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Waste Management in Two States & Urban areas in India

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ABSTRACT

The current article focuses on the waste management practices through the application of biogas plants in the states of Chhatisgarh and Karnataka. The article discusses the various modalities of biogas, its measurement methods, application not only at macro level but also micro level.

While the biogas interventions are in rural areas, the other section of the article is on the urban area. Hence, the article covers both the urban and rural areas covering both geographies. Waste management has come a long way. In the United Progressive Alliance I era, the Nirmal Bharat Abhiyan (NBA) had the October 2nd date as the day of cleanliness.

The Swacch Bharat Mission (SBM) picked up in 2014 with the efforts of Prime Minister Modi when he galvanized the efforts through Open Defecation Free efforts at the village level. The subsidies through the house hold toilet building efforts and the Community Led Total Sanitation (CLTS) efforts at the community level acted as the two active sides of the SBM coin.

The article focuses on two action points primarily. One is the bio gas intervention and the other is the waste segregation. The article aspires that biogas intervention gets into focus again since the domesticated livestock will be back in focus again at village level.

KEYWORDS

• Biogas • Waste Segregation • Efficiency • SBM

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INTRODUCTION

Through the research design of 'Case Study' at the state level of Chhatisgarh and Karnataka, the article discusses the biogas and waste segregation methods as tools of waste management. It also discusses the measuring tools of performance, efficacy, generation efficiency of the bio gas plants.

The article details out a success story of the state of Karnataka through 6 parameters at village level where the biogas project was rolled out. It evolved that about 50% of the popukation were using Biogas in the intervention villages.

The details of actual costs incurred by the Ministry of Non Renewable Energy Sources through subsidies at household level are mentioned in the article. Further, the article also gives the scenario of waste segregation as dry & wet wastes at national level for the urban areas. There are 87,095 wards in the country with 100% door to door collection of house hold waste at house hold level as on 2024.

The article also gives the types of dry waste composition through 7 types of waste. It gives the details on waste generation in 6 mega cities, metro & class I cities. Lastly, it touches upon the economic & environmental benefits of waste water treatment while touching up on the hazardous waste management.

BIOGASPLANTSOFCHHATISGARHSTATE

The study was conducted in the state of Chhattisgarh by Kumar Shailendra, B.P. Mishra, M.S. Khardiwar, S.K. Patel, B.K. Yaduvanshi and B.P. Solanki through the help of CREDA and Faculty of Agriculture Engineering, IGKV, Raipur.[1,2,3]

The primary aim of the study was the evaluation of the functioning and performance of the biogas plants across the state of Chattisgarh. As per the study, 30,376 biogas plants were installed by CREDA in the state until 2010. On an average, 3375 plants were annually added in the plant. Animal excreta and other kinds of agricultural wastes were mainly used as raw material for energy production.[1,2,3]

A survey was conducted for the study, where each plant was visited and the feedback was collected from the owners/operators of the plant. The survey required the data collectors to have technical knowledge, greater focus on climatogically correct data for temperature. They had to focus more on the collection of data regarding parameters like the gap between dung required and dung fed, status of the plant, gap between feeding practices and prevailing practice, techno-economics and the performance of the plant.[4,5]

To check the performance of the plant the theoretical gas generation was taken to be 0.04 cubic

$$\text{Gas Generation Efficency} = \frac{\text{Actual gas Consum.}}{\text{Theo. gas generation efficiency}} \times 100$$

mtrs per kg

For this the following formula was used,

The capacity wise performance of the plant was calculated using the following formula,

$$\text{Over all plant's efficiency} = \frac{\text{Actual gas Consum. x Dung fed \%}}{100}$$

The growth/size of the plants was taken to be 1-6 cubic metres/ day. The capacity wise (of the plants) dung feeding was also calculated. The dung fed per cent of the total dung required was calculated using the following formula,

$$\text{Dung fed per cent of total required dung} = \frac{\text{Dung fed per day x 100}}{25\ (\text{kg/m}^3) \times \text{plant capacity}\ (\text{m}^3)}$$

The average gas generation efficiency was maximum in the district of Mahasamund (83.5%) and it was the least in Rajnandgaon (71.6%). The overall gas efficiency was found to be 75.73%.[4,5]

The maximum average dung feed percentage was found in Dhamtari (101.67) and the least was the Durg (56.29%). The maximum gas time was found in Durg (6.04h) and minimum time was observed in Bilaspur (2.7h). The overall gas use time was found to be 3.75h/day.[4,5]

The overall plant efficiency was found to be 64.72% with maximum being recorded in Mahasamund (82.3%). Durg had the least plant performance efficiency due to the lowest dung feed percentage.[4,5,6]

SUCCESS STORY OF SIRSI, KARNATAKA

The following case study is regarding an alternative energy source called biogas. The success story is of Sirsi block of Uttara Kannada district of Karnataka. The story is more than two decades old.[6]

The study mainly focused on the rural households of Sirsi. About 50 percent of these households had cow dung based resources for operating the plants while the rest half had built the biogas plants already. All the plants were functioning satisfactorily and 85 percent of these plants helped the households meet their cooking energy needs. About 11 percent of these households met 75 percent of their daily cooking energy requirements from biogas. The last 4 percent of the households met fifty percent of their cooking needs through biogas. Multiple stakeholders were involved in the dissemination network and entrepreneurs helped boost the entire process through aiding in the construction, subsidisation, commissioning and free servicing of the plants.[6]

A shift was made from mild steel floating drum design to fibre reinforced plastic drum design and then to the less expensive fixed dome style. This showed the activeness of the rural households to the developing technology. Hence, the plants were made locally and in a cost effective manner. FRP gas holders were chosen because of their corrosion resistant nature and low post installation requirement. Fixed cover designs were built in only 3 percent of the plants and later failed.[6]

Nearly, eight villages were covered in the study. These villages had 250 plants out of which 187 were chosen for the study. The information regarding livestock ownership size, land holding, plant details, performance, and land holding were taken by visiting all the plants individually.[7]

The eight villages had a total bovine population of 3129. The block consisted of 21% of the total plants built in the 11 blocks of the district (annually). The block had a net dissemination of 248 plants/1000 HH with which were disseminated at a rate of 20 plants/1000 HH/ year. The 8 study villages had 756 HH with a dissemination rate of 330 plants/1000 HH.[7]

All the plants in the villages were active. According to the study's estimates, 15 new plants were built in the 8 study villages per annum. The block had 15 trained builder-entrepreneurs with maximum three construction teams for each plant. Each entrepreneur had the capacity of building 30 plants every year according to the estimates. Nearly, 5kg/capita of the dung was contributed to the plants daily. A high dung to gas conversion ratio was obtained.[7]

Studied parameters of the Sirsimakki and Malenalli areas consisting of 8 villages[7]

Parameters	Sirsimakki	Malenalli
Total Population	611	548
Number of Households(HH)	92	140
HH with biogas potential	50	47
HH with biogas plants	41	26
HH with biogas potential and plants (%)	82	55
Population using biogas (%)	48	43

About 250 litres/capita/day of gas was available to nearly 25 percent of the households. All of the HH had actively filed for the construction and subsidy. The actual costs approved by the Ministry of Non-Conventional Energy Sources (MNES) and endured by the House Holds along with subsidies have been listed below.[7]

Size of the plant (m3)	Actual cost range (Actual cost-Subsidy) (Rs.)	MNES approved cost (Rs.)	
		Mild steel	Fibreglass
3	10,200-10,950	10,950	11,600
4	9,600-12,600	12,300	13,100
5	10,400-13,400	15,200	15,900
6	13,300-14,300	17,800	19,000

The high dissemination rate can accredited to the high literacy rate of 74%, easy access to credit from co-operatives, credit and marketing societies and growers' societies, great financial incentive for the builders, production of arecanut or 'Supari/Gua' in Hindi (perennial cash crop) and rice, need for gaseous fuel, absence of LPG, high subsidy and the government's efforts.[7]

Other reasons of success were large cattle holdings, guarantee of the entrepreneurs, and a high income. Finally, the fixed dome Deebnandhu model also got accepted after being proven less expensive. The increase in biogas plants in Sirsi was 8 to 10 times high as the national average. Even though fuel wood was available in ample amount, still the rural people spent significantly on the plants showing the high level of awareness. Hence, with the active participation of all the stakeholders, the plants of Sirsi model became a huge success.[7]

Segregation of dry waste and wet waste[8]

India currently generates 1.45 lakh metric tonnes of solid waste, 35% of which is dry waste.

As per the Swaccha Bharat Mission, the door to door garbage collection (ward-wise) is 92,707 tonnes and the amount of waste segregated is 86,406 tonnes. The amount of waste generated is 159.47K+ and the amount of processed waste is 125.11K+. The amount of waste to be remediated is 1,586 MT.

According to the guidelines of the Ministry of Housing and Urban Affairs, the per capita waste generation ranges from 0.2 kg to 0.6 kg per day for cities with a population varying between 1 lakh to 50 lakh. In the urban areas, solid waste increase by five percent per annum along with a rising urban population. Urban Local Bodies mostly spend Rs. 500 to Rs. 1500 per ton for SWM.

Most of the municipal waste (50%) is a profitable resource and can be used for purposes like energy production, composting, Refused Derived Fuel (RDF) production, bio-methanation, pyrolysis etc.

Municipal solid waste mostly comprises of organic and inorganic waste. The bio-degradable component ranges mostly from 30 to 55 percent, inert matter from 40-55 percent, and lastly, the recyclable matter ranges from 5-15 percent. Most of the inert matter goes into engineered landfills.

According to the data presented by the Ministry of Chemical Fertilisers, Department of Fertilisers, for the year 2022, the data for the state-wise collection of Municipal Solid Waste has been listed in the following table.[8,9]

States/UTs	Number of wards with 100% door to door collection	Total number of wards	Amount of waste generated (MT/D)
Andhra Pradesh	3563	3774	6257
Andaman & Nicobar	24		53
Arunachal Pradesh	406	436	201
Assam	853	943	1274
Bihar	3392	3406	5045
Chandigarh	26	26	508
Chhattisgarh	3255	3255	1657
Dadra Nagar Haveli and Daman & Diu	43	43	114
Delhi	291	293	11143
Goa	226	226	128
Gujarat	1385	1385	9515
Haryana	1609	1628	5383
Himachal Pradesh	535	544	245
Jammu and Kashmir	925	1099	412
Jharkhand	923	940	2042
Karnataka	6682	6766	6158
Kerala	3162	3533	2229

Table Conti...

States/UTs	Number of wards with 100% door to door collection	Total number of wards	Amount of waste generated (MT/D)
Ladakh	26	26	3
Madhya Pradesh	7357	7591	6966
Maharashtra	6500	6519	22771
Manipur	238	305	31
Meghalaya	38	123	7
Mizoram	195	195	289
Nagaland	189	232	128
Odisha	2025	2025	2550
Puducherry	126	126	277
Punjab	3132	3174	3724
Rajasthan	7550	7670	6300
Sikkim	51	51	72
Tamil Nadu	12621	12834	14152
Telangana	362120585		
Tripura	3341		
Uttar Pradesh	12058		
Uttarakhand	1203		
West Bengal	2527		
Total	87,095		

The dry waste composition in the municipal solid waste is as follows[8,9]

Type	Percentage
Plastic	46%
Paper & cardboard	21%
Textiles	15%
Other (Human hair, Coconut, Tetrapack, Footwear etc.)	9%
Metals	3%
Glass & Ceramics	3%
Tyres & Rubber	3%

Wet waste is processed through bio-methanation and composting. Another category that becomes a major component of the generated waste is construction and demolition waste. About 12 million tonnes of C & D waste is produced per year. It comprises mainly of bricks & masonry (12%), soil, sand and gravel (47%), metal (6%), wood (3%).[8]

C & D waste management promotes the job market and these value chains can help in generating revenues of Rs. 416 crore per year. C & D waste can be used for structural and non-structural applications.[8]

Waste management promotes the job market, helps in obtaining the maximum value out of any material and protects the environment as well. It incentivises the ULBs to strengthen the sewage infrastructure.[8]

The concept of circular economy goes along with waste management. Circular economy is promoted through material reuse. Reuse can be of various types like adaptive reuse, deconstruction, Design for deconstruction, Design for reuse and Design for longevity.[8]

Currently, the urban areas produce 72,368 MLD of municipal sewage. According to CPCB, only 44 % of the sewage goes through installed sewage treatment. Sale of treated sewage can generate a revenue of Rs. 3285 crore annually. Treated wastewater can help increase the farmer's earnings by Rs. 17000 per hectare per annum. This wastewater will also help in saving Rs. 600 crores annually due to the substitution of pumping. Nearly 1800 people can also get employment to aid the management of treated wastewater.[8]

For wastewater recycling and reuse, policies and action plans have been made on the guidelines of CPHEEO 2013 like the Andhra Pradesh Action Plan, Telangana Action Plan, Delhi Jal Board, Tamil Nadu Draft Reuse Order etc.[8]

Apart from this, the amount of waste generated in the mega cities, metro cities and Class-1.

Towns are as follows.[8,9]

City type	Waste generated in tpd	Percentage of total garbage
6 mega cities	21,100	18.35%
Metro cities	19,643	17.08%
Class-1	42,635.28	37.07%

For dry waste, recycling can add up to Rs.11,836 crores (one crore equals to10 millions) to the economy annually. It will also help in generating employment for 40 lakh people annually. Recycling and reuse of wet waste will lead to a contribution of Rs.2,460 crores per annum if 50% of the wet waste get processed through bio-methanation. Similarly, taking the required steps towards the reduction and recycling of C& D waste can generate a revenue of Rs. 416 crore per year. Wastewater treatment and the sale of treated sewage can potentially generate a revenue of Rs. 3285 crores. Rs.6,700 crore can be extracted as revenue from sludge recycle through the generation of 82.5 lakh cubic metre of biogas and 3600 metric tonnes of compost on a daily basis.[8]

Economic and environmental benefits of wastewater treatment[8]

Amount of sewage to be reused by 2030	18,000 MLD
Amount of sewage to be sold to the industries	4500 MLD
Revenue generated from the sale of sewage to industries	9,00,00,000
Estimated nutrient value for 18,000MLD of sewage (tons/day)	3,888-5256
Minimum economic value of nutrients (Rs)	3,11,04,000
Maximum economic value of nutrients (Rs)	4,20,48,000

Material Recovery Facilities (MRFs) are a very critical production point in the overall recycling process. MRFs follow the sustainable hierarchy of management i.e. from the collection of segregated waste from the source, further segregation of the dry waste into different categories like plastic, cardboard, glass, metal etc. This segregated waste is used as a raw material by scrap dealers, recyclers, and industries.[8]

MRFs are of the following types:[8]

1) Manual - Suitable for small quantities of MSW (5-10 TPD) and cities with population less than 1 lakh or 0.1 million.
2) Semiautomatic - Can cater to 10-100 TPD of segregated waste and are suitable for cities with population of 1 lakh – 10 lakh (0.1 million to 1 million)
3) Automatic - Play their role in material recovery from large quantities of waste (more than 100 TPD) and mostly operate in cities with population more than 10 lakh/1 million.

The segregated dry waste was used for the production of Refuse-Derived Fuel (RDF), road construction etc. Three main technologies are used for the conversion and disposal of dry waste were pyrolysis, gasification and incineration.[8]

Management of e-waste has been carried out under the framework of E-waste management rules (2016). As per the rules, EPR has been to E-waste as well. The producers of electrical and electronic equipment have been given the responsibility of managing their products. Annual e-waste collection targets have been given to these producers. The producers are also responsible for the dismantling and recycling of the waste.[8]

The SPCBs and PCCs have been implemented an action plan for these rules across the country. 400 dismantlers are operating in 20 states of the country, namely, Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Goa etc. Quarterly verification of the quantity of e-waste collected is also carried out.[8]

Hazardous waste management is also done in several ways.[8,9]

1) TiO_2 is recovered from spent TiO2 - NaCl cake.
2) Spent Sodium Hypochlorite with Fresh/ Spent Caustic Solution is used for manufacturing Sodium Hypochlorite.

3) Bricks are manufactured from the sludge generated from spent acid neutralisation facilities.
4) ETP sludge generated from a secondary clarifier is used as fuel from recovery boilers.
5) Salts for industrial use are recovered from waste salts generated from CETPs/ ETPs.

Economic benefits of MRFs (in urban India) from 2021 to 2025.[8,9]

	2021	2025
Amount of materials recovered at MRFs in TPD	24,945	50,231
Cost recovered per day (Rs)	14.21 crore	46.24 crore
Cost recovered per annum (Rs)	5,187 crore	17,023 crore

Scenario of dry waste value recovery after the implementation of circular economy principles 2021 V/s 2025[8,9]

Type of Waste	Total amount of waste generated daily (TPD)		Value recovered per day (Rs in crores)	
	2021	2025	2021	2025
Plastic	145,000	205,000	7.83	24.60
Paper & cardboard			3.65	11.48
Glass & Ceramics			0.12	1.03
Metal			0.36	1.64
Textiles			0.87	3.08
Tyres & Rubber			0.70	1.64
Others (Human Hair, Coconut, Tetrapack, Footwear)			0.68	3.18
Total			14.21	46.64

The following table represents the revenue generation from bio-methanation and its contribution to the economy (in urban India) from 2021 to 2025[8,9]

Year	2021	2025
Biomethanation plants (setup) (TPD)	2,300[2] (MIS, Actual)	51,250
Potential Gas Generation @ 3 % CBG	69	1,538
Estimated Revenue Generation (Rs 46/ kg) (Rs in crores)	115.85	2,581.46
Net Contribution to the economy	Rs. 2460 crores	

Emerging Issues

Waste treatment should get focus in areas also like the urban areas. The Urbal Local Bodies (ULB) should set examples for the Panchayati Raj Institution (PRI) who are responsible for waste management in rural areas.

The concept of Waste Management has to be visualized as an occupation and not as a hobby.

CONCLUSION

To conclude in the state of Chhatisgarh, the analysis of the performance of the plant helped in identifying the problems in production, the best functioning plant and the reasons behind the failure of certain plants. The overall efficiency of all the plants in the state was found to be 64.72%. The efficiency decreased with increase in the size of the plants.

Similarly, the success story of Karnataka is to be replicated at a large scale. The hazardous management techniques should also percolate to civilians. The concept of segregation of waste, management of grey water should be prioritized at the national level for the benefit of masses.

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