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SWM & Agricultural Residue Management Through Case Studies

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ABSTRACT

The article has two portions. The first portion is regarding the Solid Waste Management (SWM) in the city of Indore. The second portion is about the management of agricultural residue.

The case study is regarding the cleanest city in India as per the Swacch Bharat Abhiyan. The process through which the city remains clean is multidimensional. One of the dimensions is Solid Waste Management (SWM). The article describes how the SWM is carried out & simultaneously it describes the other modalities of SWM.

The second part is centred on the management of agricultural residues. Further, the concept of Zero Budget Natural Farming (ZBNF) and the standard composition of compost are the subjects that are detailed upon in this section.

A sustainable environment can only be achieved through the rollout of these two key aspects across the nation. This is only possible with a cooperative federal structure that acts proactively. One of the technology that the article discusses as a cross cutting issue is In Situ Vitrification of Soil (ISVS). It is a technology used to treat contaminated soil & buried waste by melting into a stable glass like material.

From the management of solid wastes, the nation is moving towards the liquid wastes. Managing liquid wastes is far more challenging than the solid and it is here that the SBM 2.0 is venturing into. This is the reason why in the city sanitation plans, the setting up of Sewerage Treatment Plants is very crucial. Further, lots of STPs are constructed but these STPs do not function optimally.

KEYWORDS

• SWM • ZBNF • SBA • Compost

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INTRODUCTION

The section details out the case study of solid waste management in Indore. It attempts to understand the success behind Indore's waste management system in terms of 100 percent segregation, door to door collection, public awareness, GPS controlled vehicles for collecting waste etc. These were the pillars of Indore's success. Bio-compositing and Bio-methanation turned out to be one the best options for reducing waste in the city. Incineration proved to be unsuitable due to its harmful impact on the environment and public health.

Organisational activities like corporate social responsibility, employee communications, change management, external communications, and stakeholder management. The SWM system Indore was much more aligned with the Integrated Sustainable Waste Management System (ISWM). The ISWM focuses on three dimensions, stakeholders, components and phases of the transfer of materials from source to treatment, and the components used to check the system.

Community involvement was necessary to make Indore a success story. Committed stakeholders like local bodies helped execute the entire plan carefully. A proposition was made to try ORWARE (Organic Waste Research Model) model in the future for better disposal of organic and inorganic waste. It is a model that analyses substance flows, cost, and impact on environment. It can calculate the financial expenses and revenue generated from the overall management system.

As per the census of 2011, Indore had a population of 19 lakhs. The city covers an area of 276 sq km. According to the study, Indore generates 1115 MT of waste daily from both commercial and household sources. The management system got improved with source-based segregation, ultimately improving the thousands of vulnerable waste points in the city. Hazardous waste usually was dumped into the river Kahn. This posed several health risks to animals and waste pickers.

In December 2015, door to door collection as a trail project was started by IMC in the 42nd and 71st ward of Indore. The residents were encouraged to segregate the wet and dry waste. A pilot experiment was conducted in January 2016 with a door to door service in two wards of Indore. It took a year to hit the target of 100% door to door waste collection. In alignment with the Clean India Mission, the IMC attempted to make people aware about waste segregation. A two bin system was introduced with the green bins for organic/ biodegradable waste and blue bins for the non-biodegradable part.

The waste is segregated into 6 categories. These are Biodegradable, Non-biodegradable, Plastic, Sanitary, Household, Hazardous and Electronic wastes. The management occurs in phases like waste generation, segregation, collection, transportation, and disposal. Wet waste consists of 58.25% of the total waste, dry waste consists of 41.75%, and domestic and hazardous waste makes for 5% of the total waste.

Composition of the waste generated has been shown in the following table.

Table 1: waste composition of Indore

Type of waste	Percentage
Food and Garden waste	41
Paper	27
Inert	15
Glass & Ceramic	5
Textile	5
Plastic/Rubber	4
Metal	3

Based on the amount of garbage produced, waste generators were classified into three categories. These are Domestic (<25 Kg per day), Semi-bulk (25-100 kg per day) & Bulk generators (>50 kg per day).

Household waste collection systems mostly remained unorganised. Primary collection was done by municipal workers or private contractors called 'Jagirdars'. A2Z infrastructure was responsible for collecting waste from the central dustbins. But due to a financial crisis, the secondary waste collection did not take properly. Most of the waste was dumped into Devguradia. This system got replaced by divided tippers. These are controlled by a GPS system and provide the dry waste to a MRF and the wet waste to a Centralised Composting Unit. A Win Composting method was used for decomposing the waste. About 600 MT of organic waste are processed in the units.

A 300 MT fully automatic MRF was installed at Devguradia Trenching Ground. The recovered materials are sold to recycling plants. The other unusable waste is used for cement manufacturing. The plant had been divided into three recycling phases, sorting, shredding and cleaning. RDF is produced from the usable waste. Bioming was used to clean the waste of 12 lakh MT of old waste. The IMC also installed 200 MT bio-methanation plant, in the Choithram Mandi. 15 buses in Indore currently use Bio-CNG. Another plant is also present at the Kabitkhedi STP. The lighthouse plant was established in collaboration with Indo Enviro Integrated Solutions under the PPP model. This will be zero waste plant that will produce 17 to 18 metric tons of CNG. A Continued Stirred Tank Reactor will be used in anaerobic digesters. To conclude, Indore became a success story and The ORWARE model was recommended from the study.

Use of agricultural residue, animal waste for composting, manuring and mulching at the National Level

India contributes 350 million tonnes of agro waste every year as per the report of ICAR. About 1/3rd of the food waste generated in India is contributed by agro-waste. Agro waste mostly comprises of crop residues, livestock wastes, poultry waste, slaughterhouse waste, agro-industrial waste, pulps, oil seed cakes and aquaculture wastes. As per the MoHUA, there are 700 functional compost plants with a production capacity of 18.9 MT per annum. These composting plants generate composts from all kinds of wastes.

Composts are generated using various methods like the Indore method, Bangalore method, Coimbatore method, pit and heap method, windrow composting etc. Various factors impact the composting process like the type of decomposing organisms usage, type of culture used, moisture, temperature, C/N ratio, aeration and the addition of sewage or sewage sludge. The data provided by the National Sample Survey Office revealed (NSSO) revealed that more than 50 percent of the Indian farmers were living under debts due to the heavy cost of production. To achieve the target of doubled farmers' incomes by 2022, farming practices like ZBNF are being promoted currently.

ZBNF demands 50-60 percent less water and electricity, decreases methane emissions through multiple aeration and reduces crop residue burning through mulching. Four major components of ZBNF model are Bijamrita, Jiwamrita, Acchadana/ mulching and Waaphasa (soil aeration). These components together increase the soil microbial activity and nutrient content of the soil.

The concept of Zero Budget Natural Farming (ZBNF) was promoted by Padma Shri awardee Subhash Palekar in the mid-1990s. He provided the concept as an alternative to green revolution to ensure a low cost of production and environment friendly practices. ZNBF has been promoted under the the Paramparagat Krishi Vikas Yojna (PKVY).

Natural farming is a type of farming system that promotes chemical free agricultural methods. It emphasises more on the indigenous traditional practices like biomass mulching, multi species green manuring, a round the yar green cover, usage of indigenous cow breeds for dung and urine formulations like Bijamrit, Jivamrit, Ghanjivamrit etc. These formulations are used for soil fertility and nutrient management, diverse cropping systems, and for the production of botanical extracts that prevent plant infections and aerate the soil. Any kind of externally purchased inputs are mostly avoided in natural farming. Currently, the states that are actively practicing natural farming are Andhra Pradesh, Himachal Pradesh, Gujarat, Kerala, Jharkhand, Odisha, Madhya Pradesh, Rajasthan, Uttar Pradesh and Tamil Nadu.

The state of Andhra Pradesh launched ZBNF in September (2015) under the Rashtriya Krishi Vikas Yojana. The state government has been conducting experiments in collaboration with the University of Reading, UK World Agro Forestry Centre, Nairobi, FAO and NGOs, Civil Society Organisations like the Centre for Sustainable Agriculture, Hyderabad.

Karnataka has implemented ZBNF on pilot basis in 10 agro climatic zones spread of over an area of 2000 ha. This has been done with the help of state agriculture/ horticulture universities as demonstrations or experiments in the farm fields. Kerala has been running awareness programmes, trainings and workshops. Himachal Pradesh has implemented the Prakitri Kheti Khusha Kisan scheme of the from May 2018. The government has been able to bring 19936 farmers and an area of 1155 ha under the scheme. The states

have been able to improve soil quality with the help of these schemes.

ICAR has also conducted an evaluative study on ZBNF in Basmati or coarse rice-wheat system from the beginning of the Rabi season of 2017 at 4 different locations, name, Modipuram (UP), Pantnagar (Uttarakhand), Ludhiana (Punjab) and Kurukshetra (Haryana). The Indian government has been promoting natural farming through the Natural Mission on Natural Farming (NMNF). NMNF is an upscaled version of the Bhartiya Prakratik Krishi Paddhati (BPKP), which was a sub-scheme under the PKVY.

BPKP was launched in 2019 under PKVY. Under the scheme, a financial assistance of Rs. 12,200/ha was provided for 3 years. Rs. 4500/ha were spent for 3 years on deployment of manpower, data management and uploading. Cluster formation and capacity building measures like exposure visits and training of the field personnel required an expenditure of Rs. 3000/ha for 3 years. Rs. 2700/ ha were spent on PGS certification and residue analysis. Lastly, an incentive of Rs. 2000/ha was provided to the farmers as DBT.

Organic farming has been promoted through the PKVY and Mission Organic Value Chain Development for North Eastern Regions (MOVCDNER). MOVCD-NER is responsible for promoting third party certified organic farming of the niche crops OF NER with the help of the Farmer Producer Organisations (FPOs). Emphasis is put on exports. An assistance of Rs. 25000/ha is given to the farmers for a period of three years to purchase organic inputs. Rs. 2 crores are also provided under the scheme for FPO formation, capacity building and post-harvest infrastructure.

PKVY operates as a sub-component of Soil Health Management (SHM) under the National Mission for Sustainable Agriculture (NMSA). Assistance of Rs. 50,000/ha is provided for three years out of which Rs. 31,000 are given as an incentive to the farmer. The Capital Investment Subsidy Scheme (CISS) provides assistance to the state governments/government agencies in setting up mechanised fruit and vegetable marketplaces and production of 3000 tonnes/ annum of compost from waste/agro waste.

The Agriculture Infrastructure Fund (AIF) provides financial support to state agencies, FPOs etc. for the setting up of organic input production units, community farming assets and post-harvest infrastructure. Schemes like National Mission on Oilseeds and Oil Palm (NMOOP) and National Food Security Mission (NFSM) also provide financial support to the farmers. India produces 686 MT of dry biomass per annum, out of which 234.5 MT is referred to as surplus crop residue. 34 percent of crop residue is contributed by rice. Rice crop residue is used by many farmers as livestock feed, for mulching and for composting. However, paddy stubble burning and straw burning are still some major issues that cause environmental pollution.

Alternate approaches for the management of agricultural waste have been found in the form of production of organic fertiliser from agro-waste, composting, biochar production, conservation agriculture etc. Composting technologies like phosphor-sulpho-nitro compost technology, vermin composting etc. are used. P-S-N technology involves the use of rock phosphate, pyrites and phosphorous solubilising organisms like Aspergillus awamori, Pseudomonas striata etc. Pit and heap methods can be used to prepare P-S-N compost. Vermi composting is another process used for the development of compost. Vermicompost has a nutrient value which is higher than the conventional compost.

The following table represents the standard composition of compost described by the Fertiliser Control Order of 1985.

Table 2: FCO's standard composition of compost

Parameter	Amount/colour
Moisture content (% by wt)	15-20
Colour	Dark brown to black
Odour	foul odour absent
Particle size	(90% of the material should pass through the 4 mm IS sieve
Organic carbon (% by wt)	16
Nitroge n (% by wt)	0.5
Phosphates like P2O5 (% by wt)	0.5
Potash (K2O) (% by wt)	1
C:N ratio	20:1 or less
pH	6.5-7.5
Conductivity (dsm2)	4.0
Pathogens	Nil
Arsenic (As2O3)	10
Cadmium	5
Chromium	50
Copper	300

Table Cont....

Parameter	Amount/colour
Mercury	0.15
Nickel	50
Lead	100
Zinc	1000

For the development of compost, PUSA decomposers are useds which contain fungal formulations like that of A. awamori, A. clavatus, T. harzanium, A. niger, P. oxalicum and Ch. Globossum. Composts are prepared using all the three methods, pit, heap and windrow.

Biochar is another important carbon rich material produced from agro-waste. It helps in improving soil fertility, crop yield, water retention capacity, aeration, nutrient retention, balances soil pH, improves the nitrogen content of the soil etc. Biochar can also be produced from coconut wastes using a technology which was developed at ICAR-CPCRI. Press mud produced as a waste in the sugar industry also goes for composting as it is used to prepare a soil less planting media. It helps in increasing moisture retention, root anchorage, nutrient value etc. Rapid composting technique is utilised to recycle food waste worth 1.3 billion tonnes. This technique involves the usage of a compact vessel bioreactor to convert the food waste into compos using a mesophilic microbial consortium. Most of the city and food waste is recycled using this technique.

Other tehnologies that have been put to use are Family Net Vessel Compost Technology (FNVC) and BioCompost technology. The Pusa decomposer technology for agri-waste management developed by ICAR-IARI has been licensed to the following companies under the IARI best practices.

The firms are given in the table below.

Table 3: IARI firms & locations

Firm	Location
MD Biocoals Pvt. Ltd.	Haryana
IPL Biological Ltd	Gurugram, Haryana
Vijay Sales Corporation	Sudershan Park, New Delhi
OM Agro Organics	Yavatmal, Maharashtra
Krishi Vikas Sahakari Samiti Ltd.	Hanumangarh, Rajasthan
Agrella Crop Science Pvt. Ltd	Panchkula, Haryana
Global Management & Engineering Consultants International	Jaipur, Rajasthan
Balaji operation and maintenance service Private Limited	Gurugram, Haryana
Grassroots Energy Technology India Pvt. Limited	Bangalore
Ankur Organics Biofertilisers	Lucknow
Microplex India	–
Parashar Agrotech Bio. Pvt. Ltd.	Varanasi, Uttar Pradesh
Citrus Estate	Hoshiarpur, Punjab
SRL & CO	Lewis Road, Bhubaneshwar
Sanguine Novaseed Pvt. Ltd.	Maharashtra
Indore Biotech Inputs & Research Pvt Ltd.	Indore, MP
WStelematics	–
Maa Bhagwati Biotech & Chemicals	Maharashra

DISCUSSION

Three stakeholders that are discussed above are the Urban Local Bodies, community & key influencers. The synergy among the three and through a Padma awardee the article traverses through their efforts in waste management.[9,10]

Two municipal corporations of Shimla & Indore, institutions like Indian Agricultural Research Institute, technologies like ISVS, ministries like MOUHA & Drinking Water & Sanitation, regional institutions of IARI and the agricultural residue management are the exemplary pivots of the article.[9,10]

The Fertilizer Control Order & the SBM bill

are the two most significant documents that the current article dwells upon.

The cleanest city in the plain area & the hill city of Shimla show the waste management efforts in two different geography & topography.

One of the pertaining issues of agricultural management is the burning of agricultural stubs ('Parali' in Hindi language) that contributes to air pollution in every winter. This is where proper management of these residues is crucial. The adopted practices need to align with the best practices offered by the Indian Council of Agricultural Research.

Similarly, the eco friendly technologies for sustainable development of National Environmental Engineering Research Institute are also to be adopted at large scale as well.[11]

CONCLUSION

The above-mentioned efforts of corporations, institutions, ministries, national & international partnerships aspires that the efforts sustain themselves through the roll out of SBM 2.0. The critical issue of agricultural residue management is also another perennial issue. This practice is directly linked to air pollution.

It is time that Urban Local Bodies like small municipals in small towns, Notified Area Council in other small towns only learn from the experiences of such corporations so that the ever important issues of waste management practices become better across the nation.

The challenge that lies ahead is the effective management of solid & liquid wastes. While the nation has learnt to somewhat deal with the solid wastes, there is a lot to be done for the management of liquid wastes.

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REFERENCES

1. Saifi N, Jha B, SWM in Indore, MP, India: Insights from a survey of literature, ISVS e-journal, v10, i11, November 2023.
2. Bharti O, Singh A, Singh D P, Vibhor S, Effective municipal SWM practices: a case study of Shimla, HP, India, Waste management & resource utilization, 2014, copyright 2013, Oxford Publishing House.
3. GOI, IARI, Best Practices, PUSA decomposting, https://www.iari.res.in.
4. GOI, Sansad, Digital Sansad, SWM Bill, 2024, 8th July, 2024, https://sansad.in
5. GOI, SBM Urban 2.0, https://sbmurban.org
6. GOI, India Organic Waste Management Program, The International Partnership for the Satoyama Initiative, https://satoyamainitiative.org
7. GOI, Waste to Wealth, SBM Urban 2.0, https://sbmurban.org
8. GOI, MOUHA, Municipal Solid Waste, https://mohua.gov.in
9. GOI, DST, India-Japan Co-operative Science Program, IJCSP, https://dst.gov.in
10. GOI, ICAR, collecting wealth from agricultural waste, https://icar.org.in
11. GOI, CSIR, NEERI, https://neeri.res.in