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# Impact of Domestic Rooftop Water Harvesting System on Groundwater Potential in Parbhani City, Maharashtra State

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***Abstract :*** *The present study was carried out in the Parbhani city, Maharashtra State to assess the impact of Domestic Roof Water Harvesting System on Ground Water potential of the area. For the research study 20 owners who have installed DRWH system and 20 owners who have not installed DRWH system were randomly selected. Responses by the adopters and non-adopters were obtained by using a questionnaire. The result of the study showed that, the owners who have installed DRWH system by their own interest do not face scarcity of water after installation. They also reported that, before installation of DRWH system they have to face scarcity of water every year. It was observed during research work that, the cost of construction of DRWH system varied according to material used by the owners. The cost of DRWH system for the roof area of 100 $m^2$ with screen filter was estimated about Rs 6980/- and with pit method, it was about Rs 6270/-. The data obtained from the survey of the adopters and non- adopters od DRWH system it was found that, about 100% adopters were satisfied and advised non-adopters to adopt the DRWH system. Also, 100% non- adopters urged need of getting training and technical guidance regarding installation of DRWH system. They also told that, they are interested to install DRWH system in future. Regarding improvement in water quality, about 35% adopters reported that water quality improved after installation of DRWH system. Only 10% adopters were facing the difficulties like care and maintenance of DRWH system. Ninety per cent owners demanded that Government should give subsidy for installation of DRWH system. About 45% non-adopters of DRWH system reported that the cost of installation is more. From the selected non-adopters of DRWH system, 75 % reported that due to provision of municipal water supply they do not have adopted DRWH System*

## I. INTRODUCTION

Due to over exploitation the need of water harvesting by some means has arisen. The precipitation water seems to be one of the possible sources of water in water harvesting. The imbalance between excess withdrawal of groundwater and insufficient replenishment of ground water adversely affected the water table. The increase in the depth of water table is result of unplanned and uncontrolled extraction of ground water. Water harvesting is necessary to conserve and augment the storage of ground water and to reduce water table depletion. The quality of ground water is found to be improved by rain water harvesting. Water stagnation is a problem in urban areas which can mostly be controlled by rain water harvesting. It is also necessary for increasing per capita water availability and make water available for agricultural purpose. It helps in reducing soil erosion

The DRWH system is an economical method for conservation of rain water and to meet the ever increasing demand for water. The Central and State Government both are taking steps to make the installation of rain water harvesting compulsory owing to its importance. In Maharashtra, the State Government has made rain water harvesting mandatory for all buildings that are being constructed on plots that are more than 1000 $m^2$ in size for big cities like Mumbai. Other states also have their own such rule regarding rain water harvesting. In Maharashtra, the average rainfall is 120cm and its variation from region to region is very large. Due to the improper management and development of water resources, the intensity of drought condition has increased. Every year the number of tanker fed villages increased very rapidly. This water scarcity has posed threat to the existence of mankind. If, in time suitable corrective measures are not adopted, then the problem may go out of control.

For Parbhani station in Marathwada region, the average annual rainfall is 872 mm (Anonymous, 2013). Though receiving sufficient rainfall, Parbhani faces the scarcity of water on large scale during summer season. Most of dug wells and bore wells become dry during summer season. It is due to the insufficient natural replenishment of groundwater. The withdrawal of groundwater is done throughout the year, but the replenishment of groundwater takes place only during monsoon season. It also depends upon the quantity, duration and intensity of rainfall and permeability of the soil. Present study was undertaken with the following objectives,

1. To quantify the rainwater harvested throughout DRWH system.
2. To prepare the cost estimate of DRWH systems
3. To study the constraints faced by adopters and non-adopters of DRWH systems.

## II. MATERIALS AND METHODS

The study was conducted in selected colonies of Parbhani city. Twenty DRWH systems were studied to assess the impact of DRWH system on ground water potential of the selected area. Also, twenty non adopters of DRWH system were selected to study the constraints faced by them in adoption of DRWH system. The roof area of the houses where DRWH installed were measured with the help of measuring tape. The average annual rainfall data and annual rainfall data of the year, 2014 was collected from the Meteorological observatory of the V.N.M.K.V. Parbhani. The volume of rainwater harvested from the roof was calculated using the following formula

Volume of rain water harvested from roof of DRWH system ($m^3$) = $\frac{}{1000}$

Where,

R = Annual rainfall in (mm) A = Area of roof ($m^2$)

C = Runoff coefficients for concrete slab (0.9)

The impact of the DRWH system on ground water availability was assessed by comparing the water demand of the families and quantity of rainwater harvested from the roof area. The questionnaire was prepared to study the benefits received regarding groundwater availability throughout the year by the owners, who have adopted DRWH system. The questionnaires were filled with interaction with the adopters of the DRWH system. The cost estimation of DRWH system was made considering the type of filter material, PVC pipe and accessories and other necessary things required for installation of DRWH systems. The cost estimation of DRWH system consisted of cost of materials, fitting charges and the labor cost. The cost of the accessories and materials required for installation of DRWH systems were collected from the authorized supplier of the material. The rate of excavation of the pit and the material such as metal, sand and boulders required for filling the excavated pit of the DRWH system were obtained from DSR (District Scheduled Rates).Twenty each adopters and non-adopters of DRWH system from selected colonies of the Parbhani city were randomly selected to study the constraints faced by them in adoption and reasons for non-adoption of DRWH systems respectively. To know the constraints faced by adopters and non-adapters of DRWH system, the questionnaire was prepared. Accordingly the interaction was made with adopters and non-adopters of DRWH system to collect the information.

## III. RESULTS AND DISCUSSION

**Details of the DRWH system**:

The details of roof area, type of DRWH system, year of construction, cost of construction of each system are presented in Table 1

**Table: 1 Details of DRWH systems**

| DRWH Unit No | Roof Area ($m^2$) | Length of PVC Pipe (m) | Size of Pipe (mm) | Type of Filter Unit | Year of Construction | Cost of Construction (Rs) |
|---|---|---|---|---|---|---|
| 1. | 111.40 | 16.50 | 50 | Pit | 2012 | 6500 |
| 2. | 97.50 | 15.84 | 50 | Pit | 2010 | 4500 |
| 3. | 297.20 | 12.19 | 50 | Pit | 2004 | 5000 |
| 4. | 96.60 | 25.60 | 60 | Pit | 2014 | 5200 |
| 5. | 140.80 | 52.30 | 75 | Pit | 2014 | 25000 |
| 6. | 185.80 | 18.20 | 50 | Pit | 2004 | 5700 |
| 7. | 74.32 | 30.48 | 50 | Pit | 2004 | 3300 |
| 8. | 78.32 | 14.00 | 75 | Screen | 2010 | 11000 |
| 9. | 143.78 | 12.44 | 75 | Pit | 2010 | 8000 |
| 10. | 102.96 | 9.24 | 50 | Pit | 2007 | 5000 |
| 11. | 95.20 | 10.12 | 75 | Pit | 2002 | 4000 |
| 12. | 90.21 | 12.48 | 50 | Screen | 2010 | 10000 |
| 13. | 102.19 | 27.32 | 75 | Screen | 2005 | 4500 |
| 14. | 81.00 | 6.09 | 75 | Pit | 2006 | 4500 |
| 15. | 31.32 | 15.10 | 75 | Screen | 2013 | 10000 |
| 16. | 72.46 | 15.24 | 50 | Pit | 2014 | 5800 |
| 17. | 92.14 | 7.62 | 50 | Pit | 2010 | 5000 |
| 18. | 111.48 | 18.29 | 75 | Pit | 2011 | 5100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 19. | 69.67 | 9.14 | 50 | Pit | 2009 | 4500 |
| 20. | 97.55 | 18.28 | 50 | Pit | 2006 | 4000 |

**Volume of Harvested Water from Roof:** The volume of water harvested from roof area varies according to available roof area. Considering the average annual rainfall of Parbhani station (872 mm) the volume of water harvested from the roof was

calculated. Also in the year 2014 (till September) Parbhani station received rainfall of 532.1 mm. The volume of water harvested was calculated considering runoff coefficient 0.9 for concrete roof. The volume of water harvested from the roof of different DRWH system is presented in Table 2

**Table No 4.2: Volume of Rain Water harvested from roof of DRWH systems**

| DRWH Unit No. | Roof Area ($m^2$) | Volume of Rain Water Harvested Considering Average Annual Rainfall of Station ($m^3$) | Volume of Rain Water Harvested Considering Annual Rainfall During 2014 ($m^3$) |
|---|---|---|---|
| 1. | 111.4 | 87.43 | 53.39 |
| 2. | 97.5 | 76.52 | 46.68 |
| 3. | 297.2 | 233.24 | 142.30 |
| 4. | 96.6 | 75.81 | 46.25 |
| 5. | 140.8 | 111.50 | 67.41 |
| 6. | 185.8 | 145.82 | 88.96 |
| 7. | 74.32 | 58.33 | 35.58 |
| 8. | 78.32 | 61.46 | 37.50 |
| 9. | 143.78 | 112.84 | 68.84 |
| 10. | 102.96 | 80.80 | 49.29 |
| 11. | 95.20 | 74.71 | 45.58 |
| 12. | 90.21 | 70.80 | 43.19 |
| 13. | 102.19 | 80.20 | 48.93 |
| 14. | 81.00 | 63.57 | 38.78 |
| 15. | 31.32 | 24.58 | 14.99 |
| 16. | 72.46 | 56.86 | 34.70 |
| 17. | 92.14 | 72.31 | 44.12 |
| 18. | 111.48 | 87.49 | 53.38 |
| 19. | 69.67 | 54.67 | 33.36 |
| 20. | 97.55 | 76.56 | 46.71 |

The data presented in Table 2 revealed that the volume of water harvested from roof of different DRWH systems varied according to the roof area. Also it was found that in the year 2014, the volume of water harvested from different DRWH systems was less as compared to volume of water harvested considering the average rainfall of Parbhani city. In the year 2014, Parbhani station received below the average annual rainfall. Among selected all DRWH Systems the volume of rain water harvested from roof of DRWH Systems was found in the range of 24.58 to 233.24 $m^3$ considering average annual rainfall of Parbhani station and 14.99 to 142.30 $m^3$ considering average annual rainfall received for the year 2014.

All the owners who have adopted DRWH system reported that they are not facing the problem of scarcity of water during summer season even if Parbhani station receives below average annual rainfall. These owners also stated that before construction of the DRWH system they have to face problem of scarcity of water every year. They also suggested that everyone should adopt DRWH system for increasing water potential of the area.

**Cost Estimation of DRWH System :** Cost of construction of DRWH system (100 $m^2$ roof area) was estimated using the material required for construction of that DRWH system.

**Table 3(a): PVC Accessories and Fitting Cost**

| Sr. No. | PVC pipes and Accessories | Quantity (No.) | Rate (Rs.) | Total (Rs.) |
|---|---|---|---|---|
| 1. | PVC Pipes(50 mm) | 5 | 310 | 1550 |
| 2. | Elbow | 5 | 40 | 200 |
| 3. | T joint | 1 | 40 | 40 |
| 4. | Coupler | 3 | 30 | 90 |
| 5. | Fittings and labour charges | - | - | 300 |
| | Total | | | 2180 |

**Table 3(b): Filtration Equipment Cost**

| Sr. No | Particulars | Quantity (No.) | Rate (Rs.) | Total (Rs.) |
|---|---|---|---|---|
| 1. | Screen filter | 1 | 4000 | 4000 |
| 2. | Flush valve | 2 | 400 | 800 |
| | Total | - | - | 4800 |

**Table 3(c): Pit Construction Cost**

| Sr. No. | Particulars | Volume ($m^3$) | Rate(Rs/$m^3$) | Total (Rs.) |
|---|---|---|---|---|
| 1. | Cost of Excavation | 8.0 | 120 | 960.00 |
| 2. | Cost of Sand Filling | 2.64 | 370 | 976.80 |
| 3. | Cost of Gravel Filling | 2.64 | 400 | 1056.00 |
| 4. | Cost of Boulder Filling | 2.64 | 415 | 1095.60 |
| | Total | - | - | 4088.40 |

Data presented in the tables 3(a), 3(b) and 3(c) show the cost of construction required for DRWH system. The cost of DRWH system with screen filter was estimated about Rs 6980/- and with pit construction was Rs 6270/- The data revealed that the cost of construction was more in case of screen filter. Also it was noticed during the survey that majority of the owners have used remaining building material for construction of DRWH system and they have economically installed DRWH system by their own interest, in their houses.

**Constraints Faced by Adopters of DRWH System:** Datapresented in Table 4(a) showed that 100 % owners are satisfied and advised non adopters to adopt the DRWH system. About 35% owners reported the improvement of water quality and observed choking of filter unit. About 30% owners knew the cleaning procedure of filter unit. About 10% owners were facing difficulties regarding care and maintenance of DRWH system. About 5% owners are facing the problem of scouring of bore well due to direct pouring of water in the bore well.

**Table 4 (a): Evaluation of Installed DRWH Systems**

| Sr. No. | Particulars | Frequency | Percentage |
|---|---|---|---|
| 1. | Difficulty in care and maintenance of DRWH system | 2 | 10 |
| 2. | Observation regarding choking of filter unit | 7 | 35 |
| 3. | Knowledge about cleaning of filter unit | 6 | 30 |
| 4. | Improvement in quality of groundwater | 7 | 35 |
| 5. | Problem of scouring of bore well due to direct pouring of water | 1 | 5 |
| 6. | Satisfaction regarding adoption of DRWH system | 20 | 100 |
| 7. | Advice to non-adopters regarding adoption of DRWH system | 20 | 100 |

**Constraints Faced by Non-adopters in adoption of DRWH System:** Data presented in Table 4(b) shows that 100% non-adopters need training and technical guidance regarding installation of DRWH system. About 95 % non-adopters are interested to install DRWH system in future. About 90% non-adopters demanded that government should give subsidy for installation of DRWH system. About 80% non-adopters know the benefits of DRWH system. About 75% owners reported that due to provision of Municipal water supply they do not have installed DRWH system. About 50% non-adopters do not have knowledge about DRWH system and face scarcity of water. About 45% non-adopters reported that the cost of construction of DRWH system is more and they have seen DRWH system.

**Table 4(b): Constraints Faced by Non-adopters in adoption of DRWH System.**

| Sr. No. | Particulars | Frequency | Percentage |
|---|---|---|---|
| 1. | Facing scarcity of water | 10 | 50 |
| 2. | Knowledge of DRWH system | 10 | 50 |
| 3. | Exposure to DRWH system | 09 | 45 |
| 4. | Knowledge about benefits of DRWH system | 16 | 80 |
| 5. | Installation cost of DRWH system is more | 09 | 45 |
| 6. | Government should give subsidy for installation of DRWH system | 18 | 90 |
| 7. | Need of training and technical guidance for installation of DRWH system | 20 | 100 |

| | | | |
|---|---|---|---|
| 8. | Provision of Municipal water supply | 15 | 75 |
| 9. | Interested in installation of DRWH system | 19 | 95 |

## IV. SUMMARY AND CONCLUSIONS:

**The conclusions of study are given below.**

1. Among selected all DRWH Systems the volume of rain water harvested from roof of DRWH Systems was found in the range of 24.58 to 233.24 $m^3$ considering average annual rainfall of Parbhani station and 14.99 to 142.30 m3 considering average annual rainfall received for the year 2014.
2. The owners who have installed DRWH system by their own interest do not face scarcity of water after installation. Before installation they reported that they have to face scarcity of water every year.
3. The cost of construction of DRWH system varied according to material used by the owners.
4. The cost of DRWH system for an area of 100 $m^2$ with screen filter is estimated about Rs. 6980/- and with pit method is about Rs 6270/-.
5. The cost of construction is more in case of screen filter in comparison of pit construction method.
6. About 100% adopters are satisfied and advised non-adopters to adopt the DRWH system.
7. About 100% non- adopters need training and technical guidance regarding installation of DRWH system and they are interested to install DRWH system in future.
8. About 90% owners demanded that government should give subsidy for installation of DRWH system.
9. About 80 % non-adopters have the knowledge about benefits of DRWH system.
10. About 75% non-adopters reported that due to provision of municipal water supply they do not adopt DRWH system.
11. About 50% non-adopters facing the scarcity of water and have the knowledge about DRWH system installation
12. About 45% non-adopters reported that the cost of installation of DRWH system is more
13. About 35% adopters reported that water qualities improved after installation of DRWH system.
14. About 10% adopters are facing difficulties regarding care and maintenance of DRWH system and 5% adopters reported that they have faced problem of scouring of bore well due to direct pouring of water.

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