STUDYING THE CURRENT PRACTICES ON GREYWATER MANAGEMENT AND ITS REUSE POTENTIAL FOR IRRIGATION AND GROUNDWATER RECHARGE

Presented by Uzra Sultana
ARGHYAM, Bengaluru, INDIA

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Objective of the study

To document the current practices and treatment technologies in greywater management and assess the potential for reuse in irrigation and groundwater recharge.

Current scenario

1. With 55 litres per capita per day (lpcd) water supply under the Jal Jeevan Mission in rural areas, it is estimated to generate 34,000 MLD of greywater - *Tap the resource potential*
2. Nearly 17,000 MLD (60-70% of total generated) of reusable greywater is generated annually, yet rural reuse remains minimal, representing a missed opportunity to ease pressure on freshwater sources - *Tap the reuse potential*
3. Over 80% of groundwater is used for irrigation. Water-intensive crops like paddy & sugarcane caused 87% of Punjab's rural blocks are over-exploited - *Reduce over extraction*
4. Greywater reuse after treatment is nutrient rich, but poor management leads to not just poor health but also hinders education and livelihood - *Create hygienic conditions*

Untreated greywater let into waterbody in a village in Punjab

Five States, 20 Villages - Diverse Challenges – The study scope

01 & 02

Punjab & Haryana

Water-intensive crop growing states facing severe groundwater depletion and over-exploitation

03

Rajasthan

Arid zone with water scarcity, high evaporation rates and fragile hydrogeology

04

Gujarat

Semi-arid conditions with regional variation from 300-1,500 mm rainfall annually

05

Karnataka

Diverse geography from coastal high-rainfall zones to rain-shadow interior regions and semi-arid zones

- Climatically and agriculturally diverse states, selected to represent regional challenges.
- The selection of 20 villages was done in consultation with the Government Departments, focusing on best practices and where JJM has made significant progress.

Methodology

- ✓ Consultation with about 10 Experts from the sector like CDD, WASHi, WaterAid, Piramal Foundation, UNICEF, Aga Khan Foundation, Hashtag per Capita Pvt Ltd and WSAFE
- ✓ Interactions with Officials from State/District/Block Government officials, FGDs with Gram Panchayat members and interaction with community representatives
- ✓ Villages both with and without greywater treatment facilities
- ✓ Focus on the technical, financial and operational aspects of the entire value chain of greywater management
- ✓ Secondary data – JJM, SBM-G, MGNREGS, 15th FC funding; State-specific policy documents; Water quality reports; Mission Antyodaya village data

20 FGDs involving **~240** participants	**~80** Elected members interacted	**~22** State/ District/ Block Govt. officials	Over a period of **~45** days in the field

FGDs with the Gram Panchayat members and the Community representatives in Punjab

Estimation of greywater generation and reuse/recharge potential

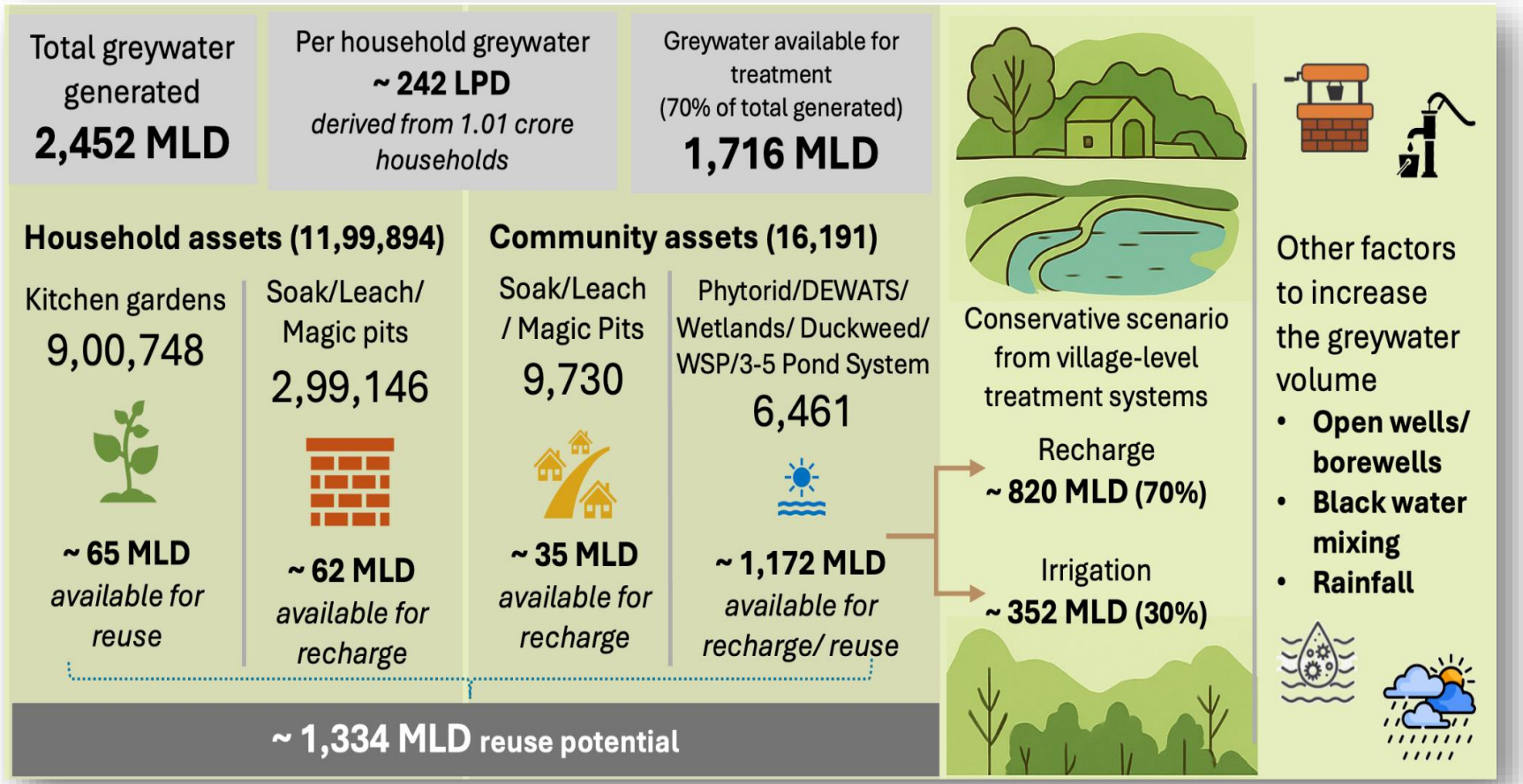
	Total greywater generated in MLD	Per household greywater in liters/day	Greywater available for treatment in MLD *(70% of total generated)*	Total reuse potential from Kitchen gardens, soak/magic/leach pits and treatment systems	Other factors increasing the volume of greywater
Gujarat	2,406	264 *(@ 91 lakhs HHs)*	1,684	**1,048 MLD**	Water supply ~100 lpcd; Open / bore/ Tube wells; Black water mixing; Rainfall
Haryana	1,018	335 (@ 30.41 lakhs HHs)	712	**589 MLD**	Open wells/ borewells; Black water mixing; Rainfall
Karnataka	2,452	242 *(@101 lakhs HHs)*	1,716	**1,334 MLD**	Open wells/ borewells; Black water mixing; Rainfall
Punjab	1,003	293 *(@34.2 lakhs HHs)*	702	**561 MLD**	Water supply >150 lpcd; Open / bore/ Tube wells; Black water mixing; Rainfall
Rajasthan	3,206	298 *(@107 lakhs HHs)*	2,244	**1,105 MLD**	Open / bore/ Tube wells; Black water mixing

Assumptions made based on data from SBM-G dashboard, Oct 2025

Key takeaways

- More water is being supplied
- Significant volume of greywater available for treatment and reuse

Example from KARNATAKA – A visual representation of greywater reuse/recharge potential

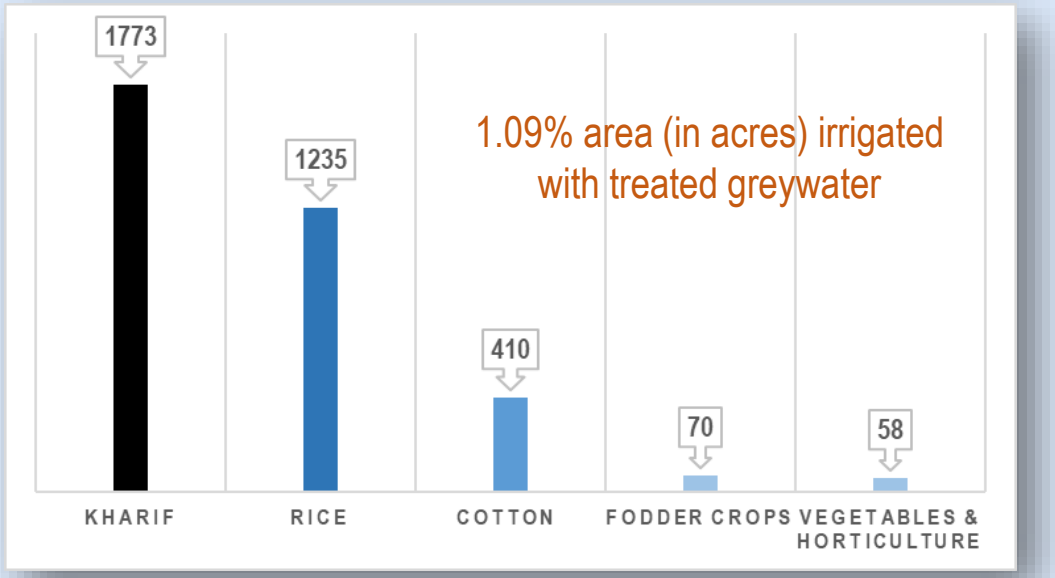


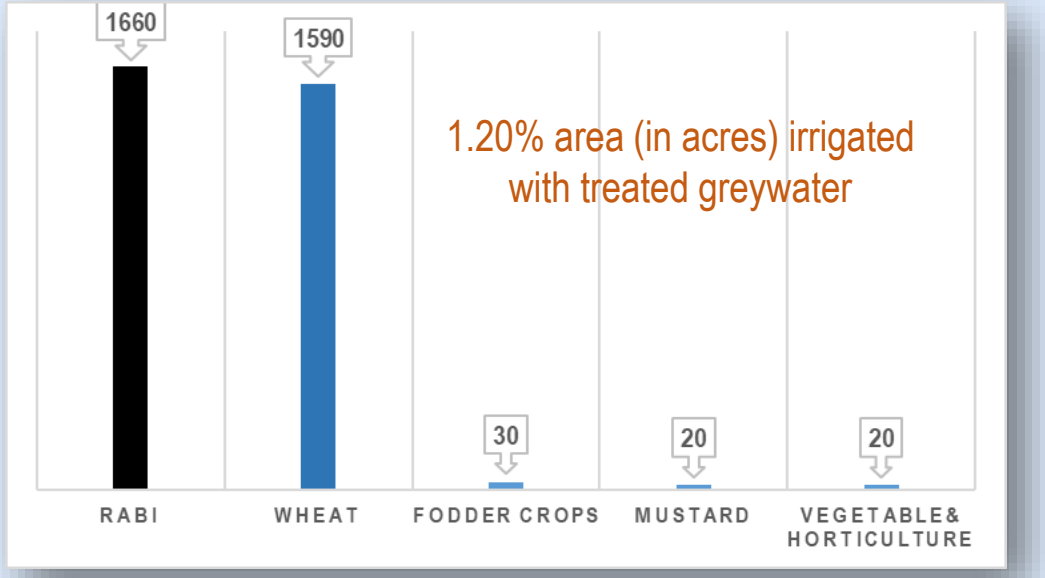
Can reusing treated greywater for irrigation save enough WATER?

Bhai Bhaktaur Village, Bathinda District generates **3,12,000 Ltrs/day** of greywater

In total 2001 acres, **1843 acres** is cultivable area

20 acres of area utilized for irrigation using treated greywater



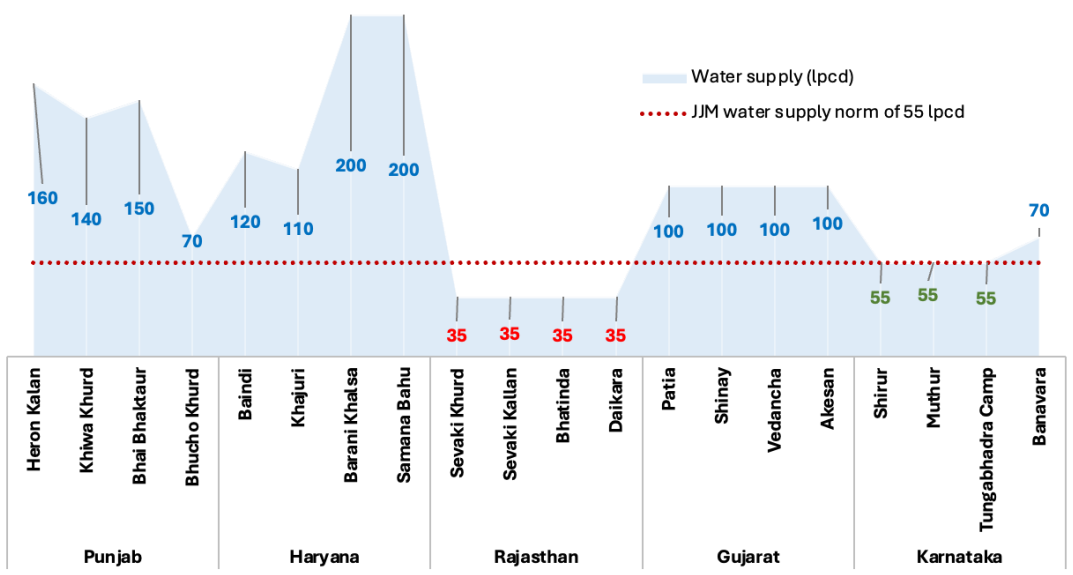


Irrigating Kharif and Rabi crops using treated greywater

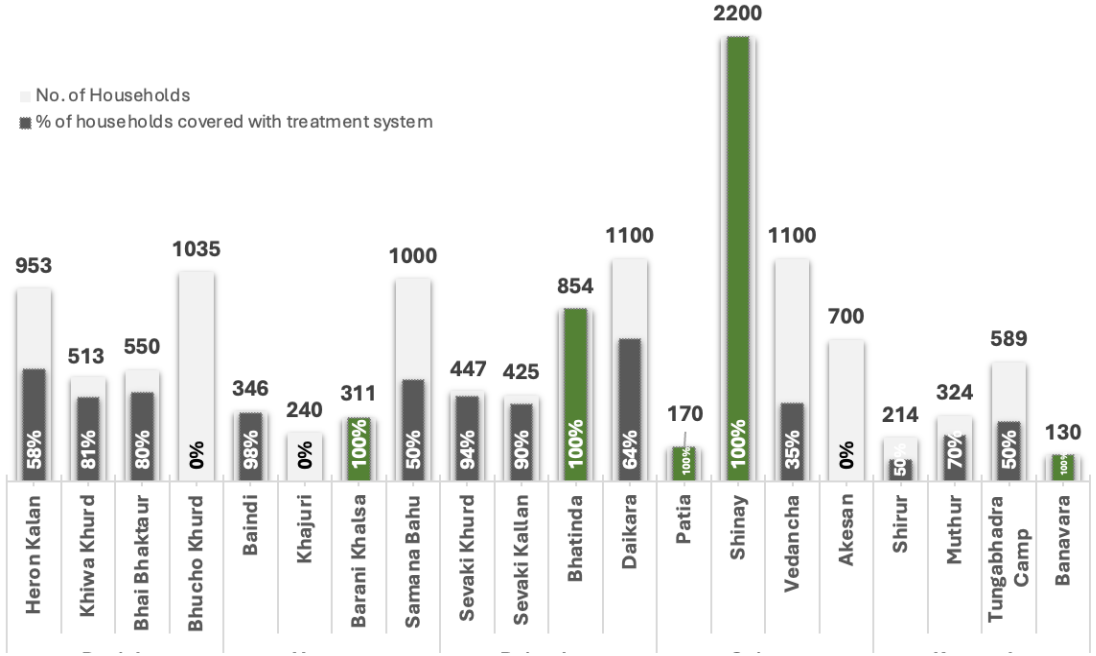
FINDINGS

Water Supply and Greywater Management Coverage

- Greywater facilities are designed based on the JJM supply norm of 55 lpcd, but the actual water supply in the villages ranges from 35 to 200 lpcd, reflecting both shortages and oversupply.
- Villages with treatment facilities have complete coverage in about 50% to over 100% of households. Clustered area – centralized arrangement; Scattered area – individual arrangement



Villages showcasing variations in water supply quantity standards from the sample survey

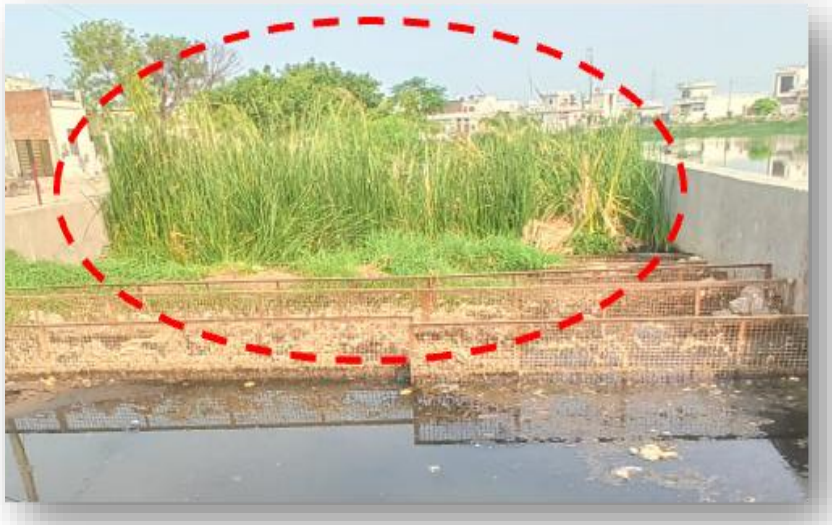


Households from 5 (25%) of the 20 villages were 100% covered with greywater treatment system

Water Quality and Treatment

- 11 (55%) out of 20 villages reported blackwater mixing with greywater, primarily due to inadequate infrastructure.
- Although greywater is rich in nutrients and reusable, only 2 villages test for total suspended solids (TSS), turbidity, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and microbiological contaminants before reuse.
- 4 villages discharge untreated greywater into open land or water bodies, highlighting major gaps in treatment infrastructure.

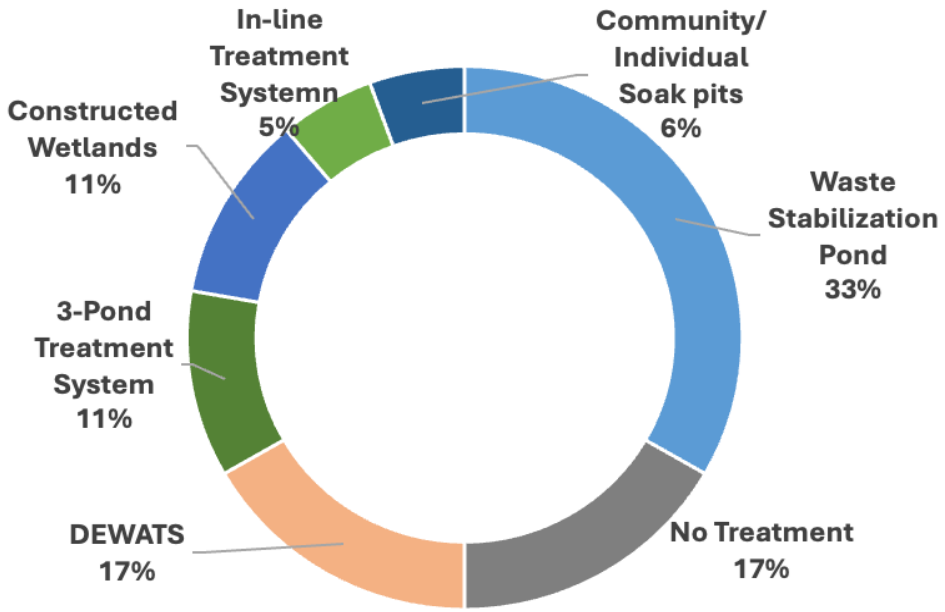
Constructed wetland in Gujarat



Stabilization Pond using Vetivera zizanioide Plantations as part of a treatment in a constructed wetland in Haryana

Technology and Design

- Technology choice for greywater treatment depends on population size, available space and financial capacity.
- Designing stormwater drains to divert excess water directly into wetlands can reduce the load on treatment plants as seen in one of the villages in Karnataka.

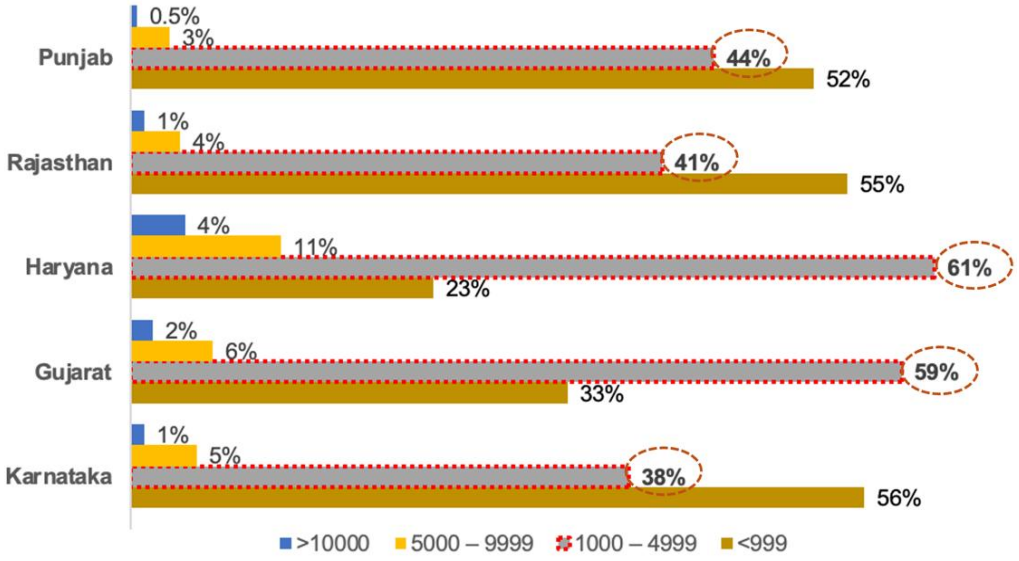


Different types of treatment system from the surveyed villages

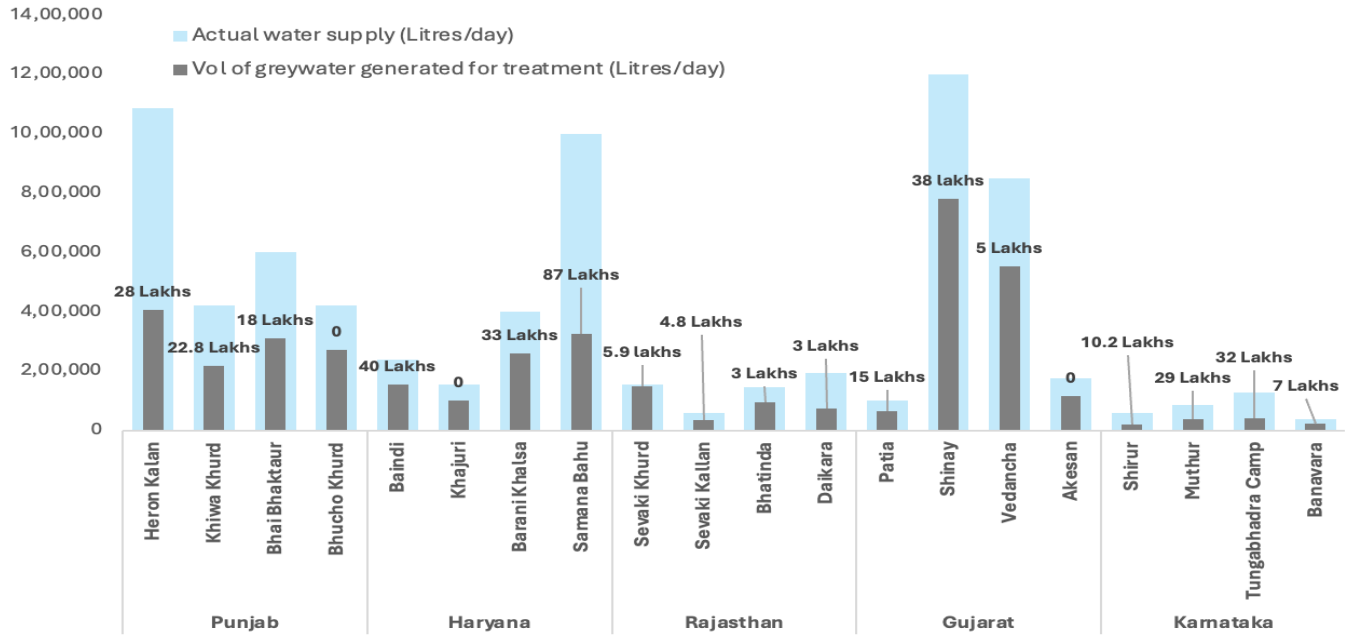
Separate diversion channels of stormwater and greywater in Muttur Village, Karnataka

Financial aspects

- Swachh Bharat Mission Grameen 2.0 allocation: Villages > 5000 population = Rs. 660/- per capita | Villages < 5000 population = Rs. 280/- per capita *(Only the big villages would have the financial support, which are only 3% of the villages)*
- Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) contributes 70–80% in Karnataka, Haryana, Punjab; SBM-G2 covers 20–30% in Gujarat & Rajasthan
- Across the five states, per capita costs vary widely due to local context, design, and technology choices rather than village size alone. Example: Patia village in Gujarat (population ~1,000) has a per capita cost of ₹1,500, while Sevaki Khurd in Rajasthan (population ~4,400) has a much lower cost of ₹142.
- Capital cost varies from INR 3 Lakhs – 87 Lakhs through MGNREGS, SBM-Grameen 2.0 & 15th FC.
- Operation & Maintenance costs vary by technology from INR 4,000 – 30,000/month.



Villages sizes based on population



Greywater generation and the cost of greywater treatment system

Reuse and Revenue

- Reuse - irrigation, groundwater recharge, fishing and manure production; Rajasthan shows limited reuse due to low water availability, high infiltration and evaporation.
- CSR-funded NGO models in Karnataka have successfully supported entire greywater treatment systems in selected villages.
- In Gujarat, revenue is generated by selling manure from treated sludge; While in Punjab and Haryana the treated greywater ponds are leased out for fishing.
- Annual earnings from reuse range from INR 40,000 to INR 4 lakhs, depending on coverage and community participation.

Patia Village, Kutch District, Gujarat

- *A ₹15 lakh DEWATS system in Patia village treats greywater and supports reuse on 3 acres of GP land through drip irrigation.*
- *Greywater reuse has doubled Pomegranate yields (1.5 to 3 tons/acre) and tripled farmer income (₹10,000 to ₹30,000 per acre).*

Barani Khalsa village, Haryana

- *Leasing treated water ponds for fish farming, generating a steady income of 1-1.5 lakhs per annum.*

Irrigated paddy fields with treated greywater in Haryana

Major gaps and challenges identified that need immediate action

1. **No water quality testing prior to reuse** - Untreated or partially treated greywater used for irrigation poses long-term risks to soil health and groundwater quality.

2. **Financial constraints** - ₹280 per capita for villages <5,000 inadequate for decentralized systems & reliance on Capex funds, not lifecycle costs, especially the O&M cost.

3. **Poor design integration** - Frequent mixing increases organic load, pathogen content, and treatment requirements. Undermines reuse potential and system efficiency.

4. **Limited scalability** - High-cost systems are difficult to replicate and remain non-functional if there are design flaws or maintenance gaps.

5. **Inappropriate technology selection** - One-size-fits-all solutions unsuitable for diverse terrains. Soak pits fail in areas with <2m groundwater depth.

6. **Limited digital tracking** - Lack of digital tools to plan, monitor and scale solutions. Difficult to track system performance. Only asset mapping, no performance tracking.

7. **Incomplete drainage networks** - Not all households connected to treatment systems. Quality and functionality of soak/leach pits require investigation.

8. **Seasonal failures** - Overflow during monsoon (Punjab, Haryana), drying in summer (Rajasthan). Systems lack the capacity to handle peak flows.

Recommendations

1. **Context-specific technical and policy measures**: Greywater reuse policies should be context-specific, combining technical measures in water-scarce regions and incentives in groundwater-stressed, but energy-subsidised states.

2. **Needs-based funding**: Shift from rigid population thresholds to allocations aligned with hydrogeological context, system design and O&M requirements. Promote revenue-generating models: fisheries, leased ponds, compost sales.

3. **Institutionalize testing**: Mandate periodic testing of BOD, COD, TSS. Establish district laboratories or mobile testing units. Link compliance to fund disbursements under SBM-G/ FC grants. Display results on State/National dashboard.

4. **GIS-based digital planning tool:** Enable systematic planning using data on population, water supply, soils, land availability, rainfall and groundwater conditions.

5. **Accurate greywater quantity estimation and quality**: Factor in all water sources including borewells, handpumps, and animal husbandry wastewater. Conduct realistic assessments of quantity and quality.

6. **Context-specific technology**: Design based on actual BOD load and wastewater quantity. Match technology to hydrogeology: lined systems in high water table zones, infiltration-based were safe.

7. **Empower VWSCs**: Capacity building and cross learning on greywater management and best practices.

8. **Research and monitoring**: Develop practical frameworks to measure recharge volumes, system performance and seasonal variability. Link evidence to design standards, funding norms and programme guidelines for wider adoption.

Thank You

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