ECONOMICS OF RAIN WATER HARVESTING IN KERALA WITH SPECIAL REFERENCE TO PALAKKAD DISTRICT

MINOR RESEARCH PROJECT

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Submitted by

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CHAPTER 1

Introduction

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1.1 INTRODUCTION

Rain water harvesting has regained its importance as a valuable alternative or supplementary water resource, along with more conventional water supply technologies. Water shortages can be relieved if rainwater harvesting is practiced more widely. People collect and store rainwater in buckets, tanks, ponds and wells. This is commonly referred to as rainwater and has been practiced for centuries. Rainwater can be used for multiple purposes ranging from irrigating crops to washing, cooking and drinking.

Rainwater harvesting is a simple low-cost technique that requires minimum specific expertise or knowledge and offers many benefits. Rainwater harvesting is one of the alternative technology for delivering drinking water. In fact, through the ages, this has been a traditional way of enhancing domestic water supply. Rainwater harvesting systems are viable options both for storing water for domestic use and for recharging groundwater aquifers; Nature has endowed India with huge water resources. We have perennial rivers like GANGA, Brahmaputra, Yamuna, Beas and other along with their tributaries and distributaries besides in North and Eastern India, we have spring and rain fed rivers in central and peninsular India. The major rivers among these are Godavari, Krishna, Narmada, Tapti and KAVERI.

These huge potential water resources notwithstanding, are facing a water crisis across the country. Over the years, rising population, growing industrialization and expanding agriculture have pushed up the demand for water. Monsoon is still the main hope of our agriculture. Water conservation has become the need of the day. Rainwater harvesting is a way to capture the rainwater at the time of downpour, store that water above the ground or charge the underground water and use it later. This happens in open areas as well as in congested cities through the installation of required equipment. The collection and storage of rainwater from run-off areas such as roofs and other surfaces has been practiced since ancient times in India. It is particularly useful where water supply is inadequate.

Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply. It provides water when there is a drought, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable groundwater levels to be sustained. It also helps on the availability of potable water as rainwater is substantially free of salinity and other salts. Application of rainwater harvesting in urban water system provide a substantial benefit for both water supply and wastewater subsystems by reducing the need for clean water in water distribution system, less generated storm water in sewer system, as well as a reduction in storm water runoff polluting freshwater bodies.

There has been a large body of work focused on the development of Life Cycle Assessment and Life Cycle Costing methodologies to assess the level of environmental impacts and money that can be saved by implementing rainwater harvesting systems. More development and knowledge is required to understand the benefits rainwater harvesting can provide to agriculture. Many countries especially those with an arid environment use rainwater harvesting as a cheap and reliable source of clean water. To enhance irrigation in arid environments, ridges of soil are constructed in order to trap and prevent rainwater from running down hills and slopes. Even in periods of low rainfall, enough water is collected in order for crops to grow. Water can be collected from roofs, dams, and ponds can be constructed in order to hold large quantities of rainwater so that even on days where there is little to no rainfall, there is enough available to irrigate crops.

Rainwater harvesting systems can range in complexity, from systems that can be installed with minimal skills, to automated systems that require advanced setup and installation. The basic Rainwater harvesting system is more of a plumbing job than a technical job as all the outlets from the building terrace are connected through a pipe to an underground tank that stores water.

Systems are ideally sized to meet the water demand throughout the dry season since it must be big enough to support daily water consumption. Specifically, the rainfall capturing area such as a building roof must be large enough to maintain adequate flow. The water storage tank size should be large enough to contain the captured water. For low-tech systems, there are many low-tech methods used to capture rainwater: rooftop systems, surface water capture, and pumping the rainwater that has already soaked into the ground or captured in reservoirs and storing it into tanks (cisterns).

1.2 STATEMENT OF THE PROBLEM

Rain water Harvesting System provides the protection of water. It has reduced the spoilage and wastage etc. Now a days, it performs a variety of other functions include the direct collection of rainwater that can be stored in surface or underground water tank, through wells and ponds etc. Palakkad District is a very drought – prone area. Very few studies has been conducted to examine the performance of rainwater harvesting. So, present study makes an attempt to examine the economics of rain water harvesting. The collection and storage of rainwater from run-off areas such as roofs and other surfaces has been practiced since ancient times in India. It is particularly useful where water supply is inadequate.

1.3 IMPORTANCE

Rainwater Harvesting refers to the process where rainwater is gradually gathered and accumulated, so that it can be used for agricultural, commercial or domestic purposes. The importance of developing rainwater harvesting system is briefly given below in points:

- The ever-increasing demand for water can be satisfied.
- The quantity of the subterranean water can be increased.

- Wastage of water flowing through drain, gutter, or any water-cause can be stopped.
- Water-logging on roads and thoroughfares can be checked and localities can be saved from being inundated.
- The quantity of water can be raised and soil erosion can be check.

1.4 OBJECTIVES

1. To examine the extent of water stress and the significance of roof top rainwater harvesting in recharging the background water level.
2. To investigate impact of rain harvesting to eliminate the problem of water scarcity in Palakkad District.
3. To know the methods used in rainwater harvesting.
4. To understand the role of Government and Non- Government Organisations in rainwater harvesting.
5. To know the expenditure pattern of rainwater harvesting.

1.5 SCOPE OF THE STUDY

Palakkad is the land of Palmyrahs and Paddy fields. Palakkad is a major paddy growing areas of the state. It is often called as the "Gateway of Kerala". Palakkad is the largest district in Kerala having an area of 4480sq.km, which accounts for 11.21 percentage of the total area of the state. The district is situated in the south west coast of India.

The district is blessed with 6 important rivers. These rivers are having good facilities for irrigation. There is no backwater or lakes or navigable canals in the district. The district is experiencing severe droughts appearing year after year. It is an irony that a green verdant state like Kerala has an average per capita availability of potable water lesser than that of Rajasthan.

Among all 14 districts in Kerala, Palakkad is facing the worst droughts in every year. An assessment of surface water and ground water availability of the district by Central Ground Water Board, Govt. of India, in 2007, it is reported that the district receives on an average 2348mm of rainfall annually. In this district the water available both as surface water and ground water are not enough to meet the daily demand. Hence there should be an optimum level of extraction and conservation of water resource. The study tries to examine the composition of user groups in utilising the rainwater harvesting system. The study was conducted in Palakkad District. The aim of the study is to give an overview and to understand the concept of rainwater harvesting.

It is clear that artificial ground water recharge using rainwater is a basic concept for the sustainable management of vital fresh water resources. Consequently, the present study aims to develop a methodology to access the impact of Rainwater Harvesting by integrating various parameters to evaluate the design of implemented Rainwater Harvesting Structures.

1.6 METHODOLOGY OF THE STUDY

The Information relating to the study is collected through Primary and Secondary Sources. Primary data has been collected from individual households with the help of a structured interview schedule and through personal interview. The project was mainly focused on Palakkad region and 70 samples were collected. Out of 4 municipalities and 13 block panchayaths 1 municipality and 3 block panchayaths were taken for the study**.** Institution like Anganvadi, School, District Panchayat, Palakkad Municipality, Social Services and Hospitals were the main study areas. The Selected respondents have been contacted personally and information required for the study has been collected. To instil confidence and to ensure their corporation in getting information, the purpose of the study has been explained to the respondents and also they are ensured that the information would be kept confidential. Simple tools such as tables, graphs, percentage have been used for data analysis and interpretation.

Secondary data has been collected from sources like Economic Reviews, Economic Surveys and Statistics for Planning, Agricultural Journals, Department of Economics and Statistics and Previous Studies in the Field. Specifically, the rainfall capturing area such as a building roof must be large enough to maintain adequate flow. The water storage tank size should be large enough to contain the captured water.

1.7 LIMITATION

The main limitation of the project was lack of corporation of the respondents in revealing the details and the number of respondents were very less in Palakkad District. And they were also scattered.

1.8 CHAPTERISATION

The study is divided into six chapters:

1. The First Chapter includes Introduction, Statement of the problem, Importance, Objectives, Scope of the study, Limitations and Chapterisation.
2. The Second Chapter includes Background of the Study.
3. The Third Chapter traces out the concept of Rain Water Harvesting (Secondary Data).
4. The Fourth Chapter examines Primary Data Analysis.
5. The Fifth Chapter provides the Summary and Conclusions.

CHAPTER 2

BACKGROUND OF THE STUDY

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2.1 HISTORY OF RAINWATERHARVESTING

The capturing and storing of rainwater goes back thousands of years to when we first started to farm the land and needed to find new ways of irrigating crops. In hotter climes, catching that intermittent rainfall often meant the difference between life and death for communities. Whilst the need to conserve water fell away with greater urbanisation in the last thousand years, we are once again returning to this ancient and vital part of greener living.

2.2RAINWATER HARVESTING IN ANCIENT TIMES

Civilisations in the Indus Valley were far more advanced than we may think nowadays. In many of the ancient cities that still remain; we can still find huge vats that were cut into the rock to collect water when there was torrential rainfall. These were used to keep the population and local vegetation going in hotter, dryer times and were fed by numerous stone gullies that weaved their way through the city. Some of these rock vats are still used today in parts of India.

Another technique that has been used for hundreds of years in India is to build water harvesting systems on top of the roofs of houses. It’s a simple technology that has spread across the world, particularly to countries such as Brazil and China.

The technology of rainwater harvesting is deeply rooted in the social fabric of India with a variety of ancient methods still found today. These include:

- Talibs: Medium to large sized reservoirs that provide irrigation for plants as well as drinking.
- Johads: Dams that are used to capture and keep rainwater.
- Baoris: Wells dug into the ground that is often still used for drinking.
- Jhalaras: Specially constructed tanks that are used for the local community and religious purposes.

2.3THE ROMANS AND RAINWATER HARVESTING

During the time of the Roman Empire, rainwater collection became something of an art and science, with many new cities incorporating state of the art technology for the time. The Romans were masters at these new developments and great progress was made right up until the 6th Century AD and the rule of Emperor Caesar.

One of the most impressive rainwater harvesting constructions can be found in Istanbul in the Sunken Palace which was used to collect rainwater from the streets above. It's so large that you can sail around it in a boat.

2.4LATER RAINWATER HARVESTING

In the 17th Century the small island of Malta built an aqueduct to collect rainwater for its growing population. It was a popular way of getting water to the people but as new methods of building houses and supplying water improved with things like water pipes and reservoirs, the technology of rainwater harvesting stalled over the following centuries.

The other thing that stopped using collected rainwater for many towns and cities was also the prospect of spreading disease. The Sunken Palace in Istanbul stopped using the water for drinking many hundreds of years ago and the caches that Arab tribes kept across desert lands have mainly fallen into disuse. With increased urbanisation, the need for effective rainwater catchment hasn't been a major concern except in countries where the climate dictates it and water is in short supply.

2.5MODERN RAINWATER HARVESTING

Go into any garden store in the UK and you will no doubt be able to see various plastic butts that are designed to collect rainwater so that we can water our gardens and keep the plants in good health during any dry period. There's no doubt that climate change has got us thinking about water conservation again, especially with the supply companies beginning to put their prices up. The general consensus is that letting all that rainwater go to waste is no longer acceptable. It can be collected and that can help reduce water bills. In other words, is not only a good idea ecologically, it makes sense financially.

Recycled water can be used for a variety of daily tasks from washing clothes, flushing toilets and even cleaning the car. With the possibility that we could face more prolonged drier periods in the near future, the onus is on us all to conserve what we consume and make the most of what comes to us free of charge from the sky.

2.6RAINWATER HARVESTING ACROSS THE WORLD

While we may be some way behind in our rainwater recycling, the rest of the world has been embracing it more and more in recent years. The UK sustainable homes policy now argues that houses should have an underground tank that can be used to collect rainwater for various washing tasks. Most new builds in China and Brazil now incorporate rooftop rainwater harvesting technology whilst many countries are making it law to be greener when it comes to our most vital commodity.

In many states in the US, until recently, rainwater harvesting was actively discouraged but new legislation is beginning to come in to make it possible for individual houses to incorporate the technology to save water for their homes.

In Israel, they are beginning to install rainwater harvesting devices in schools as a way of teaching kids the value of water conservation and in South Africa research is well under way to find new ways of employing catchment technology.

The future of rainwater harvesting appears to be in fairly good shape and the great thing is that many modern systems can be installed with a minimum of effort.

2.7 THEORETICAL BACKGROUND

In India, it is an old practice in high rainfall areas to collect rainwater from roof tops into storage tanks. In foot-hills water flowing from springs is collected by embankment type water storage. In Himalayan foot-hills people use the hollow bamboos as pipelines to transport the water of natural springs.

Rajasthan is known for its “Tanks” (underground tanks) and “Chains” (Embankments) for harvesting rainwater. In our ancient times, we had adequate Taalaabs, Baawaris, Johars, Hauz etc. in every city, village and capital cities of our Kings and Lords which were used to collect rainwater and ensure adequate water supply in dry periods.

In arid and semi-arid regions artificial ground water recharging is done by constructing shallow percolation tanks. Check-dams made of any suitable| native material (brush, polls, rocks, plants, loose rocks, wire nets, stones, slabs, sacks etc.) are constructed for harvesting runoff from large catchments areas.

As compared to surface dams, ground water dams have several advantages like minimum evaporation loss, reduced chances of contamination etc. In roof top rainwater harvesting which is a low cost and effective technique for urban houses and buildings, the rainwater from the top of the roofs is diverted to some surface tank or pit through a delivery system which can be later used for several purposes. Also it can be used to recharge underground aquifers by diverting the stored water to some abandoned dug well or by using a hand pump.

All the above techniques of rainwater harvesting are low cost methods with little maintenance expenses. Rainwater harvesting helps in recharging the aquifers, improves ground water quality by dilution, improves soil moisture and reduces soil erosion by minimizing run-off water.

2.8 RAINWATER CAN BE MAINLY HARVESTED BY ANYONE OF THE FOLLOWING METHODS:

1. By storing in tanks or reservoirs above or below ground

2. By constructing pits, dug wells, lagoons, trench or check dams on small rivulets.

3. By recharging the ground water.

Before adopting a rainwater harvesting system, the soil characteristics, topography, rainfall pattern and climatic conditions should be understood.

2.9ADVANTAGES OF RAINWATER HARVESTING

1. Easy to Maintain: Utilizing the rainwater harvesting system provides certain advantages to the community. First of all, harvesting rainwater allows us to better utilize an energy resource. It is important to do so since drinking water is not easily renewable and it helps in reducing wastage. Systems for the collection of rainwater are based on simple technology.

The overall cost of their installation and operation is much lesser than that of water purifying or pumping systems. Maintenance requires little time and energy. The result is the collection of water that can be used in substantial ways even without purification.

2. Reducing Water Bills: Water collected in the rainwater harvesting system can be put to use for several non-drinking functions as well. For many families and small businesses, this leads to a large reduction in their utilities bill. On an industrial scale, harvesting rainwater can provide the needed amounts of water for many operations to take place smoothly without having to deplete the nearby water sources.

It also lessens the burden of soil erosion in a number of areas, allowing the land to thrive once again. In fact, it can also be stored in cisterns for use during times when water supplies are at an all time low.

3. Suitable for Irrigation: As such, there is little requirement for building new infrastructure for the rainwater harvesting system. Most rooftops act as a workable catchment area, which can be linked to the harvesting system. This also lessens the impact on the environment by reducing use of fuel based machines.

Rainwater is free from many chemicals found in ground water, making it suitable for irrigation and watering gardens. In fact, storing large reservoirs of harvested water is a great idea for areas where forest fires and bush fires are common during summer months.

4. Reduces Demand on Ground Water: With increase in population, the demand for water is also continuously increasing. The end result is that many residential colonies and industries are extracting ground water to fulfill their daily demands. This has led to depletion of ground water which has gone to significant low level in some areas where there is huge water scarcity.

5. Reduces Floods and Soil Erosion: During rainy season, rainwater is collected in large storage tanks which also help in reducing floods in some low lying areas. Apart from this, it also helps in reducing soil erosion and contamination of surface water with pesticides and fertilizers from rainwater run-off which results in cleaner lakes and ponds.

6. Can be Used for Several Non-drinking Purposes: Rainwater when collected can be used for several non-drinking functions including flushing toilets, washing clothes, watering the garden, washing cars etc. It is unnecessary to use pure drinking water if all we need to use it for some other purpose rather than drinking.

2.10 DISADVANTAGES OF RAINWATER HARVESTING

1. Unpredictable Rainfall: Rainfall is hard to predict and sometimes little or no rainfall can limit the supply of rainwater. It is not advisable to depend on rainwater alone for all your water needs in areas where there is limited rainfall. Rainwater harvesting is suitable in those areas that receive plenty of rainfall.

2. Initial High Cost: Depending on the system's size and technology level, a rainwater harvesting system may cost anywhere between $200 to $2000 and benefit from it cannot be derived until it is ready for use. Like solar panels, the cost can be recovered in 10-15 years which again depends on the amount of rainfall and sophistication of the system.

3. Regular Maintenance: Rainwater harvesting systems require regular maintenance as they may get prone to rodents, mosquitoes, algae growth, insects and lizards. They can become as breeding grounds for many animals if they are not properly maintained.

4. Certain Roof Types may Seep Chemicals or Animal Droppings: Certain types of roofs may seep chemicals, insects, dirt or animals droppings that can harm plants if it is used for watering the plants.

5. Storage Limits: The collection and storage facilities may also impose some kind of restrictions as to how much rainwater you can use. During the heavy downpour, the collection systems may not be able to hold all rainwater which ends in going to drains and rivers.

2.11SOME STUDIES ON RAIN WATER HARVESTING

- Bores and Asher (1980) stated that Rain Water Harvesting encompasses methods for inducing, collecting, storing and conserving runoff from various sources and for various purposes. These methods are applied depending on local condition.
- Bruins and Nessler (1986) stated that Rain Water Harvesting agriculture is a specialized from of rain fed farming that has a significant potential to increase food production in the arid-zones of environment. Runoff farming and Rain Water Harvesting are considered to be synonyms terms.
- Gould and Mc Pherson (1987) have described bacteriological analysis of water samples from 13 roofs tanks and 8 ground catchment tanks in Botswana. The results show that the rain water collected from corrugated iron roofs and stored in covered tanks is of high quality compared with traditional water sources. Water from roof catchment systems in Bottwana presents a serious health hazard.
- CritchelySiegert (1991) stated that Rain Water Harvesting is the collection of run off for productive purpose. Instead of runoff left to cause erosion, it can utilize and harvested arid -and semi-arid regions.
- Otieno (1994), Kenya has established from a study that the except or the initial rainfall the quality of rain water is quite high, comparing favourably with river waters. He has also tabulated comparison of rainwater from roof catchment with river water and WHO standards.
- Xijing (1995) from China have analyzed and assessed water quality of the catchment and storage rain water physicochemical testing result have been discussed. P, Cu, pb, se, zinc, k, nitrites, total alkalinity have higher values

in the rain water contained in concrete water cellars with cement or grey tile catchment surfaces.

- Rao (1996) has reviewed the importance of artificial recharge of rainfall water for the city water supply. Rainfall water from the roof tops of the building recharged through specially designed recharge pits in the city. This water meets the 80% water needs for domestic purpose.
- Ramaswamy & Anbazhagan (1997) aggregated the data of water level fluctuation, geology, geomorphology and sub-surface geology for identifying suitable sites for artificial recharge in Ayer sub-basin in Cauvery River in India.
- Finch (1998) used a simple water balance model to estimate the direct ground water recharge. The results of varying the Vegetation Canopy Parameter for forest addition to varying the soil moisture model were discussed.
- Mitraniketan (1999) stated that chemical parameters included pH, alkalinity, chloride, iron, nitrate, sulphate; total solids and hardness were there in the collected water from tanks. Bacterial examination was also done and the results revealed that the stored water had potable status.
- Amrita (2000) reviewed various methods of estimating natural ground recharge such as soil water balance method , Zero Flux Plane method, one – dimensional soil water flow method, inverse modelling technique, ground water level fluctuation method, hybrid water fluctuation method, ground water balance method and profile technique.
- Naidu (2001) in his study on Vanjuvankal watershed of AndraPradesh noticed that, because of water harvesting structures and percolation ponds the ground water level in watershed area showed a rise by 2 to 3 metres.

- Microbiological quality of collected rain water depends on several factors. These include the quality of roof materials and contamination of roof. The bacteriological quality of rain water from metallic roof is generally better than that from other types of roofs (Vasudevan and Ghanayem 2001).
- Khare (2004) has reviewed the impact assessment of Rain Water Harvesting on ground water quality at Indore and Dewas, India. The impact assessment of roof top is to improve the quality and the quantity of rain water. By using various methods, in order to filtrate the water.
- According to Kim (2005) Rain Water Harvesting may be one of the best methods available to recovering the natural hydrologic cycle and enabling urban development become sustainable. Rain water collection has the potential to impact many people in the world.
- Hattum (2006) stated that in order to improve water quality sedimentation should be prohibited from entering system; this is, accomplished through the use of filters and separators an inlet and outlet.
- According to Kinkade (2007) Rain Water has the ability to provide a community with many cost effective benefits such as eliminating the need for the municipal fluoridation and chlorination treatments and also exterminating the expensive need to lay distribution pipes, drilling wells, and pumping to greater attitudes.
- Han and Mun (2008) recognized that the quality of water released from rain water systems will not only determine the mode of water usage but also will affect the degree to which people accept this water source.
- Bingguo et al (2009) estimated ground water recharge in high quality of properly stored rainwater is seen. However, the factors which will determine whether a water source is used or not are more likely to be related

to taste, colour and odour than directly to quality as started in the paper. I n a roof top rain water harvesting is generally considered as a none polluted or at least not significantly polluted.

- P.K Sivanandan (2011) has reported feasibility of using roof rainwater catchment systems in West Bank Palestine as supplementary water sources.

CHAPTER 3

SECONDARY DATA ANALYSIS

CHAPTER 3

CONCEPT OF RAINW WATER HARVESTING

3.1 WORLD SCENARIO

The Water in the oceans and seas cannot be used as drinking water and little of it can be utilized for other purposes. As a result, there is a constant shortage of water that is either good for drinking or home and industrial use. Areas on the planet that have long faced water shortage were able to combat this problem by harvesting what little rain water they received. This slowly started spreading to areas where there was plenty of rainfall. As a result, the modern day rainwater harvesting system was bought into place.

The idea behind the process is simple. Rainwater is collected when it falls on the earth, stored and utilized at a later point. It can be purified to make it into drinking water, used for daily applications and even utilized in large scale industries. In short, Rainwater harvesting is a process or technique of collecting, filtering, storing and using rainwater for irrigation and for various other purposes. These are the some of the profile of the country which are using rainwater harvesting system.

The rainwater that is harvested is used for drinking and cooking and its acceptance as a safe, easy-to-use source of water is increasing amongst local users. Water quality testing has shown that water can be preserved for four to five months without bacterial contamination. The NGO Forum has also undertaken some recent initiatives in urban areas to promote rainwater harvesting as an alternative source of water for all household purposes.

Over the past decade, many NGOs and grassroots organisations have focused their work on the supply of drinking water using rainwater harvesting, and the Irrigation of small-scale agriculture using sub-surface impoundments. Most of these tanks are made of pre – cast concrete plates or wire mesh concrete.

Rainwater harvesting is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Rainwater can be collected from rivers or roofs, and in many places the water collected is redirected to a deep pit (well, shaft, or borehole), a reservoir with percolation, or collected from dew or fog with nets or other tools. Its uses include water for gardens, livestock, irrigation, domestic use with proper treatment, and indoor heating for houses etc. The harvested water can also be used as drinking water, longer-term storage and for other purposes such as groundwater recharge. Rainwater harvesting is one of the simplest and oldest methods of self-supply of water for households usually financed by the user.

Countries all across the globe are realizing the pronounced need to save water as the world faces a severe water crisis. Reasons for this are plenty, including the rapidly depleting sources of water available presently, the mounting global population, and the flourishing industrial sector, and infrequent rainfalls. Finding ways to effectively manage and conserve rainwater, as it is the only way of receiving natural water, has thus become imperative for the world. The scenario has led to an increased focus on the field of rainwater harvesting in the past few decades as it is one of the most effective methods of water conservation and management. Countries across the globe are ramping up efforts to effectively harvest rainwater to provide their populations and industries with sustainable supply of water. Rainwater harvesting involves many techniques of collecting and storing rainwater at surface or sub-surface formations, before the water is lost as surface run off. Rainwater harvesting and utilization is now an integrated part of educational programs for sustainable living in the semi-arid regions in Brazil. The rainwater utilization concept is also spreading to other parts of Brazil, especially urban areas. A further example of the growing interest in rainwater harvesting and utilization is the establishment of the Brazilian Rainwater Catchment Systems Association, which was founded in 1999 and held its 3rd Brazilian Rainwater Utilization Symposium in the falls of 2001.

3.2 INDIAN SCENARIO

India receives the highest rainfall among countries comparable to its size. Its landmass has gorgeous and perennial rivers criss-crossing it – particularly through the northern part. But the other side of the story is this: one part or another of India has continued to experience drought conditions with an alarming regularity. The rivers have been drying up and getting polluted. The underground water tables are shrinking rapidly.

If water management is not accorded the importance it deserves, the country can very much expect to find itself in troubled waters as the years roll by. Estimates of the Central Ground Water Board are that the reservoir of underground water will dry up entirely by 2025 in as many as fifteen States in India – if the present level of exploitation and misuse of underground water continues. By 2050, when more than 50 per cent of the Indian population is expected to shift to the cities, fresh drinking water is expected to get very scarce. A new category of refugees is expected to emerge around that time: the water migrants. Future wars, between or within nations will be fought on the issue of water. India –which has 16 per cent of the world's population, 2.45 per cent of the world's land area and 4 per cent of the world's water resources already has a grave drinking water crisis .

The reservoir of underground water ,estimated presently at 432 billion cubic meters (BCMs) has been declining at a rapid rate of 20cms annually in as many as fifteen States with major metropolitan centers including Delhi, being estimated to go dry as early as 2015 on account of over-exploitation and misuse.

According to a study done by the New Delhi-based Central Ground Water Board, it will take just 2,600 additional tube wells running at an average of ten hours per day to exhaust the entire reserve of underground water in Delhi. Punjab, Haryana, Bihar, Andhra

Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Orissa have also been categorized by the Ground Water Board as the potentially 'gray areas'.

3.3 PROBLEM

The annual inter-State feuds over water are becoming more and more common in India. Per capita water availability in the country which was 5,000 cubic metres earlier, has dropped to 2,200 cubic metres. This is against the world figure of 8,500 cubic metres. As a result, India is fast approaching a phase of stressed water availability conditions.

Several perennial flows like the Ganga-Brahmaputra-Barak are becoming seasonal. Rivers are dying or declining and aquifers are getting over-pumped. Thus, people have to depend on limited municipal water supply. Consequently, they are forced to rely on their own resources. This scarcity has led to the birth of water markets with private entrepreneurs doing business in supplying water tankers. This, once again, is putting pressure on surface and groundwater sources which are fast depleting all over the country. Eighty-five per cent of India's urban population has access to drinking water but only 20 per cent of the available drinking water meets the health and safety standards. Furthermore, there are serious inequities in the distribution of water. Consumption of water ranges from 16 litres per day to 3 litres per day depending on the city and the economic strata of the Indian consumer.

The water in rivers is wasted as it flows into the sea and is not properly harnessed. The debate on dams as a means of harnessing water continues to make this issue politically and environmentally sensitive. No clear ecologically stable and financially viable solution has emerged. The poor state of local and municipal authorities renders them unable to provide basic water to the cities. Strengthening of local bodies could lead to another means of addressing this issue.

3.4 POLICY

India’s national water policy gives overriding priority to drinking water. The policy requirements of urban development projects include a drinking water component. India is developing both its ground and surface water resources. Current policies prioritize the utilization of static reserves to prevent ground water mining but development of ground water mining is very intensive in Punjab, Haryana, Uttar Pradesh and some other parts of India.

India’s rainfall is temporal (with as much as 70 per cent rainfall occurring in four months) and the rain is also unevenly distributed. With the glacier or snow-fed surface or river water, there is the multiplying problem of pollution.

There are vast stretches of Indian rivers that are unable to support fish on account of the levels of pollution caused by the unwillingness or reluctance on the part of small and big industrialists to adhere to effluent treatment norms. While pollution is a problem, an equally important issue is to prevent the groundwater levels from declining any further. And it is here that the concept of rainwater harvesting comes into place.

3.5 RAINWATER HARVESTING

On account of inadequate awareness or planning, excess rainfall water has been getting discharged into the oceans after coursing its way through the drains and rivers. In effect, it is possible to prevent this wastage of water by storing it during the rainy season — for use as drinking water during the dry seasons. Or for allowing it to seep underground in the dry areas as a measure of maintaining adequate levels of ground water. This water can subsequently be ‘recharged’ or pumped up for irrigational or drinking water purposes. And this is what rainwater harvesting is all about.

There are different ways in which rainwater can be harvested. There is a method of what is known as ‘rooftop harvesting’ in which the rainwater is allowed to get collected in built-up tanks. This water can be used for direct consumption as also for recharging groundwater through simple filtration devices. Water can also be collected in tanks that have cement slabs built at their base to prevent the water from seeping underground. This method is usually employed in the desert areas of Rajasthan which often face drinking water problem.

3.6 ANCIENT TRADITIONS

Historically, Indians have been the world's greatest water harvesters. Proof of this is found in a variety of archaeological material which speaks of the functional classification of rainfall regimes, soil types, crop mixes, and irrigation techniques of the ancient Indians. This evidence translates to a proliferation of types of harvesting systems — rainfed, stream or riverfed, and groundwater-based. Each of India's 15 ecological zones had systems adapted to local needs and micro-ecological peculiarities- such as artificial wells like *khadins*, typical to Rajasthan but which can be made and used to store rainwater elsewhere too. Or the intricate networks of bamboo pipelines that carry water over inhospitable terrain in southern Meghalaya and are technologically adequate to function as a drip irrigation system for betel leaf plantations. Or the Mughal groundwater-based water supply system in Burhanpur town in Madhya Pradesh, so well engineered that people use it even today.

Evidently, the art and science of collecting water where it falls is then the ancient, 'dying wisdom' that needs to be revived to meet our contemporary fresh water needs adequately, equitably and sustainably.

3.7 GOVERNMENT INITIATIVES

The Government of India is well aware of this. Plans for adopting an inter-ministerial approach for tackling the water situation are being worked out while several state governments are enacting legislations to make rainwater harvesting compulsory in all housing societies, residential, commercial, industrial and other complexes. The Delhi

Development Authority and the Municipal Corporation of Delhi have amended their existing building bye-laws, making it compulsory for every house or hotel, 200 yards or more in area, to undertake rainwater harvesting.

FIG NO: 3.1

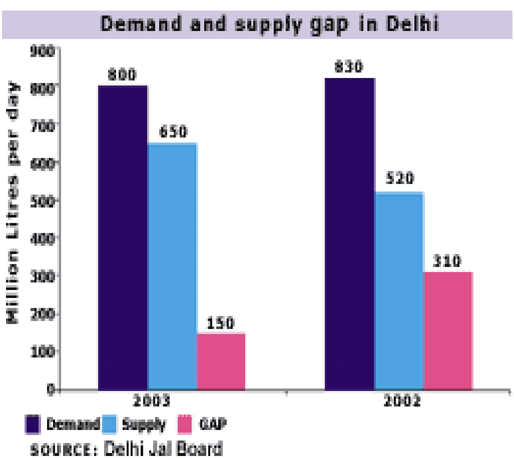
Even though the rate of urbanisation in India is among the lowest in the world, the nation has more than 250 million city-dwellers. Experts predict that this number will rise even further, and by 2020, about 50 per cent of India's population will be living in cities. This is going to put further pressure on the already strained centralised water supply systems of urban areas.

The urban water supply and sanitation sector in the country is suffering from inadequate levels of service, an increasing demand-supply gap, poor sanitary conditions and deteriorating financial and technical performance. According to Central Public Health Engineering Organisation (CPHEEO) estimates, as on 31 March 2000, 88 per cent of urban population has access to a potable water supply. But this supply is highly erratic and unreliable. Transmission and distribution networks are old and poorly maintained, and generally of a poor quality. Consequently physical losses are typically high, ranging from 25 to over 50 per cent. Low pressures and intermittent supplies allow back siphoning, which results in contamination of water in the distribution network. Water is typically available for only 2-8 hours a day in most Indian cities. The situation is even worse in summer when water is available only for a few minutes, sometimes not at all.

According to a World Bank study, of the 27 Asian cities with populations of over 1,000,000, Chennai and Delhi are ranked as the worst performing metropolitan cities in terms of hours of water availability per day, while Mumbai is ranked as second worst performer and Calcutta fourth worst (Source: Background Paper - International Conference on New Perspectives on Water for Urban & Rural India - 18-19 September, 2001, New Delhi.)

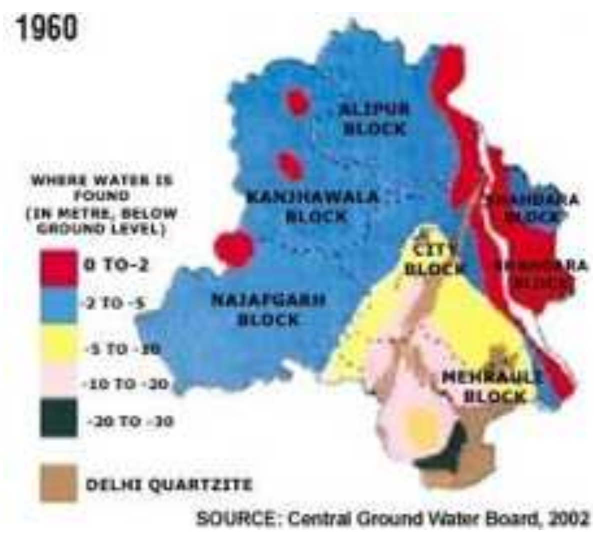
In most cities, centralised water supply systems depend on surface water sources like rivers and lakes. Chennai, for instance, has to bring in water from a distance of 200 km whereas Bangalore gets its water from the Cauvery River, which is 95 km away. Where surface water sources fail to meet the rising demand, groundwater reserves are being tapped, often to unsustainable levels.

<u>FIG NO: 3.2</u>



<u>Delhi:</u> The nation's capital is perpetually in the grip of a water crisis, more so during the dry season, when the situation gets particularly worse. As the demand-supply gap widens, more groundwater is being exploited. Of the water supplied by the municipality, approximately 11 per cent comes from groundwater reserves and remaining from the Yamuna River. It is, however, difficult to establish the total quantity of groundwater extracted because a large number of tubewells owned by individuals, industries and bottled water companies) remain unregistered.

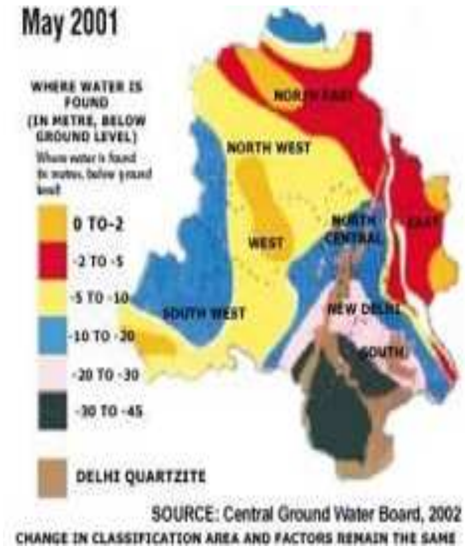
FIG NO: 3.3

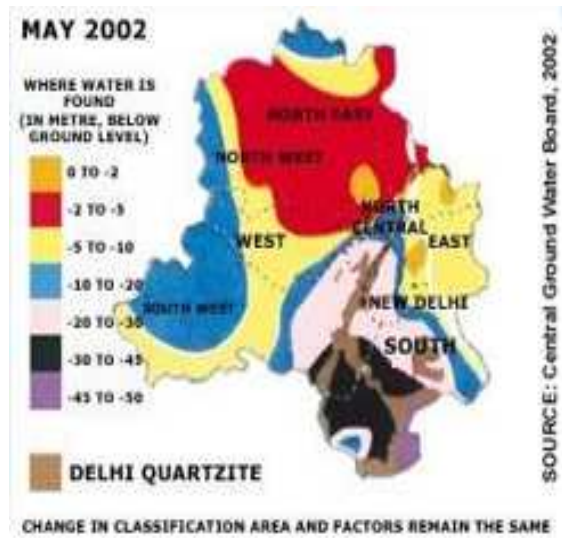


In Delhi approximately 13 per cent (Source: Zerah., M Helene, 2000, *Water - Unreliable Supply in Delhi*, French Research Institute of India) households do not receive water every day and in Rajkot, Gujarat, water availability in April 2000 was only for 30 minutes every alternate day.

FIG NO: 3.4

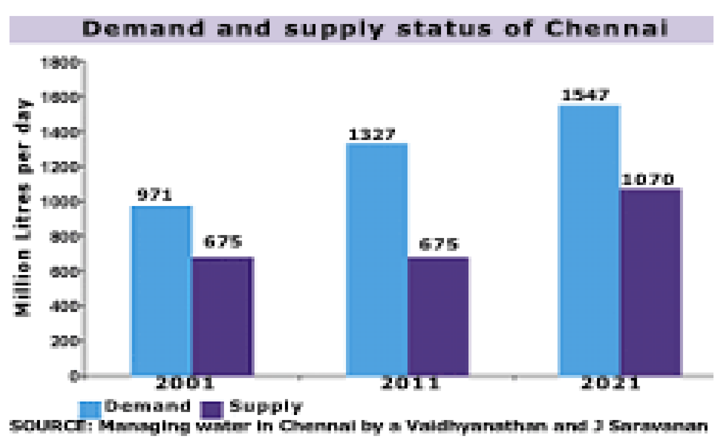
FIG NO: 3.5





Chennai: The main sources of public water supply in the city are the three reservoirs - Poondi, Redhills and Cholavaram - with an aggregate storage capacity of 175 MCM. Even when the reservoirs are not full, they get inflows from intermittent rains, which are then drawn. On the other hand, losses due to evaporation from the reservoirs result in the effective availability being lower than the storage.

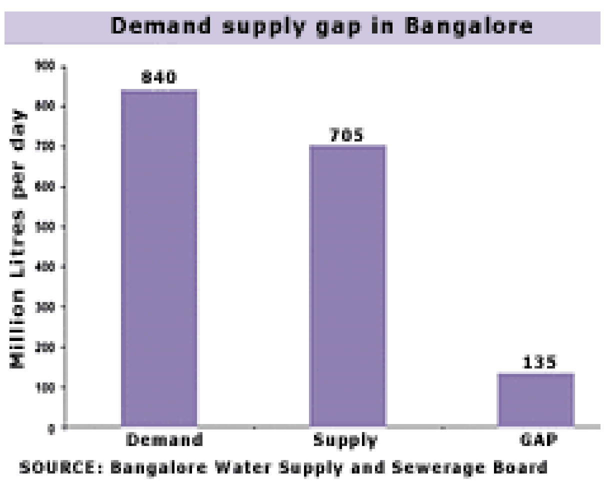
FIGNO: 3.6



The other major resource is groundwater from the well fields in the Araniar-Kortaliyar basin and the southern coastal aquifer, and a large number of wells and tubewells spread all across the city.

Over-extraction of groundwater in the north western coastal belt resulted in a rapid ingress of seawater, which extended from 3 km inshore in 1969 to 7 km in 1983 and 9 km in 1987. Groundwater levels within the city also fell and brackish water began to appear even in localities which earlier had good quality groundwater sources.

FIG NO: 3.7



Bangalore: With a population of 5,686,000, Bangalore is India's fifth largest city. As per the estimates of the Bangalore Water Supply and Sewerage Board (BWSSB), the total demand of water is 840 million litres per day (MLD) (assuming a population of 6 million and a supply rate of 140 litres per capita per day [lpcd]). (The demand works out to be 1200 MLD, at the standard rate of 200 lpcd set by the Bureau of Indian Standards [BIS] for water supply in urban areas). Corresponding demand supply gaps are 135 and 495 MLD.

TABLE 3.1

SOURCES OF WATER

Surface water:

Source	Design capacity (MLD)	Present withdrawl (MLD)3
1.Arkavathyriver **a)Hesarghatta** **b) T.G.Hally**	 **36** **148**	 **6.0** **36.0**
2.Cauveryriver **a)Stage-I** **b)Stage-II** **c) Stage-III**	 **135** **135** **270**	 **135** **135** **270**
	724	**582**

Source : WATER SUPPLY IN URBAN AREAS

Rainwater harvesting (RWH) is a simple method by which rainfall is collected for future usage. The collected rainwater may be stored, utilised in different ways or directly used for recharge purposes. With depleting groundwater levels and fluctuating climate conditions, RWH can go a long way to help mitigate these effects. Capturing the rainwater can help recharge local aquifers, reduce urban flooding and most importantly ensure water availability in water-scarce zones. Though the term seems to have picked up greater visibility in the last few years, it was, and is even today, a traditional practice followed in rural India. Some ancient rainwater harvesting methods followed in India include madakas, ahar pynes, surangas, taankas and many more .

As compared to surface dams, ground water dams have several advantages like minimum evaporation loss, reduced chances of contamination etc. Roof top rainwater harvesting can be a very effective tool to fight the problem of water shortage particularly in urban areas. Roof top rainwater harvesting depends upon the amount of rainfall and the roof top area.

3.8 KERALA SCENARIO

Kerala gets an average of 250 to 300 cm rainfall, annually. Due to the steep terrain, the major chunk of the rainwater falling reaches the Oceans within a span of 48 hours. This rainwater if harvested can be used for drinking and cooking purposes during the stringent summers. Rainwater is harvested from the rooftops of buildings by channelling through chutes. Passing through layers of sand, gravel and activated carbon filters it before it gets collected in the harvesting tank. It is a proven fact that rainwater thus collected and kept without contact with air or sunlight can be retained pure for a year. Thus collecting rainwater at every household is the most economical and feasible remedy for shortage of drinking water.

For an individual, per day, 20 litres of water is needed for cooking and drinking purposes. Thus for a family of 5, around 100 litres of water is needed per day. Hence 10,000 litres of rainwater can suffice the need for drinking water for a family of 5 for a period of three months. In a place, which gets an average 200cm of rainwater annually, a surface area of 8 sq.m is enough to fill a harvesting tank of capacity 10,000 litres in 8 days. The cost per litre on rainwater harvested in a ferro cement tank is around 2 rupees less than that from a synthetic tank. Moreover, the technology is eco-friendly. The cost is further reduced if the tank is built underground.

3.9 “VARSHA" - RAINWATER HARVESTING SCHEME

The project was undertaken by us under the aegis of kerala water authority (KWA), govt. of Kerala envisaging construction of ferro cement rain water harvesting systems in the districts of Ernakulum, Aleppy, Kottayam, Thiruvananthapuram and Pathanamthitta. Through this project we have covered more than 30,000 families. Introduction of a new technology in government sector-ferro cement technology-is one of the indirect advantages of the project. We have constructed rain water harvesting systems in more than 500 governemnt institutions and schools. the largest single rainwater system we have constructed is having 200000 ltr capacity.

Other water management programmes we implement are WGDP (western ghatts development program), NWDPRA (national water development project under rain fed areas) and RAINS (rainwater harvesting awareness implementation network system), Jalanidhi of KRWSA under the world bank project .

TABLE 3.2

Consolidated Number of Families Assisted Through VARSHA Rain Water Harvesting programme

Sl. No.	Name of the District	Total Number of Families Assisted
1	Ernakulam	5,600
2	Thiruvananthapuram	3,100
3	Kottayam	3,800
4	Alappuzha	3,600
5	Pathanamthitta	850
6	Idukki	2,200
	Total	19,150

As on June, 2015.

Source : **www.theandhyodaya.in**

STATE NAME : KERALA **DISTRICT NAME : PALAKKAD**

OUR PARTNERS

- Kerala Rural Water Supply & Sanitation Agency (KRWSA) - Govt.of Kerala
- Kerala Water Authority (KWA) - Govt.of Kerala
- Western Ghats Development Programme (WGDP) - Govt.of India
- Local Self Government bodies

- Department of Water Supply - Govt.of India

3.10 WATERSHED MANAGEMENT

The Andhyodaya's one of the servicing area is the implementation of the watershed and its management. We have constructed many watersheds effectively, an example is Assamnnur Panchayat. A watershed is a basin like landform defined by peaks which are connected by ridges that descend into lower elevations and small valleys. It carries rainwater falling on it drop by drop and channels it into soil, rivulets and streams flowing into large rivers and in due course sea.

Watershed management is the the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a satershed boundary. Features of a waterhsed that agencies seek to manage include water supply, water quality, drainage, stormwater runoff, water rights and the overall planning and utilization of watersheds.

3.11 RAIN WATER HARVESTING TO AUGMENT GROUND WATER RESOURCES

- Rain Water Harvesting is the technique of collection and storage of rain water at surface or in sub-surface aquifer, before it is lost as surface run off. The augmented resource can be harvested in the time of need. Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that under natural conditions of replenishment.

3.12 NEED

- To overcome the inadequacy of surface water to meet our demands.
- To arrest decline in ground water levels.
- To enhance availability of ground water at specific place and time and utilize rain water for sustainable development.
- To increase infiltration of rain water in the subsoil which has decreased drastically in urban areas due to paving of open area.
- To improve ground water quality by dilution.
- To increase agriculture production.
- To improve ecology of the area by increase in vegetation cover etc.

3.13 ADVANTAGE

- The cost of recharge to sub-surface reservoir is lower than surface reservoirs.
- The aquifer serves as a distribution system also.
- No land is wasted for storage purpose and no population displacement is involved.
- Ground water is not directly exposed to evaporation and pollution.
- Storing water under ground is environment friendly.
- It increases the productivity of aquifer.
- It reduces flood hazards.
- Effects rise in ground water levels.
- Mitigates effects of drought.
- Reduces soil erosion.

3.14 DESIGN CONSIDERATIONS

The important aspects to be looked into for designing a rainwater harvesting system to augment ground water resources are:-

- Hydrogeology of the area including nature and extent of aquifer, soil cover, topography, depth to water level and chemical quality of ground water.
- The availability of source water, one of the prime requisite for ground water recharge, basically assessed in terms of non-committed surplus monsoon runoff.
- Area contributing run off like area available, land use pattern, industrial, residential, green belt, paved areas, rooftop area etc.
- Hydrometerological characters like rainfall duration, general pattern and intensity of rainfall.

3.15 POTENTIAL AREAS

- Where ground water levels are declining on regular basis.
- Where substantial amount of aquifer has been de-saturated.
- Where availability of ground water id inadequate in lean months.
- Where due to rapid urbanization, infiltration of rain water into subsoil has decreased drastically and recharging of ground water has diminished.

3.16 METHODS & TECHNIQUES

The methods of ground water recharge mainly are:

Urban Areas

Roof top rain water / storm runoff harvesting through

- Recharge Pit
- Recharge Trench
- Tubewell
- Recharge Well

Rural Areas

Rain water harvesting through

- Gully Plug
- Contour Bund
- Gabion Structure
- Percolation tank
- Check Dam / Cement Plug / Nala Bund
- Recharge shaft
- Dug well Recharge
- Groundwater Dams / Subsurface Dyke We started implementing '**VARSHA**' a Kerala Govt. program of Roof top rain water harvesting using " Ferrocement technologies" in the year 2002 by now we have covered nearly 30,000 families in the state.

TABLE NO: 3.3

S. No.	Block Name	SC	ST	GEN	Total
1	ALATHUR	46607	924	226521	274052
2	ATTAPPADY	3229	30023	35708	68960
3	CHITTOOR	24385	4203	142860	171448
4	KOLLAMKODE	18866	4089	72089	95044

5	KUZHALMANNAM	47545	150	131242	178937
6	MALAMPUZHA	26204	2087	141855	170146
7	MANNARKKAD	39463	1974	274250	315687
8	NENMARA	25989	1620	119392	147001
9	OTTAPALAM	29105	8	119875	148988
10	PALAKKAD	42173	142	170907	213222
11	PATTAMBI	40692	1057	246882	288631
12	SREEKRISHNAPURAM	36238	693	138196	175127
13	THRITHALA	36627	0	161441	198068
	Total:	417123	46970	1981218	2445311

Source : **Kerala Govt. program of Roof top rain water harvesting**

The collection and storage of rainwater can be in man-made structures or natural depressions. Catchment areas can be rooftops, compounds, rocky surfaces or hill tops. Rooftop harvesting structures on islands like Lakshadeep and in the North Eastern Provinces are very successful.

The most popular means of collecting rainwater for individual households is from the roof tops. Another method of harvesting rainwater is collection of runoff rainwater in abandoned dug wells, recharge pits and recharge trenches. These methods are for groundwater recharge, which eventually helps in raising the water table. For instance in Chellanum Grama Panchayat in Kerala roof water is harvested around the dug wells to recharge the well and reduce the salinity intrusion.

Rainwater can be collected from large roof surface areas to underground sumps. From the sumps water can be pumped to overhead tanks. After proper water treatment this drinking water can be supplied to institutions. Rainwater from clusters of households can also be collected in large storage tanks and after suitable treatment the drinking water can be distributed.

The Kerala government is implementing such projects in Varsha Scheme. Varsha is a project of Kerala Water Authority to construct rainwater harvesting structures for low income families. The beneficiaries contribute 10% and the government 90% of the total cost. This project is implemented by experienced agencies.

CHAPTER 4

PRIMARY DATA ANALYSIS

CHAPTER 4

PRIMARY DATA ANALYSIS

4.1 PROFILE OF THE DISTRICT

Palakkad, the district of Kerala is a multifarious district known for its history, natural resources, and standard of education, tourist destination and more over due to its rapid development in every field of economic development. Palakkad district is bordered in the North - West by Malappuram and on the South – West by Thrissur. The East lies the Coimbatore and Tamil Nadu .It lies between 10’21 and 11’14 North latitude and 76’02 and 76’54 East longitude. The geographical area of the district is 4480 sq.km represent in 11.53 percent at the states geographical area of the district is 4480 sq.km represent in 1.53 percent at the states geographical area. The forest land percent covers 136257 hectors. According to 2011 census total population of Palakkad is 2810,892. This shows an increases of 7.39 percent in 2011 compared to figures at 2001 census and constituted 8.4 percent at total Kerala population. The district has achieved 88.35 percent literacy in 2011 compared to 84.35 of 2011 calculated on the basis of population above the age of years. Located in the heart of the state, the district adjoins Kerala to rest of the Indian States. The district has its own historical importance. Most of the population resides in the rural areas.

GENERAL INFORMATION OF FAMILY RESPONDENTS

TABLE 4.1

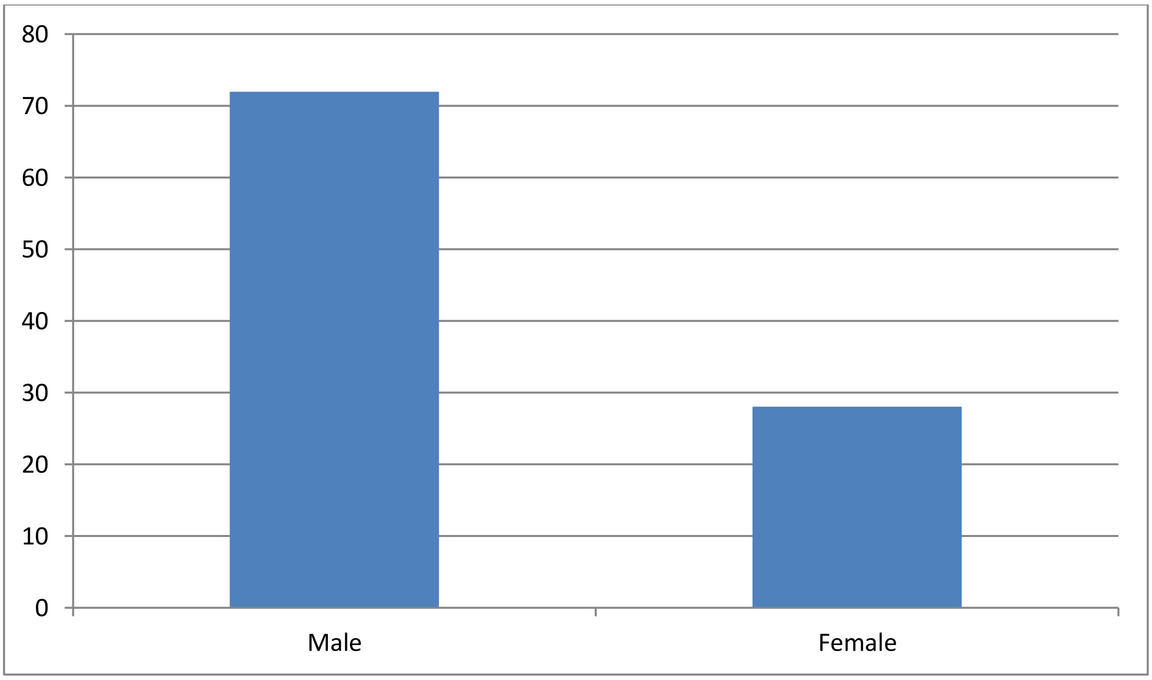
GENDER

Gender	No of respondents	Percentage
Male	13	72
Female	5	28
Total	18	100

Source: Field Survey

The above table indicates the gender of the respondents. About 72 percentages of them are males and remaining 28 percentages of them are females.

FIG 4.1 GENDER OF THE RESPONDENTS



4.2 AGE WISE CLASSIFICATION

AGE WISE CLASSIFICATION

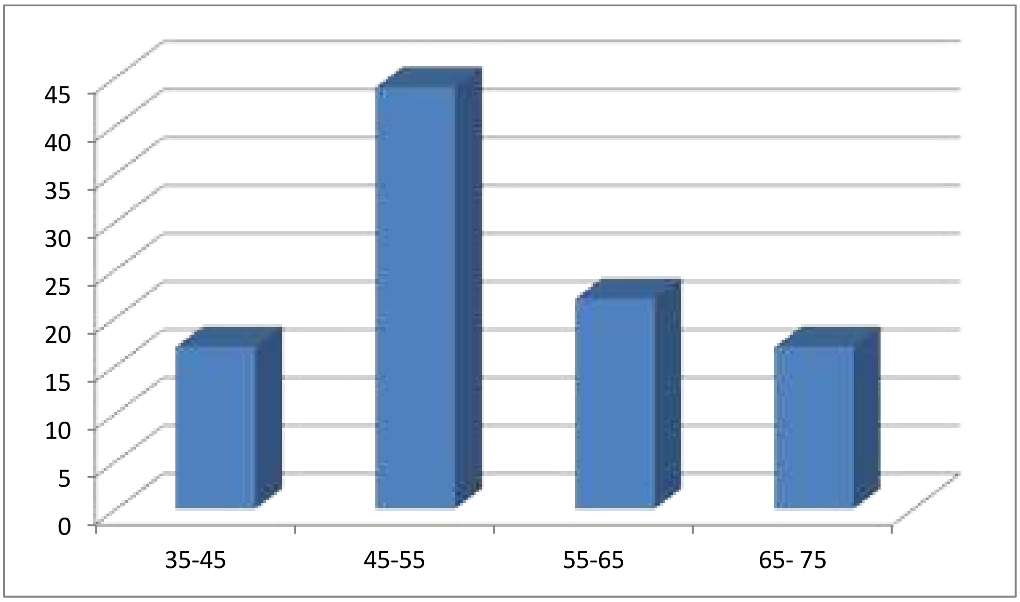
TABLE 4.2

Age	No of respondents	Percentage
35-45	13	17
45-55	18	44
55-65	14	22
65- 75	13	17
Total	18	100

Source : Field Survey

The above table indicates that the age wise classification of respondents. 44 percentages of the respondents are in the age group of 45-55 and 22 percentages are in the age group of 55-65. About 17 percentages belong to the age group of 65-75. And 17 percentages of respondents included in the age group of 35-45. Hence it is concluding that out of 18 respondents, majority of them are in the age group of 45 – 55.

FIG 4.2 AGE WISE OF THE RESPONDENTS



4.3 EDUCATIONAL QUALIFICATION

TABLE 4.3

Educational Qualification	No of persons	Percentage
Lower Primary	4	22
Upper Primary	3	17
High School	4	22
Pre Degree Course	4	22
Graduation	3	17
Total	18	100

Source : Field Survey

The above table represents the educational qualification of the respondents. 22 percentages of them completed High School, Lower primary and Pre Degree Course, and 17 percentages of them completed Upper Primary and Graduation

4.4 FAMILY INCOME

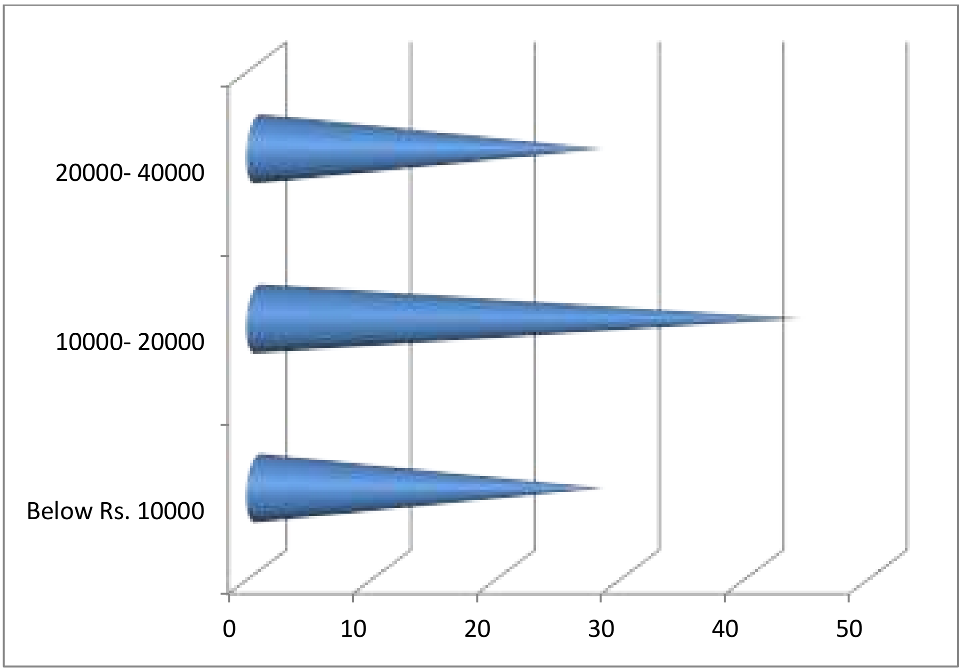
TABLE 4.4

Family Income	No of Respondents	Percentage
Below Rs. 10000	5	28
10000- 20000	8	44
20000- 40000	5	28
Total	18	100

Source: Field Survey

The above table represents the family income of the respondents. 44 percentages of them have family income between 10000 -20000, 28 percentages of people had monthly income between 20000- 40000, & 10000 - 20000.

FIG 4.3 FAMILY INCOME OF THE RESPONDENTS



4.5 OCCUPATIONAL STATUS

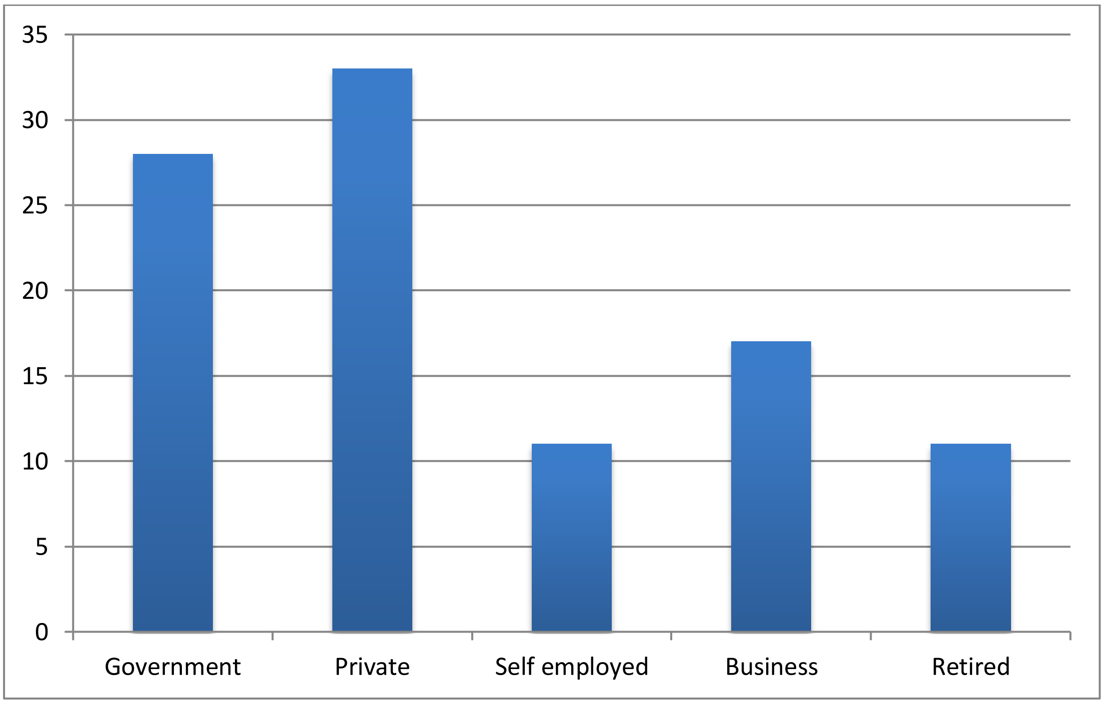
TABLE 4.5

Occuation	No of persons	Percentage
Government	5	28
Private	6	33
Self employed	2	11
Business	3	17
Retired	2	11
Total	18	100

Source: Field Survey

The above table represents the occupational status of the respondents. 33percentages of people are working in the Private sector, 28 percentages of people are in the Government sector, 17 percentages of people are doing Business and 11 percentages of people are self employed and Retired.

FIG 4.4 OCCUPATIONAL STATUS OF THE RESPONDENTS



4.6 TYPE OF FAMILY

TABLE 4.6

Type of Family	No of persons	Percentage
Nuclear Family	5	28
Joint Family	13	72
Total	18	100

Source: Field Survey

The above table represents the type of family. 72 percentages of them are followed joint Family system and remaining 28 percentages of them had Nuclear Family system.

4.7 COMMUNITY

TABLE 4.7

Community	No of persons	Percentage
General	8	44
OBC	4	23
SC	6	33
Total	18	100

Source: Field Survey

The above table represents the community of the respondents. 44 percentages of people are in the General Community , 33 percentages of people are in the SC Community and remaining 23 percentages of people are in the OBC Community.

4.8 SIZE OF FAMILY

TABLE 4.8

Size of Family	No of Respondents	Percentage
0 - 2	5	28
2 - 4	6	33
4 - 6	5	28
6 - 8	2	11
Total	18	100

Source: Field Survey

The above table represents the size of family members. About 33 percentages of the respondents have 2 – 4 members in their family , 28 percentages of the respondents have 4 – 6, 0 –2 members in the family respectively and remaining 11 percentages of the respondents have 6 - 8 Members in their family.

4.9 NATURE OF HOUSE

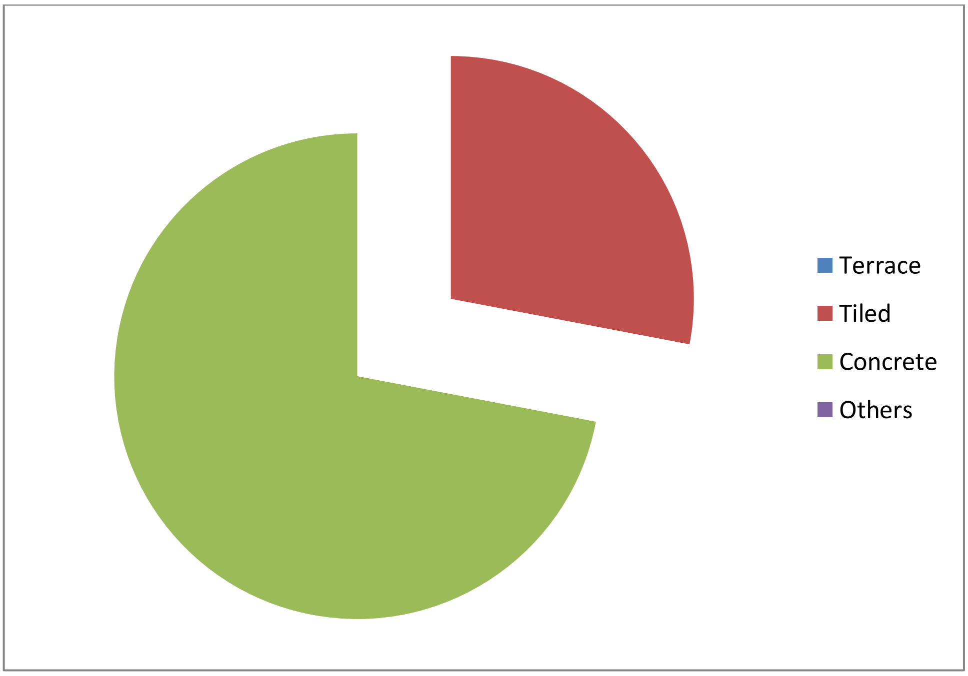
TABLE 4.9

Nature	No of Respondents	Percentage
Terrace	0	0
Tiled	5	28
Concrete	13	72
Others	0	0
Total	18	100

Source: Field Survey

The above table represents the nature of house, About 72 percentages of the respondents have concrete houses , 28 percentages of the respondents have tiled houses .

FIG 4.5 NATURE OF HOUSE OF THE RESPONDENTS



4.10 FUNCTIONING OF RAIN WATER HARVESTING SYSTEM

PROFILE OF THE STUDY AREA

TABLE 4.10

Sources	No of Respondents	Percentage
Government Office	13	18.57
Schools	14	20
Anganvadi	9	12.86
Social Service Institutions	8	11.42
Hospitals	8	11.42
Households	18	25.72
Total	70	100

Source: Field Survey

The above table represents profile of the study area. About 25.72 percentages were households, 20 percentages were schools, 18.57 percentages government offices, 12.86 percentages of anganvadi, 9.9 percentages of social service Institutions and 11.42 percentages of hospitals were the main study areas.

4.11 LAND REQUIRED FOR CONSTRUCTING RAIN WATERTANKS

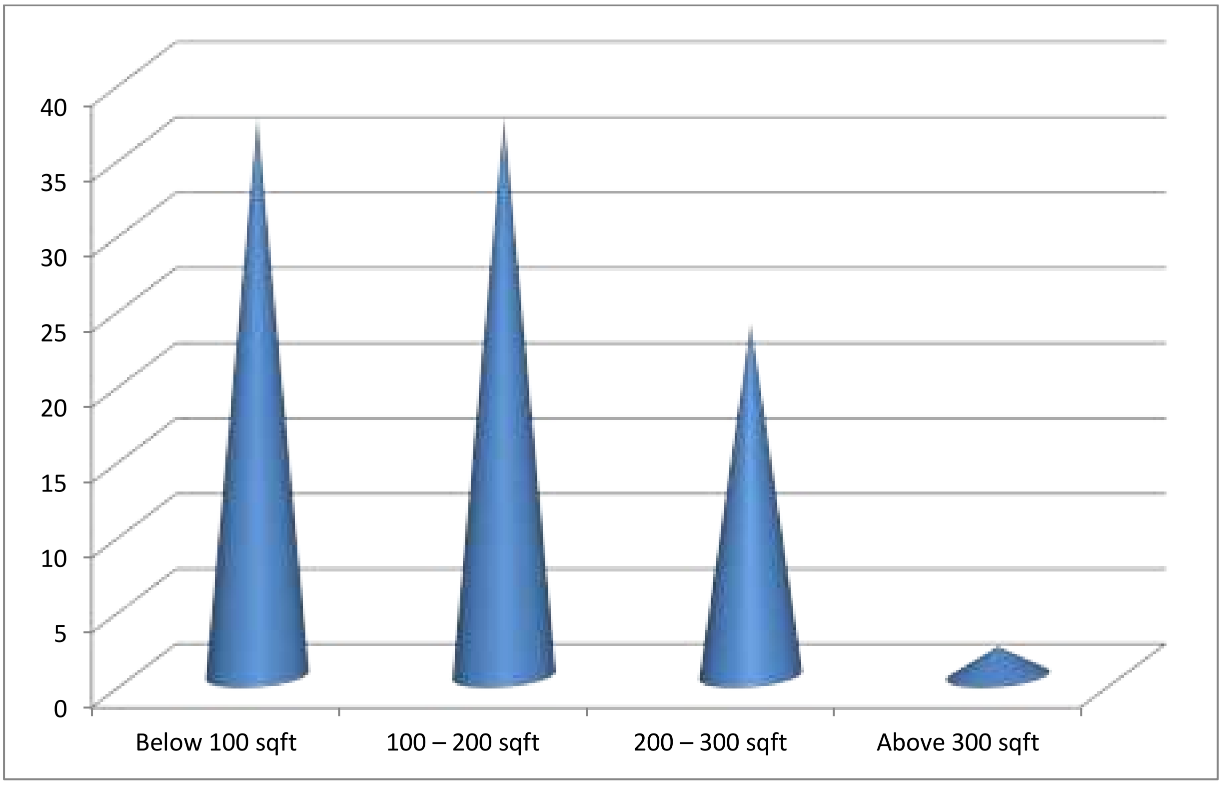
TABLE 4.11

Land in Possession	No of Respondents	Percentage
Below 100 sqft	25	35.72
100 – 200 sqft	25	35.72
200 – 300 sqft	16	22.85
Above 300 sqft	4	5.71
Total	70	100

Source: Field Survey r = - 0.022

The above table represents the land required for constructing the tank. 35.72 percentages of the respondents constructed their tanks within below 100 square feet and 100 – 200 square feet, 22.85 percentages of the respondents constructed their tanks within 200 – 300 square feet and 5.71 percentages of the respondents constructed their tanks above 300 square feet. To know the relationship between the land required for constructing rain water tanks and storage capacity of tank regression analysis was carried out. The result shows that there is negative relationship between land required for construction of tank and number of tanks(r= -0.022). This indicates that a minimum land is required for the construction of tank, shortage of land is not a problem to construct rain water tanks.

FIG 4.6 LAND REQUIRED OF THE RESPONDENTS



4.12 METHODS OF COLLECTING RAINWATER HARVESTING

TABLE 4.12

Methods	No of Respondents	Percentage
Roof Top Harvesting	64	91.42
Surface Runoff Harvesting	6	8.58
Total	70	100

Source: Field Survey

The above table represents the different methods of collecting rain water. 91.42 percentages of respondents had roof top harvesting method and remaining 8.58 percentages of respondents had surface runoff harvesting method.

4.13 STORAGE OF RAIN WATER

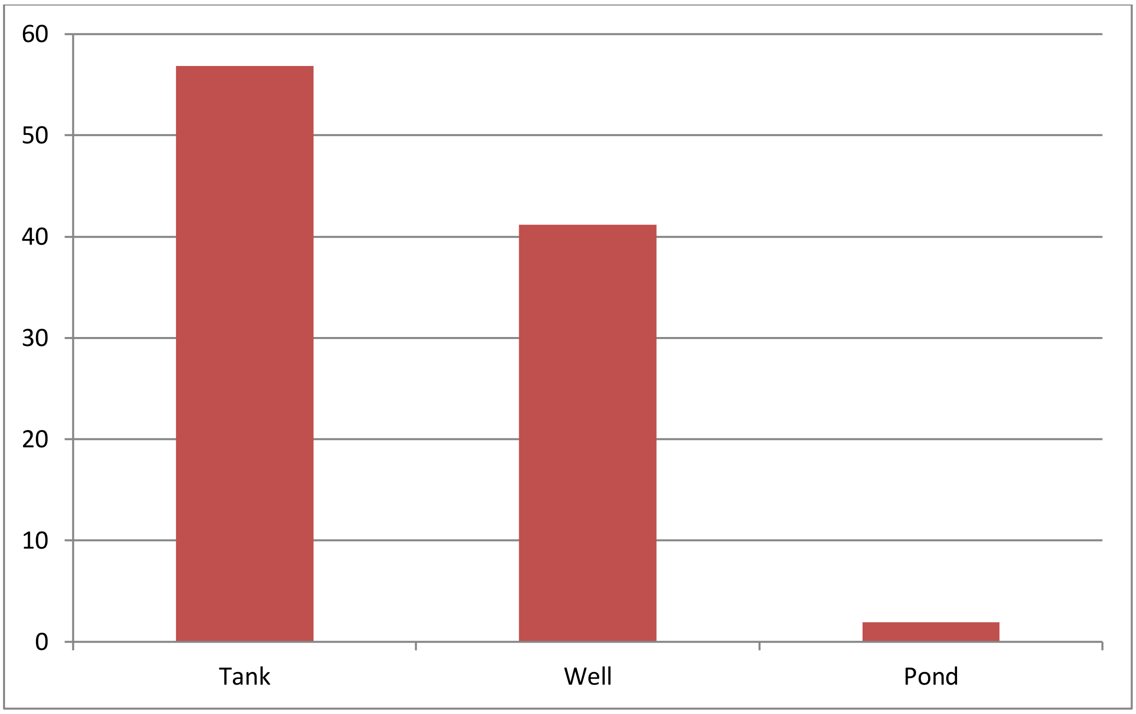
TABLE 4.13

Storage	No of Respondents	Percentage
Tank	35	50
Well	31	44.29
Pond	4	5.71
Total	70	100

Source: Field Survey

The above table represents the storing of rain water. 50 percentages of respondents are using tank to store rain water , 44.29 percentages of respondents are using well to store rain water and remaining 5.71 percentages of respondents are using pond to store rain water.

FIG 4.7 STORAGE OF RAIN WATER



4.14 USAGES OF RAIN WATER

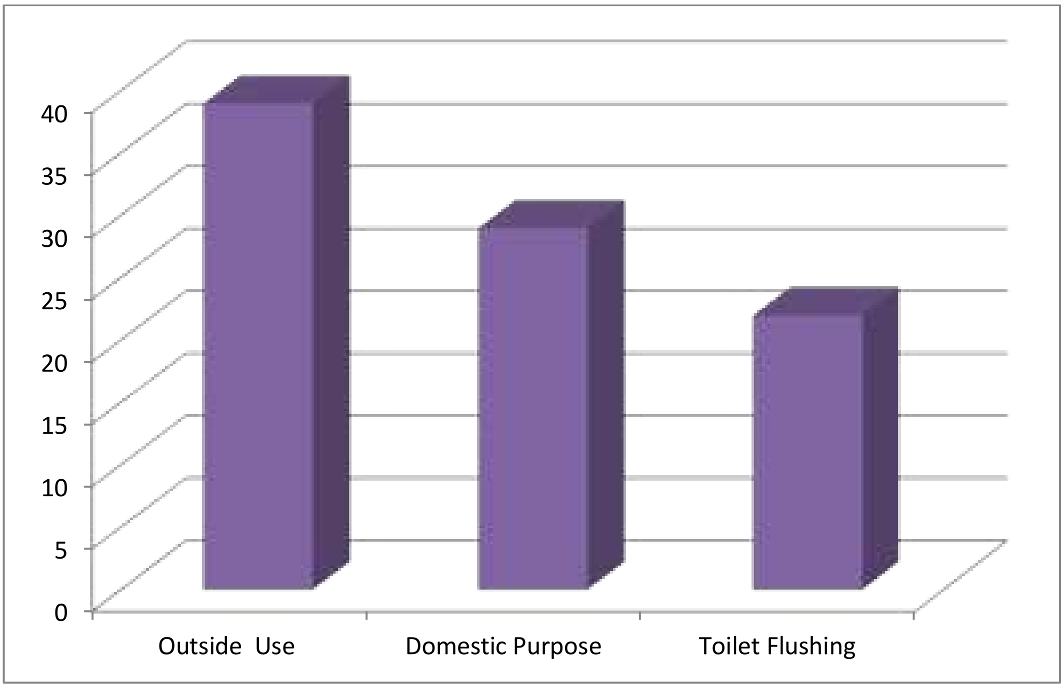
TABLE 4.14

Purpose	No of Respondents	Percentage
Outside Use	30	42.86
Domestic Purpose	28	40
Toilet Flushing, cleaning etc.	12	17.14
Total	70	100

Source: Field Survey

The above table represents the usage of rain water. 42.86 percentages of respondents were using rain water for outside purpose, 40 percentages of respondents were using rain water for domestic purpose and remaining 17.14 percentages of respondents were using for toilet flushing and cleaning etc.

FIG 4.8 USAGE OF RAIN WATER



4.15 Cost / Expenditure of Plant

TABLE 4.15

Cost in Rupees	No of Respondents	Percentage
25000 - 50000	5	7.15
50000 - 75000	10	14.27
75000 - 100000	13	18.57
100000 above	17	24.29
Below 10000	25	35.82
Total	70	100

Source: Field Survey

The above table represents the cost and expenditure for installation of plant. 35.82 percentages of respondents had Rs.10000 below cost incurred for installation of plant is, 24.29percentages of respondents were cost incurred for installation of plant is rupees100000 and above, 14.27 percentages of respondents were cost incurred for installation of plant varies from rupees 50000 to 75000, 18.57percentages of respondents are cost incurred for installation of plant varies from rupees 75000 to 100000 and remaining 7.15 percentages of respondents are cost incurred for installation of plant varies from rupees 25000 to 50000 .

4.16 ASSISTANCE FROM GOVERNMENT

TABLE 4.16

Government Assistance	No of Respondents	Percentage
Financial Assistance	18	25.71
Technological Assistance	8	11.43
Subsidy	32	45.71
Free Installation	0	0
No	12	17.14
Total	70	100

Source: Field Survey

The above table represents assistance from government. 45.71 percentages of respondents have received subsidy from government, 17.14 percentages of respondents did not get any kind of benefits from government, 25.71 percentages of respondents had financial assistance from government and remaining 11.43 percentages of respondents received technological assistance from government.

4.17 METHODS USED FOR FILTERING

TABLE 4.17

Methods	No of Respondents	Percentage
Charcoal Filter	0	0
PVC Filter	0	0
Sand Filter	70	100
Sponge Filter	0	0
Bubble Filter	0	0
Total	70	100

Source: Field Survey

The above table represents the methods used for filtering the water. 100 percentages of respondents are using sand filter. It should be noted that none are using charcoal filter, PVC filter, sponge filter and bubble filter.

4.18 MATERIALS USED FOR THE CONSTRUCTION OF THE TANK

TABLE 4.18

Materials	No of Respondents	Percentage
Plastic	7	10
Cement	63	90
Steel	0	0
Other	0	0
Total	70	100

Source: Field Survey

The above table explains the material used for the construction of the tank. 90 percentages of respondents are using cement for constructing the tank with and they are using Ferro cement technology and remaining 10 percentages of respondents are using plastic for constructing the tank. None are using steel and other materials to construct the tank.

4.19 TIME DURATION FOR CLEANING THE TANK

TABLE 4.19

Duration	No of Respondents	Percentage
Monthly	0	0
Quarterly	40	57.14
Half yearly	20	28.57
Yearly	10	14.29
Total	70	100

Source: Field Survey

The above table indicates that the time duration for cleaning the tank. 57.14 percentages of respondents were cleaning tank quarterly and remaining 28.57 percentages of respondents were cleaned the tank half yearly.14.29 respondents were cleaned the tank annually. It should be noted that none are preferred to clean their tank on monthly basis.

4.20 REASONS FOR CONSRUCTING RAIN WATER HARVESTINGTANKS

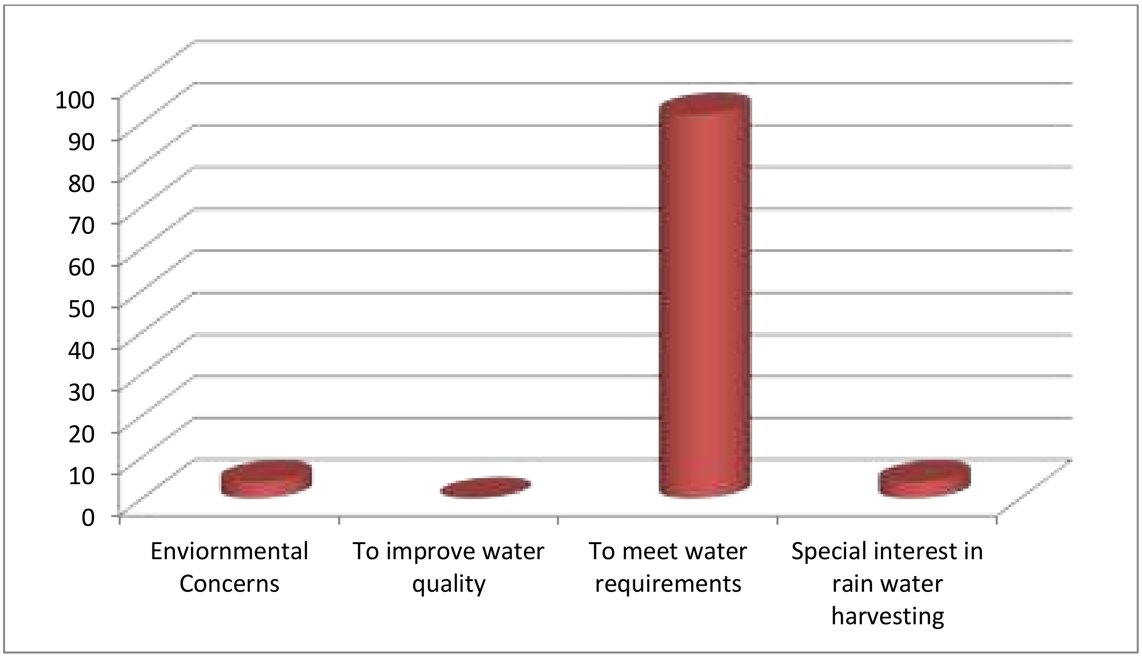
TABLE 4.20

Reasons	No of Respondents	Percentage
Environmental Concerns	3	4.28
To improve water quality	0	0
To meet water requirements	64	91.42
Special interest in rain water harvesting	3	4.28
Total	70	100

Source: Field Survey

The above table explains the reasons for constructing rain water harvesting tanks. The main reason for constructing rainwater harvesting tanks is to meet water requirements (91.42 percentages). Environmental concerns, special interest in rain water harvesting (4.28 percentages) are the other reasons for constructing rainwater harvesting tanks.

FIG 4.9 REASONS FOR CONSTRUCTING RAIN WATER



4.21 STORAGE CAPACITY OF TANK

TABLE 4.21

Volume in Litters	No of Respondents	Percentage
10000l - 20000l	29	41.42
20000l - 40000l	17	24.28
40000l - 50000l	0	0
50000l and above	24	34.28
Total	70	100

Source: Field Survey

The above table indicates the storage capacity of tank. 34.28 percentages tank had storage capacity between 50000liters and above, 41.42 percentages tank had storage capacity between10000 to 20000liters, 24.28 percentages tank had storage capacity between 20000 to 40000liters and in the study area none of them had 40000 to 50000liters storage capacity tanks.

4.22 MATERIALS USED IN GUTTER AND DOWNSPOUTS

TABLE 4.22

Materials	No of Respondents	Percentage
Metal	0	0
Plastic	70	100
Cement	0	0
Others	0	0
Total	70	100

Source: Field Survey

The above table shows that majority of respondents (100 percentages) are using plastic to construct gutters and downspouts. It should be noted that none are using metal, cement or others to construct the gutters and downspouts.

4.23 MATERIALS USED IN ROOFS

TABLE 4.23

Materials	No of Respondents	Percentage
Asphalt shingle	0	0
Tiled Sheet	25	35.71
Cement	45	64.29
Wood Shingle	0	0
Total	70	100

Source: Field Survey

The above table shows that majority of respondents (64.29 percentages) are using cement to construct roof of the tank. And the rest 35.71 percentages are used tiled sheet to construct the roof. It should be noted that none are using asphalt shingle or wood shingle to construct the roof.

4.24 LEVELOF SATISFACTION AS COMPARED WITH OTHER WATER RESOURCES

TABLE 4.24

Level	No of Respondents	Percentage
Yes	0	0
Good	0	0
Average	70	100
No	0	0
Total	70	100

Source: Field Survey

The above table shows the level of satisfaction as compared to other water resources. About 100 percentages of respondents were getting average level of satisfaction. Because they are using traditional methods of water resources. They are less familiar with rain water harvesting.

4.25 YEAR OF INSTALLATION

TABLE 4.25

Years	No of Respondents	Percentage
Below 5 years	27	38.57
5 - 10 years	18	25.71
10 - 15 years	25	35.71
Above 15 years	0	0
Total	70	100

Source: Field Survey

The above table represents the year of installation. About 38.57 percentages of respondents had installed their rain water harvesting system below five years, 35.71 percentages of respondents had installed their rain water harvesting system between 10 – 15 years and 25.71 percentages of respondents had installed their rain water harvesting system between 5 – 10 years.

4.26 SEASON WISE USE OF HARVESTING WATER

TABLE 4.26

Season	No of Respondents	Percentage
Rainy	0	0
Summer	70	100
Winter	0	0
Autumn	0	0
Total	70	100

Source: Field Survey

The above table represents the season wise use of harvesting water. 100 percentages of respondents are using the harvesting water in summer season.

4.27 SOURCE OF INFORMATION ABOUT RAINWATER HARVESTING

TABLE 4.27

Source	No of Respondents	Percentage
Government Institution	30	43
Through Neighbours, Friends, Relatives	0	0
By Awareness Programmes	40	57
Other Sources	0	0
Total	70	100

Source: Field Survey

The above table indicates that sources of information about rainwater harvesting. 57 percentages of respondents had the sources of information from awareness programmes and 43 percentages of respondents had received information through Government Institutions.

4.28 NUMBER OF TAPS ARE CONNECTED TO THE TANK

TABLE 4.28

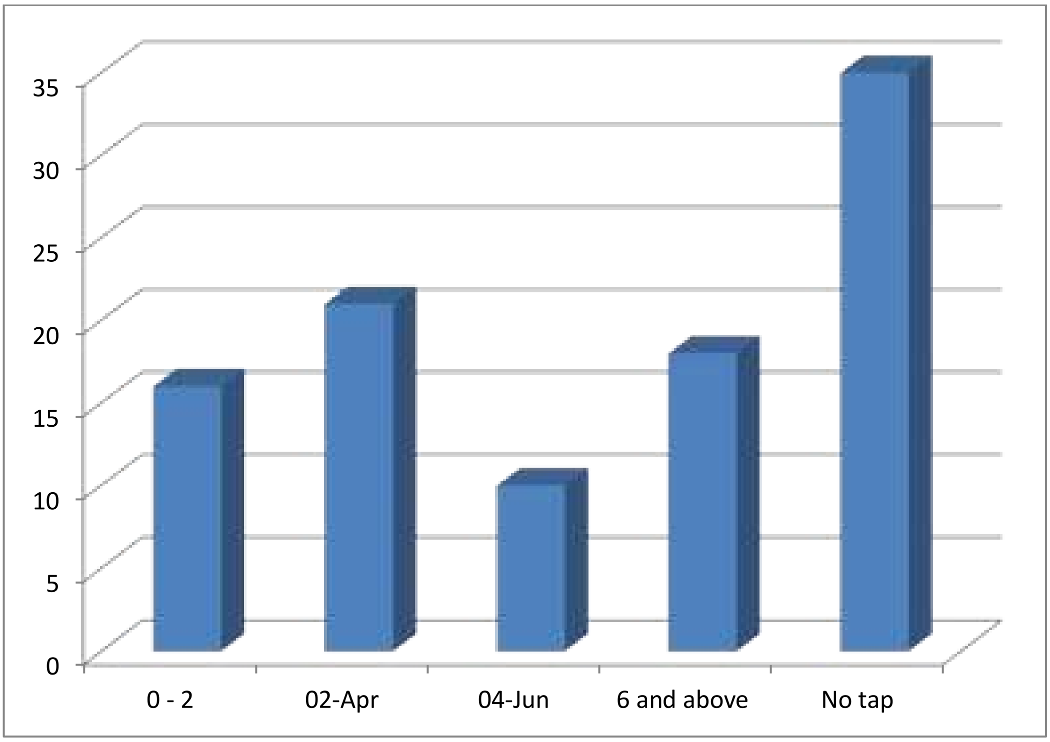
No of Taps	Number of Respondents	Percentage
0 - 2	11	15.71
2 - 4	15	21.42
4 - 6	7	10
6 and above	13	18.57
No tap	24	34.28

Total	70	100

Source: Field Survey

The above table shows the numbers of taps are connected to tank. 34.28 percentages of respondents had no tap connection, 21.42 percentages of respondents had 2 – 4 taps connected, 18.57 percentages of respondents had 6 and above connected taps, 15.71 percentages of respondents had connected 0 – 2 taps, 10 percentages of respondents had 4 – 6 connected taps.

FIG 4.10 NUMBER OF TAPS CONNECTEDTO TANK



4.29 EXPENSIVE PART OF RAINWATER HARVESTING SYSTEM

TABLE 4.29

Expensive Part	No of Respondents	Percentage
Roof	0	0
Tank	70	100
Filters	0	0
Other part	0	0

Total	70	100

Source: Field Survey

The above table represents the expensive part of rainwater harvesting system.The tank is the most expensive part of rainwater harvesting system(100).

4.30 OPINION ABOUT RAINWATER HARVESTING SYSTEM

TABLE 4.30

Opinion	No of Respondents	Percentage
Yes, It is needed for every households	24	34.28
Yes, it is very useful in meeting water requirements	46	65.72
No, it is very difficult in maintain	0	0
No, it is very waste	0	0
Total	70	100

Source: Field Survey

The above table represents the opinion about rainwater harvesting system. About 65.72 percentages of respondents revealed that rainwater harvesting system is very useful to meet water requirements, and it is essential for every households(34.28).

4.31 PART OF THE PLANT GETS COMPLAINT

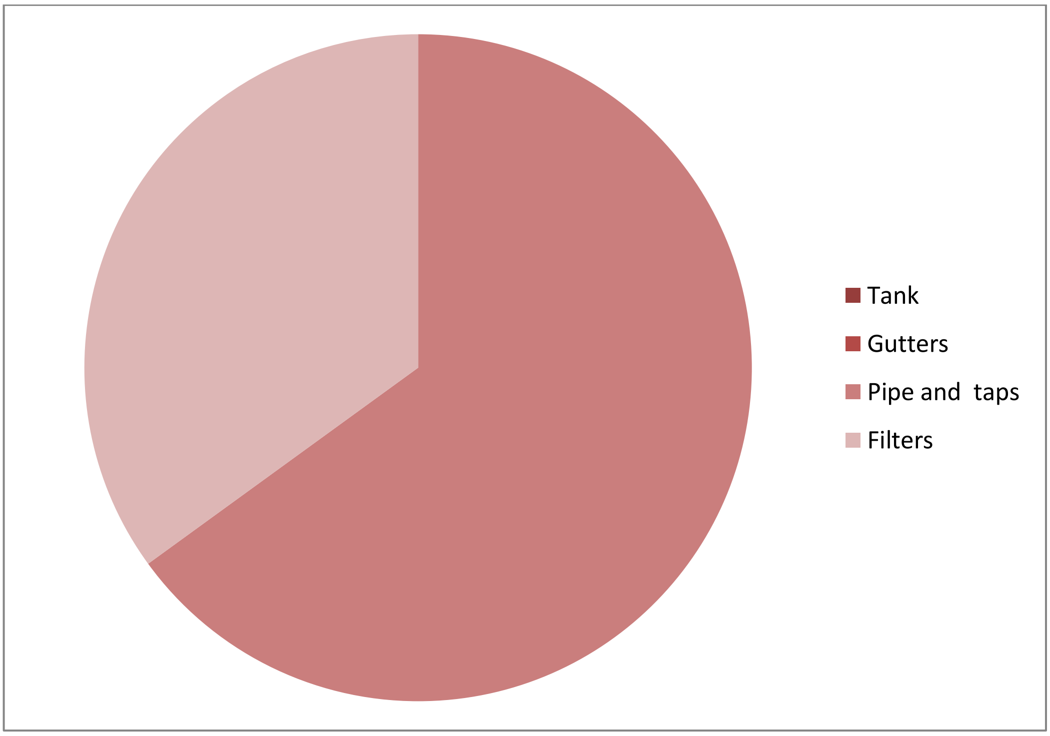
TABLE 4.31

Part of the Plants	No of Respondents	Percentage
Tank	0	0
Gutters	0	0
Pipe and taps	46	65.71
Filters	24	34.29
Total	70	100

Source: Field Survey

The above table represents the parts of the plant mostly gets complaint. About 65.71 percentages of respondents had reported that pipe and taps gets complaint usually and 34.29 percentages of respondents claimed that filters is the another part to get complaint.

FIG 4.11 PARTS OF PLANT GET COMPLAINTS



CHAPTER 5

SUMMARY AND CONCLUSIONS

CHAPTER 5

SUMMARY AND CONCLUSION

This chapter makes an attempt to summarize the various findings made in the course of the study. Conclusions have been derived at as a result of the analysis of surveyed data.

Both primary and secondary sources have been explored for data collection. Secondary data have been collected from reliable sources like journals, books and websites. Primary data has been collected using interview schedule through personnel interview schedule through personnel interview.

From the primary data collected from the respondents it can be concluded as:

5.1 General Information Of Family Respondents

- The survey reveals that 72 percentage of the respondent are Males.
- The survey brings out 44 percentages of the respondents are in the age wise classification of 45-55.
- The survey on the educational qualification of the respondents reveals that 22 percentages of them completed High School, Lower primary and Pre Degree Course.
- The survey also brings out that about 44 percentages of them have family income between 10000 -20000.
- The survey on the occupational status reveals that 33 percentages of people are working in the Private Sector.

- The survey shows that 72 percentages of the respondents belongs to joint family system.
- The survey shows that 44 percentages of the respondents belong to General community.
- The survey depicts that 33 percentages of the respondents have 2-4 size of family.
- The survey reveals that 72 percentages of the respondents have concrete houses.

5.2 Functioning Of Rain Water Harvesting System

- 25.72 percentages were households, 20 percentages were schools, 18.57 percentages government offices, 12.86 percentages of anganvadis, 9.9 percentages of social service Institutions and 11.42 percentages of hospitals were the main study areas.
- 35.72 percentages of the respondents constructed their tanks within below 100 square feet and 100 – 200 square feet. The relationship between the land required for constructing rain water tanks and storage capacity of tank regression analysis was carried out. The result shows that there is negative relationship between land required for construction of tank and number of tanks(r= -0.022). This indicates that a minimum land is required for the construction of tank; shortage of land is not a problem to construct rain water tanks.
- 91.42 percentages of respondents had roof top harvesting method and remaining 8.58 percentages of respondents had surface runoff harvesting method.
- 50 percentages of respondents are using tank to store rain water, 44.29 percentages of respondents are using well to store rain water.
- 42.86 percentages of respondents were using rain water for outside purpose, 40 percentages of respondents were using rain water for domestic purpose

- 35.82 percentages of respondents were cost incurred for installation of plant is below Rs.10000, 24.29percentages of respondents were is rupees100000 and above,
- 45.71 percentages of respondents have received subsidy from government, 17.14 percentages of respondents did not get any kind of benefits from government, 25.71 percentages of respondents had financial assistance from government and remaining 11.43 percentages of respondents received technological assistance from government.
- 100 percentages of respondents are using sand filter for filtering water.
- 90 percentages of respondents are using cement for constructing the tank with and they are using Ferro cement technology and remaining 10 percentages of respondents are using plastic for constructing the tank.
- 57.14 percentages of respondents were cleaning tank quarterly and remaining 28.57 percentages of respondents were cleaned the tank half yearly.14.29 respondents were cleaned the tank annually.
- The main reason for constructing rainwater harvesting tanks is to meet water requirements (91.42 percentages). Environmental concerns, special interest in rain water harvesting (4.28 percentages) are the other reasons for constructing rainwater harvesting tanks.
- 34.28 percentages tank had storage capacity between 50000liters and above, 41.42 percentages tank had storage capacity between10000 to 20000liters
- (100 percentages) are using plastic to construct gutters and downspouts. It should be noted that none are using metal, cement or others to construct the gutters and downspouts.
- Majority of respondents (64.29 percentages) are using cement to construct roof of the tank. And the rest 35.71 percentages are used tiled sheet to construct the roof.

- About 100 percentages of respondents were getting average level of satisfaction.
- About 38.57 percentages of respondents had installed their rain water harvesting system below five years, 35.71 percentages of respondents had installed their rain water harvesting system between 10 – 15 years and 25.71 percentages of respondents had installed their rain water harvesting system between 5 – 10 years.
- Almost100 percentages of respondents are using the harvesting water in summer season.
- 57 percentages of respondents had the sources of information from awareness programmes and 43 percentages of respondents had received information through Government Institutions.
- 34.28 percentages of respondents had no tap connection, 21.42 percentages of respondents had 2 – 4 taps connected, 18.57 percentages of respondents had 6 and above connected taps, 15.71 percentages of respondents had connected 0 – 2 taps, 10 percentages of respondents had 4 – 6 connected taps.
- The tank is the most expensive part of rainwater harvesting system(100).
- 65.72 percentages of respondents revealed that rainwater harvesting system is very useful to meet water requirements, and it is essential for every households(34.28).
- 65.71 percentages of respondents had reported that pipe and taps gets complaint usually and 34.29 percentages of respondents claimed that filters is the another part to get complaint.

5.3 CONCLUSION

To sum up Palakkad is a drought prone area therefore rain water harvesting is an important source for meeting the water requirements of the respondents. The entire respondent has roof top method to collect the rainwater. Majority of the respondents has incurred rupees below 10000 rupees. As compared to non government organisation the role of government to provide subsidy is more. All the respondents are satisfied with their system.

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APPENDIX

INTERVIEW SCHEDULE

1) Name :

2) Gender :

3) Age :

4) Religion : Hindu ☐ luslim ☐ ristian ☐

5) Community : General ☐ 3C ☐ C ST ☐

6) Category : A1 ☐ B1 ☐

7) Educational Qualifiation: Lower Primary ☐ per Primary ☐

High School ☐ Pre Degree Course ☐

Graduation ☐

8) Occupational Status : Government ☐ ivate ☐ elf employed ☐

Business ☐ Retired ☐

8) Ownership of house : Own ☐ Rent ☐

9) Type of house : Tiled Roof ☐ eeted Roof ☐

9) Income Status : Below Rs. 5000 ☐ s. 5000 - 10000 ☐

Rs. 10000 - 15000 ☐ Rs. 15000 - 20000 ☐

Rs. 20000 - 25000 ☐ Rs. 25000 above ☐

10) Family Status : Nuclear Family ☐ oint Family ☐

Alone ☐

11) Sources of drinking water: Well ☐ ube well ☐ hers ☐

12) Which is the method used Surface runoff harvesting ☐

For rainwater harvesting : Roof top harvesting ☐

13) Where does the collected Tank ☐ echarge Well ☐

Rainwater : Pits ☐ renches ☐

14) For what purposes does the Drinking ☐ tside use ☐

Collected rainwater goes: Domestic purpose ☐ et flushing ☐

15) What is the cost incurred Rs. 25000 – 50000 ☐ s. 50000 – 75000 ☐

For plantation: Rs. 75000 – 100000 ☐ Rs.100000 and above ☐

16) Did you get any assistance Yes, financial assistance ☐

from government : Yes, technological assistance ☐

Yes, subsidy ☐

Yes, free installation ☐ No ☐

17) Which filtering methods charcoal filter ☐ nd filter ☐

are used : sponage filter ☐ ubble filter ☐

18) What is your tank

made off : Plastic ☐ Cement ☐ Steel ☐ Other ☐

19) What is the time period

for cleaning the tank : Monthly ☐ Quaterly ☐

Half yearly ☐ Yearly ☐

20) What is the primary reason for

Constructing rain water harvesting system: Environmental. Concerns ☐

To improve water quality ☐

To meet water requirements ☐

Special interest in rain water

Harvesting ☐

21) How much land required for

Constructing rain water harvesting: Below 100 sq ☐ 100 – 200 ☐

200 – 300 sq ☐ Above 300 sq ☐

22) How many liters of water 10000l - 20000l ☐ 20000l – 40000l ☐

can be stored : 40000l – 50000l ☐ 50000l and above ☐

23) What are your gutters Metal ☐ Plastic ☐

and downspouts made off : Cement ☐ Others ☐

24) What material is used Asphalt shingle ☐ Tile sheet ☐

in your roof : Cement ☐ Wood shingle ☐

25) As compared with other water Yes ☐ Good ☐

sources do you get more satisfaction: Average ☐ No ☐

26) How many years since you Below 5 years ☐ 5 – 10 years ☐

have installed your plant: 10 – 15 years ☐ Above 15 years ☐

27) How long does the plant 10 – 20 years ☐ 20 – 30 years ☐

Survive: 30 – 40 years ☐ 40 years and above ☐

28) Which season you would Rainy ☐ Summer ☐

use the harvested water : Winter ☐ Autumn ☐

29) From where did you known government institutions ☐

about rain water harvesting system : through neighbours, friends, relatives ☐

by awareness programme ☐

other sources ☐

30) How many taps are connected 0 – 2 ☐ 2 – 4 ☐ 4 - 6 ☐

to the tank : 4 - 6 ☐ No tap ☐

31) Which part of rain water Roof ☐ Tank ☐

harvesting system in most costly : Filters ☐ Other parts ☐

32) What is your opinion about Yes, it is needed for every households ☐

rain water harvesting system : Yes, it is very useful in meeting water requirements ☐

No, it is very difficult in maintain ☐

No, it is very waste ☐

33) How satisfied are you with very satisfied ☐ satisfied ☐

Your rain water harvesting system : somewhat unsatisfied ☐

Very unsatisfied ☐

34) Have you faced any complaints Yes big issues ☐ Somewhat small ☐

in this plant : No ☐ Not yet ☐

35) Which part of the plant mostly gets Tank ☐ Gutters ☐

complaints and getting changed frequently : Pipe and taps ☐ ters ☐

RAIN WATER HARVESTING RECHARGE WELLS