Rain Water Harvesting and Recharge Augmentation through Percolation Tank in Semi-arid areas- A Case Study

S. Vijayakumar[1], K.V. Rao[1], C. Sarala[2], Vinaykumar K.[1] and M. Prabhakar[1]

[1]*Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad - 59.*

[2]*Jawaharlal Nehru Technological University Hyderabad (JNTU), Hyderabad - 85.*

E-mail: vijay@crida.in

ABSTRACT

The paper discusses the use of rain water harvesting as an effective tool for water management by using of different techniques. In arid and semi-arid regions the problem of water shortage is one due to low rainfall and uneven distribution throughout the season, which makes rain fed agriculture a risky. Rain water harvesting for dry-land agriculture is a traditional water management technology to ease future water scarcity in many arid and semi-arid regions. As rainfall is the main source of surface water and its conservation is essential. Hence, rainwater harvesting is one of the most promising techniques for collection of excess runoff. Augmentation of recharge to ground water through percolation tank is closely related to the survival of about 30 open and bore well water levels increased, 4.5 ha cropping area increase under the tank, 60 farmers and 120 numbers of cattle, living animal getting benefit in KVK adopted village. Here the Monsoon rains are restricted to 30 to 40 and frequency of very event is less. The efficiency of the percolation tank is hampered by the silt, which accumulates in the tank bed, year after year. It is therefore, necessary for the beneficiary farmers to remove silt from the tank bed when the tank dries in the summer season.

The present study deals with the intervention to enhance the land water productivity and cropping intensity through multiple use management of the harvested rainwater. The study was focused on the conservation of rain water at farmers' fields. This technique attributed to significant improvement in ground water levels in open and bore well depth 4.2 meters.

Keywords: Rainfall, Groundwater Recharge, Percolation Tank, Watershed and Rain Water Harvesting.

INTRODUCTION

Percolation tank is Necessity for rainwater harvesting to improve ground water through artificial recharge to reserve the trend or to reduce the effect of over exploitation, the ground water recharge is essential at large scale at agricultural and residential. But the effort made towards the replenishment of augmentation of ground water resources, are very meager.

Objectives

To address these objectives, an attempt was made by the CRIDA-KVK to design and develop a technology for enhancing intake rate of runoff with inverted filter system / unit by harvesting rainwater available in the form of surplus runoff and its reuse for ground recharge through bore wells / open wells. Further studies were conducted to determine the impact of these by observing the ground water levels of bore wells / open wells existing in the kandlapalli village in pudur mandal and also an attempt was made to recharge ground water using surface runoff. The objectives of these activities are

- To improve ground water resources by artificial recharge.
- To know the technical feasibility and impact of recharge system/unit
- Rearing fish is an additional income to village committee as a source of livelihood
- To know the economic aspects of recharge techniques.

STUDY AREA

The study was carried out during 2011–14 in the Kandlapalli Village Community Percolation Tank situated in Pudur Mandal of Rangareddy district, Andhra Pradesh (Figure 1). The selected tank covers 13 ha, an average slope ranging from 2% to 9%, and consists mainly of red soils. The mean annual rainfall of the area is750 mm. The programme was implemented by the CRIDA under NICRA Project.

Renovation of Village Tank as Recharge Structure

A percolation tank can be defined as an artificially created surface water body submerging a highly permeable land area so that the surface runoff is made to percolate and recharge the ground water storage. Percolation tanks are to be normally constructed on second or third order streams, as the catchment area of such streams would be of optimum size. The existing village tank, which are normally silted and damaged, can be modified to serve as recharge structures. Unlike in the case of properly designed percolation tank, waste weirs damaged and water leakages were there and renovation provided for village tanks. De-silting of village tanks together with proper provision of waste weir can facilitate their use as recharge structures.

Advantages of Rainwater Harvesting by Community Percolation Tank

- An ideal way to solve the water problem
- The ground water levels will rise
- It reduces the runoff which chokes the storm water drains
- It reduces flooding of fields, also reducing soil erosion
- The quality of water improves
- To enhance the sustainable yield in areas where over-development has depleted the aquifer
- Conservation and storage of excess surface water for future requirements, since these requirements often change within a season or a period.
- To improve the quality of existing ground water through dilution.
- The basic purpose of artificial recharge of ground water is to restore supplies from aquifers depleted due to excessive ground water development. Desaturated aquifer offers good scope in locations where source water, if available, can be stored using artificial recharge techniques.

Community percolation tank is situated at N 17^0 17.895^1 and E 78^0 1.056^1 towards kandlapally village road Pudur mandal of Rangareddy district. The present tank does not have enough capacity to accommodate all the runoff from the catchment. The tank bed was silted up. After discussion with the farmers it was proposed to enhance the storage capacity by de-silting the tank bed area of 0.354 ha and bud strengthening. With the provision, it is express to increase the groundwater level in wells located surrounding areas and increase the availability of drinking water for livestock. The tank silt of thickness of approx one meter need to be excavated over tank bed. The proposal has been discussed with farmers and they have agreed to transport the tank silt to their fields for application of same. The tank is surrounded by 15 to 20 open wells and bore wells of which some of them are defunct. If the tank is renovated, all the wells would get recharged and cropping intensity. Could be enhanced 50 to 60 farmers may get benefited from this interventions.

Total Catchment Area to tank: 13 hectares

Water spread area of tank: 0.354 hectares

Annual average rainfall: 750mm

Max. Expected water yield: 10400 m^3

Existing storage capacity: 5575 m^3

Designed storage capacity: 9115 m^3

(To achieve the designed capacity the following work need to be carried out)

Total earth work involved to achieve design storage capacity: $3540 m^3$

The additional volume is attaining by one meter deep throughout the tank bed area of 0.354 ha

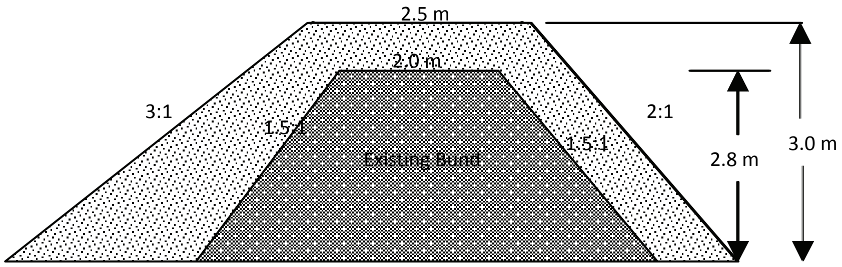


Fig. 1 Cross Section of the Existing Bund and Dimensions for the Proposed Bund (Fig. not to scale)

Table 1 Technical details of Proposed Bund Cross Section

S. No	Particulars	Existing Bund	Proposed Bund
1	Bund width	2.0 m	2.5 m
2	Bund height	2.2-2.8 m	3.0 m
3	U/S slope	1.5 :1	3:1
4	D/S slope	1.5 :1	2:1
5	Average cross section	$14.37 m^2$	$30 m^2$

A total length of 75 m bund needs to be strengthened to attain proposed cross section, the earth work involved is around $1062 m^3$

Hydrological analysis

Annual rainfall data from 2004 to 2013 (10 years) of this area was analyzed for distribution and probability. It was observed that the average annual rainfall of the past 18 years was 675 mm and run-off-producing rainfall was 418 mm (62% of total rainfall) spread over nine runoff producing rainy days out of a total of 32 rainy days. Average run-off depth was estimated to be 8.60 cm (12.57% of total rainfall) based on SCS method for red soils. Since 2004, the watershed has been treated with soil and water conservation measures. Storm-wise rainfall, antecedent precipitation index (API), run-off, evaporation and percolation for all the structures and detailed water budgeting for predicting run-offs and other related required data collecting form tank.

RESULTS AND DISCUSSIONS

Fish Production for Livelihood

Fish production in Tank was studied with different breeds of fishes released in percolation tank in year 2013. Total 6000 finger lings viz.., Rohu (2000 finger lings), Catla (2000), Shelavathi (2000) were released in the community percolation tank through resolution pass by the village committee, quality of water was observed frequently and nutrient food was provided as per required interval. Through this activity, an additional income was generated to the village committee.

Groundwater use in Pre-project Period

In the pre-project period (2010–11), total water requirement for irrigation during kharif and winter was increase in 15%. This requirement was met by rainfall (0.5 ha m) and by the net availability of groundwater quantity (53.4 ha m) due to existing percolation tanks in the vicinity. This resulted in a desirable situation of groundwater surplus to tide over drought years, which is a common occurrence (once in three years) in this arid to semi-arid tract.

Groundwater use in Post-project Period

In the post-project period (2011–2014), the average irrigated area in the pre-project period. Correspondingly, the average groundwater draft increased pre project period to average post-project period. Irrigation water was met by direct rainfall and natural recharge plus recharge due to existing Tank in the vicinity

Among the existing eighteen open wells (average depth 15 m) some of the well shave dried up since 2006 due to the indiscriminate drilling of bore wells. Further, failure rate of the bore wells commissioned since 2003 was three for every successful bore well and resulted in increasing the financial liability of the farmer. The above situation suggests that authorities should take up measures for groundwater recharge and exploitation simultaneously and should issue guidelines for groundwater exploitation. Percolation Tank actually leads to increased water use for irrigation as shown in table 2, Table 3 because extending the area under irrigation is often an explicit objective or an unintended outcome.

Table 2 Increase in Groundwater use for Irrigation with Time

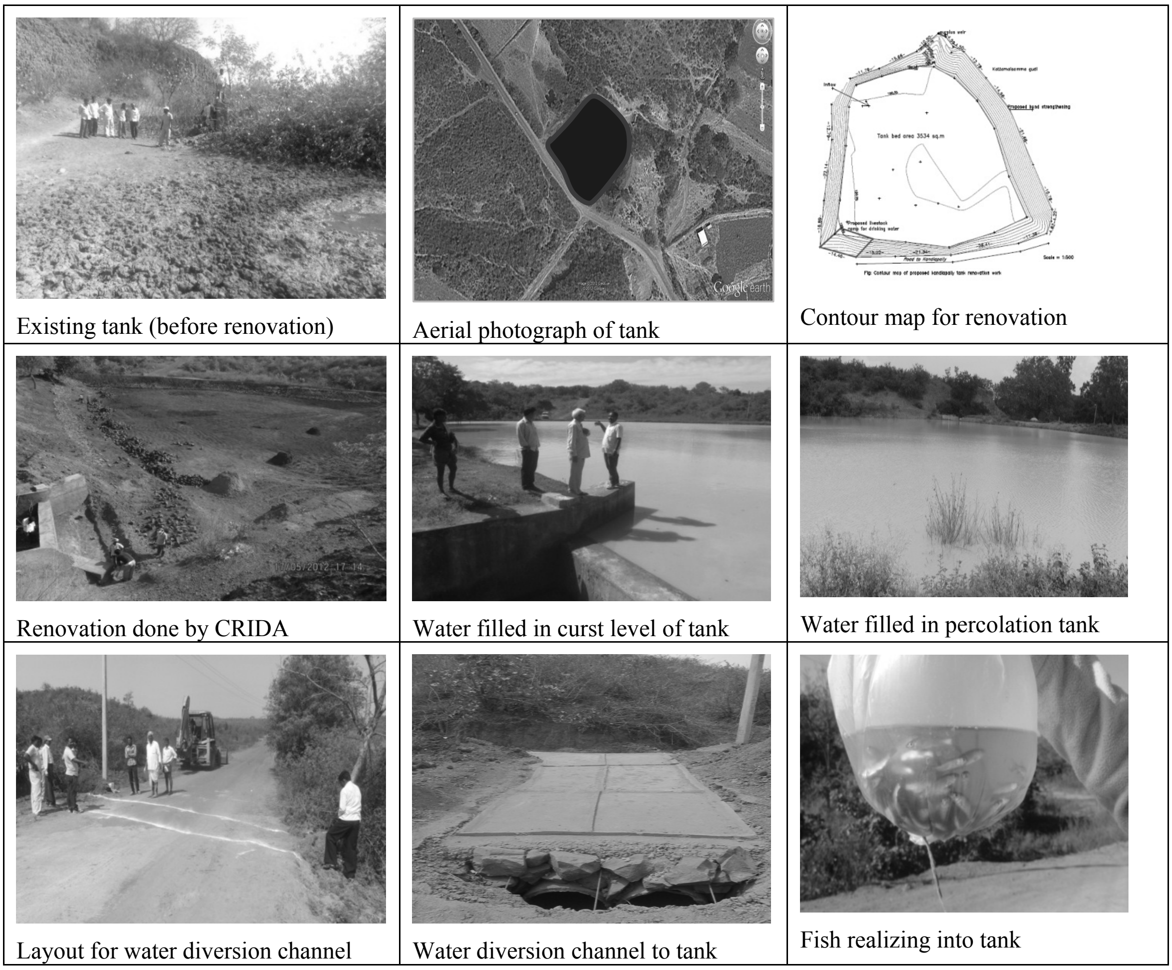
Project type	Period (Years)	Rainfall (mm)	Irrigation quantity required (ha m)	Water availability* (ha m)	Over-exploitation (ha m)
Pre-Project	2010	1108	14	15.51	0
Post-Project	2011	612	28	17.13	10.864
	2012	780	36	28.08	7.92
	2013	655	30	19.65	10.35
Average		**682.33**	**31.33**	**21.62**	**9.71**

*Source of water availability include rainfall, natural recharge form Tank and outside the tank

Table 3 Irrigated Crops during Pre and Post Project Area enhanced through Percolation Tank

S.No	Main crops	Pre-2010	Post-Project Irrigation area(ha)			Average (ha)	Area Increased (ha)
		Irrigation area(ha)	2011	2012	2013		
1	Paddy	12.3	14.5	15.6	16.3	15.47	25.75
2	Maize	4.7	5.1	5.3	6.5	5.63	19.86
3	Red gram	12.2	14.1	16.4	20.2	16.90	38.52
4	Jowar	7.5	8.3	9.1	9.8	9.07	20.89
5	Turmeric	3.2	3.5	4.3	5.8	4.53	41.67
6	Vegetables	6.5	7.2	7.7	8.3	7.73	18.97
7	Fodder	2.1	2.4	3.2	3.5	3.03	44.44

Percolation tanks have immense potential to store rainwater. The harvested rainwater can not only be used to meet water requirements but also to recharge groundwater aquifers. The artificial recharge to ground water aims at augmentation of ground water reservoir by modifying the natural movement of surface water. Any man made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system.



Existing tank (before renovation) | Aerial photograph of tank | Contour map for renovation

Renovation done by CRIDA | Water filled in curst level of tank | Water filled in percolation tank

Layout for water diversion channel | Water diversion channel to tank | Fish realizing into tank

Fig. 2 A View of Rainwater harvesting structure

CONCLUSION

In this study various hydrological parameters related to groundwater recharge have been estimated. Relationship between API-based rainfall and run-off has been developed. The results show that the threshold value of rainfall for ensuring 1 mm potential recharge is 28– 82 mm in this dry region. Potential recharge has been estimated to be 3% of rainfall. The study clearly indicates that water harvesting committee, in semi-arid red soil region helped in improving groundwater recharge, but also led to its subsequent over-exploitation. The results of the study can be applied for similar agro-climatic regions for approximate quantification of surface storage and groundwater recharge.

SUMMARY AND RECOMMENDATIONS

The ground water use may be further enhanced to support agricultural development and to improve rural livelihoods apart from meeting water supply demand. There is a need of adequate knowledge of rainwater harvesting and formulation of proper strategy. An appropriate strategy may take into consideration the following:

- ♦ Identification of Aquifers under the stress and the potential recharge zones in respect of overexploited aquifers. Detailed aquifer mapping is required for scientific planning of the ground water augmentation.

- Design and implement suitable, site-specific surface water harvesting structure to raise the ground water table.
- Introduction of water-harvesting structures on unpolluted stream water bodies and open areas
- Protect aquifer sanctuaries and make them sustainable for future demand.
- Capacity building of the Community / Gram Panchayat /Water User Association/ and its involvement in implementation and maintenance. Participatory approach for monitoring and management of ground water resources is to be promoted in coming years.

REFERENCES

1. Jaya Rami Reddy, 1996. A Test book of Hydrology. Laxmi publications (pvt), pp420-432.
2. Mishra PK, Rama Rao CA and Shiv Prasas S (1998) Economic evaluation of farm pond in a micro watershed in semi arid alfosol Deccan Plateau. Indian Journal of Soil Conservation 26(1) 59-60.
3. Nash.J.E, 1960, “A note on investigation into two aspects of the relation between rainfall and strom runoff” int.assn.of sci.and hydrol, pub1.51, pp 567-578.
4. Santosh Kumar Grurg, 1999, A Test book of Irrigation engineering and hydraulic structures, Khanna publishers, pp 372-414.
5. Wani, SP, Joshi PK, Raju KV, Sreedevi TK, Wilson JM, Shah Amita, Diwakar PG, Palanisami K, Marimuthu S, Jha AK, Ramakrishna YS, Meenakshi Sundaram SS and D’souza Marcella. (2008). Community Watershed as a Growth Engine for Development for Dry land Areas. A Comprehensive Assessment of Water she Programs in India. Global Theme on Agro ecosystems Report No.47, Patanchery 502324, Andhra Pradesh, India, ICRISAT.36 pp.
6. http://nrega.ap.gov.in/Nregs/AP web site