CHAPTER-III

METHODOLOGY
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This chapter briefly outlines the background data of the study area, the nature and sources of data, sampling techniques adopted, statistical tools employed and terms and concepts used in the present study. The present study was conducted in Bangalore Urban and Bangalore Rural Districts of Karnataka State, India. The study focuses on the impact of Rainwater harvesting programmes implemented by the Government of Karnataka.

3.1 Profile of the Study Area

Karnataka, a land of Royal Grandeur and Oriental Glory is the eighth largest state in India both in area and population. It was formerly known as Mysore but on 1st November 1973 the name was changed to Karnataka. Karnataka State situated on a tableland where the Western and Eastern Ghats ranges converge into the Nilgiri hill complex, the State of Karnataka is confined roughly within 11.5 degree North and 18.5 degree North latitudes and 74 degree East and 78.5 degree East longitude. The State is bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamilnadu States in the South and by the State of Andhra Pradesh in the East. The State extends to about 750 km from North to South and about 400 kilo meters from East to West, and covers an area of about 1,91,791 square kilo meters.

Bangalore Urban is a district of the Indian state of Karnataka. It was formed in 1986, when Bangalore was divided into Bangalore Rural and Bangalore Urban districts. This is the most advanced district in Karnataka. Bangalore Urban
District has the distinction of having Karnataka State Capital Bangalore City, State Legislature and High Court in its jurisdiction. It is the nerve center of Karnataka State's Legislative, Judicial and Executive Administration. Bangalore Urban district consists of four Talukas (Sub-divisions), viz., Bangalore North, Bangalore South, Anekal and Bangalore East. The Bangalore Urban district has 17 hoblies (cluster of villages), 668 villages and 9 municipal corporations. The Net District Income of the Bangalore Urban district is US$ 47 billion, as of 2001.

The Bangalore Rural District lies to the South-East of Karnataka state. Bangalore Rural district comprises eight Taluks namely, Channapatna, Devanahalli, Doddaballapura, Nelamanagala, Hoskote, Kanakapura, Magadi, and Ramanagar. Bangalore Rural District has 2 divisions, 8 Talukas, 35 Hoblies, 1,713 inhabited and 177 uninhabited villages, 9 towns, and 229 Gram Panchayats. The district is endowed with agricultural and horticultural crops such as ragi, rice, groundnut, sugarcane, castor, grapes, mulberry etc. There are adequate infrastructural facilities such as transport and communications, banking, credit and marketing. Though the region is not rich in mineral resources, its non-metallic mineral resources are utilized for bricks, tiles and stoneware manufacture. For many years now, weaving has also been a major occupation for a large section of the population. The soil and such climatic conditions are congenial for the cultivation of mulberry, rearing of silkworms and production of silk besides other agro-based industries. There is a proposal by the Government of Karnataka to rename Bangalore Rural district to Kempe Gowda, in September 2007, the taluks of Ramanagaram, Magadi and Channapatna were merged to form the Ramanagaram district. The view of study districts in Karnataka map is shown in Figure 3.1.
Figure 3.1.
View of the Study Districts in Karnataka State Map

Map not to scale
3.1.1 Brief History

The Bangalore Rural and Urban Districts derive their name from its headquarters town, Bangalore. The earliest reference to the name is seen in a Ninth Century Ganga Inscription from Begur as ‘Benguluru’. ‘The present name Bangalore is the Anglicized form of Bengaluru. A popular story tries to suggest the origin of Bengaluru from ‘Bendakaluru’. Hoysala Ballala, during his long journey is stated to have been fed by old women with Benda kalu (Boiled beans). The prince named the place as ‘Bendakaluru’.

An inscription dating back to 890 A.D. shows Bangalore is over 1,000 years old. Historically, the earliest dynasty which established its way over this district is that of the Gangas. In about the fourth century A.D., the Gangas established themselves at Kolar and the territory comprised in Bangalore Rural district formed part of Gangavadi 96,000 and Honganur of Channapatna Taluka was the chief town of a sub-division, called Chikka Gangavadi, which occupied the Shimsha valley. During the Seventh century, Mankund was a place of great importance and was the second royal residence of Ganga Bhuvikrama (654-79) and also of Shivamara (679-726). In the eight century Shri Purusha made Manyapura (Manne of Nelamanagala Taluka) his royal residence and later it was a major center under the Rashtrakutas. Manne or Mannekadakam of Tamil records had been the headquarters of Rashtrakutas Governor Kambarasa. Certain parts of the district, especially in the East, were held by the Nolamb Pallavas.

Modern Bangalore was founded by Kempe Gowda I (1510 - 1570) of the Vijayanagara Empire, who built a mud fort in 1537 and with the help of King Achutaraya built the little towns of Balepet, Cottonpet and Chickpet all inside the fort. A hundred years later the Vijayanagara Empire fell and in 1638, Mohammed Adil
Shah the Sultan of Bijapur conquered it and ruled for next 50 years. In 1687 Aurangzeb’s army captured the city and sold it to the Wodeyars for a paltry sum of 3 lakhs. Three years later, in 1759 Hyder Ali received Bangalore as a *jagir* from Krishna Raja Wodeyar II. When Tipu Sultan died in the 4th Mysore war in 1799, the British gave the kingdom including Bangalore back to Krishna Raja Wodeyar III. The British Resident stayed in Bangalore and in 1831, alleging misrule by Krishna raja Wodeyar III the British took over the administration of the Mysore Kingdom.

Under the British influence, Bangalore bloomed with modern facilities like the railways, telegraphs, postal and police departments. The first ‘Train’ chugs out of the city in 1859 and five years later, in 1864 the lovely Cubbon Park is built by Sankey. The end of the century saw the building of Attara Kacheri and the Bangalore Palace. In 1881, the British returned the city to the Wodeyars. Diwans like Mirza Ismail and Sir M.Vishweshwaraya were the pioneers to help Bangalore attain its modern outlook. With the direct rule of the British Commissioners based in Bangalore, it became the State Administrative Headquarter.

After Indian independence in August 1947, Bangalore remained in the new Mysore State of which the Maharaja of Mysore was the Rajpramukh. But later, on November 1, 1973, the integrated state was renamed as Karnataka. At present Bangalore is capital of Karnataka State. Bangalore is India's fifth largest and the fastest growing city in Asia.

3.1.2 Location and Topography

Bangalore rural and urban districts are situated in the heart of the South-Deccan plateau in peninsular India to the South-Eastern corner of Karnataka State between the latitudinal parallels of 12° 39' N & 13° 18' N and longitudinal meridians of 77° 22' E & 77° 52'E at an average elevation of about 900 meters. The
Bangalore North taluk is more or less a level plateau and lies between 839 to 962 meters above mean sea level. In the middle of the taluk there is a prominent ridge running NNE-SSW. The highest point (Doddabetta Halli 962m) is on this ridge. The gentle slopes and valleys on either side of this ridge hold better prospects of ground water utilization. The low-lying area is marked by a series of tanks varying in size from a small pond to those of considerable extent, but all very shallow. Bangalore South Taluk represents an uneven landscape with intermingling of hills and valleys with bare rocky outcrops of granites & gneisses raising 30-70 meters above ground level are common in the southern portion. The highest point is 908m above mean sea level and the lowest at 720 meters above the mean sea level. Southern and Western portions present a rugged topography composed of Granitic and Gneissic masses. The eastern portions of the Taluk form an almost featureless plain with minor undulations. Bangalore (U & R) District borders with Kolar District in the northeast, Tumkur District in the northwest, Mandya District in the southwest, Chamarajangar District in the south and the neighboring state of Tamil Nadu in the southeast.

3.1.3 Climate

Bangalore (U & R) district is classed as the seasonally dry tropical savanna climate with four seasons. The dry season with clear bright weather is from December to February, with summer from March to May, followed by the southwest monsoon season from June to September, October and November constitute the post-monsoon or retreating monsoon season. The main features of the climate of district are the agreeable range of temperatures, from the highest maximum of 33°C in April to the lowest minimum of 14 °C in January. The two rainy seasons, June to September and October to November, come one after the other but with opposite wind regimes, corresponding to the southwest and northeast monsoons.
The climate of the district is Dry tropical savanna with four seasons.

1) Dry : Characterized with bright weather from Dec to Feb.
2) Summer : Characterized by high temperatures, from March – May.
3) Monsoon : South-West monsoon(S-W), Jun – Sept.
4) Post-monsoon : North-West monsoon (N-E), October – November.

The district records high temperatures during April with daily mean temperatures of 33.4 (°C and mean daily minimum in the month of December) at 25.7 (°C, as the coolest month). The mean monthly relative humidity is the lowest during the month of March at 44% and records highest between the months of June and October at 80 to 85%. The surface winds in district have seasonal character with the Easterly components predominating during one period followed by the Westerly in the other. The high wind speed averages 17 kmph during the westerly winds in the month of July and a minimum of 8-9 kmph during the months of April and October.

3.1.4 Rainfall

Rainfall data of the study areas are presented in the Table 3.1. As per the table the annual average rainfall of the Bangalore Urban District is 936 millimeter and Bangalore Rural District is 879. June to September being rainy season receives 54 per cent of the total annual rainfall in the South –West monsoon period. Most of the rainfall occurs during late afternoon/evening or night and rain before noon is infrequent. The monthly rainfall distribution of study districts is shown in Figure 3.2.
Table 3.1
Average Annual Rainfall Data of Study Districts and Talukas

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<tr>
<th>Sl.No</th>
<th>Name of Districts/Talukas</th>
<th>Rainfall (in milli meters)</th>
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<td>Bangalore North Taluka</td>
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<td>3</td>
<td>Bangalore South Taluka</td>
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<td>4</td>
<td>Bangalore East Taluka</td>
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<tr>
<td>II</td>
<td>Bangalore Rural District</td>
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<td>1</td>
<td>Channapatna Taluka</td>
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</tr>
<tr>
<td>2</td>
<td>Devanahalli Taluka</td>
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</tr>
<tr>
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<td>Doddaballapura Taluka</td>
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<td>4</td>
<td>Hoskote Taluka</td>
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</tr>
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<td>5</td>
<td>Kanakapura Taluka</td>
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</tr>
<tr>
<td>6</td>
<td>Magadi Taluka</td>
<td>875</td>
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<td>7</td>
<td>Nelamanagala Taluka</td>
<td>911</td>
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<td>8</td>
<td>Ramanagar Taluka</td>
<td>982</td>
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</table>

Figure 3.2
Monthly Rainfall (in mm) Distribution of Bangalore Urban and Rural Districts

MONTHLY RAINFALL DISTRIBUTION
■ Bangalore Rural   ■ Bangalore Urban

3.1.5 Geographic and Demographic Features

The geographical area of the Bangalore Rural District is 5824 square kilometers. The area of the district is 3.02 per cent of the total area of the state and occupies 16th place in the State. According to the 2001 Census, the total population of the district was 1,881,514 of which 21.65% were urban with a population density of 309 persons per square kilometers. Bangalore Rural district has 22.5% of its population belonging to the Scheduled Caste and Scheduled Tribe. The district literacy rate 64.70 per cent is lesser than literacy rate of Karnataka (66.40 per cent). Hinduism is the major religion of this district. The geographical area of the Bangalore Urban District is 2190 square kilometers. Bangalore Urban district had a population of 6,537,124 of which 88.11% is urban as of 2001 and district literacy rate 82.96 per cent is higher than literacy rate of Karnataka (66.40 per cent) and Bangalore Rural District. The general background data of study districts and talukas (2003-04) are summarized in Table 3.2.

3.1.6 Water Resources

The Bangalore district supports about 461 tanks serving the irrigation needs to various capacities. Most of these tanks are seasonal and carry water for six months during a year. (Bangalore: north - 98 tanks, south - 166 tanks, Anekal - 197 tanks). Bangalore North supports about 98 tanks irrigating about 2,102 hectares of land. These are mostly seasonal and carry water for about six months in a year. The biggest tank in the Taluka is Hesaraghatta with a catchment area of 490 square kilometers. The total surface water potential created in the Taluka is about 2,330 hectares. Bangalore South Taluka has about 166 tanks irrigating about 4,450 ha of land. The major tanks include those of Bellandur and Varthur with a catchment area
of 3.5 and 1.8 square kilometers respectively. The Taluka includes parts of Chamarajaendra reservoir and Hoskote tanks with the total surface water potential created are about 5,610 hectares. The total surface water potential created by these tanks is about 12,541 hectares accounting to about 54 percent of the total water resources of the district.

3.1.6.1 Rivers

Bangalore has no major rivers flowing in the district. The Arkavathi River flows in the district for a small distance in Bangalore North Taluka and the Dakshina Pinakini touches the borders of the district to the Northeast of the Anekal Taluka. The Vrishabhavati, a tributary of Arkavathi that takes its birth in the Bangalore City at Basavanagudi, flows in the district before joining the Arkavathi near Muduvadidurga and the Suvarnamukhi from Anekal Taluka joins the tributary before joining the Arkavathi.

3.1.6.2 Ground Water

Ground water in the district occurs under water table conditions in the weathered mantle of the granites gneisses and in the joints, crevices and cracks of the basement rock. Ground water is developed largely by means of open wells and bore wells. Open wells as well as bore wells can both yield between 70 to 90 meters of water per day.

3.1.6.3 Water Supply

As shown in Table 3.2, the average liters of water supply per capita per day (LPCD) in Bangalore Urban district is 58 liters and in Bangalore Rural District is 143 liters.
Table 3.2
The General Background of the Study Districts and Talukas (2003-04)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Particulars</th>
<th>Bangalore District</th>
<th>Banasura Taluka</th>
<th>Bugaude Taluka</th>
<th>Bylakuppe Taluka</th>
<th>Chamarajanagar Taluka</th>
<th>Davanagere Taluka</th>
<th>Devarabetta Taluka</th>
<th>Hessaragutta Taluka</th>
<th>Hemmakupp Taluka</th>
<th>Hegur Taluka</th>
<th>Hunsur Taluka</th>
<th>Kanakapura Taluka</th>
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<th>Ramanagaram Taluka</th>
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<td>1499</td>
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</tr>
<tr>
<td>21</td>
<td>No of Bore Wells (Not in Use)</td>
<td>72185</td>
<td>897</td>
<td>313</td>
<td>98</td>
<td>206</td>
<td>280</td>
<td>1755</td>
<td>186</td>
<td>101</td>
<td>274</td>
<td>322</td>
<td>291</td>
<td>276</td>
<td>162</td>
</tr>
<tr>
<td>22</td>
<td>No of Mini Water Supply Schemes (In Use)</td>
<td>66700</td>
<td>993</td>
<td>271</td>
<td>294</td>
<td>293</td>
<td>135</td>
<td>1796</td>
<td>204</td>
<td>109</td>
<td>248</td>
<td>227</td>
<td>442</td>
<td>246</td>
<td>156</td>
</tr>
<tr>
<td>23</td>
<td>No of Piped Water Supply Schemes (In Use)</td>
<td>56150</td>
<td>440</td>
<td>96</td>
<td>147</td>
<td>105</td>
<td>92</td>
<td>765</td>
<td>125</td>
<td>46</td>
<td>80</td>
<td>104</td>
<td>120</td>
<td>116</td>
<td>48</td>
</tr>
<tr>
<td>24</td>
<td>No of Piped Water Supply Schemes (Not in Use)</td>
<td>347820</td>
<td>19</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>260853</td>
<td>22</td>
<td>1</td>
<td>75</td>
<td>18</td>
<td>177</td>
<td>181</td>
</tr>
<tr>
<td>25</td>
<td>No of Public Taps</td>
<td>243259</td>
<td>12249</td>
<td>3264</td>
<td>3658</td>
<td>3632</td>
<td>1695</td>
<td>13586</td>
<td>2043</td>
<td>1223</td>
<td>1397</td>
<td>1176</td>
<td>2812</td>
<td>1390</td>
<td>1451</td>
</tr>
<tr>
<td>26</td>
<td>No of Household Taps</td>
<td>852818</td>
<td>17294</td>
<td>3165</td>
<td>5052</td>
<td>4421</td>
<td>4656</td>
<td>37439</td>
<td>6782</td>
<td>1472</td>
<td>3977</td>
<td>7226</td>
<td>7220</td>
<td>3336</td>
<td>2433</td>
</tr>
<tr>
<td>27</td>
<td>Watershed Area in Hectres</td>
<td>1783360</td>
<td>4446</td>
<td>1240</td>
<td>1759</td>
<td>808</td>
<td>640</td>
<td>18409</td>
<td>7465</td>
<td>2159</td>
<td>1019</td>
<td>878</td>
<td>2074</td>
<td>504</td>
<td>3345</td>
</tr>
</tbody>
</table>

3.2 Sampling Design

The focus of the study was confined to the economic evaluation of Rainwater Harvesting (RWH) programmes and their impact on labour productivity, employment, income, etc. of the households in Bangalore Rural and Bangalore Urban Districts of Karnataka State, where the Rainwater Harvesting project is implemented by the Rural Development and Panchyath Raj (RDPR) Department, Government of Karnataka. Bangalore Urban and Rural Districts are purposively selected for the following reasons.

- Availability of accurate and needful data.
- High rainfall area.
- It covers 12 RWH project villages from 12 talukas, which provide good sample size.
- Studies conducted on RWH programmes have not focused on economic implication of the programmes on the people.

The Rainwater Harvesting project is implemented in all the 176 Talukas (sub-divisions) of 27 Districts of the Karnataka State. This project covers one village in each Taluka of the State, with at least 20 household level Rooftop rainwater harvesting systems, Rajiv Gandhi Navagrama housing colonies (habitations) that are allocated to poor families are selected for the implementation of project. Details of Rooftop rainwater Harvesting project are shown in APPENDIX-I. For the present study 12 housing colonies of 12 villages from 12 Talukas of Bangalore Urban and Bangalore Rural Districts were selected, which covers total 240 Rooftop rainwater Harvesting systems implemented by Government of Karnataka. The list of study villages and talukas is given in the Table 3.3. The location of study talukas and villages in Bangalore Rural District and Bangalore Urban District are presented in
Figures 3.3 and 3.4. Out of 240 beneficiaries’ households, 216 households are randomly selected for the present study which is equivalent to 90 per cent of total beneficiaries’ households in the study areas. Each Rooftop rainwater harvesting system has received the grant of Rs 5000/- by government. Hence, the total investment by government for Rooftop rainwater Harvesting project in the study areas is Rs 12,00,000/-.

Table 3.3

The List of study Villages and Talukas

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>District</th>
<th>Talukas</th>
<th>Villages (Housing colonies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bangalore(Urban)</td>
<td>Anekal</td>
<td>Neraga</td>
</tr>
<tr>
<td>2</td>
<td>Bangalore(Urban)</td>
<td>Bangalore North</td>
<td>Kenchanahally</td>
</tr>
<tr>
<td>3</td>
<td>Bangalore(Urban)</td>
<td>Bangalore South</td>
<td>B.M.Kaval</td>
</tr>
<tr>
<td>4</td>
<td>Bangalore(Urban)</td>
<td>Bangalore East</td>
<td>A. Krishanappanagara</td>
</tr>
<tr>
<td>5</td>
<td>Bangalore(Rural)</td>
<td>Channapatna</td>
<td>Gendekattedoddi</td>
</tr>
<tr>
<td>6</td>
<td>Bangalore(Rural)</td>
<td>Devanahalli</td>
<td>Halekurubarakunte</td>
</tr>
<tr>
<td>7</td>
<td>Bangalore(Rural)</td>
<td>Doddaballapura</td>
<td>Karanala</td>
</tr>
<tr>
<td>8</td>
<td>Bangalore(Rural)</td>
<td>Hoskote</td>
<td>Injanalli</td>
</tr>
<tr>
<td>9</td>
<td>Bangalore(Rural)</td>
<td>Kanakapura</td>
<td>Maralabekuppe</td>
</tr>
<tr>
<td>10</td>
<td>Bangalore(Rural)</td>
<td>Magadi</td>
<td>Kuduru</td>
</tr>
<tr>
<td>11</td>
<td>Bangalore(Rural)</td>
<td>Nelamanagala</td>
<td>Shivagange</td>
</tr>
<tr>
<td>12</td>
<td>Bangalore(Rural)</td>
<td>Ramanagar</td>
<td>Kumbhapura</td>
</tr>
</tbody>
</table>

Figure 3.3

Study Talukas and Villages in Bangalore Rural District
Figure 3.4

Study Talukas and Villages in Bangalore Urban District

BANGALORE URBAN DISTRICT

Kenchennahalli
BANGALORE NORTH
A.Krishnanappanagaram
B.M.Kaval
BANGALORE SOUTH
Anekal
Neraga

TALUKAS

VILLAGES

Map not to scale
3.3 Nature and Sources of Data

The case study method of research was employed for the present study. This study utilized qualitative and quantitative methods for collecting required data. The required data for the study included both primary and secondary data.

3.3.1 Primary Data

The primary data on household composition, socio-economic aspects, management, impacts and benefits of Rooftop rainwater Harvesting structure were collected from the selected 216 sample beneficiaries using well-structured and pre-tested interview schedules. The contents of schedule are shown in ANNEXURE- I. The schedule was administered either to the head of the household or any other responsible member of the family. The survey is conducted during 2005-2006.

3.3.2 Secondary Data

Secondary data relevant to the present study were obtained from the following officials sources.

- Rural Development and Panchyath Raj Department, Government of Karnataka, Bangalore.
- Rajeev Gandhi Rural Housing Corporation, Bangalore.
- Urban and Rural Nirmiti Kendras (Rain Centers) offices at Bangalore.
- Karnataka State Council for Science and Technology (KSCST), Bangalore.
- Census Publications.
3.4 Analytical Techniques Employed

Different analytical techniques were employed to analyze the data, interpret the results, to draw inferences and to design policy options for adoption by households, researchers and government. The data were subjected to quantitative analysis through following appropriate techniques.

3.4.1 Conventional Analysis

For the analysis of socio-economic features of sample households tabular presentation technique was employed including percentages, averages, ratio, pie charts and bar diagrams wherever suitable.

3.4.2 Financial Feasibility Analysis

The Financial feasibility analysis is a systematic way to compare the streams of benefits and costs. The cost and benefits can be evaluated to find out the economic efficiency of the project. In the present study the Cost Benefit analysis of Domestic Rooftop rainwater Harvesting (DRWH) structure was studied to determine whether the technology was economically viable or not by using four measures viz., Net Present Worth (NPW), Benefit Cost Ratio (BCR), Pay Back Period (PBP) and Internal Rate of Returns (IRR) based on the following assumptions;

❖ The benefits of DRWH were taken based on the saved time of water fetching and productive utilization of rainwater.

❖ The construction cost per DRWH structure Rs 5000/- was considered as an initial investment.

❖ It was assumed that, an average Rs 100/- would have been spent every year for the maintenance of the DRWH structure.

❖ Cash inflows were discounted at 10 per cent as this rate represents prevailing bank rate on working capital.
The project period was considered for 15 years, accordingly discounted cash inflows were worked out and analyzed with the four-foresaid parameters.

3.4.2.1 Net Present Worth (NPW)

Net Present Worth (NPW), also known as the present value, is based on the desire to determine the present value of net benefits from the DRWH systems. For a project to be economically viable the NPW should be positive and as high as possible. The formula used for the calculation of NWP is:

\[
NPW = \sum_{i=1}^{n} \frac{Y_i}{(1+r)^i} - I
\]

Where,

\( Y_i = \) Net cash inflow obtained by the sample households due to the DRWH in \( i^{th} \) year \( (i = 1, 2, \ldots n) \).

\( r = \) Discount rate.

\( i = \) Number of year.

\( n = \) life period of the DRWH structure.

\( I = \) Initial investment on the DRWH structure.
3.4.2.2 Benefit Cost Ratio (BCR)

The Benefit Cost Ratio of the DRWH technology was analyzed to compare the present value of benefits to the present value of costs to determine whether the DRWH project is economically a viable proposition or not. The Benefit Cost Ratio (BCR) was worked out by using the following formula.

\[
BC Ratio = \frac{\text{Discounted Returns}}{\text{Initial investment}}
\]

If the benefit cost ratio of the DRWH technology appears greater than unity, then the adoption and implementation of the DRWH structure would be economically sound. The ratio expressed in the following form:

\[
BC Ratio = \sum_{i=1}^{n} Y_i \ (1+r)^{-i} / I
\]

Where,

\( Y_i = \) Net cash inflow obtained by the sample households due to the DRWH in \( i^{th} \) year (\( i = 1, 2, \ldots n \)).

\( r = \) Discount rate.
i = Number of year.

n = life period of the DRWH structure.

I = Initial investment on the DRWH structure.

3.4.2.3 Pay Back Period (PBP)

The pay back period is the time required to recover invested money in the project. The pay back period was estimated by summing up all the discounted net benefits over years to make up the initial investment incurred for establishment.

The pay back period is worked out as below

\[ P = \frac{I}{Y} \]

Where,

P= Pay Back Period in pre-defined time units.

I= Capital investment on the project in rupees.

Y=Net income.
3.4.2.4 Internal Rate of Returns (IRR)

The rate at which the net present value of project is equal to zero is nothing but the Internal Rate of Return (IRR). The net cash inflows were discounted to determine the present worth following the interpolation technique as under

\[ IRR = \text{Lower discount rate} + \text{Difference between the two discount rates} \]

\[ \text{Net present worth of the cash flows at lower discount rate} \]

\[ \text{Absolute difference between present worth (cash flow) streams at the two discount rates.} \]

The Internal Rate of Return (IRR) is the capacity of investment recovery for a project. If the calculated IRR appears greater than reference rate, then the adoption of DRWH technology in the sample households is economically attractive. If the calculated Internal Rate of Return (IRR) is lesser than reference rate, then the adoption of DRWH technology in the sample households is economically not viable.
3.5 Terms and concepts used in the study

- **Rain water Harvesting (RWH)**
  Refers to direct collection of rainwater. The collected rainwater can be stored for direct use or can be recharged into the groundwater.

- **Domestic Rooftop rainwater harvesting (DRWH)**
  Refers to collection of rainwater from rooftop for domestic purposes.

- **Man day**
  Refers to eight hours work turned out by an adult male in a day.

- **Opportunity Cost**
  The sacrifice of some good or service made because of a decision to acquire some other good or service.

- **Runoff**
  Refers to the term applied to the water that flows away from a surface after falling on the surface in the form of rain.

- **Runoff Co-efficient**
  Refers to the ratio of the volume of water which runs off a surface to the volume of rainfall which falls on the surface and it takes into account losses due to spillage, leakage, infiltration, catchment wetting, evaporation and overflow.

- **Catchment Area**
  Refers to surface upon which rain falls.