International Journal of Agriculture, Environment and Biotechnology
Citation: *IJAEB*: **15**(02): 213-217, June 2022
DOI: 10.30954/0974-1712.02.2022.8

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

AGRICULTURAL ENGINEERING

Water Storage and Conservation Structures in Rajasthan

Balram Sharma[1*], Raj Kumar[2] and Rohitashv Sharma[3]

[1]Indian Institute of Technology, Kharagpur, West Bengal, India
[2]College of Technology and Engineering, Udaipur, Rajasthan, India
[3]Kailash Nath Katju College of Horticulture, Mandsaur, Madhya Pradesh, India

*Corresponding author: balram1997sharma@gmail.com (**ORCID ID:** 0000-0002-4103-0383)

Paper No. 978 **Received:** 21-02-2022 **Revised:** 18-04-2022 **Accepted:** 23-05-2022

ABSTRACT

Water conservation is a wide spread topic for research and discussion. Rajasthan is a dry state with a large arid and semi-arid area. Groundwater levels in region is increasing day by day due to overexploitation and lack of groundwater recharge measures. Precipitation in western Rajasthan is very low out of which maximum are wasted due to run off and infiltration. So, water conservation with storage structures are a solution to meet water demand of area. For water conservation there are many storage and conservation storage are used since a long time. Among these storage Tanka, Nada and Nadi are common structures used in western Rajasthan. Other than these traditional storage systems now-a-days roof rain water harvesting system is also popular due to its various advantages. Objectives of study are determination of different water conservation techniques in Rajasthan and there advantages with economic estimations of roof rain water harvesting system (RRWHS). We also discussed detailed analysis of conservation and restoration measures for traditional storage structures.

HIGHLIGHTS

- Traditional and Modern water storage structures in Rajasthan.
- Roof rain water harvesting system design and uses.

Keywords: Roof rain water harvesting, traditional water conservation methods, Tanka, Nada

Water is life-it is vital for drinking and sanitation, to grow food and support industry. It is backbone of life, and livelihood. India is water stressed country with water availability is below 1700 m^3/head/year. Water management to overcome water scarcity is a necessity to meet global water requirement (Singh *et al.* 2018). Rajasthan is a water scare area especially the MARWAR region has very high water deficit (Choudhary 2018). Area wise Rajasthan is the largest State of India with an area of 342,000 km^2 (10.4% of the country total) have only 1% of water resources of India (Rathore 2004). Annual rainfall in Rajasthan is highly variable and very low that even drinking water demand cannot fulfilled (Choudhary 2018). Rajasthan has the country's largest arid and semi-arid land and faces acute water scarcity due to erratic monsoonal rainfall. There is a need to conserve water in Rajasthan to meet water requirement of livelihood. Water conservation in Rajasthan has received financial aids, political attention, policy implementation, and research curiosity, especially in the western arid region than the relatively water-rich eastern tracts (Rathore 2004). MUKHYAMANTRI JAL SWAVLAMBAN scheme is recent example of policies made for water management in area. Budget for water sector is

How to cite this article: Sharma, B., Kumar, R. and Sharma, R. (2022). Water Storage and Conservation Structures in Rajasthan. *Int. J. Ag. Env. Biotech.*, **15**(02): 213-217.

Source of Support: None; **Conflict of Interest:** None

increasing year by year and goes to 15% of total budget of state (Reddy 2010) economic, financial and equity performance across sub-sectors. The assessment brought out clearly that no indicator has shown satisfactory performance in any of the sub-sectors. Though the urban drinking water sector is relatively better in performance, a lot more needs to be done in order to bring it to the threshold level of economic and financial performance. The huge expenditures incurred in this sector are not going towards real investments that would improve the performance of the sector. Despite the fact that the water sector (except groundwater. Groundwater is critically overexploited in Rajasthan and there are only Monsoon Rivers available in western Rajasthan area so, water storage structures are only hope (Garg 2021). A solution to overcome the water scare condition is to restore water storage structure and stablish new water storage and conservation structures (Goyal and Gaur, n.d.) (Reddy 2010) economic, financial and equity performance across sub-sectors. The assessment brought out clearly that no indicator has shown satisfactory performance in any of the sub-sectors. Though the urban drinking water sector is relatively better in performance, a lot more needs to be done in order to bring it to the threshold level of economic and financial performance. The huge expenditures incurred in this sector are not going towards real investments that would improve the performance of the sector. Despite the fact that the water sector (except groundwater. There are two types of water storage structures in Rajasthan traditional and modern (Prasad *et al.* 2017). Water storage techniques are variable according to social and economic conditions of different-different areas in India. This paper provide the advantages, disadvantages, economical evaluation, structure design of both traditional and modern water conservation measures and techniques. The paper especially emphasize on RRWHS, Tanka, Nada, Nadi, ponds etc.

Methodology

Study area: Study is conducted in Mundwa village of Nagaur district of north-west region of Rajasthan state. Water storage structure in this particular area is developed by various NGOs especially Ambuja Cement foundation. RRWHS, Tanka, Nada, Nadi are the common structures found in region.

Method of study: The economical evaluation is based on survey and ground inspection of area to find out actual cost of structure. Common RRWHS connected with Tanka has capacity of 15000 litter is funded by NGOs so the study emphasize the economical and design of this particular size structure.

Traditional storage structures

1. Tanka: Tanka is an old rain water harvesting structure of Rajasthan. These are available in different shape and sizes, round shaped and rectangle shaped Tanka are common in area. Size of Tanka is depend on available water harvesting area near by it. Tanka can be connected with RRWHS also but traditionally it is connected to "Aagor" (sloped nearby area of Tanka) from where rain water is collected to the storage. Tanka can be made by cement masonry or lime or stones. This should be non-water leakage structure so water can be stored for long time.

Fig. 1: A typical picture of round and rectangle shaped Tanka

Basic characteristics of Tanka for better storage qualities:

- Tanka should not be located close to a source of contamination, such as a septic tank etc.
- Tanka must be located on a lower level than the roof to ensure that it fills completely.
- A rainwater system must include installation of an overflow pipe which empties into a non-flooding area.
- Excess water may also be used for recharging the aquifer through dug well or abandoned hand pump or tube well etc.
- A speed breaker plate must be provided below inlet pipe in the filter so as not to disturb the filtering material.

- Storage tanks should be accessible for cleaning.
- The inlet into the Storage tank should be screened in such way that these can be cleaned regularly.
- Water may be disinfected regularly before using for drinking purpose by chlorination or boiling etc.

2. Nada/Nadi: These are pond sized structure with variable and high water storage capacity. Basically the share of Nada/Nadi is circular but it is changed by various weather activities and generally the shape will become irregular with time. These structures are multipurpose structures that can be used for drinking water for human and other livelihood, for bathing or other activities. In some villages it was found that the Nada and Nadi are separate for human and animal drinking purposes. Basic difference in Nada and Nadi is Nada is bigger than Nadi in size. Nada/Nadi should store the runoff from extreme events and it is well known that this runoff transports high loads of suspended sediment. In the storage, the water velocity decreases and as a result suspended particles settle As a result of the process of capturing sediment, retention ponds gradually become filled with sediment and thus their retention capacity diminishes. So, there is a need for regular evacuation of soil and other organic/inorganic material from Nada/Nadi to prevent the reduction in its storage capacity. The soil evacuate from storage is either used for social/religious purpose of village or sell by local government boards.

(a) (b)

Fig. 2: (a) Nada and (**b**) Sediment extraction from a Nada in Didiya Umrav village Nagaur district Rajasthan

Roof rain water harvesting system

Rainwater harvesting is the accumulation and storage 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 livestock, irrigation, domestic use with proper treatment, 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. The most useful rainwater harvesting technic is roof rain water harvesting system in arid and semi-arid area of Rajasthan. The percolation rate is high so the other harvesting system is not suitable in this area.

Rooftop Rain Water Harvesting is the technique through which rain water is captured from the roof catchments and stored in Tanka (Prasad *et al.* 2017). Harvested rain water can be stored in sub-surface ground water reservoir by adopting artificial recharge techniques to meet the household needs through storage in tanks. The Main Objective of rooftop rain water harvesting is to make water available for future use. Capturing and storing rain water for use is particularly important in dry land, hilly, urban and coastal areas. Advantages of Rain Water Harvesting system can be listed as; (1) Provides self-sufficiency to your water supply. (2) Reduces the cost for pumping of ground water. (3) Provides high quality water, soft and low in minerals. (4) Improves the quality of ground water through dilution when recharged to ground water. (5) Reduces soil erosion in urban areas. (6) The rooftop rain water harvesting is less expensive. (7) Rainwater harvesting systems are simple which can be adopted by individuals. (8) Rooftop rain water harvesting systems are easy to construct, operate and maintain. (9) In saline or coastal areas, rain water provides good quality water and when recharged to ground water, it reduces salinity and also helps in maintaining balance between the fresh-saline water interfaces. (10) In desert, where rain fall is low, rain water harvesting has been providing relief to people.

Design

1. Capacity of RRWHS

Capacity of RRWHS is dependent on the need of individual family or community, purpose of

Table 1: Detailed cost estimation of RRWHS

Sl. No.	Description	Quantity Estimate	Quantity	Rate (₹)	Cost (₹)
1	Earthwork Excavation for RRWHS GI to 2.7026	(3.14*2.7026*3.424*3.424)/4	24.8850	50	1244.25
2	Cement Concrete Foundation (1:3:6) with 150 Mm Size Nominal Size Aggregate (a) RRWHS (b) Silt Trap	(a) (3.14*3.424*3.424*0.15)/4 (b) (.6405*.6405*.15)/4	1.38117 0.01538	2406	3325.8573 37.00428
3	Course Rubble Measonary for Side Walls in Cement Mortar (1:6) (a) Side Wall (b) Silt Trap	(a) (3.14*(3.424^2-2.652^2)*3.1872)/4 (b) (.6405^2*.4575) - .4575^3	11.7417 0.09192	1829	21475.569 168.12168
4	Stone Khrancha on Bottom of RRWHS 150Mm	(3.14*3.424*3.424*.15)/4	1.38117	1000	1311.7
5	Stone Slab Roofing 100 Mm Thick	(3.14*3.424*3.424)/4	9.2078	1300	11970
6	Cement Palaster (1:6) 12 Mm Thick (a) Side Walls (Inside) (b) On Parapet (Outside) (c) Silt Trap Sides (d) Silt Trap Bottom	(a){3.14*2.64*3.1872}/4 (b)[3.14*3.442*3.1872]/4 (c)(4*.4572^2)+(4*.6405^2) (d).4572*.4572	26.4340 34.28411 2.4770 0.20908	97	6149.8
7	25 Mm Thick Cement Concrete Flooring (1:2:4) with 125 Mm Aggregates (a) RRWHS Bottom (b) Top of RRWHS Roofing	(a) (3.14*2.64^2*0.15)/4 (b) (3.14*3.424^2*0.15)/4	0.082108 1.38117	2280	2585.63
8	Providing and Fixing Lid or Roofing for Drawl of Water Made of Iron with Lock	1	1	750	750
9	Hand Pump	1	1	450	450
10	PVC Pipe	30 Feet	30 Feet	35	1050
11	Sub Total				50287.39
12	Miscellaneous	7%			3520
13	Total				53807.5

Where L, B, H and V are length (m), Width (m), depth (m) and Volume (m^3) respectively. For known volume (V) and two pre-decided dimensions of length, width or depth, third unknown dimension can be worked out using above equation.

harvested water and the capital available for the investment. The designed capacity must match with the available runoff as estimated above by

$$R = P*C*A \qquad \ldots(1)$$

Where R is runoff, P is rainfall, C is runoff coefficient. For individual family water requirement can be worked out considering the family size, daily water requirement and time period using

$$V = N \times Q \times T \qquad \ldots(2)$$

Where V is volume or Capacity of RRWHS, N is number of persons dependent on RRWHS, Q is daily water requirement and T is number of days for which water is required. Daily minimum water requirement of a person varies from 7 liters to 10 liters depending upon the season and work stress. Additional requirement of water for other purposes like animals (about 40 liters per day) and raising small nursery etc. can be worked out using above formula separately and total capacity can be estimated by adding all individual water requirements. The total capacity should be multiplied by a factor of 1.1 taking in to consideration of evaporation and seepage losses if any to arrive at final capacity of RRWHS.

Dimensions of RRWHS

Once the capacity of RRWHS is decided, its shape and other dimensions can be worked out.

Evaporation losses are higher in RRWHSs with wider opening and shallow depth but are more stable and easy to construct. However, cost to cover the opening of such RRWHS is more. On the other hand, narrow opening RRWHS with deeper depth causes less evaporation but needs extra strengths in bottom for stability in terms of material and cost of excavation is high at deeper depth. Therefore, opening and depth of RRWHS should be optimized for minimum evaporation loss and construction cost. For circular RRWHS, depth and diameter should ideally be equal and can be calculated by using:

$$D = (1.27 \times V)\ 0.33 \qquad \ldots(3)$$

Where D is the diameter as well as depth in meters and V is capacity in cubic meters. For designing rectangular RRWHS, two dimensions of either length, width or depth are first decided on the basis of local site conditions and third dimension is calculated using:

$$V = L \times B \times H \qquad \ldots(4)$$

Where L, B, H and V are length (m), Width (m), depth (m) and Volume (m^3) respectively. For known volume (V) and two pre-decided dimensions of length, width or depth, third unknown dimension can be worked out using above equation.

Estimation of cost for a 15000 liter capacity RRWHS

15000 liter is a general size used to make by NGOs in area and financial assistance has been given according to following calculation. The financial assistance is provided higher to the socially weaker section as SC/ST and women. This estimation is based on data collected to local level and varies NGOs at the time of study. The total cost calculated for a 15000 liter RRWHS is 53807.30 Indian rupees (table 1). After the financial assistance the cost is reduced significantly and that will be nominal cost paid up by the beneficiaries. So, RRWHS is cost effective and efficient technology for water storage and conservation (Goyal *et al.* 1995).

CONCLUSION

There are different water storage structures and techniques available in Rajasthan. Among these Tanka and RRWHS are most popular and widely adopted method of water conservation. Both methods are economically and socially acceptable because of simple construction and better efficiency. Financial assistance provided by NGOs and government supports the water conservation movement and reduce to effective cost for beneficiary.

REFERENCES

Choudhary, V. 2018. A Study of water crisis problem in Kishangargh area in 5, 722–727.

Garg, V. 2021. Design of rain water harvesting structure in Rajasthan.

Goyal, R.K. and Gaur, M.K., n.d. Water Resources and Surface Water Bodies in Hot Arid Zone.

Goyal, R.K., Ojasvi, P.R. and Bhati, T.K., 1995. Economic evaluation of water harvesting pond under arid conditions.

Prasad, J., Purohit, D.G.M., Sharma, S., Ameta, N.K., Education, T., Engg, C., College, M.B.M.E., Jodhpur, J., Engg, C., College, M.B.M.E. and Jodhpur, J. 2017. Rain Water Harvesting Through Tanka in Western Rajasthan, pp. 281–290.

Rathore, M.S. 2004. International Water Management Institute State Level Analysis of Drought Policies and Impacts in Rajasthan, India.

Reddy, V.R. 2010. Water sector performance under scarcity conditions: A case study of Rajasthan, India. *Water Policy*, **12**: 761–778.

Singh, C., Osbahr, H. and Dorward, P. 2018. The implications of rural perceptions of water scarcity on differential adaptation behaviour in Rajasthan, *India. Reg. Environ. Chang.*, **18**: 2417–2432.