

Circular Economy Approaches for Rural Waste Management: A Case Study of Aandhi Village, Rajasthan, India

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Abstract

Rural India continues to face challenges in waste management due to poor infrastructure, low awareness, and inadequate collection systems. This Short Communication highlights the development of a decentralised waste management model in Aandhi village, Rajasthan, integrating green technologies with community participation. Baseline surveys revealed that 84% of household waste was organic, 15% plastics, and 1% e-waste and glass. Open dumping, minimal segregation (66%), irregular collection (88.7%), and unsafe menstrual and biomedical waste disposal were major issues. Interventions included a solar-powered vermifiltration unit to treat hospital wastewater, constructed wetlands for greywater and pond rejuvenation, and a 100 kg/day biogas plant that replaced 35–37 LPG cylinders annually. A Material Resource Recovery Centre (MRRC) enabled segregation, composting, and recycling. Awareness drives and IEC campaigns significantly improved household participation, with 85% of villagers willing to segregate waste when provided proper infrastructure. Health assessments recorded better outcomes, linking improved sanitation practices with reduced disease burden. The study demonstrates that integrating technology with behavioural change and local governance provides a replicable zero-waste rural model aligned with SDGs 6 (Clean Water and Sanitation), 11 (Sustainable Cities and Communities), and 12 (Responsible Consumption and Production).

Keywords: Rural waste management, vermifiltration, constructed wetlands, biogas, zero waste, circular economy, SDGs.

Introduction

India's rural areas generate large quantities of organic and plastic waste but lack formal waste management systems. This results in open dumping, burning, and water contamination, which directly impacts community health. Aandhi village, in Jaipur district, faced severe issues including plastic accumulation, open wastewater drains, and associated diseases. This work presents a concise case study of how decentralised, community-driven interventions using green technologies helped the village transition toward a zero-waste model.

Methodology

A baseline survey of 515 households was conducted to assess socio-economic status, waste composition, health indicators, and sanitation practices. Waste audits quantified types of waste, while focus group discussions with women, farmers, and youth identified barriers to waste

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segregation. Based on this, interventions were introduced in three domains: (i) solid waste segregation and recycling, (ii) wastewater treatment using eco-technologies, and (iii) behavioural change through IEC campaigns. Implementation was supported by the Gram Panchayat and funded under the Department of Science and Technology's ITISE scheme.

Results and Discussion

- **Waste Composition:** The audit revealed 84% organic waste, 15% plastics (mainly polyethene), and 1% glass/e-waste. Most households disposed of waste in open areas, and 82.6% of menstrual pads were discarded without treatment.
- **Technological Interventions:** A 10 KLD solar-powered vermifiltration plant treated hospital wastewater, ensuring safe reuse in agriculture. Constructed wetlands restored the central pond ecosystem, treating 80% of greywater. A 100 kg/day biogas plant installed at the local school processed kitchen and cattle waste, replacing 35–37 LPG cylinders annually and reducing reliance on fossil fuels. The Material Resource Recovery Centre (MRRC) enabled segregation, recycling, and composting through vermicomposting and NADEP units.
- **Community Engagement:** IEC activities—school campaigns, cultural events, incentive-based competitions, and clean commons drives—strengthened community ownership. Segregation willingness improved from 34% to 85%.
- **Impact:** Improved health outcomes were recorded, with reduced cases of waterborne and respiratory illnesses. Sanitation improved visibly in public spaces, and economic benefits included reduced LPG purchase and compost availability for agriculture. The model demonstrated that linking waste with value creation enhances adoption.

Conclusion

The Aandhi village initiative demonstrates the potential of decentralised waste management through a combination of green technologies and active community engagement. By addressing both solid and liquid waste challenges, the project provides a scalable zero-waste framework for rural India. Its success highlights the importance of local governance, technology integration, and behaviour change in achieving sustainable rural development.

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Conflict of Interest

The authors declare no conflict of interest.