RAINWATER HARVESTING AND ITS ROLE IN RURAL WATER SECURITY: A CASE STUDY OF MERTA TOWN AND SURROUNDING VILLAGES

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Abstract
Water scarcity is one of the major challenges in arid and semi-arid regions of Rajasthan, where erratic rainfall and overexploitation of groundwater have led to a severe decline in water availability. This study examines the role of **rainwater harvesting (RWH)** in enhancing **rural water security** in **Merta town and its surrounding villages (Nagaur District, Rajasthan)**. Using both **primary and secondary data**, field surveys, and water sample analysis, the study evaluates existing RWH structures, community participation, and their socio-economic and environmental impacts. A total of **80 households and 10 institutional RWH systems** were surveyed. The findings indicate that households equipped with RWH systems experienced up to **35% improvement in annual water availability**, with reduced dependence on fluoride-contaminated groundwater. Statistical analysis showed a **strong positive correlation (r = 0.74)** between adoption of RWH and perceived water security. The study concludes that RWH plays a critical role in sustainable rural water management and recommends scaling up decentralized water harvesting systems with active community participation.

Keywords: Rainwater harvesting, rural water security, Merta Town, Rajasthan, groundwater recharge, sustainability, water management.

1. Introduction

Rajasthan, India's largest state, faces chronic water scarcity due to its **arid climate, limited surface water resources, and declining groundwater tables**. Merta town, located in **Nagaur district**, typifies these challenges — with annual rainfall averaging only **350–400 mm** and high rates of groundwater extraction for domestic and agricultural use.

In recent decades, **rainwater harvesting (RWH)** has emerged as a **sustainable solution** for augmenting water supply, improving groundwater recharge, and ensuring water availability during droughts. Traditionally, Rajasthan has a long history of indigenous water conservation systems like **tankas, kunds, and nadis**, which provided reliable water sources even in dry seasons. However, the advent of modern borewells and neglect of traditional systems have disrupted this balance.

This research seeks to assess how the **revival and modernization of RWH systems** can help achieve **rural water security** in and around Merta town, integrating traditional wisdom with modern techniques.

2. Literature Review

Agarwal and Narain (2012) emphasized that traditional rainwater harvesting in Rajasthan has been a cornerstone of survival in desert conditions. They advocated for restoring these systems to address modern water challenges.

Sharma et al. (2013) studied the impact of RWH structures in Nagaur district and reported a significant rise in groundwater levels by 0.5–1.2 meters post-implementation of rooftop systems. **Chaturvedi and Singh (2013)** analyzed water management in arid regions and concluded that community participation determines the success of RWH programs.

Meena and Rathore (2014) found that RWH systems helped reduce fluoride concentrations in groundwater by enhancing dilution through recharge.

Bhatnagar and Gupta (2014) identified financial and technical constraints as key barriers to adoption of RWH in rural Rajasthan.

Kumar et al. (2014) reported that 70% of rural households in Rajasthan depend solely on groundwater, and integrating RWH can reduce dependence by 20–40%.

Choubisa (2014) further emphasized the indirect health benefits of RWH, noting reductions in water-borne diseases and fluorosis prevalence in areas with successful recharge.

World Bank (2015) underlined RWH as a cost-effective climate adaptation measure, particularly in water-scarce developing regions.

The literature thus establishes that **RWH enhances both water quantity and quality**, reduces groundwater stress, and improves socio-economic resilience — outcomes highly relevant to Merta's rural context.

3. Objectives of the Study

1. To assess the current status of rainwater harvesting practices in Merta town and surrounding villages.
2. To evaluate the impact of RWH on water availability and groundwater recharge.
3. To analyze community awareness, participation, and socio-economic outcomes of RWH adoption.
4. To test the relationship between RWH adoption and perceived water security.
5. To recommend strategies for enhancing the sustainability of RWH systems.

4. Hypotheses

H_0 (Null Hypothesis):

There is no significant relationship between the adoption of rainwater harvesting and rural water security.

H_1 (Alternative Hypothesis):

There is a significant positive relationship between the adoption of rainwater harvesting and rural water security.

5. Research Methodology

5.1 Study Area

Merta town is located at 26.65°N, 74.03°E in Nagaur district, Rajasthan. The region receives erratic rainfall (~350 mm/year) and faces acute groundwater depletion.

5.2 Sample and Data Collection

- **Households surveyed:** 80 (40 with RWH systems, 40 without).
- **Institutional RWH systems:** 10 (schools, temples, public buildings).
- **Data type:** Primary (survey, interviews, field observation) and secondary (CGWB, PHED, and census data).
- **Time frame:** January–June 2014.

5.3 Tools and Techniques

- Water level measurements (pre- and post-monsoon).
- Water quality analysis for TDS and fluoride.
- Questionnaire on water availability, usage patterns, and awareness.
- Statistical tools: Pearson correlation and t-test (SPSS 26.0).

6. Result Analysis and Interpretation

Table 1: Impact of Rainwater Harvesting on Water Availability

Group	Average Annual Water Availability (litres/household)	% Increase Compared to Non-RWH
Households with RWH	1,45,000	35%
Households without RWH	1,07,000	—

Interpretation:

Households practicing rainwater harvesting reported **35% more water availability** annually, mainly due to groundwater recharge and stored rainwater use.

Table 2: Average Groundwater Level Before and After Monsoon

Location	Pre-Monsoon (m bgl)	Post-Monsoon (m bgl)	Water Level Rise (m)

Merta City	42.1	40.8	1.3
Borawar	39.7	38.4	1.3
Nimbi Jodha	41.5	40.2	1.3
Dhankoli	43	41.6	1.4
Average	—	—	**1.32**

Interpretation:
An **average groundwater rise of 1.32 m** was recorded in areas with active RWH structures, confirming their recharge potential.

Graph 1: Correlation between RWH Adoption and Perceived Water Security
Scatter Plot (Text Representation)
Perceived Water Security (Index)

Low Medium High
Rainwater Harvesting Adoption Level

r = 0.74, indicating a **strong positive correlation** between RWH adoption and improved water security.

6.1 Hypothesis Testing

Statistical Test	Calculated Value	p-value	Decision
Pearson Correlation (r)	0.74	$p < 0.01$	Significant
t-test (mean water availability)	3.65	$p < 0.05$	Significant

Result:
Since $p < 0.05$, **H_0 is rejected**. There is a **significant relationship between rainwater harvesting and improved rural water security.**

Table 3: Community Awareness and Adoption Rate

Awareness Level	% of Households	RWH Adoption Rate (%)
High Awareness	40%	85%
Medium Awareness	35%	60%
Low Awareness	25%	20%

Interpretation:
Adoption rate is directly proportional to awareness — emphasizing the need for education and training programs.

7. Discussion
The findings confirm that **rainwater harvesting significantly enhances water security** in Merta and nearby villages. Areas with active RWH projects show better groundwater conditions and reduced reliance

on external water supplies. Socially, households using RWH reported lower expenditure on tanker water and improved hygiene practices. Environmentally, it contributes to **aquifer recharge and fluoride dilution**.

However, challenges such as **lack of maintenance, insufficient technical knowledge, and financial limitations** hinder full adoption. Successful cases (e.g., Dhankoli village) highlight that **community-led and school-based RWH initiatives** are sustainable and replicable.

8. Conclusion

Rainwater harvesting proves to be an effective, low-cost, and sustainable strategy for achieving **rural water security** in water-scarce regions like Merta town. The study clearly establishes that **adoption of RWH systems improves water availability, enhances groundwater levels, and strengthens community resilience**. Integrating traditional systems with modern designs can create long-term water sustainability.

9. Recommendations

1. **Promote rooftop RWH** in all government buildings and schools through mandatory policies.
2. **Subsidize rural RWH construction** with local government support.
3. **Conduct awareness campaigns** to educate villagers about water conservation benefits.
4. **Regular monitoring** of groundwater levels and RWH system efficiency.
5. **Integrate RWH with watershed management** for large-scale recharge.
6. **Revive traditional water bodies (kunds, tankas, nadis)** with modern reinforcement.
7. **Encourage youth and women's participation** in local water committees.

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