% use of saved time

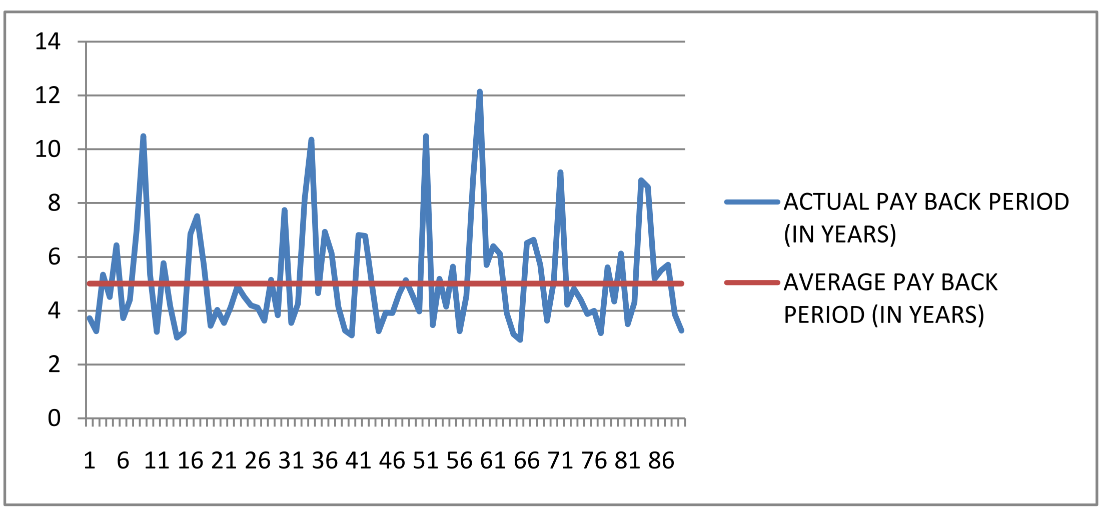


Minimum and maximum value of ERR is -3% and 49% respectively. Under the criterion of ERR, overall RRWH project is profitable for hilly and high rainfall areas. Moreover, scaling up this project means more diffusion benefits to rural population.

5.3.1 (c) Pay Back Period (PBP)

Average and actual PBP trends are revealed in Graph 5.3.1 (c). It is also based on the assumption of 30% save time which is being utilized in this scenario. Straight horizontal line in graph is representing the average PBP that is 5 years, and it imply that on average this project required 5 years to get back the total return of investment. Actual PBP curve fluctuates due to the variation in individual's benefits. Furthermore, in the first scenario minimum PBP is 3 years and maximum is 12 years. And this indicates that the PBP for RRWH project could be in this range. And this range depends upon the accrued benefits, which are in control of the population being benefited from the project.

Graph 5.3.1(c) Actual and average PBP assuming 30% use of saved time



By this finding of the study we can conclude that profitability of a project is not the function of its cost and how it is implemented, but it is also determined by the way people use it.

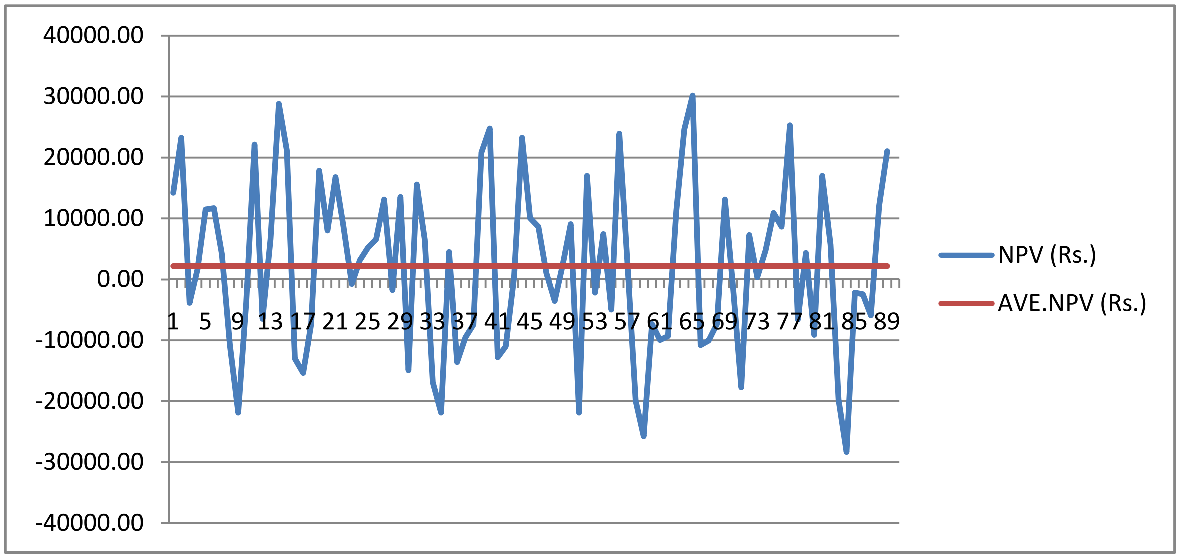
5.3.2 Second Scenario of 20 % Saved Time

In this scenario study has used assumption of 20% women time saving in order to compute the benefits of RRWH technology. Based on this assumption net cash flow is calculated for NPV, ERR, and PBP. First of all findings of NPV are presented and explained. Next step explains the outcomes of ERR and PBP which further highlights the scope of the project.

5.3.2 (a) Net Present Value (NPV)

NPVs of each individual beneficiary of the project are represented in Graph 5.3.2 (a). The vertical axis demonstrates the different values of NPV (in Rs.) while horizontal axis shows the number of beneficiaries. The straight horizontal line in graph presents the average NPV and the second line which apparently fluctuates is showing the actual values of NPV for all treated households. In case of project assessment, rule of thumb is that, NPV should be positive which is true in case of RRWH project.

Graph 5.3.2 (a) Actual and average NPV when 20% use of saved time



Considering the results presented in Graph 5.3.2 (a) there are few households which have negative NPV otherwise majority of the households are lying above the horizontal axis.

The lowest value of NPV is 28330.37 while the highest is 30156.71. The average value of NPV is 2157.70, which is a relatively higher figure for any successful project. The fluctuation in value of NPV is due to the fluctuations in benefits of RRWH system which were computed by the study. In case of high value of NPV we can say that the households are using the facility properly and getting the maximum benefits (like time saving, kitchen gardening, health improvement etc.) out of it.

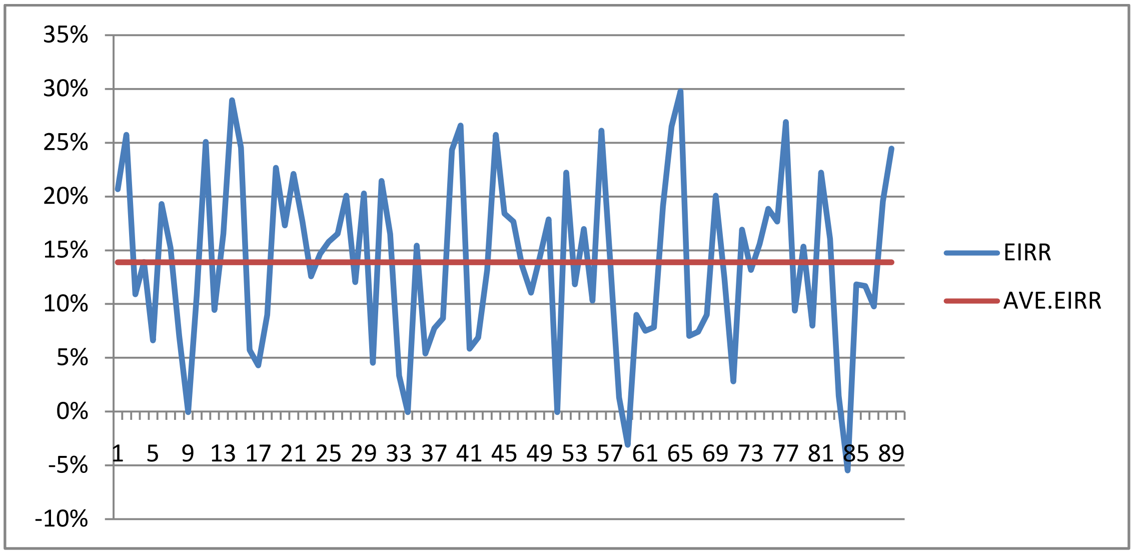
When, value of NPV is low, it means those households are not benefiting from the potentials of RRWH productively. Still RRWH is viable and profitable project for the rural areas of Bagh and Battagram districts. And this project could be extended to the remaining population.

5.3.2 (b) Economic Rate of Return (ERR)

Study has estimated ERR for each individual facilitated household taking the assumption of 20% use of save time. In Graph 5.3.2 (b) straight horizontal line is showing the average ERR for whole sample while, the fluctuating line demonstrates the actual values of ERR for individual households. Average value of ERR is 14% which is reasonably good for project considering the rate of return and market interest rate. All samples have positive ERR and lie above the horizontal line except one sample. The reason of variation in ERR across the households is same as of NPV.

Minimum and maximum value of ERR is -5% and 30% respectively. Under the criterion of ERR, overall RRWH project is profitable for hilly and high rainfall areas.

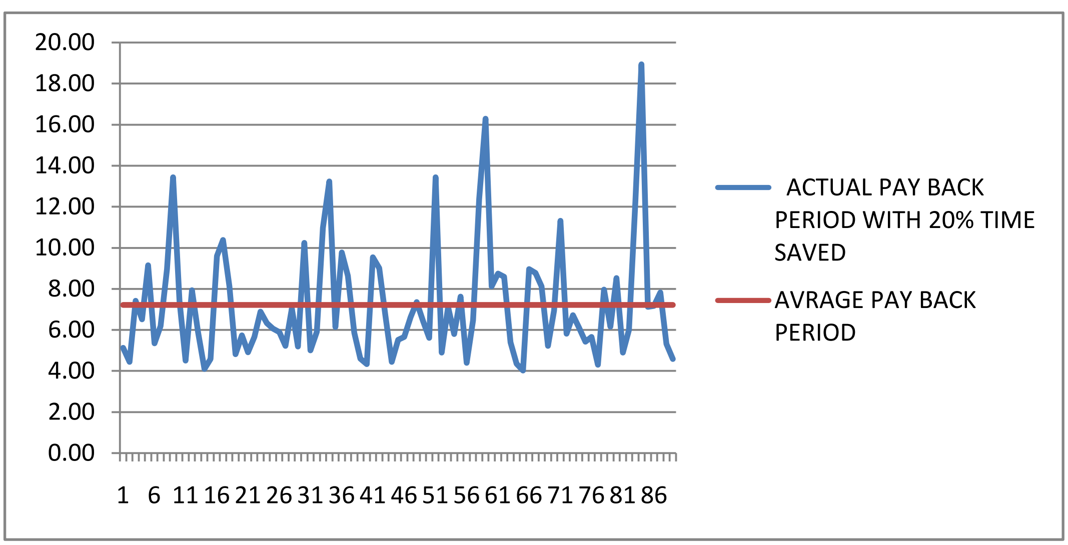
Graph 5.3.2(b) Actual and average ERR when 20% use of saved time



5.3.2 (c) Pay Back Period (PBP)

Average and actual PBP trends are revealed in Graph 5.3.3 (c). It is also based on the assumption that 20% save time is being utilized. In graph straight horizontal line is representing the average PBP that is 5 years, and it imply that on average this project required 7.2 years to get the total return of investment. Actual PBP curve fluctuates due to the variation in individual's benefits.

Graph 5.3.2 (c) Actual and average PBP when 20% use of saved time



Furthermore, in first scenario minimum PBP is 4 years and maximum is 19 years. And this indicates that the PBP for RRWH project could be in this range. And this range depends upon the accrued benefits, which are in control of the population being benefited from the project. By this finding we can conclude that profitability of a project is not the function of its cost and how it is implemented, but it is also determined by the way people use it.

5.4 Results of Informal Survey

Apart from formal interviews of the respondents through questionnaire, study used Participatory Rural Appraisal (PRA) tools like Key Informants Survey (KIS). Moreover, Focused Group Discussion (FGD), and Case Studies of some beneficiaries were also the part of Informal Survey. During survey, some incidents were reported regarding the water fetching, which are included in last part of informal survey findings.

5.4.1 Key Informants Survey (KIS)

This is a technique of gathering important information from key persons using the tool of informal discussion on specific topic. The key informant could be from any field but normally he has enough understanding of that particular issue. Sometimes, they are picked on the basis of their knowledge of area, and sometimes they hold a key position in a community where they can speak on the behalf of the others. Their keen observation and interaction with people let them know about the changes which are taking place but, an ordinary man cannot observe them. In this study, mainly two people were contacted for this purpose, one from Bagh and other from Battgram. In Bagh doctor of Rural Health Centre (RHC) was selected for key person interview, and in Battagram Secretary of RRWH system was considered as most suitable for this job.

5.4.1.1 Doctor of Rural Health Centre

Dr. Asif Ahmed is a government servant and rendering his services against the post of Senior Medical Officer in Rural Health Centre (RHC), Chira Topi. When we asked him to share his experience of RRWH technology he said that;

> "*This is very useful system to conserve the rain water which is gift of God. Personally I am very much impressed by this technology and government should support it, so that remaining population of the area could enjoy this facility".*

When he asked about his observation about the system and impact of this technology on patients visiting him, He told that;

> *"First of all, I would like to tell you about its impact on our routine work. It has improved our work efficiency in two ways; first our lab is functioning now because, before this facility there was no water and we were not able to use our equipment as every time it needs to wash, secondly before this facility there was very less water available and we were facing problems regarding sanitation. I felt a significant change, as for as its impact on individuals' health is concerned. Sanitation and hygiene of the patients has improved".*

5.4.1.2 Secretary of Scheme

In order to investigate the perception of people about RRWH system from Battagram, study has contacted Uzair Ahmed, the Secretary of RRWH scheme in area. This was a key person and facilitator of all kinds of assistance offered by organizations to the community regarding this project. He was interacting with local people and getting their views about the functions of system. Furthermore, he was speaking with outsider agencies and individuals on the behalf of the people. According to him;

> *"This technology is very valuable. It helped women in managing their domestic activities in better way. And it is good for their health as well. Apart from that local people are very happy with this system, and their satisfaction level has increased"*

He further added that;

> *"It has significantly increased the livestock holding in community because before this women were not able to fetch water for animals"*

Interestingly Secretary has told that;

> *"People who can afford are copying this technology and scaling it up within and across the households"*

This is very useful because this technology is a source of sustainable water supply and if it is being promoted, human wellbeing is going to increase.

5.4.2 Case Studies of Beneficiary of RRWH System

Analysis includes two Case Studies from Bagh region in which two respondents have shared their personal experiences of use of this technology that has changed their lifestyle and created ease in their daily activities.

1. RahilaBibi (Bagh)

This lady is residing in Chitra Topi, Bagh, and she is a house wife. Her husband is doing job somewhere out of area. She was very upset before the installation of RRWH system because, she was the only person in her household and she was holding a buffalo. She was not able to leave her house. But without fetching water, her survival was difficult because she needed the water for domestic consumption and livestock. She belonged from a low income family which cannot afford to purchase the water from water carrier. While asking about the RRWH system she said;

> *"We are praying for service providers all who are involved in providing us with water tanks because it created ease for us, and we were not able to purchase these without having your support."*

Furthermore, she was a asthmatic patient, due to which it was not possible for her to collect water from long distance. Also she was holding the buffalo so it was not possible for her to fulfill the requirement of domestic water. In this regard she said;

> *"I am an asthmatic patient and can't even walk for very short distance in sloppy terrain; I would have died if they did not facilitate me with this system. Because I have a buffalo without which I can't live, and I had problem in arranging water for her. But now thankfully it is possible for me to manage my daily life".*

Rahila is very happy and living in better and satisfactory conditions regarding water supply.

2. Riaz Ahmed (Bagh)

Riaz was a manual worker in Chitra Topi Bagh, who spends his whole day in doing labor work out of his house to earn the bread for his family. Due to which he was not able to stay at home even for a single day. He was very tense before the provision of RRWH system in his house because, it was very difficult for women to fetch and manage the demand of water for whole family. So he had to take potential days off from his job of rendering labor services in market. When he was asked to share his satisfaction of being the beneficiary of RRWH system, he replied as;

"The difference between having RRWH system and not having is like difference between day and night. When we got this system, it gives us a feel of life and being the part of normal world, because with the problem of water we were feeling like if nobody is bothered about our pain."

Furthermore, while explaining the scope of technology he said that;

"*This is very useful system and it should be scaled up to all households of this village as soon as possible because people are really in trouble".*

5.4.3 Focused Group Discussion:

This is the third tool of data collection through informal survey, in which different people having some understanding of research issue are invited and asked to share their experiences and observations about that particular issue. The need of this Focused Group Discussion was felt when some respondents from Bagh reported that children hygiene has significantly improved due to this facility. In order to test this claim, study has carried out a Focused Group Discussion with the teachers of secondary school in Chitra Topi. Following are the findings of this focused group discussion.

5.4.3.1 Discussion with School Teachers

In order to conduct the Focused Group Discussion five teachers were taken. First they were invited to take part in this discussion and share their observation being the teacher who meet and see the children every day. Then certain key questions were asked to cross check the provided information. All of them were of the view that RRWH has improved hygiene level of the children coming from facilitated households.

According to them, now children coming from those households which are being benefited by the facility are comparatively cleaner. Furthermore, they have observed that it happened after the installation of RRWH system. They added that the children who are coming from control group are coming with same hygiene conditions.

5.4.4 Incidents

During the survey some incidents regarding water fetching were reported, and study has included them in findings. The reason of including those reported information was to make this clear that RRWH is not only providing water on sustainable basis but it also resolves the problems of maternal health. Two incidents are reported and among them one was from Bagh and other from Battagram. Following is the detail of both incidents;

5.4.4.1 Incident in Bagh

This incident was narrated by the nurses of the Rural Health Centre, Bagh, when they were interviewed and asked about maternal health. They have told that they are appointed from last two years, and in these two years 10 cases of miscarriages were reported to them. These miscarriages had no such reason, no woman was the patient of any serious disease which could cause this. Furthermore, they have told that after detailed examination we were able to find that it happened due to extra workload on pregnant women. Interestingly, when the matter was further investigated, it was found that majority of them were from control group.

5.4.4.2 Incident in Battagram

While collecting the data, we met with one respondent from Battagram region. He shared an incident faced by his family with reference to fatigue of water fetching. He told that one day his pregnant wife was bringing water from spring and while crossing the sloppy path, she fell down. She survived some small injuries which were recovered later, but she got miscarriage of five month pre matured infant which was unbearable emotional loss to his whole family. Besides that, the body of that infant baby was damaged as the lady fell on sloppy land. And according to him that was only due to the fatigue of water fetching.(Thomas and Martinson 2007 and DfidKar Report R1 2002) has also accentuated that injury and falling while carrying water usually takes place. The respondent further explained that, this facility will not only provide water to the poor people of backward helmets but it will reduce the problems of maternal health.

CHAPTER VI

CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusion

The study is based on rural domestic water management using Rooftop Rain Water Harvesting (RRWH) technology. Results revealed that the initiative of RRWH has not only addressed the issue of water supply but it happened to be a very cost-effective and gainful deal by ERRA and other funding agencies. Authority has taken a prudent step keeping in view that these areas are earthquake prone and receiving high rain fall. Study analyzed the potential benefits of technology which are being accrued by the people of those communities in Bagh and Battagram.

There are three main parts of the present study. First part is based on descriptive analysis which showed that technology has huge potential in terms of water supply for domestic usage. Moreover, in descriptive analysis, socio economic profile of the study areas was also investigated. In this regard level of awareness and understanding of the technology is found to be the most important determinant of effectiveness of the technology in terms of accruing the optimum benefits. This part of the study has also reported that saved time of water fetching is being utilized by women in advantageous activities. Second part is based on econometric analysis which yielded that there is significant positive impact of RRWH technology on women health and women time allocation. Findings exposed that technology has reduced the probability of women illness, associated medical costs, and time allocation for fetching water.

Financial analysis is the third part of study which was carried out to investigate the overall profitability of the RRWH system. Net Present Value (NPV), Economic Rate of Return (ERR) and Pay Back Period (PBP) are calculated on the basis of economic benefits and costs of the system. Study considered two scenarios in order to evaluate the benefits of the project. Findings of the financial reckoning endorsed that this system is very viable, profitable, women friendly, and sustainable source of water supply.

6.2 Policy Recommendation

The findings of the present study have following policy implications.

1. Firstly, there is huge potential of RRWH technology in hilly areas of Bagh and Battgram districts, because rain fall is comparatively higher in AJK and KPK. Therefore present study recommends that the technology should be extended and installed in all those areas which are receiving high rainfall.
2. The system has special importance with reference to women wellbeing, because it improves their health, reduces their fatigue involved in fetching water. Study proposes that women of those communities should be trained to utilize their saving of time and better health for some productive activities.
3. It is also found that women who are harvesting rain water have comparatively better health and less health expenditures. Based on this finding we can conclude that in order to manage women health and subsequent cost in rural and hilly areas, they should be provided with clean drinkable water at their dwelling unit.
4. Study has explored that kitchen gardening has huge potential whichis being utilized with the provision of rain water. Households are producing surplus amount of home grown vegetables. In this regard there is the need of doing capacity building of people in those

communities regarding kitchen gardening. This will reduce their household expenses, increase their saving, and ensure food security in poor rural helmets.

5. RRWH is environmental friendly in many respects like it increase water and soil conservation, ensure sustainable water supply, put less pressure on existing water sources, has no such negative externality, and enhances the poor's resilience against drought conditions. So in order to ensure environmental sustainability this technology should be promoted at large scale.
6. Financial appraisal of RRWH technology yielded that, this system has number of benefits with least initial and maintenance cost, which shows that it, is the best alternative for supplying water in rural and hilly areas which are receiving good rainfall.
7. Present study has found that education and awareness of supported population played significant role in accruing the benefits of any development. Based on this finding study proposes that in order to ensure the maximum benefits of any facility, beneficiaries should be trained so that they could get maximum out of that.

The above discussion on policy implications recommends that RRWH system should be promoted in rural communities in order to conserve and use rain water efficiently. As Pakistan is water stressed country this is a prudent approach of water conservation. It ensures sustainable use of rain water which is a gift of nature to our country.

REFEREENCES

Baguma .D, Loisk and .W, Jung.H, (2010) “Water Management, Rainwater Harvesting and Predictive Variables in Rural Households”, Water Resource Management, DOI 10.1007/s11269-010-9609-9.

Bourne A. P, Shearer E. D, McGrowder D, and Crawford T (2009) “Examining health status of women in rural, peri-urban and urban areas in Jamaica” North American Journal of Medical Sciences 2009 October, Volume 1. No. 5. 256.

Dwivedi and Bhadauria (2010) “Environmental planning, management and policy issues” TERI Information Digeston Energy and Environment Year: 2010, Volume: 9, Issue: 2

Bagh (2007) “District Profile – Battagram” Earthquake Reconstruction and Rehabilitation Authority Prime Minister’s Secretariat, Islamabad Website: http://www.erra.gov.pk

Battagram (2007) “District Profile – Battagram” Earthquake Reconstruction and Rehabilitation Authority Prime Minister’s Secretariat, Islamabad Website: http://www.erra.gov.pk

DfidKar Report R1 (2002) “Very Low Cost Domestic Roof water Harvesting in the Humid Tropics: Existing Practices”, Development Technology Unit School of Engineering, University of Warwick.

Estrada, Javier, Mean-Semivariance Behavior (II): The D-CAPM (February 2003). EFMA 2002 London Meetings; IESE Working Paper No.D/493. Available at SSRN: http://ssrn.com/abstract=307242 or doi:10.2139/ssrn.307242

Fayez A. A, and Shareef A, AW (2009) Roof rainwater harvesting systems for household water supply in Jordan, Desalination. 243, 195–207.

Helmreich.B, Horn .H, (2009) “Opportunities in rainwater harvesting”, Desalination 248 (2009) 118–124.

Hightower M and Pierce A. S (2008) “The energy challenge”, Commentary Nature Vol 452:20 March 2008.

Jean-marc M K, Akpofure E. T, and Jean R. B, (2007) “Domestic rainwater harvesting to improve water supply in rural South Africa”, Physics and Chemistry of the Earth, 32: 1050–1057.

Kumar, M. D (2004) “Roof Water Harvesting for Domestic Water Security: Who Gains and Who Loses?” Water International, 29: 1, 43 — 53

Liaw C. H and Tsai Y.L (2004) “Optimum Storage Volume of Rooftop Rain Water Harvesting Systems for Domestic Use”, Paper No. 03014 of the Journal of the American Water Resources Association, august 2004.

Lehmann. C and Tsukada. R (2009) “Low Cost but High Impact: The Effect of Rainwater Harvesting on Poverty”, This version: December 14, 2009 International Policy Centre for Inclusive Growth.

Li .F, Cook .S, Geballe G. T., and Jr W .R.B (2000) “Rainwater Harvesting Agriculture:An Integrated System for Water Management onRainfed Land in China’s Semiarid Areas”Ambio Vol. 29 No. 8, Dec. 2000, Royal Swedish Academy of Sciences.

Mihelcic, J. R, Zimmerman, J B., and Ramaswami A., (2007) "Integrating Developed and Developing World Knowledge into Global Discussions and Strategies for Sustainability. 1. Science and Technology" *Environ. Sci. Technol.*, 2007, 41 (10), pp 3415–3421.

Pandey K. M, Singh P, Yv A. R (2009) "Domestic Violence and Women's Health in India: Evidence from Health Survey", ASARC WP 2009/13.

Reynaldo F, Paulo Pi, Ricardo B, Carlos C, Miguel F, Daniel S, Simone W, and Maria C L, (2002), " Adolescents in Latin America and Caribbean: Examining Time Allocation Decisions with Cross-Country Micro Data", Inter-American Development Bank Latin American Research Network Red de Centros de Investigación Research Network Working paper #R-470.

Shahateet M. I (2008) "An Econometric Model for Water Sector in Jordan", Journal of Social Sciences 4 (4): 264-271, 2008 ISSN 1549-3652 © 2008 Science Publications 264 Jordan.

Tang C. (2009) "Water Quality Study and Cost-Benefit Analysis of Rainwater Harvesting in Kuttanad, India", Submitted in partial fulfillment of the Bachelor of Science Degree with Honors in Environmental Science from the Center of Environmental Studies at Brown University.

Thomas, T.H. and Martinson, D.B. (2007) "Roof water harvesting: a handbook for practitioners''. Delft, The Netherlands, IRC International Water and Sanitation Centre. (Technical paper series; no. 49).

Tripathi A. K, and Pandey K. U (2005) "Study of Rainwater Harvesting Potential of Zura Village of Kutch District of Gujarat", J. Hum. Ecol., 18(1): 63-67

UNEP, (2009) “Rainwater Harvesting: A Lifeline for Human Well-being”, A report prepared for UNEP by Stockholm Environment Institute, Copyright© 2009, United Nations Environment Programme/SEI.

UN, (2003) “Water for People Water for Life” The United Nations World Water Development Report, World Water Assessment Programme.

Vo L P (2009) “Water Resource Management in Ho Chi Minh City, Vietnam: An Overview”, Science & Technology Development, Vol 12, No.02 – 2009.

World Bank (2005) “Pakistan Country Water Resources Assistance Strategy Water Economy: Running Dry” Report No. 34081-PK: November 14, 2005.

Xinshen. D, Roe,T., and DoukkaliR. (2005) “Economy Wide Gains from Decentralized Water Allocation in a Spatially Heterogeneous Agricultural Economy”, Environment and Development Economics, 10: 249–269, C 2005, Cambridge University Press.

Yie-Ru C, Chao-H L, Liang-C C (2009) “Optimizing rainwater harvesting systems as an innovative approach to saving energy in hilly communities”, Renewable Energy, 34: 492–498.

APPENDICES

APPENDIX-A

(Table: 3.1) Population distributions with respect to Profession in Battagram

Profession	Population Percentage
Labor	60%
Agriculture	10%
Livestock	15%
Others	15%
Total	100%

(Table: 4.1.1)Coefficient of Runoff (Cr) for different Rooftop Types

Type	Coefficient of Runoff
Galvanized Iron Sheet	0.90
Asbestos Sheet	0.80
Tiled Roof	0.75
Concrete Roof	0.70

RRWH Construction and Maintenance Manual, AFPRO (Action for Food Production) UNICEF.

(Table: 4.5)Data Collection Tools

Data Type	Data Collection Tools
Probabilistic Survey	Personal interviews
Non Probabilistic Survey	Focused group discussions
Non Probabilistic Survey	Key informants interviews
Secondary Information	ERRA, Maqsood Welfare Foundation, Save the Children.

APPENDIX-B

Questionnaire

ROOFTOP RAIN WATER HARVESTING: A PROJECT INITIATED BY ERRA IN BAGH AND BATAGRAM DISTRCTS

(Date: Mo………../Day………/Year………)

A. GENERAL INFORMATION
Name of the HH ……………………..….HH Quom/Zaat/Biradari: ……..Name of the Enumerator: ……… +Questionnaire code #............. (like 011or 112)
Distance of village from the paved road: ……… (Kms.), from highway/main road: ……… (kms.), distance from nearest market ………, nearest city ………., name of the city ……………... Faimly system (1=joint, 2= separate)……………..
Distance of school boys ………. Distance of girls schol……….Distance of boys college………… Distance of girls college………Distance of nearest hospital ..……

+ First digit in code is for group (treated=1 and control=2) , second for village (1= Chitra Topi 2= Saroona) and third Questionnaire no.

Family members	1+	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Family member Names															
Age (years)															
*Sex															
**Relation with HHH															
Years of schooling															
On farm income															
Off farm work (Type+++)															
Off farm. Income: (Rs/month)															
- Domestic															
- Foreign															

+ Start with the Head of the HH followed by the next elder * (1 = Female and 2 = Male) ** Relation with the Head of the HH (HHH) {1= Head, 2 = Spouse, 3 = Son/Daughter (unmarried), 4 = Son/Daughter (married), 5 = Father/Mother, 6 = Brother/Sister, 7 = Other relative, 8 = Servant, 9 = Non-relative}, +++ 1 = Laborer, 2 = Armer service, 3 = Govt. service, 4 = Private service , 4 = Private bussiness, 5 Foreign service, 6 = Pensioner, 7= Zakat, 8 = Any other

B. WATER INFORMATION

I. CONSUMPTION OF WATER

Water Supply sources / Consumption/day (in liters)	Drinking	Kitchen use	Washing clothes	Washing house	Toilet flush	Shower	Gardening	Animals	Any other	Total	Per day demand
Public supply											
Bore/well											
Open spring											
Rain harvested											
Tanker											
Bottles											
Others											
+ Qulity of the water											

+ 1= Very good 2= Good 3= Satisfactory 4= Bad 5= Don't know

Do you had the home toilet before RRWH: ------ (1=Yes 2= No) If yes what was the per day water consumption (in liters): --------

II. WATER FETCHING

Household members	No of persons involved in WF	Ages (in years) of persons			Per day time spent for WF (in hours)	Distance of water source (in km)	Daily no of visits to water source	Any monetary cost (in Rs.)
Female								
Children								
Male								

III. ROOFTOP RAIN WATER HARVESTING (RRWH) INFORMATION

Size of the rooftop (in sqrs feet)	want to increase the storage (1=Yes 2= No)	+Constraints on increasing the storage	No. of time tank get filled in one month	++ What type of storages do you have	Rs. would you like to invest to increase the storage	Are you satisfied from storage quality (1=Yes 2= No)
If not what is the issue?	Locally skilled people are available to install the system (1=Yes 2= No)	Equipment is available in local market (1=Yes 2= No)	RRWH system save your time (1=Yes 2= No)	Daily you saved time(in hours) due to RRWH	*you are investing that time in	

+ 1=Technical 2= Financial 3= Others ++ 1=given tank, 2= your own purchased 3= cemented, 4=drum or 5=any other *1=Entertainment and social activities 2=agriculture and livestock 3=domestic work 4=education and awareness 5=others

C. DAILY TOTAL WOMEN TIME ALLOCATION (IN HOURS) IN DIFFERENT ACTIVITIES

Breakfast preparation	Kids Prep. for school	House cleaning	Dish Washing	Fuel Collection	Daily prayers/recitation	Lunch preparation	Clothes washing	Livestock activities
Gardening activities	Dinner preparation	Evening tea	+Time spend in social activities	Net sleeping time	Embroidery	Any other	No of women involved in household work	

+ With friends, neighbors, or relatives

D. HEALTH INFORMATION OF WF INDIVIDUALS

Sex (1 = Female and 2 = Male)	+ If sleeping<6 hours the reason is	No. of times you became ill in last 6 month	No. of time you visit hospital in last 6 month	While doing WF what type of disease you commonly face	No. of times you became ill due to Muscular spasm, Headache or Fever while doing WF	Health expenditures (in rupees) of last 6 months

+ 1= Tension 2=Busy routine 3= Physical disease 4= Stress 5= Any other reason

E. KITCHEN GARDENING INFORMATION

Total plot size of your house: ……(kanal)	Total covered area under house: ..…(in square feet)	Are you growing vegetables: …... (1=Yes 2= No)
+If you are not growing vegetables then reason is: ……	If yes plot size where you are growing vegetables: ……. (kanal)	If you have sold them in past average per annum revenue……..(in rupees)
Per annum monetary value (in rupees) of home grown vegetables…………..	Have you observed any soil erosion around your house in last 6 months………(1=Yes 2= No)	If yes tell me about the area (in kanals) which is affected by soil erosion………
*In last 6 months rain caused damage to your house ………..	In last 6 months vegetation cover around your house……… (0= decrease 1= increase)	Which type of fertilizers you use for vegetables growth……… (0=inorganic 1= organic)

+ 1= Lack of area 2= Lack of water 3= Lack of interest *1=walls, 2=rooftop, 3=floor 4= Not

F. LIVESTOCK INFORMATION

Animal Type	No. of animals	Ages of the animals	Total MV of the animals	*Output of the animals	MV of animals output	Sold in the last 1year	Amount received	+ Feed	++Water source

Buffalo												
Cow												
Goats												
Sheep												
Cattle												
Others												

+ 0=Self Produced 1=Buy ++ 1=Public supply 2=Rain harvested 3=Open spring 3=Bore/well 4= others *1=milk 2=yogurt 3=butter 4=ghee 5=Hide 6=Skin 7=Wool 8=Manure 9=Eggs 10=Other

G. AGRICULTURAL INFORMATION

Crops	Area (in kanals)	Production (Kg)	Seed (kg)	Fertilizers (1=inorganic,2=organic, 3= both)			Home Consumption (Kg)	Total input cost	By Product (Value Rs)	++Sold	Price (Rs/40kg)
1………………… + (0) (1)											
2 ………………… (0) (1)											
3 ………………… (0) (1)											

+ 0= Kharif 1= Rabi + + 1 = Local shop, 2 = dealer. 3 = wholesaler, 4 = retailer , 5 = Other (Pl. specify) *1= Local market, 2 = Govt. purchase center, 3 = Wholesaler, 4 = Commission agent, 5 = Hotels & restaurants, 6 = Main market, 7 = Supermarkets, 8 = Processing agent, 9 = Retailer, 10 = Consumer, 11 = Pre Harvest Contract, 12 = Consumer Picks at Farm (Farm Fresh), 13 = Combination of these (Pl. specify), 14 = Any other (pl. specify)}

CLIMTE CHANGE INFORMATION

Do you think temperatures change in last 5 years………..(1=Yes 2= No)	+If yes it is…………	Do you think rainfall pattern has changed in last 5 years…….((=Yes 2= No)	+If yes it is…………	Have you grown any plant with RRWH
Do you feel any change in floods in last 5 years………..(1=Yes 2= No)	+If yes it is…………	Floods losses have increased in last 5 years ……. (1=Yes 2= No)	Do you thing weather change affected agriculture yield………(1=Yes 2= No)	+If yes it is…………

+1=increasing 2= decreasing 3= fluctuating

How RRWH facility affected the school attendence of children ……………………………………………………………………………

What is your opinion about the RRHS…………………………………………………………………………………………….

Interviewer observation………………………………………………………………………………………………….

THANK YOU VERY MUCH