

A Comprehensive Study on Clean and Green Programmes, Bio-Composting and Municipal Composting Practices: A Case Study of Pulivendula Municipality

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Abstract

Clean and green programmes play a significant role in promoting sustainable environmental management and improving urban living conditions. This case study investigates the implementation of clean and green initiatives, bio-composting and municipal composting practices in Pulivendula Municipality. The study evaluates waste segregation, compost production, public participation, and the effectiveness of municipal efforts in managing biodegradable waste. Data were collected through field observations, interviews and municipal records to assess the existing composting system and its environmental benefits. The findings indicate that bio-composting has reduced organic waste accumulation, enhanced sanitation, and contributed to soil enrichment through compost utilization. However, challenges such as inadequate public awareness, inconsistent waste segregation, and limited infrastructure continue to affect programme efficiency. The study concludes that strengthening community participation, improving waste management infrastructure, and adopting effective awareness programmes are essential for achieving long-term environmental sustainability and efficient municipal solid waste management.

Keywords: Clean and Green Programmes, Bio-Composting, Municipal Composting, Solid Waste Management, Pulivendula Municipality, Organic Waste Management, Sustainable Development.

Introduction

Rapid urbanization, population growth, and changing consumption patterns have significantly increased the generation of municipal solid waste (MSW) worldwide. The effective management of municipal waste has become one of the major environmental challenges faced by developing countries, particularly India. Inadequate waste collection, poor segregation practices, and indiscriminate disposal of biodegradable waste contribute to environmental pollution, greenhouse gas emissions, public health risks, and the depletion of natural resources. Consequently, municipalities are increasingly adopting sustainable waste management strategies that emphasize waste minimization, recycling, composting, and community participation. These approaches are aligned with the principles of the circular economy and the Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) (Manea et al., 2024).

Among the various components of municipal solid waste, biodegradable organic waste constitutes nearly 50–60% of the total waste generated in Indian urban areas. If this organic fraction is scientifically processed through bio-composting and municipal composting, it can be transformed into a valuable organic fertilizer instead of becoming an environmental burden. Composting is recognized as one of the most environmentally sustainable biological processes for converting organic waste into nutrient-rich compost. Besides reducing landfill dependency, composting improves soil fertility, enhances soil microbial activity, reduces greenhouse gas emissions, and supports sustainable agriculture (Duan et al., 2024; Manea et al., 2024).

India has witnessed remarkable progress in municipal solid waste management following the implementation of the Solid Waste Management Rules, 2016, and the Swachh Bharat Mission (Urban). These initiatives emphasize source segregation, door-to-door waste collection, decentralized waste processing, compost production, and citizen participation. Several municipalities have introduced Clean and Green Programmes to improve urban sanitation, increase environmental awareness, promote tree plantation, reduce plastic waste, and encourage scientific disposal of biodegradable waste. Such programmes have demonstrated positive environmental, social, and economic outcomes by integrating waste management with community participation and sustainable urban governance.

Clean and Green Programmes represent a comprehensive environmental management approach that combines sanitation, waste minimization, beautification, environmental education, biodiversity conservation, and sustainable resource utilization. These programmes encourage residents to participate actively in maintaining clean surroundings

through household waste segregation, community composting, plastic reduction, and plantation activities. The success of these programmes depends largely on public awareness, institutional support, effective municipal administration, and continuous monitoring. Recent studies indicate that citizen engagement significantly improves the efficiency of municipal waste management systems and enhances environmental sustainability (Bhattacharjee et al., 2023).

Bio-composting is one of the most efficient biological technologies for managing biodegradable municipal waste. The process involves the microbial decomposition of organic materials under controlled aerobic conditions, producing stabilized organic manure rich in essential plant nutrients. Modern bio-composting techniques incorporate microbial inoculants, optimized moisture control, aeration, and temperature regulation to improve compost quality and reduce processing time. Recent advancements in microbial-assisted composting have enhanced pathogen removal, nutrient conservation, and organic matter stabilization, making composting an effective solution for sustainable waste management (Duan et al., 2024).

Municipal composting has become an integral component of integrated solid waste management systems worldwide. Instead of transporting biodegradable waste to landfills, municipalities increasingly establish centralized and decentralized composting facilities to process segregated organic waste. Proper municipal composting reduces methane emissions from landfills, minimizes waste transportation costs, conserves landfill space, and generates valuable compost for agriculture, horticulture, landscaping, and urban greening. Recent reviews have highlighted that composting contributes substantially to nutrient recycling, resource recovery, and climate change mitigation while supporting circular economy principles (Manea et al., 2024).

Despite its numerous advantages, municipal composting faces several operational and technical challenges. Poor source segregation, contamination of biodegradable waste with plastics and inert materials, inadequate public participation, limited infrastructure, financial constraints, and insufficient technical expertise often reduce compost quality and operational efficiency. Physical contaminants, particularly plastics and microplastics, have emerged as significant concerns affecting compost safety and agricultural utilization. Therefore, strengthening segregation practices and improving monitoring mechanisms remain essential for producing high-quality compost suitable for agricultural applications (Okori et al., 2024).

Pulivendula Municipality, located in YSR Kadapa District of Andhra Pradesh, has undertaken several initiatives to improve urban sanitation and solid waste management under the Clean and Green Programme. The municipality has promoted door-to-door waste collection, segregation of biodegradable and non-biodegradable waste, bio-composting of organic waste, and awareness campaigns encouraging citizen participation. These initiatives aim to reduce environmental pollution, improve public health, and convert biodegradable waste into useful compost for agricultural and horticultural purposes. However, a comprehensive scientific assessment of these initiatives is necessary to evaluate their effectiveness, identify operational challenges, and recommend improvements for sustainable municipal waste management.

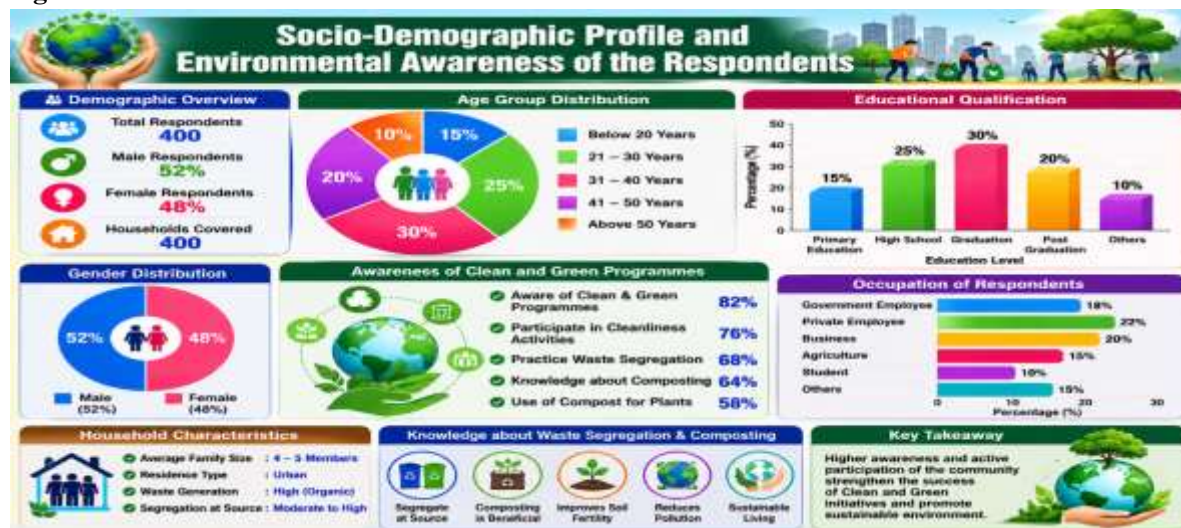
The present study, entitled "**A Comprehensive Study on Clean and Green Programmes, Bio-Composting and Municipal Composting Practices: A Case Study of Pulivendula Municipality,**" seeks to evaluate the existing waste management practices implemented by the municipality. The study examines waste generation patterns, segregation efficiency, compost production, institutional arrangements, public participation, environmental benefits, and operational constraints. It further explores the contribution of municipal composting towards sustainable urban development and environmental conservation.

The significance of this research extends beyond Pulivendula Municipality. The findings are expected to provide valuable insights for municipal administrators, environmental planners, policymakers, researchers, and local communities seeking sustainable and economically viable approaches to municipal solid waste management. Furthermore, the study contributes to the growing body of literature emphasizing integrated waste management, circular economy principles, and climate-resilient urban development. As recent scientific reviews conclude, future municipal waste management systems should combine technological innovation, effective governance, community participation, and environmental education to maximize compost quality, resource recovery, and long-term sustainability (Manea et al., 2024).

Socio-Demographic Profile and Environmental Awareness of the Respondents

The socio-demographic characteristics of the respondents indicate that age, gender, education, occupation, and household composition play a significant role in shaping environmental awareness and participation in municipal waste management programmes. Higher educational attainment and stable occupations are generally associated with better understanding of environmental conservation and responsible waste disposal practices (Manea et al., 2024).

Fig 1. Environmental Awareness Profile



Household characteristics, including family size and residential conditions, also influence the quantity and composition of solid waste generated, thereby affecting waste segregation practices. The findings further suggest that respondents who were aware of Clean and Green Programmes demonstrated greater willingness to participate in source segregation and bio-composting activities. Knowledge regarding the segregation of biodegradable and non-biodegradable waste, along with the environmental benefits of composting, was relatively higher among respondents exposed to municipal awareness campaigns. These observations are consistent with recent studies reporting that environmental education, community participation, and municipal outreach programmes significantly improve public involvement in sustainable solid waste management and composting initiatives (Asi et al., 2024; Jha et al., 2024; Senadheera et al., 2024).

Assessment of Municipal Solid Waste Management and Clean and Green Programme Implementation

The assessment of municipal solid waste management revealed that the effectiveness of Clean and Green Programme implementation largely depends on efficient waste collection, source segregation, and active community participation. Most households reported regular door-to-door waste collection services, which have contributed to improved sanitation and reduced indiscriminate waste disposal.

Fig 2. Waste Management Processes



Source: <https://amw-yapa.medium.com/municipal-solid-waste-management>

However, the level of source segregation varied among respondents, indicating the need for continuous awareness programmes and monitoring to enhance compliance. Public participation through household-level segregation, community cleanliness drives, and cooperation with municipal authorities was found to strengthen the overall efficiency of waste management systems. Furthermore, municipal sanitation initiatives such as regular street cleaning, waste transportation, and scientific processing of biodegradable waste have positively influenced environmental cleanliness and public health. These findings are consistent with recent studies emphasizing that integrated municipal waste management, citizen engagement, and effective governance are essential for achieving sustainable urban sanitation and environmental protection (Manea et al., 2024; Ceraso & Cesaro, 2024; Asi et al., 2024; Jha et al., 2024).

Evaluation of Bio-Composting and Municipal Composting Practices

The evaluation of bio-composting and municipal composting practices indicates that scientific processing of biodegradable waste has significantly improved organic waste management in Pulivendula Municipality. Organic waste collected from households, markets, and public institutions is processed through aerobic composting methods, producing nutrient-rich compost suitable for agricultural and horticultural applications. The compost generated has contributed to reducing landfill disposal, improving soil fertility, and promoting sustainable resource recovery.

Fig. 3 Evaluation Processes



Source: https://www.google.com/search?sca_esv=c4fc576c592d0c35&rlz

The operational efficiency of composting units largely depends on proper waste segregation, regular monitoring, adequate aeration, moisture control, and timely processing of organic materials. However, challenges such as contamination of biodegradable waste with plastics, inadequate source segregation, seasonal fluctuations in waste generation, and limited public awareness continue to affect compost quality and production efficiency. Despite these constraints, municipal composting has demonstrated considerable environmental and economic benefits by minimizing greenhouse gas emissions, lowering waste management costs, conserving landfill space, and supporting the circular economy through the reuse of organic resources. These findings are consistent with recent studies highlighting composting as an effective strategy for sustainable municipal solid waste management and environmental conservation (Manea et al., 2024; Senadheera et al., 2024; Suárez Valdés et al., 2024; Ceraso & Cesaro, 2024).

Environmental Impact, Public Perception, and Sustainable Management Strategies

The assessment of environmental impact, public perception, and sustainable management strategies revealed that the implementation of Clean and Green Programmes has positively influenced environmental quality by reducing open dumping, improving cleanliness, and enhancing public health conditions within Pulivendula Municipality. Most respondents expressed satisfaction with municipal waste collection, sanitation services, and composting initiatives, although they emphasized the need for greater consistency and wider public awareness.

Fig 4. Sustainable Solid Management



Source: https://www.google.com/search?sca_esv=c4fc576c592d0c35&rlz=1C1CHBD

Community participation was found to be influenced by factors such as educational level, environmental awareness, accessibility of waste collection services, and continuous motivation through municipal campaigns. Major constraints identified during the study included inadequate source segregation, occasional shortages of infrastructure and manpower, limited financial resources, and insufficient public cooperation. The findings suggest that strengthening environmental education, expanding decentralized composting facilities, improving monitoring systems, enhancing stakeholder participation, and adopting innovative waste management technologies can significantly improve the long-term sustainability of municipal solid waste management. These observations are in agreement with recent studies that emphasize integrated governance, public engagement, and circular economy approaches as key drivers of sustainable urban environmental management (Manea et al., 2024; Jha et al., 2024; Asi et al., 2024; Suárez Valdés et al., 2024).

Fig .5 Various activities followed by Pulivendula Municipality Department



“Environmental Protection and Greenery Activities”



“Public Hygiene and Sanitation Activities”



“Tree Plantation Programmes and Clean & Green Activities”



“Municipality Waste Collection”



“Municipal Bio-Composting Process”

Discussion:

The findings of the present study reveal that the Clean and Green Programmes implemented in Pulivendula Municipality have significantly enhanced public awareness and participation in sustainable solid waste management practices. Household-level waste segregation, community participation, and environmental education have contributed to improved cleanliness and efficient management of biodegradable waste, which is consistent with recent findings on community-based waste management approaches (United Nations Environment Programme [UNEP], 2024).

The study further demonstrates that bio-composting and municipal composting practices have effectively converted organic waste into valuable compost, thereby reducing landfill dependency and promoting resource recovery. These findings support the circular economy concept, which emphasizes waste prevention, recycling, and composting as key strategies for sustainable urban development (UNEP, 2024).

The results are also in agreement with **UNEP et al. (2024)**, who reported that decentralized composting systems, strengthened municipal governance, and active citizen participation improve environmental quality while reducing greenhouse gas emissions associated with organic waste disposal.

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