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SUSTAINABLE SANITATION MANAGEMENT IN RURAL INDIA: A NATIONAL CHALLENGE

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ABSTRACT

The UNDP's Sustainable Development Goal No. 6 aims to ensure clean drinking water and sanitation for all by 2030 worldwide. The government of India launched the "Clean India Mission" in 2014 to make India clean and hygienic. This program was to ensure a clean environment all over the India and to eliminate open defecation before 2nd October 2019. At present, the Ministry of Jal Sakti has declared India open and defecation-free after providing toilet facilities to every household. However, toilet construction is not the only solution to the sanitation crisis. There are also other emerging challenges to deal with, such as waste management in a sustainable form and finding opportunities in the waste management sector. Therefore, there is a strong need to adopt a sustainable framework for sanitation waste management to strengthen capacity building.

The present study explains sustainable development in the waste management sector, specifically in the rural context. The study is based on reviews of various research papers and reports. It says that sustainability should guide the government's implementation of sanitation programs and policies. A sustainable sanitation framework must be economically viable, socially cancelable, easily maintainable, technologically appropriate with various technology choices, and environmentally friendly. The study broadly explains four kinds of sustainability in this sector: (1) technological sustainability, (2) behavioral sustainability, (3) sustainability in program delivery, and (4) sustainable community toilets. The present study explores the challenges and existing opportunities in waste management in rural areas. However, the present government has introduced some national schemes, such as the National Bioenergy Frame Program 2022, the Govardhan Scheme 2018, and the SATAT schemes, resulting in positive results. More than 30 percent of households in India have door-to-door solid waste collection services, which the government of India is providing. This sector has many challenges in maintaining sustainability, but every challenge brings an opportunity, so this sector has been introducing many employment opportunities to rural people.

Keywords: Clean India Mission, SDGS, Sustainable Sanitation Management, UNDP

1. INTRODUCTION

The UNDP's Sustainable Development Goal No. 6 aims to ensure clean drinking water and sanitation for all by 2030 worldwide. The government of India also launched the "Clean India Mission-Gramin" in 2014 to make India clean and hygienic. The program was to ensure a clean environment all over India and to eliminate open defecation before 2nd October 2019. After that, the Ministry of Jal Sakti has declared India open-defecation-free.

Sanitation and waste management are critical components of public health and environmental sustainability. In rural India, these challenges are magnified by factors such as population density, lack of infrastructure, and socioeconomic conditions. Despite various government initiatives, achieving sustainable sanitation and waste management in rural areas remains daunting. The need for sustainable sanitation is increasingly recognized. It is also linked to various dimensions, such as economic, social, technical, and environmental Andersson, K. et al. (2016). This paper explores the current state of sanitation and waste management in rural India, identifies key challenges, and suggests viable solutions to create a sustainable future.

2. REVIEW OF LITERATURE

Kulappa, M. (2020), in their study titled "Rural Sanitation in India: Trends, Achievements, and Policy Challenges - An Overview," states that access to sustainable sanitation services is one of the most critical factors in enhancing the quality of human life. Improved sanitation facilities, coupled with the availability of clean water, can meaningfully reduce the incidence of diseases and deaths. However, diseases related to inadequate water and sanitation still heavily burden communities and health services, preventing children from attending school regularly. The consequences of poor sanitation place a strain on the economic and social environment, leading to lost productivity.

Kala Seetharam Sridhar and Surendra Kumar (2013) highlight that poor sanitation remains a major challenge, as a large segment of the population continues to practice open defecation, which contributes to the pollution of surface and groundwater sources. This situation is typical of India and other developing countries. Following the success of the Clean India Mission – Gramin, there has been a notable shift in sanitation practices, with people becoming more aware of the benefits of using and recycling human and animal waste. However, Sridhar and Kumar (2013) also note that households or individuals may revert to open defecation (OD) if toilet pits or tanks are problematic, such as being too small or broken, if emptying services are unavailable or unaffordable, or if there is a lack of awareness about the proper utilization of human and animal waste.

In this context, Strande et al. (2014) emphasize the need for proper disposal or management of sludge and human waste. They suggest that community members must be educated on effectively managing and reusing fecal sludge. Similarly, Manjari Manisha (2016). argues that sustainable sanitation in India is crucial to achieving the Sustainable Development Goals (SDGs) by 2030. Since this is a significant challenge, there is considerable scope for improving sanitation. Additionally, she recommends that the government employ more advanced technical tools and expertise to develop a robust infrastructure for toilets and sewage systems nationwide and strengthen capacity building. The study further argues that sustainability is not limited to physical infrastructure; it also requires changing societal attitudes, behaviors, and cultural beliefs. People should be encouraged to adopt better hygiene practices rather than adhering to decades-old habits. This highlights the need to initiate a sustainable sanitation transition.

3. NEED OF THE STUDY

India ranks 93rd on the WASH Performance Index (2015), indicating challenges in rural sanitation management, including waste disposal and hygiene practices. Despite some progress, sustainable sanitation growth remains uncertain,

emphasizing the need for improved waste management strategies and enhanced capacity for technological and social monitoring.

3.1. OBJECTIVE OF THE STUDY

- To study the existing challenges for sustainable sanitation waste management in rural India.
- To explain the different dimensions and types of sustainability in sanitation coverage.
- To study the futuristic opportunities for waste management and sustainable development in rural India.

4. METHOD OF THE STUDY

The present study is a descriptive study based on a review of different published research articles and institutional reports. The research articles are collected from well-known websites like Google Scholar, Web of Science, and Research Gate and reports of different institutes like the Ministry of Jal Sakti, the Department of Drinking Water and Sanitation, and the Ministry of Environment for a better understanding and the utilization of this waste as a source of income.

Sustainable Development: The Brundtland Report defines sustainable development as meeting present needs without compromising the ability of future generations to meet theirs. In ancient India, sustainable practices like using human and animal waste as fertilizer were common, enriching the soil naturally and enhancing agricultural productivity. Today, an adult produces around 500 liters of urine and 50 liters of feces annually, containing nutrients equivalent to 10 kilograms of synthetic fertilizer, valued at about US$10 but potentially increasing crop yields by US$50 Andersson, K. et al. (2016). Similarly, modern methods such as biogas production through anaerobic digestion mirror ancient techniques of recycling waste for multiple uses, aligning with SDG Goal 6's focus on safe water, sanitation, and sustainable waste management. SDG Goal 6 aims for universal access to safe water and sanitation, emphasizing sustainable practices in waste management. Innovative approaches, such as using human waste as fertilizer and producing biogas from sewage sludge, offer potential benefits for agriculture and energy, particularly for poor farmers.

The following types of sustainability need to be followed in the sustainable development of sanitation coverage.

5. TECHNICAL SUSTAINABILITY

In the sanitation sector, technology should be a key pillar in designing sustainable waste management systems. To ensure long-term success, it is crucial to conduct micro-level socioeconomic and demographic assessments, considering factors such as land availability, water access, population density, and the social and economic status of communities. Trained engineers must design cost-effective, sustainable solutions, as local governments in low-resource settings often lack the capacity and expertise to build and maintain infrastructure Manisha (2016).

5.1. BEHAVIORAL SUSTAINABILITY

Sustainable sanitation practices require consistent behavioral changes, such as regular handwashing, using toilets for defecation, proper waste disposal, and maintaining cleanliness in living areas. For example, under the Swachh Bharat Abhiyan-Gramin, a sanitation worker (Safaeekarmi) is designated to clean village drains regularly, promoting community hygiene. To encourage such sustainable behaviors, it is essential to implement awareness programs tailored to the specific cultural and geographical contexts of rural areas Manisha (2016). Personal hygiene practices, like brushing teeth, bathing, and wearing clean clothes, should be emphasized, alongside sustainable waste management practices such as timely pit emptying and separating organic and inorganic waste for recycling and use as fertilizer.

5.2. SUSTAINABILITY IN PROGRAM DELIVERY

For social development programs to be effective, they must maintain continuity and address common pitfalls like delayed implementation, poor delivery, and inadequate monitoring. To ensure sustainable program delivery, the government has created robust mechanisms for effective grassroots-level execution. For example, after the Swachh Bharat Abhiyan Gramin 1.0, the Clean India Mission 2.0 was launched to maintain rural sanitation coverage. Local initiatives, such as Darbaja Band Abhiyan, waste segregation with gila and sukha kachara dustbins, community toilets, and loans for animal waste management, were introduced to support these efforts. A portion of program funding is also allocated to Information, Education, and Communication (IEC) to raise awareness about waste management and public health Manisha (2016).

5.3. SUSTAINABILITY OF TOILET USE IN PUBLIC INSTITUTES

Public institutions in rural areas, such as health centers, schools, and panchayat offices, generate both liquid and solid waste. Under the Swachh Bharat Abhiyan, these institutions are equipped with toilet facilities for men and women. However, due to a lack of awareness, improper use of these facilities persists, with some individuals resorting to open spaces for sanitation. Efforts are needed to ensure proper use and keep villages waste-free.

5.4. PRESENT SCENARIO OF WASTE MANAGEMENT IN RURAL INDIA

Solid and liquid waste management (SLWM) involves waste collection, transport, processing, recycling, or disposal to minimize health and environmental impacts (NARSS Report 2018-19). According to NARSS Round 2 (2018–19), 97.5% of households reported no visible garbage, though over half disposed of waste outside standard systems. Poor sanitation is not only unpleasant but also dangerous, causing stigma and anxiety (SSG 2022). The SBM-2.0 and Gobardhan schemes aim to enhance rural sanitation and reuse of animal waste, yielding positive results. Despite significant progress, 13% of respondents still lack home toilets, and while 58.5% and 60.3% report solid and liquid waste management initiatives, only 32.2% of villages have facilities for waste segregation.

Figure 1

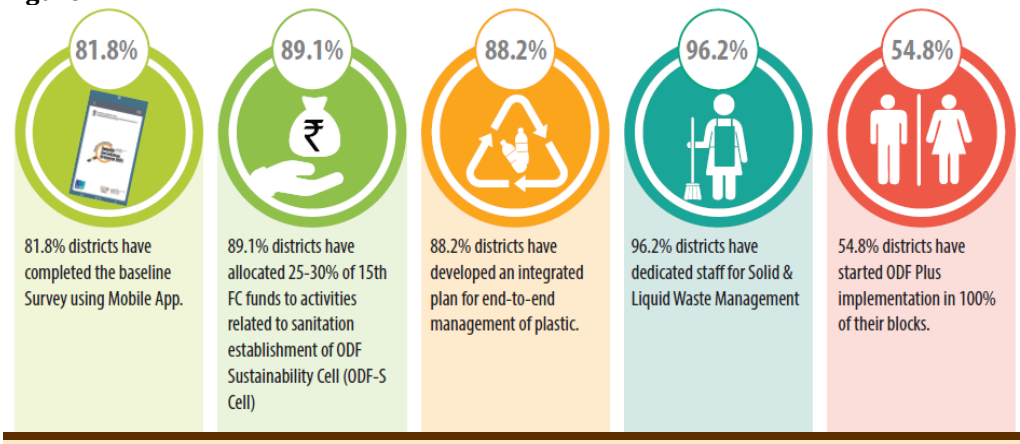

Figure 1 Distribution of Waste Management in India
Sources National Annual Rural Sanitation Survey (NARSS), Round-2, 2018-2019

There are 35.7 villages with a community soak pit/magic pit/ drains/ WSP for wastewater. Community-level composting pits also exist in almost 24 percent of villages, where the villages can dump their house-caused waste (SSG 2022). Currently, only 32.9 percent of villages have a door-to-door solid waste collection service, which the government of India provides. Menstrual waste remains taboo at the village level, with 94.6% of households unaware of menstrual hygiene management (MHM) practices. While 88.2% of districts have developed integrated plastic waste management plans, 96.2% have appointed solid and liquid waste management staff. Additionally, 54.8% of districts have implemented ODF Plus in all their blocks (SSG-2022). However, the lack of MHM awareness and inadequate menstrual waste handling contribute to ongoing sanitation challenges.

Figure 2

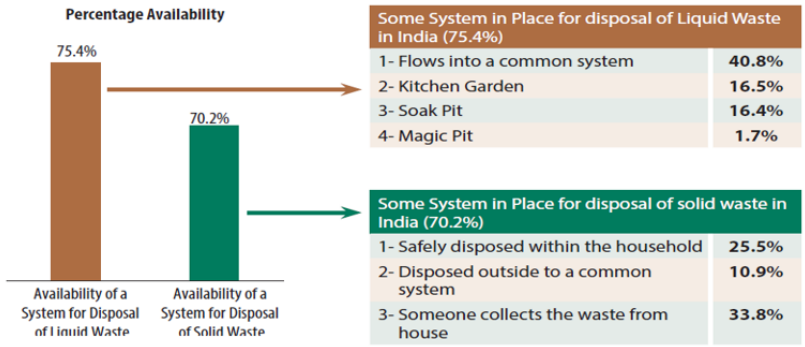

Figure 2 Availability of Some Facilities to Dispose of Solid and Liquid Waste at the National Level
Sources National Annual Rural Sanitation Survey (NARSS), Round-2, 2018-2019

Telangana leads in solid and liquid waste management, followed by Haryana and Tamil Nadu. Among smaller states, Andaman and Nicobar top the list, with Daman & Diu and Sikkim following. In districts, Bhiwani (Haryana), Jagtial, and Nizamabad (both Telangana) rank highest. The Swachh Sarvekshan-Gramin 2022, covering 17,559 villages, highlighted SBM-G Phase 2's focus on ODF sustainability, solid and liquid waste management, and menstrual hygiene. Public places show 74.6% with toilet facilities and 93.1% with minimal stagnant wastewater. Despite improvements, 95.4% of ODF villages and 59.9% of non-ODF villages dispose of

child excreta safely, with 63.1% using toilets and 12.3% burying waste (NARSS Report, 2018-19).

Three key governmental schemes in India focus on waste management and sustainability:

Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan Scheme (2018): This scheme was Announced by Union Finance Minister Nirmala Sitharaman on February 1, 2023, with a total investment of ₹10,000 crore. This scheme aims to promote a circular economy by converting organic waste, particularly cattle waste, into biogas and fertilizer. It is managed by the Ministry of Jal Shakti and the Department of Drinking Water and Sanitation, it supports rural entrepreneurship, income generation, and environmental sanitation. The scheme plans to establish 500 new plants, including 200 compressed biogas plants (75 in urban areas and 125 in rural communities). Each district can receive financial assistance of up to ₹50 lakh under SBM-G, shared between central and state levels. The scheme also targets to contribute in fight against climate change by achieving net-zero emissions by 2027. The scheme is supporting villages to safely manage their cattle and agricultural waste, and converting into wealth using treatment systems. And also, to promote environmental sanitation and curb vector-borne diseases through effective disposal of waste in rural areas.

The 2023 budget significantly boosted the "waste to wealth" initiative by announcing the establishment of 500 new plants with a Rs. 10,000 Crore investment. In FY 2023-24, 198 plants were set up, including 12 Compressed Biogas (CBG) plants and 186 biogas plants. Additionally, 556 plants are under construction, comprising 129 CBG plants and 427 biogas plants.

Table 1

Table 1 Top Five State Having Largest Number of Biogas Plants Registered

Biogas Plants Registered in India						
State/ UT Name	Percent of Districts covered in state	Yet to start construction	Construction in progress	Completed	Functional	Total
Chhattisgarh	93.90%	19	80	1	280	380
Gujarat	100%	5	5	2	41	53
Karnataka	96.80%	17	5	4	65	91
Madhya Pradesh	100%	3	51	26	104	184
Uttar Pradesh	100%	9	9	5	107	130
Total	**66.20%**	**109**	**257**	**101**	**863**	**1330**

Table 2

Table 2 Top Five States Having the Largest Number of CBG/ Bio CNG Plants Registered

CBG/ Bio CNG Plants Registered					
State/ UT Name	Yet to start construction	Construction in progress	Completed	Functional	Total
Gujarat	17	12	0	18	47
Haryana	29	15	1	11	56
Maharashtra	77	22	2	9	110
Punjab	56	14	0	8	78
Madhya Pradesh	33	10	0	5	48

Uttar Pradesh	85	34	3	17	139
Total	**443**	**176**	**7**	**104**	**730**

Sources Ministry of Jal Shakti, access link GOBARdhan Unified Registration Portal

National Bioenergy Framework Program (2022): This program focuses on enhancing bioenergy production through various waste-to-energy initiatives. It was launched by the Ministry of New and Renewable Energy (MNRE) with a total budget of ₹1715 Crore, allocating ₹858 Crore for Phase-1. The Programme not only encourages the utilization of surplus biomass from rural areas but also offers additional income opportunities for rural households.

SATAT Scheme: It is managed by the Ministry of Petroleum and Natural Gas, SATAT (Sustainable Alternative Towards Affordable Transportation) aims to produce 15 million metric tonnes of Compressed Biogas (CBG) by 2023-24 from 25,000 CBG plants. Plants must have a minimum production capacity of 2.0 tonnes per day to qualify. Financial assistance of up to ₹10 crore per plant is available under this scheme.

5.5. THE EXISTING CHALLENGES FOR SUSTAINABLE SANITATION WASTE MANAGEMENT

Sustainable sanitation and waste management are critical to environmental conservation and public health. However, this sector has various challenges. The challenges in sustainable management of sanitation waste in rural areas can be particularly acute due to limited resources, low population density, and unique cultural and geographical factors.

1) Rural areas often have more people without access to basic sanitation facilities such as toilets and clean water. In India, there is a lack of disposal and waste segregation Infrastructure. Direct dumping of solid and liquid waste on the surface of the earth is also leading to the contamination of water sources and the environment.
2) There is a lack of awareness regarding sustainable sanitation waste management, especially in rural India. Lower literacy about the importance of waste management does not allow people to initiate to manage their animal and house waste economically. There is a lack of knowledge of using and recycling human and animal waste into economic goods and services.
3) The biggest challenge for rural people in managing waste is the lack of finances. Establishing and maintaining adequate sanitation and waste management systems is costly, especially for low-income communities. Due to the lower population density, governments and investors have also not taken the steps to invest in this area.
4) Seasonal Variability: In agricultural-based rural areas, waste generation patterns may vary seasonally, creating challenges in waste management planning and infrastructure capacity.
5) Cultural norms and classical traditions in rural areas influence people's attitudes and behaviors toward sanitation and waste management. Changing these practices requires modern economic approaches. Especially in Indian society, people consider human and animal waste very unpurified tasks to think and touch. Thus, they are still not mentally prepared to generate income from this waste in India; only a particular category deals with manual scavenging or emptying toilet pits.

6) Implementing advanced waste treatment and sanitation technologies can be limited in some regions, hindering sustainable practices.
7) There is a slow reach of government policies and support for the rural people to invest in this sector. Weak regulations, inadequate enforcement, and governance issues can hinder the implementation of sustainable waste management and sanitation practices.
8) The growing problem of plastic pollution, particularly in ponds and water bodies, poses a significant challenge, as plastics can take centuries to degrade and harm marine ecosystems.

5.6. THE OPPORTUNITIES FOR WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT

There are several opportunities in sustainable sanitation and waste management in rural India that can lead to significant improvements in public health, rural employment, environmental conservation, and overall quality of life. With Animal Waste and kitchen waste, the people from rural India can develop comprehensive waste management plans, promote awareness and education, and establish partnerships with relevant stakeholders. These efforts can lead to waste management practices, agricultural productivity, and a cleaner, healthier environment for rural communities. The following are some sectors where waste management can be an opportunity for individuals and the environment.

1) Biogas Production: Animal waste such as manure and kitchen scraps can be used as a feedstock for biogas production. Biogas can serve as a renewable source of clean energy for cooking, heating, and lighting in rural households. Thus, encouraging rural communities to see waste as an energy resource can lead to opportunities for recycling, composting, and waste-to-energy projects. These initiatives can generate income for the households and can reduce environmental impacts.
2) Biofertilizer Production: Animal manure and vegetable & crop waste can be processed and converted into biofertilizers, which are rich in nutrients and can enhance soil fertility. These biofertilizers can improve crop yields and reduce the need for chemical fertilizers. Also, composting animal waste can produce high-quality organic compost, enriching the soil for agricultural purposes. Many small entrepreneurs in India produce fertilizer from garbage and sell it in the agricultural market.
3) Rural communities can explore income-generating opportunities by selling surplus animal waste-based products like biogas, bioproducts, bioplastics, biofertilizers, and compost to neighboring areas. Recycling animal waste into valuable products reduces the need for external inputs such as chemical fertilizers and fossil fuels, which can lead to resource savings and cost reductions for farmers. Integrating animal waste management with rural livelihoods can create diversified income sources, such as waste collection and processing businesses.
4) Waste management offers employment opportunities in rural areas through recycling and collection initiatives. Supporting rural entrepreneurs in this sector can lead to economic growth, job creation, and improved gender equality. Linking waste management with agriculture can generate organic fertilizers for farming, promoting sustainable practices and economic development.

5) Improving animal waste management can lead to better hygiene and reduced health risks in rural areas, as it helps prevent the spread of diseases and the breeding of disease vectors. Proper animal waste management can help prevent water pollution, particularly in regions where agricultural runoff can contaminate water sources. Thus, we can say that effective waste management reduces community disease.
6) Innovative technologies like small-scale anaerobic digesters can improve animal waste management efficiency and sustainability. Governments offer incentives and subsidies to promote proper waste management practices, encouraging rural communities to adopt sustainable solutions. Training programs and workshops build local capacity to implement and maintain effective waste management practices for long-term success.
7) Encouraging research and innovation in sustainable sanitation and waste management can lead to the development of new technologies and solutions tailored to rural India's needs. There have been many research institutes working in the research area of waste and recycling. They are providing farmers with a new technology to generate income from the waste.

6. SOME CASE STUDIES OF THIS SECTOR

Union Minister Shri Gajendra Singh Shekhawat emphasizes that the GOBARdhan scheme transforms waste into wealth, promoting biogas production to meet energy needs and reduce greenhouse gas emissions. Mrs. Vini Mahajan, Secretary of the Department of Drinking Water and Sanitation, highlights the importance of affordable and feasible green alternatives. Over 2100 rural blocks in India now have plastic waste management units, enhancing the circular economy of sanitary waste.

To advance sanitation, Karnataka launched the PARIHARA helpline in March 2020 for complaints about wastewater stagnation, drainage issues, and waste management. Complaints can be made via WhatsApp, Facebook, Twitter, email, or their website, with the contact number 9480985555.

Debipur village in West Bengal exemplifies sustainable waste management with a hybrid system that handles dairy farm waste, reduces air pollution, and provides manure to farmers. Puducherry has achieved ODF Plus status in all 108 villages, featuring solid and liquid waste management systems, including community compost pits and cow dung plants. Kodagu district in Karnataka has implemented the first FSTP to protect River Cauvery from pollution, aiming to manage grey and black water scientifically.

Sikkim leads in ODF Plus status with 100% solid and liquid waste management coverage and is renowned for its organic farming, single-use plastic ban, and comprehensive disposal mechanisms. The state has earned global recognition, including an award from the Food and Agriculture Organization (FAO) for being the world's first organic state.

Ancient Indian practices such as composting and biogas production in traditional waste management systems align with these modern initiatives, reflecting a historical commitment to sustainable waste management.

7. CONCLUSION

The Indian government is advancing sustainable sanitation and waste management through several key programs. The National Bio-energy Program, GOBERdhan Scheme, SATAT Scheme, and National Bioenergy Frame Program 2022 focus on transforming waste into resources, enhancing biogas production, and fostering sustainable sanitation practices. These initiatives have made notable progress, including over 30% of households now receiving door-to-door solid waste collection services and heightened awareness about waste management and menstrual hygiene.

In addition to these modern efforts, integrated plans for plastic management, dedicated staff appointments for solid and liquid waste management, and the rollout of ODF-plus programs in various districts are driving significant improvements. The introduction of 500 new waste-to-wealth plants under the Govardhan scheme marks a substantial advancement towards a circular economy. This modern approach echoes ancient Indian practices where sustainable waste management was integral to community health and environmental stewardship, as seen in traditional organic waste reuse and composting systems.

Despite ongoing challenges, these efforts are creating job opportunities in rural areas and contributing to sustainable development. The progress in sustainable sanitation and waste management reflects the government's commitment to building a cleaner, healthier India. As these initiatives evolve, they promise to positively impact the environment, public health, and the economy, setting a precedent for a sustainable future.

CONFLICT OF INTERESTS

None.

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