Impact of Rooftop Rain Water Harvesting (RRWH) Technology on Women Time Allocation in Hilly and Fragile Areas of Bagh and Battagram Districts

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Abstract

Fresh water availability remained a serious issue in developing as well as developed countries. Particularly, its significance is further enhanced in earthquake prone, hilly, and rural areas. Majority of the population in Pakistan is living in rural areas, where access to safe drinking water is very serious issue. In these areas most vulnerable segment of population is women, they are the ones who have to fetch water far from their dwelling units. In order to resolve the water crisis in Pakistan, government along with a number of private agencies (NGOs) are working in the field. Different approaches, techniques, and practices are being adopted to address this issue. Rooftop Rain Water Harvesting (RRWH) technology is one among them which is practiced in number of countries. This study assesses the impact of RRWH system with special reference to women time allocation in the hilly and earth quake affected Bagh and Battagram villages of Azad Jammu & Kashmir (AJK) and Khyber Paktunkhwa, respectively. Analyses are carried out using Ordinary Least Square (OLS) technique to quantify the results. The results reveal that RRWH technology is viable, time saving, women friendly and sustainable source of water supply, especially in the earthquake prone, hilly, and rural areas of Pakistan.

Keywords: Rooftop Rain Water Harvesting: Earthquake Prone and Hilly Areas: Negative Binomial Regression, Pakistan.

JEL classification: O13, Q25, Q56, Q58, R28

1. INTRODUCTION

The importance of fresh water is well recognized and documented. 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, 2005; and Dwivedi and Bhadauria 2010). Particularly, its significance is further enhanced in earthquake prone, hilly, and rural areas where access to water is difficult, expensive and tiresome (Kumar, 2009). 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 (United Nations; 2003). It is frequently asserted that quality of life depends on the quality of water being used. Beside its importance and necessity, water is becoming a scarce commodity on whole earth.

Water demand has increased with alarming pace in the last few decades. On the other hand, the availability of fresh water has decreased drastically in this period (Liaw and Tsai, 2004; and Lehmann and Tsukada, 2009). This is primarily due to the higher population and industrial growth, intensive agriculture production, and rapid urbanization (Kumar, 2009 and UNEP, 2009). This surge in water demand is putting tremendous 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 contemporary world (UNEP, 2009). Consequently, a number of water supply schemes have been initiated by governments and international agencies. However, millions of people are still suffering from acute water shortage.

The growing scarcity of water in low income countries, where majority of the poor resides in the rural sector, results in water allocation problems (Xinshen et al., 2005). Given the

grim situation of water, there is a dire need to formulate some water conservation strategies. There are many prudent approaches to conserve water at domestic as well as commercial level. Rain Water Harvesting (RWH) is one of them to conserve, store and utilize rain water. RWH is an old but useful approach to channel and use the rainwater in productive manners (Li et al, 2000; and UNEP, 2009).

The history of RWH in Asia can be traced back to 9^{th} or 10^{th} century (Mihelcic et al; 2007). It has been used by almost all societies in all parts of the world to provide water for drinking, livestock, and irrigation. Tripathi and Pandey (2005) examine the potential of RWH system and find it an effective source of drinking water in drought prone and rural areas. Furthermore, RWH is also very useful for soil conservation which would otherwise erode due to flash flow of rains (UNEP, 2009). Generally, 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 as the country is confronting acute water shortage. World Bank (2005) declares Pakistan as water stressed country in South Asia. Furthermore, more than 60 percent of total population lives in rural and hilly areas where high cost and low success rate make it difficult to provide water supply schemes. Moreover, supplying water in hilly areas is time consuming, hazardous, and costly business with numerous risks involved with it (Baguma *et al*., 2010). Hence, this was further endorsed by World Bank (2005) as the most suitable and viable approach for hilly areas of Pakistan.

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 system. It greatly reduces operational and maintenance problems because of its individualistic use and ownership. Water collected from roof catchments is usually of as acceptable quality as from other available water sources (Kumar, 2009).

An important advantage of RRWH is for women as it reduces their fatigue as well as time required to fetch water from other water sources. The available saved time can thus be used for productive purposes such as domestic work, agriculture and livestock activities, and child care. In this regard, Lehmann and Tsukada (2009) and Baguma *et al*. (2010) examine rainwater harvesting with reference to health and time allocation. They conclude that this technology reduces cost incurred on health as well as time allocation for curing sick people, which could be used for profitable activities. Similarly, young children (both male and female) can go to school who are otherwise busy in fetching water. Furthermore, this system improves the sanitation and hygiene facilities to 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 technology. Although, substantial work on economics of RRWH has been done in many countries, yet this is an unfortunate fact that no ample attention was devoted to research on this technology with special reference to women in Pakistan. The current study attempts to fill this gap in literature by examining the impact of RRWH facility on women time allocation with special reference to water fetching in hilly and earthquake prone areas.

Rest of the study proceeds as follows; the second section describes theoretical considerations and econometric specification. Section 3 discusses methodology of the study

including the estimation technique. The fourth section presents results and discussion, while section 5 concludes the study along with some policy implications.

2. THEORETICAL CONSIDERATIONS AND ECONOMETRIC SPECIFICATION

This section briefly describes the channels through which the Rooftop Rain Water Harvesting (RRWH) technology and other control variables affect the women time allocation. Theoretically speaking, the RRWH technology is expected to have positive effect on women time allocation in terms reducing their time allocation which they are spending on water fetching. The RRWH technology has huge potential in terms of water supply and it facilitates women by providing them required amount of water which is otherwise brought from distanced water sources.[1] Consequently, this facility saves their time which can be used in other social and healthy activities. Hence, one may expect positive impact of the RRWH technology on time allocation in rural and hilly areas. This variable is quantified by using a dummy variable where "1" represents the household possessing this technology (also called the "treated group") and "0" represents the household where this facility is not provided (also named as "control group"). On the other hand, the women time allocation is quantified as the total work time which they allocate in different activities.

The control variables used in the women time allocation model include region, age, household income (HHInc), and education of the woman, distance from water sources (DWS), and social activities time (SAT). The variable "region" is quantified using '1' for Bagh and '0' for Battagram. This variable is incorporated in order to investigate whether there is any impact of regional differences. "Age" denotes the age of water fetching woman. The sign of its coefficient

[1] The supply of water through RRWH system can be calculated by using the formula given by Tripathi and Pandey (2005). According to this formula $S = R \times A \times Cr$ where *S, R, A and Cr* represent supply of water by RRWH system, mean annual rainfall in millimeters, catchment's area in meter squares and coefficient of runoff of rooftop respectively. Potential of RRWH with respect to catchment area is provided in Table I in Appendix.

is positive, because with the increase in age, women allocation of time is expected to increase. Because after a particular age, the body and the resistance weaken as the woman enters to older age group. Subsequently, a positive sign of the coefficient may also be expected.

Education, taken as the years of schooling of the water fetching woman, is expected to improve the women time allocation for the reason the educated women are aware about the productive allocation of time. Therefore, its expected sign is positive. DWS measures the distance of water source in kilometers and its probable sign is negative, HHInc is the income of a household which may affect time allocation negatively because women time allocation may reduced due to increased purchasing power for goods and services from market. SAT is the social activities time for women (in hours) in which they can interact with their friend, relatives and neighbors in daily life. Expected sign of its coefficient is positive. In the light of above discussion, the following econometric specification can be given:

$$TWT = \alpha_0 + \alpha_1 RRWH + \alpha_2 \text{Re}\,gion + \alpha_3 Ages + \alpha_4 HHInc + \alpha_5 SAT + \alpha_6 Edu + \alpha_7 DWS + \varepsilon \text{..... .....(1)}$$

In order to estimate the above equation Ordinary Least Square methodology was used.

3. METHODOLOGICAL ISSUES

3.1 Description of the Study Area

This subsection provides the detailed description of study area where RRWH project has been initiated by Earthquake Reconstruction and Rehabilitation Authority (ERRA) with Maqsood Welfare Foundation (MWF) and Save the Children as its implementing partners. ERRA was established by the Government of Pakistan on October 24, 2005 to take up the task of rebuilding in the earthquake affected regions of Khyber Pakhtunkhwa and AJK. Maqsood Welfare Foundation (MWF) is local NGO of Bagh, AJK which implemented the project of

RRWH in Bagh. Save the Children is an international NGO operating in different areas of Pakistan was involved in the implementation of RRWH project in Battagram.

Battagram is a district of Hazara division of the Khyber-Pakhtunkhwa province in Pakistan. It has a total land area of 1301 square kilometers and the estimated population of Battagram district in 2004-2005 was 361,000 (Battagram 2007). It is 90 km away from Abbottabad and 240 km from the capital Islamabad. The 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 (Battagram 2007). Before Battagram obtained the status of district, it was a Tehsil of the Mansehra district.

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. 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 was ruled by Khans (tribal rulers) until 1949, when it signed the Instrument of Accession with Pakistan (Battagram 2007). The 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. Poilet project of RRWH system was implemented in Saroona which is one village of union council of Allai. The total no of households of Saroona village are 330 (Battagram 2007). The total population of the village is 5000, whereas the average household size is 8. In pilot phase the facility of RRWH was provided to 45 households.

Bagh is one of the eight districts of Azad Jammu and Kashmir, Pakistan. The total area of the district is 1,368 square kilometers (Bagh 2007). 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.

Specifically, survey of this study has been carried out from, 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 Bagh city at an altitude of 7000 feet above from sea level and on a distance of 18 KM. 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.

3.2 Survey Methodology

For a comprehensive and in-depth analysis, the study collected primary data through surveys for selected study areas. The data was collected through personal interviews of respondents in the selected villages of both districts (Bagh and Battagram). For this purpose, pre-tested questionnaire was followed to construct a sound and well-developed questionnaire.

Sampling is the process of selecting units (e.g. individuals, households, and organizations) from a population of interest. Based on the sample, the results are fairly generalized for the population from where the respective sample is drawn. Population of the present study comprises of two groups; the one provided with RRWH systems is called the "treated group", while the other using the traditional water supply sources within the same

localities is entitled the “control group”. The purpose behind this sampling pattern is to carry out comparative analysis of RRWH system. The present analysis has been carried out in two villages; one is Chitra Topi village from district Bagh which has comparatively less population of 175 households, whereas the second village is Saroona from district Battagram with a population of 375 households.

In order to conduct the analysis, the study has taken the entire population of treated group. This had been possible due to less number of households 45 in each village. Sample from control group of population is picked for analysis using Random Sampling methodology. The methodology is selected for the reason that all samples of the same size have an equal chance of being selected from the population. Secondly the population in control group was homogenous with respect to water supply. Lastly, the approach is suitable provided the resource limitation, location and facilitation. The optimum sample is the one which maximizes precision per unit cost, and by this criterion, Random Sampling is often superior over other methods.

4. RESULTS AND DISCUSSIONS

4.1 Descriptive Analysis

In descriptive analysis some of the important variables like Water Fetching Women Ages, Education, Social Activities Time, Sleeping Time, and Distance from Water Source, Per Day Time for Water Fetching, Persons Involved in Water Fetching, Daily Saved Time due to RRWH and its spending are included. In addition to overall sample results, statistics of the both regions are also presented separately (Table: 4.1 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: 4.1(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

Table: 4.1 a shows that average age of water fetching women is 33 years in the overall sample, as well as at village level. Moreover, 12 years as minimum and 65 years as maximum age were reported 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 it is difficult for old women to 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 resourcefully utilized 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, especially in decision making regarding 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: 4.1 a). Average education of women in Bagh is 7 years of schooling, whereas in Battgram almost all women have no 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 may be more vulnerable to water fetching hazards. Minimum distance reported in Bagh is 0.1 kilometer and maximum is 2 whereas, in Battagram it is 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, but among both villages, it is higher in Bagh and lesser in Battagram. Because culturally, women in Battagram 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: 4.1 a). This is the social capital of rural women which help them in easing out the stress and 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: 4.1 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, internet etc. where people can engage themselves for long after evening.

Table: 4.1 (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 Battagram was 4 and 6 hours, respectively. The average water fetching time in Battagram was higher by 2 hours, which was due to the higher average distance of water source from dwelling unit (Table: 4.1 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 reveals that on average each household had 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: 4.1 b). Maximum number of water fetching individual was 4 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 which become possible after getting installed the RRWH System. Findings of the study yielded that in both villages women save on average 6 hours of daily water fetching time due to this facility (Table: 4.1 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.

These activities includes, entertainment and social activities, agriculture and livestock, domestic work, education and awareness etc. (Table: 4.1 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 or offer help within their networks. Contrary to Bagh, women in Battagram are not spending their saved time in social activities and 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 out of their homes, 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: 4.1 (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 exposed that women are utilizing almost 25 percent of their time saving in agriculture and livestock in both regions (Table: 4.1 c). It means that agriculture and livestock is getting almost equal attention of women 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

no time allocation for social activities which is being used in domestic work. Moreover, they have less education and mobility out of their houses, which compel them to use saved time in domestic work. 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.

4.2 Econometric Analysis

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 4 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 variable is used as proxy for 'RRWH' where '1' stands for treated group and '0' for the control group. It is the key or focused variable of the study and 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. 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 is resourceful and it enhances the wellbeing of communities which are using RRWH technology.

Region 'REGION' is also a dummy variable, included in analysis to investigate the regional difference of time allocation. The construction of this dummy is such that '1' represents Bagh and '0' symbolizes Battagram. The variable 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. Additionally women access to health, education, nearest market and transportation service is comparatively better in Bagh as of Battagram. Moreover, regional income disparity is also found by the study, which is due to different levels of on and off farm available job opportunities and role of agriculture and livestock across the regions.

(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
$\mathbf{R^2}$	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 is that on average women age was 33 years and data has reported less variation in women ages. Secondly, women who were young and comparatively less vulnerable to disease could manage their domestic work easily. So women age has no affect on total work time.

Household Income 'HHINC' is very important variable engulfed in model. 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 social activities time cannot exactly isolated from their work time and is 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. CONCLUSION AND POLICY IMPLICATIONS

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.

Mainly there are two 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 time allocation. Findings exposed that technology has reduced the time allocation for fetching water. Findings endorsed that this system is very viable, profitable, women friendly, and sustainable source of water supply. 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 reduces the time and 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. 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.

4. 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.

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APPENDIX

Table I: 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).