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Municipal Solid Waste Characterization and Feasibility of Decentralized Management in Rural Agricultural Settlements of Nuh District

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Abstract - *The ongoing problem of effective municipal solid waste management (MSWM) remains unsolved because agricultural areas struggle with waste disposal due to their lack of official waste collection systems and waste management facilities. The study investigates how households in Nuh district of Haryana create waste and what waste materials they produce to determine if decentralized solid waste management (DSWM) solutions work in rural agricultural communities. The research collected data from 25 households which represented three different income levels through a seven-day monitoring period. The research findings show that people generate more waste when their income increases because high-income households produce more waste than medium-income households and medium-income households produce more waste than low-income households. All income groups produced their main waste material through domestic and agricultural activities which created biodegradable waste as the most common waste type. The winter season brought about changes in inert waste production because low and medium-income households started using biomass-based materials for cooking and heating purposes. The local community demonstrates how they can manage waste through their practices which include using biodegradable waste as animal feed and burning waste as extra fuel for cooking and using ash to improve their crop fields. The research demonstrates how DSWM methods help Nuh district agrarian rural areas solve the problem of open waste dumping while they work to achieve environmentally friendly resource recovery systems.*

Key Words: MSWM, Nuh district, Decentralized approach, Rural Waste Methods, Agrarian Communities

1.INTRODUCTION

The rapid growth of population and the shift in consumption habits together with the rise in waste production have created a situation where Municipal Solid Waste Management (MSWM) becomes an urgent environmental and public health problem for developing nations. The problem of solid waste management in India presents its most difficult challenge to rural areas because these regions lack both official waste collection services and proper waste treatment facilities. Research indicates that rural areas without organized waste management systems tend to dispose of waste through open dumping and burning which results in serious environmental damage and health threats [3], [11].

Rural communities that depend on agriculture produce a large amount of biodegradable waste which comes from their home and farming activities. The communities without proper MSWM systems implement informal methods which include reusing materials and giving livestock access to biodegradable waste and burning waste materials to create energy. The economical methods become dangerous for the environment when people fail to handle them correctly [3]. The traditional centralized waste management systems have not succeeded in meeting the specific needs of rural communities because they require expensive operations and face difficulties in moving waste while communities show low involvement [15].

The practice of Decentralized Solid Waste Management (DSWM) has gained recognition as an environmentally friendly solution that works especially well in rural areas. Decentralized systems enable waste management at or near the source of generation which leads to lower transportation expenses and better waste sorting results and environmental resource recovery through community-based methods [7], [14]. Community-based waste management systems demonstrate their effectiveness in increasing public engagement while teaching people to act in ways that benefit the environment.

1.1 Waste Characterization

Waste characterization requires identification and measurement of all waste types produced by a community. The research categorized municipal solid waste from Nuh district rural households into three groups which included biodegradable waste and non-biodegradable waste and inert waste. The study results demonstrated that all income groups produce their highest waste volume as biodegradable waste because of their agricultural way of life. Non-biodegradable waste mainly includes plastics and paper materials, while inert waste consists of ash that results from biomass cooking during the winter season [16]. The existing methods of localized waste reuse demonstrate how communities in rural areas can

implement decentralized systems for solid waste management.

1.2 Decentralized MSWM

The community-based method of Decentralized Solid Waste Management (DSWM) enables municipal solid waste management through multiple small-scale local waste management units which process waste material at or near its origin. The system operates multiple local waste management units which handle waste processing at its source to achieve better waste handling results. The approach decreases expenses associated waste transportation while decreasing environmental damage and increasing hygienic conditions throughout rural regions.[15]

Benefits of Decentralized Solid Waste Management (DSWM) in Rural Areas

[1]	The system decreases expenses for waste transportation
[2]	The system supports the process of composting organic materials
[3]	The system decreases both open dumping and open burning activities
[4]	The system increases both recycling rates and resource recovery efficiency
[5]	The system decreases waste volume that needs to be processed at landfills
[6]	The system creates better conditions for public health and sanitation purposes
[7]	The system motivates residents to take part in their community activities
[8]	The system enables sustainable agricultural practices through compost application

1.3 Methodology

A waste characterization study for household waste was done in selected agricultural villages of Nuh district, Haryana to study municipal solid waste (MSW) generation patterns and test decentralized solid waste management (DSWM) methods. The researchers selected 25 households through stratified purposive sampling which studied annual household income and family size and agricultural dependence and domestic livestock ownership and participant willingness. The researchers divided households into three income groups which included:

- Low income – below 1 lakh
- Medium income – 1-2 lakh
- High income – above 2 lakhs

Waste samples were collected from each household over a seven-day monitoring period to account for daily variability in generation rates. The collected waste was segregated into three categories, namely biodegradable, non-biodegradable, and inert waste (ash, dust, etc.), and measured using a digital weighing balance. Per capita waste generation was subsequently calculated based on the total weekly waste generated and the corresponding household size.

This methodology enabled the assessment of waste composition and existing resource utilization practices at the household level within the rural agrarian context of Nuh district.

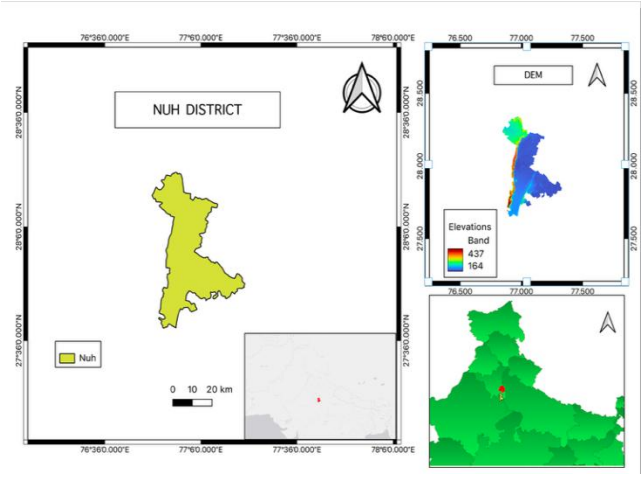

Fig -1: Nuh district

2. RESULTS AND DISCUSSION

The research analyzed weekly household waste production across different income groups in the rural agricultural areas of Nuh district which demonstrated that waste production increased as income levels rose. High-income households generate the most waste with an average of 7.14 kgs per week while medium-income homes generated 6.36 kgs and low-income homes produced 3.69 kgs. High-income households generated 160.7 grams of waste for everyone every day while medium-income households generated 123 grams and low-income households generated 72.8 grams. The local population behaves as agricultural people which results in biodegradable waste becoming the primary waste type for all income groups in this area.

The winter data collection period caused a decrease in inert waste production for Nuh district. Nuh district rural households use traditional biomass cooking methods which depend on firewood and agricultural leftovers as their main cooking source during winter. The combustion of these materials produces ash which causes both low- and medium-income households to create more inert

waste. High-income households showed lower ash production because they used cleaner cooking fuels such as LPG. The different fuel choices made by various income groups produced distinct seasonal patterns of inert waste production.

Table -1: Weekly Waste Generated

Weekly Waste Generated					
Income Level	Inert(kg)	Biodegradable(kg)	Non-biodegradable(kg)	Total (kg)	gm/c/day
High	0.4725	4.805	1.862	7.14	160.7
Medium	1.862	3.504	0.997	6.363	123
Low	1.815	1.479	0.397	3.691	72.8

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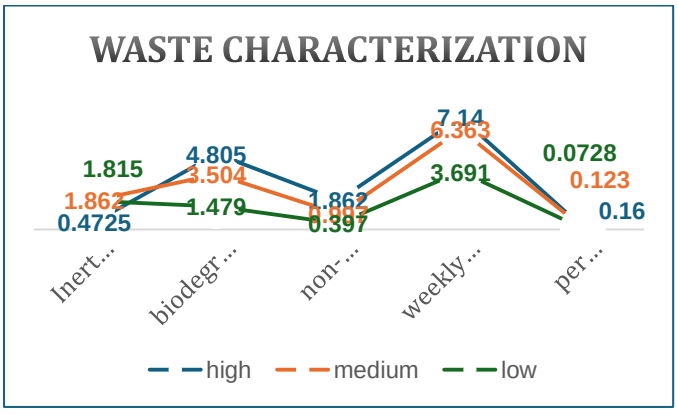

Chart -1: Waste Characterization

The waste characterization study in Nuh district demonstrates how different income levels impact the waste disposal patterns and waste materials disposed by households. The study shows that all income groups produce their highest waste volume through biodegradable materials which results from their agricultural and household operations in rural areas.
High-income households generated the highest quantity of biodegradable waste (4.805 kg/week), followed by medium-income (3.504 kg/week) and low-income households (1.479 kg/week).

3. CONCLUSIONS

The study evaluated decentralized solid waste management (DSWM) methods by analyzing municipal solid waste generation and composition from Nuh district Haryana agricultural rural households. The research discovered that as household income increases per person waste production rises because high-income households dispose 1607 grams of waste per person each day while medium-income households produce 123 grams and low-income households generate 728 grams. Biodegradable waste appeared as the most common waste type throughout all income levels because people followed agricultural waste disposal methods which included their domestic and agricultural waste disposal methods.

Winter seasonal weather conditions majorly impacted inert waste production because low- and medium-income households relied more on traditional biomass feedstock for their cooking and heating needs. High-income households produced less ash waste because they used cleaner cooking fuels which included LPG.

Households practice decentralized waste management through their practices of using biodegradable waste as livestock feed and burning combustible waste materials for cooking and applying ash to their agricultural fields. The local practices decrease the need for formal waste collection services while they enable rural communities to achieve sustainable resource recovery.

The study shows that decentralized solid waste management methods designed for agricultural rural environments can reduce environmental damage while enhancing public health and establishing environmentally sustainable farming methods in Nuh district.

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