



REUSE OF BIOSOLIDS AND TREATED WASTEWATER

ASSESSING POTENTIAL AND PRACTICES IN
56 FSSM CITIES OF UTTAR PRADESH





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56 FSSM CITIES OF UTTAR PRADESH**

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Maps in this report are indicative and not to scale.

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LIST OF ABBREVIATIONS

Abbreviation Full form

FSSM	Faecal sludge and septage management
FSTP	Faecal sludge treatment plant
STP	Sewage treatment plant
PDB	Planted drying bed
SDB	Sludge drying bed
SBM-U	Swachh Bharat Mission–Urban
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
NMCG	National Mission for Clean Ganga
ULB	Urban local body
KLD	Kilolitres per day
GIS	Geographic Information System
SOP	Standard Operating Procedure
NTPC	National Thermal Power Corporation
CSE	Centre for Science and Environment

Executive summary

This report assesses the potential to recover and reuse biosolids and treated wastewater from 59 faecal sludge and septage treatment facilities across Uttar Pradesh. Using a mixed-methods design, CSE staff collected quantitative data on plant performance (May–July 2025) and conducted interviews with operators, nodal officers and farmers to document current practices.

Key findings

- **By-product generation:** At 40 per cent average current capacity utilization, the state's FSTPs and co-treatment plants produce about ~71,000 quintals of biosolids and 200 million litres of treated effluent annually. Full utilization could nearly triple these outputs.
- **Uneven reuse:** Approximately 60 per cent of cities report zero biosolid reuse. Of the remaining 40 per cent, most distribute biosolids to farmers (free or at Rs 1–10/kg), while a few apply them to on-site landscaping, public parks or co-composting pilots. Treated effluent reuse is observed primarily in high-utilization cities via greenbelt irrigation, road cleaning (e.g., Moradabad) and industrial supply (Bulandshahr–NTPC).
- **Barriers:** The absence of regulatory standards and testing protocols, limited institutional capacity, infrastructure gaps (weighbridges, storage), inconsistent data management, weak market demand, and low plant utilization constrain resource-recovery efforts.

To bridge these gaps, the report recommends:

1. **Regulatory clarity** with biosolid and effluent quality guidelines;
2. **Testing networks** and 'biosolid passports' for certification;
3. **Capacity building** for ULB staff and operators;
4. **Minimal-cost infrastructure** upgrades (weighbridges, storage bays);
5. **Demonstration projects** (co-composting, tanker networks);
6. **Market incentives** (grants, PPPs) to stimulate demand; and
7. **Enhanced data systems** with GIS dashboards and annual scorecards.

Implementing these measures will transform sanitation end products from waste liabilities into valuable resources, advancing Uttar Pradesh's circular-economy objectives and environmental resilience.

1. Introduction

India's rapidly expanding urban population is placing unprecedented demands on sanitation infrastructure, particularly in small and medium towns with limited sewerage coverage. In response, **faecal sludge and septage management (FSSM)** has emerged as a scalable, decentralized solution, especially for areas reliant on onsite sanitation systems. FSSM not only addresses treatment needs but also offers an entry point into **circular economy** practices, transforming waste into valuable resources.

Among the most promising opportunities is the **reuse of treatment end products**—biosolids and treated wastewater—which have applications in agriculture, landscaping, construction and groundwater recharge. Yet this potential remains largely untapped due to limited regulatory guidance, low institutional capacity and the absence of structured reuse systems.

Uttar Pradesh (UP), India's most populous state, has taken ambitious steps to scale up FSSM infrastructure under national programmes like SBMU, AMRUT and NMCG. However, the reuse dimension of sanitation remains underdeveloped. This study addresses that gap by mapping existing reuse patterns across UP's FSTPs and co-treatment plants, identifying operational challenges, and highlighting pathways to mainstream resource recovery. The aim is to enhance the circular economy potential of FSSM, contributing to environmental resilience, water security and urban sustainability.

1.1. Background

From sanitation access to resource recovery

India's sanitation journey has evolved from addressing access gaps to enabling sustainability and resource efficiency. The first phase of this transition—focused on toilet construction and safe containment—established the foundation for improved public health. The current phase, however, seeks to close the sanitation loop by transforming waste into resources.

FSSM lies at the centre of this shift. By treating waste from septic tanks and pits, it enables cities to move beyond collection and treatment towards reuse and recovery. Biosolids can enrich soils, treated effluent can support irrigation and greening, and both can reduce environmental footprints when managed safely.

This vision of circular sanitation aligns with global Sustainable Development Goals (SDG 6.3 and 12.5) and is embedded in India's SBM-U 2.0 framework.¹ Uttar Pradesh—one of the early adopters of FSSM—has 59 operational projects across 56 cities, positioning it to demonstrate large-scale reuse models. This study documents how these systems are functioning, what reuse practices exist, and what steps are needed to institutionalize resource recovery in the state.

1.2. National context: Evolving urban sanitation in India

Over the past decade, India's urban sanitation landscape has matured through comprehensive policy, and institutional and financial frameworks. The Swachh Bharat Mission-Urban (SBM-U) catalysed behaviour change, infrastructure creation and safe management of faecal sludge. Its successor, SBM-U 2.0 (2021–26), moves the agenda further—toward 'Garbage-Free Cities' through circular economy approaches that promote reuse of treated water and biosolids.² Parallely, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) complements SBM-U by improving water supply, expanding sewerage and integrating wastewater treatment into broader city-resilience planning. Together with initiatives under NMCG and Jal Jeevan Mission, these programmes provide a coherent policy environment for decentralized sanitation, co-treatment and resource recovery.

This evolving national ecosystem not only strengthens the regulatory base for FSSM but also opens avenues for states like Uttar Pradesh to align local actions with national sustainability goals.

1.3. Uttar Pradesh: Scaling ambition and action

Uttar Pradesh faces significant challenges in urban sanitation due to the large number of towns with limited sewer coverage and reliance on on-site sanitation systems such as septic tanks and pits. In response, the state has taken structured steps to expand FSSM infrastructure, strengthen governance mechanisms, and promote safe treatment and management of faecal sludge. These efforts set the stage for a coordinated approach that combines infrastructure development, regulatory support and awareness initiatives, as discussed in the following section on statewide strategic alignment.

1.3.1. Statewide strategic alignment

The government of Uttar Pradesh has undertaken a comprehensive, phased approach to strengthen faecal sludge and septage management (FSSM) across the state, combining infrastructure development, institutional reforms and capacity-

building initiatives. Through programmes such as AMRUT and the Namami Gange Mission (NMCG), the state has established multiple faecal sludge treatment plants (FSTPs) and co-treatment facilities, creating a robust foundation for decentralized sanitation.³ This infrastructure ensures safe treatment of sludge from septic tanks and pits, enabling cities to address sanitation challenges systematically.

In parallel with physical infrastructure, the state has advanced regulatory and operational mechanisms to ensure sustainability. This includes the formulation of **model FSSM bye-laws**, the regularization of private service providers, and structured handover of treatment plants to city authorities for local management.⁴ These interventions are designed to strengthen governance, enhance accountability and build long-term operational capacity across urban local bodies (ULBs).

Recognizing that technical guidance and best practices are critical for operational excellence, the government has collaborated with the Centre for Science and Environment (CSE) to develop and institutionalize **Standard Operating Procedures (SoPs)** for the operations and maintenance (O&M) of FSTPs and co-treatment plants.⁵ These SoPs provide step-by-step frameworks for sludge receipt, treatment processes, biosolid management and monitoring, ensuring that plants operate safely, efficiently, and in compliance with environmental standards. Capacity-building programmes for plant staff have also been rolled out to bridge knowledge gaps and reinforce consistent operational practices.

To support evidence-based decision-making, the state has implemented the '**Ease of Septage Management**' (ESM) tool, which provides a **holistic assessment of city-level FSSM performance**.⁶ This tool evaluates multiple aspects, including citizen interface, desludging scheduling, plant operations and reuse potential, using a **city scorecard approach**. By benchmarking performance, identifying bottlenecks and preparing actionable improvement plans, the ESM tool has enabled ULBs to monitor progress systematically and prioritize interventions that enhance both operational efficiency and resource recovery.

The government has also guided ULBs to implement city-level IEC campaigns to sensitize communities on safe sanitation practices, scheduled desludging, and the potential benefits of reuse. These campaigns, developed with technical inputs from CSE, are part of a broader strategy to integrate public awareness with operational improvements, thereby strengthening the demand side of FSSM services.

Through this stepwise approach—from infrastructure creation to regulatory reforms, operational guidelines and community engagement—the government

of Uttar Pradesh is building a sustainable FSSM ecosystem. As cities have now started to engage in FSSM and plants are receiving sludge, there is an urgent need to manage these end products sustainably to close the loop and move towards a circular economy.

1.4. Scale and distribution of FSSM treatment infrastructure

Uttar Pradesh now hosts an evolving network of **59 faecal sludge and septage treatment projects spread across 56 cities**. This network comprises a combination of **standalone Faecal Sludge Treatment Plants (FSTPs)** and **co-treatment plants** that handle both faecal sludge and municipal sewage. The infrastructure has been supported through funding from **AMRUT, NMCG** and urban local body (ULB) budgets, and it forms the backbone of UP's decentralized sanitation strategy—particularly critical in areas without comprehensive sewerage networks.

1.4.1. Treatment technologies in use

The treatment technologies deployed across Uttar Pradesh's FSTPs and co-treatment plants represent a diverse mix of nature-based, hybrid and mechanized systems, each suited to specific urban contexts and influencing the type and quality of outputs generated.

FSTPs in the state operate **four distinct treatment chains, predominantly combining nature-based systems such as constructed wetlands, planted drying beds (PDBs) and sludge drying beds (SDBs) with hybrid elements like anaerobic digesters, mechanical thickening or lamella clarifiers** (see *Fig. 1: FSTPs*

Figure 1: FSTPs treatment chains in UP

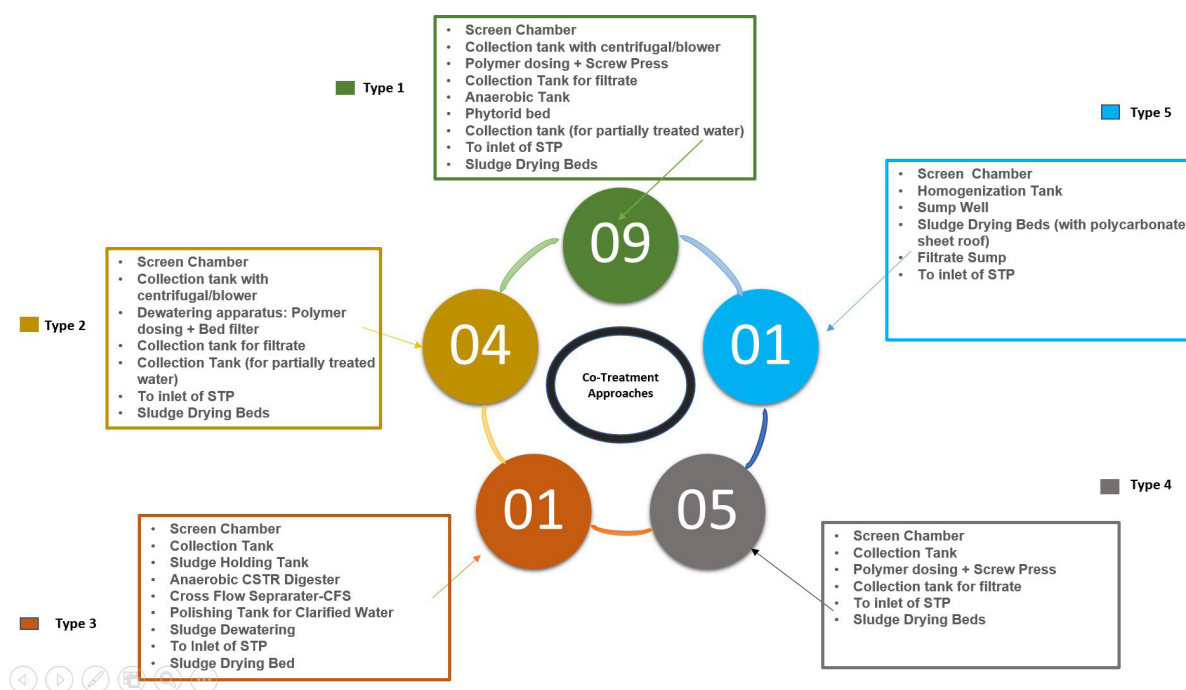


treatment chains in UP). The selection of technology directly affects the quantity, quality and frequency of biosolids and treated wastewater produced, which in turn determines their reuse potential.

For example, **mechanized systems** such as lamella clarifiers often digest most of the sludge internally, producing minimal or no biosolids. In contrast, **tiger bio-filters** (vermi-based systems) generate biosolids that can be readily reused—provided regular maintenance is ensured. Similarly, **drying bed-based systems** vary in output cycles: *sludge drying beds* can yield reusable biosolids more frequently, while *planted drying beds* may require up to one to two years for complete stabilization.

Co-treatment facilities utilize five different treatment chains, often blending **mechanized processes** (such as centrifugation, screw presses or dewatering units) with **nature-based components** like polishing ponds or sludge drying beds integrated within existing sewage treatment setups (see *Fig. 2: Co-treatment chains in UP*).

Figure 2: Co-treatment chains in UP



In co-treatment plants, only the solid fraction of faecal sludge is separated and treated on-site, while the liquid fraction is diverted to nearby sewage treatment plants (STPs). Because these STPs are typically managed by separate agencies, the precise quantification of treated wastewater originating from co-treatment units becomes challenging—the contribution from septage inflow is relatively minor compared to the total wastewater treated at STPs.

Thus, the technological diversity across FSSM systems in Uttar Pradesh not only shapes treatment performance but also plays a critical role in determining the nature, consistency and reuse potential of biosolids and treated wastewater produced.

2. Study relevance, scope and objectives

The emergence of FSSM infrastructure introduces a new and critical challenge for cities—the sustainable and safe reuse of treatment end-products, especially biosolids and treated wastewater. This aspect is gaining increasing importance in the context of sustainable sanitation and resource recovery. Biosolids are the semi-solid, nutrient-rich organic materials produced during the treatment of faecal sludge or septage, which, when adequately stabilized and dried, can serve as soil conditioners or inputs for composting.⁷ Similarly, treated wastewater, depending on its quality, can be reused for landscaping, irrigation or other non-potable applications.

The relevance of this study lies in assessing the status of reuse of treated water and biosolids in cities that have faecal sludge and septage management (FSSM) systems. With 59 FSTPs and co-treatment facilities operational across the state—featuring diverse treatment technologies spanning nature-based, hybrid and mechanized systems—there exists significant variation in the quality and characteristics of the end products. However, despite this extensive infrastructure, the systematic and safe reuse of these, outputs remain limited and inconsistent.

The circular economy potential of FSSM remains largely untapped due to critical institutional and regulatory gaps, including:

- **Absence of national standards** or state-level guidelines for safe handling, classification and reuse of biosolids creates uncertainty and risk aversion among ULBs.
- Most cities lack **testing protocols** to ascertain biosolid quality in terms of pathogens, heavy metals, nutrient content and moisture levels.
- There is **limited understanding among ULBs and operators regarding feasible end-uses** and associated safety measures, leading to underutilization or indiscriminate disposal of biosolids.

Despite the absence of formal standards and structured reuse frameworks, several emerging patterns of resource recovery have been observed across cities in Uttar Pradesh. In select locations, treated wastewater is being repurposed for

horticultural use—either within FSTP premises or by nearby agricultural users. Similarly, biosolids are being informally utilized in agriculture, landscaping and horticulture, and as landfill cover. However, these reuse practices remain sporadic, unregulated and poorly monitored, lacking the technical guidelines or quality benchmarks needed for safe and sustained application.

These fragmented examples nonetheless highlight the untapped opportunity to build circular value chains around sanitation end-products. With appropriate interventions, these resources could contribute meaningfully to soil health, water conservation, climate resilience and urban sustainability.

Recognizing this opportunity, this study has been undertaken to systematically document existing reuse practices, identify barriers and enablers, and develop a roadmap to unlock the circular economy potential of FSSM in Uttar Pradesh—ensuring that biosolids and treated wastewater are no longer viewed as waste, but as valuable resources.

2.1. Objectives and key questions

- **Generation potential:** Quantify the current potential of Uttar Pradesh state by analysing the volume of biosolids and treated wastewater generated in recent months—May, June and July 2025—to establish a concrete basis for reuse opportunities.
- **Reuse practices:** Investigate current practices, motivations and hindrances in reusing treated wastewater and biosolids across UP’s FSSM facilities.
- **Challenges and gaps:** Identify technical, regulatory and behavioural barriers to safe and scalable reuse, and propose strategies to overcome them.

3. Methodology

3.1. Study design

This research employs a mixed-methods approach to capture both quantitative metrics and qualitative insights on the reuse of biosolids and treated wastewater generated by faecal sludge and septage treatment processes (see *Table 1: Distribution of selected FSSM treatment facilities in Uttar Pradesh*).

3.2. City selection

The study covered a total of 54 cities across Uttar Pradesh, which collectively operate 57 faecal sludge and septage management (FSSM) treatment facilities. These include 38 faecal sludge and septage treatment plants (FSTPs) and 19 co-treatment plants, where faecal sludge is treated along with sewage in existing sewage treatment plants (STPs). The FSTP in Maunath Bhanjan was under testing at the time of assessment, and the co-treatment facility in Meerut had not yet been handed over to the urban local body (ULB); therefore, both have been excluded from this analysis.

3.3. Data collection method

The **Centre for Science and Environment (CSE)** provides ongoing technical support to the government of Uttar Pradesh for effective implementation of FSSM. CSE's team conducts regular field visits to all FSTP and co-treatment facility cities to assess plant operations, infrastructure conditions and O&M challenges. During visits conducted in June 2025, both **quantitative and qualitative data** were collected to address the study's objectives.

Quantitative data (Objective 1: Generation potential): Data was collected to quantify the generation potential of biosolids and treated wastewater. This primarily included:

Table 1: Distribution of selected FSSM treatment in Uttar Pradesh

Facility type	Number of plants	Plants considered for study	Notes
FSTPs	39	38	Maunath Bhanjan FSTP under trial and testing, excluded from the study
Co-treatment plants	20	19	Meerut not handover, excluded from the study
Total plants	59	57	Across 54 cities

Source: CSE

-
- **Sludge volumes received** at the plant inlets, monitored to calculate average daily inflow over May, June and July 2025.
 - **Capacity utilization** of each plant, comparing actual inflows with installed treatment capacity.
 - **Biosolid outputs**, including the volume transported via trolleys, quantities sold or given for free, and amounts reused directly by the ULB.
 - **Treated wastewater volumes** that were reused or diverted for landscaping, irrigation, or other non-potable purposes.

All quantitative data were centrally maintained in a Google Sheet for further analysis.

Qualitative data (Objectives 2 and 3: Reuse practices and challenges):

To understand the management and reuse end products, we conducted semi-structured interviews with multiple stakeholders, including plant operators, city nodal officers, farmers and nursery owners. These interactions captured insights on:

- How biosolids and treated wastewater are **handled, stored, and applied**.
- Motivations and **drivers for reuse**, including operational, financial and regulatory factors.
- Practical challenges and **barriers** in managing or marketing these resources.
- Opportunities for generating **economic value or profit** from biosolids or treated effluent.
- Perceptions of **safety, convenience and sustainability** in current reuse practices.

This combination of quantitative and qualitative data allowed the study to **assess approximate production volumes and reuse patterns, and identify technical, regulatory and behavioural gaps**, forming a base to inform recommendations for safe and scalable reuse of biosolids and treated wastewater across Uttar Pradesh.

3.4. Assumptions for data analysis

For this study, faecal sludge characteristics were assumed to comprise 3–5 per cent solids and 95–97 per cent liquid. Biosolids are defined as the dried and stabilized fraction of these solids, obtained after processes such as dewatering, drying, digestion, stabilization or composting, which help reduce moisture content, pathogens and contaminants. The liquid fraction was considered to undergo further treatment through anaerobic digestion, nutrient removal (e.g. through constructed wetlands), filtration and disinfection.

Using the records compiled in the Google Sheet, the average plant capacity utilization for May–July was assessed. For analytical consistency, daily solids generation was estimated as 3 per cent of the average faecal sludge input, representing the dry-solids portion of the inflow, while the remaining 97 per cent corresponded to the liquid component destined for further treatment. Since solids do not reach a completely moisture-free condition in routine operations, a moisture correction factor was applied. Accordingly, the final biosolids output was assumed to be approximately 20–30 per cent higher than the dry-solids mass, reflecting the residual moisture typically retained after drying at FSTPs.

To illustrate the application of these assumptions, consider a 32-KLD FSTP. With a daily input of 32,000 litres of septage, the dry-solids content (3 per cent) amounts to 960 kg/day. Accounting for typical drying efficiency—where around 80 per cent of the moisture is removed—the final biosolids generated become 1,152 kg/day. Assuming the plant operates six days a week, this results in an annual biosolids output of approximately 359,000 kg/year (≈ 360 tonnes/year). This example guided the conversion approach used across all study locations.

Microsoft Excel was used to generate comparative charts illustrating current versus potential biosolids and treated-water outputs under existing and full-capacity operational scenarios.

4. Findings

The findings presented in this section summarize the outcomes of field assessments and data analysis conducted across 57 operational FSSM facilities in Uttar Pradesh. They provide an integrated understanding of how treatment plants are functioning, the scale and pattern of biosolid and treated wastewater generation, and the extent to which reuse practices have been adopted across cities. Together, these insights form the basis for identifying gaps, opportunities, and future pathways for promoting safe and productive resource recovery.

4.1. Overview of treatment plants

Uttar Pradesh hosts 59 operational faecal sludge treatment plants (FSTPs) and co-treatment facilities, ranging in capacity from 10 KLD to 100 KLD. Specifically, there is one plant each at 10 KLD, 18 KLD, 20 KLD and 75 KLD; two at 100 KLD; five at 50 KLD; 12 at 25 KLD; and 35 at 32 KLD. The fifty-ninth plant, which is FSTP in Maunath Bhanjhan, is under trial run. Six of these facilities use lamella clarifiers—which by design generate no dewatered biosolids—and have therefore been excluded from biosolids quantification. Additionally, the Pilibhit plant remains non-functional following severe flood damage in July 2024.

An overview of all 59 treatment plants of both types, i.e. FSTPs and co-treatment plants, is given in *Table 2: Summary of 59 treatment plants*.

Table 2: Summary of 59 treatment plants

	FSTP					Co-treatment					
Capacity of plant (KLD)	32	25	18	10	Total	100	75	50	20	25	Total
Number of plants	35	1	1	1	38	2	1	5	1	11	20
Total plant capacity (KLD)	1,120	25	18	10	1,173	200	75	250	20	275	820
Total capacity (KLD)											1,993

Source: CSE

4.2. Biosolids: Generation, handling and reuse

Generation

Current output: Across 32 biosolid-producing FSTPs, average capacity utilization during May–July 2025 was 327 KLD, yielding roughly 117.72 quintals of biosolids per day ($\approx 35,316$ quintals annually).

- o Nineteen co-treatment plants (Meerut is excluded as it has not been handed over yet) on an average processing 332.2 KLD, producing about 119.76 quintals of biosolids per day ($\approx 35,928$ quintals annually). Combined, these facilities generate approximately 237.48 quintals daily ($\approx 71,244$ quintals per year).

Graph 1: Biosolids generation based on current capacity utilization and full capacity utilization (quantity of generation in quintals per year)

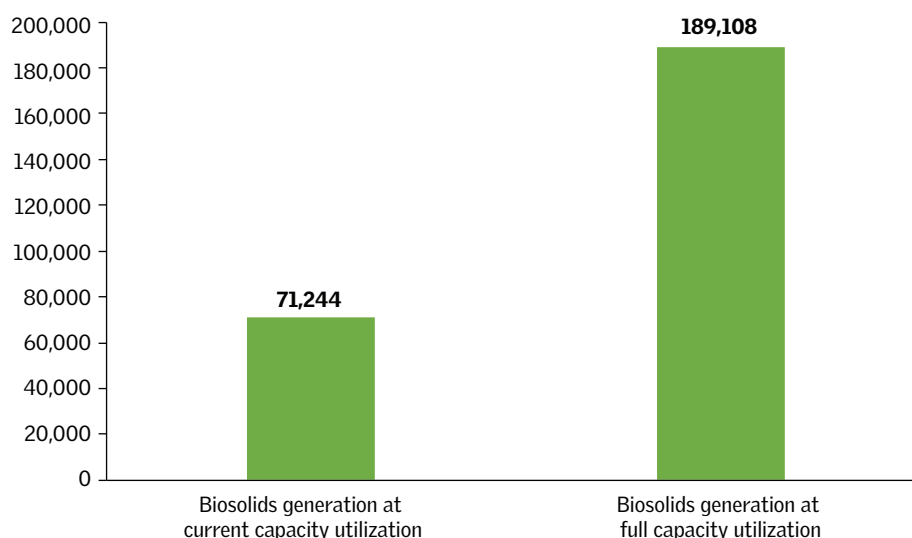


Table 3: Summary of biosolids generation

Type of plant (total capacity-KLD)	Current average capacity utilization (KLD)	Biosolids generation per day (quintals)	Biosolids generation per year (quintals)	Potential scope of utilization of the plant (KLD)	Potential bio solids generation per day for full capacity utilization (quintals)	Potential bio solids generation per year for full capacity utilization (quintals)
FSTPs (981)	327	117.72	35,316	981	353.16	105,948
Co-treatment (770)	332.22	119.76	35,928	770	277.2	83,160
Sum (1,751)	659.22	237.48	71,244	1,751	630.36	189,108

Source: CSE

- o **Full potential:** At 100 per cent capacity utilization, FSTPs could yield 353.16 quintals/day ($\approx 105,948$ quintals/year), and co-treatment units 277.2 quintals/day ($\approx 83,160$ quintals/year) for a combined 630.36.59 quintals/day ($\approx 189,108$ quintals/year).

Reuse patterns

Nearly 60 per cent of cities with FSSM infrastructure report no reuse of biosolids. Among the 40 per cent that do, the most widespread approach is distribution to farmers, either gratis or for a nominal fee (Rs 1–10 per kg) (see *Graph 2: Reuse practice in the study cities*). Smaller subsets of municipalities channel biosolids into on-site landscaping—sprucing up treatment-plant greenbelts—or into public parks and other Urban Local Body (ULB) properties. A handful of forward-looking cities have piloted co-composting, blending biosolids with organic waste to produce a soil amendment. However, technical challenges (inconsistent feedstock quality, limited process control) and weak market pull have kept co-composting from scaling. Because there are no formal guidelines or standardized protocols for biosolid reuse, cities default to the easiest disposal methods, including:

- o Distribution to farmers, either free or at token prices;
- o On-site reuse for treatment-plant landscaping; and
- o Public-space landscaping in parks or ULB-managed grounds.



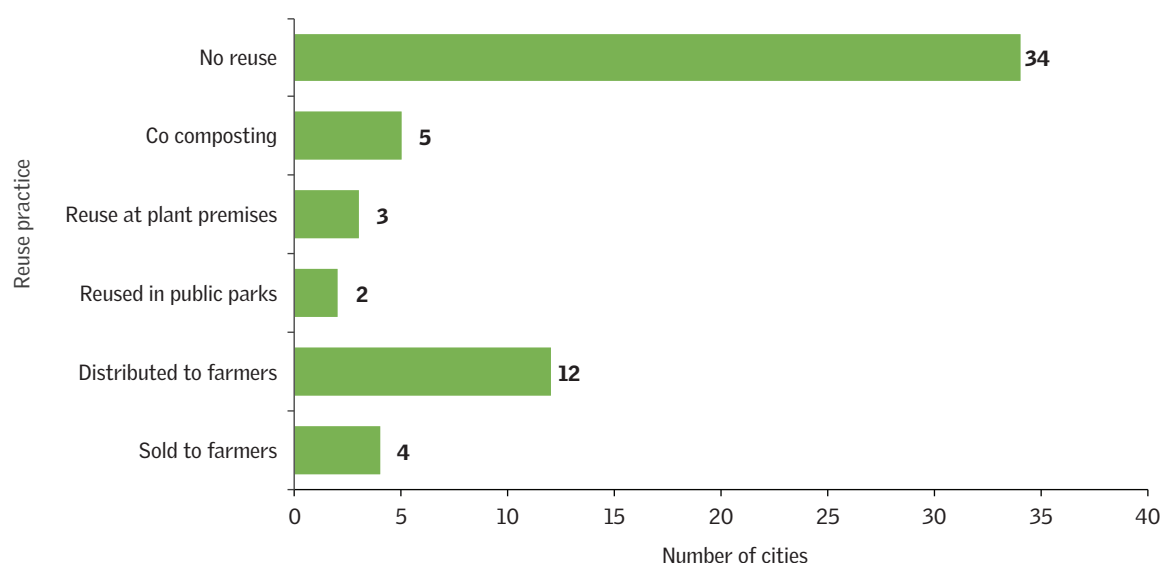
Sludge drying beds full of biosolids (overflow) in Badaun city



Biosolids stored on the pathways when the storeroom is full in Amroha city

HARSH YADAVA AND SARIM / CSE

Graph 2: Reuse practice in the study cities



Source: Compiled by CSE

In practice, plant operators resort to informal metrics—such as ‘one trolley’ or ‘one 20–50 kg bag’—to quantify removals. Without weighbridges or field-testing kits, neither the volume nor the quality of biosolids is systematically tracked. This ad hoc measurement, while expedient, undermines traceability, prevents quality assurance, and hampers any effort to build robust, market-oriented reuse programmes.

4.3. Treated wastewater: Quantity and reuse

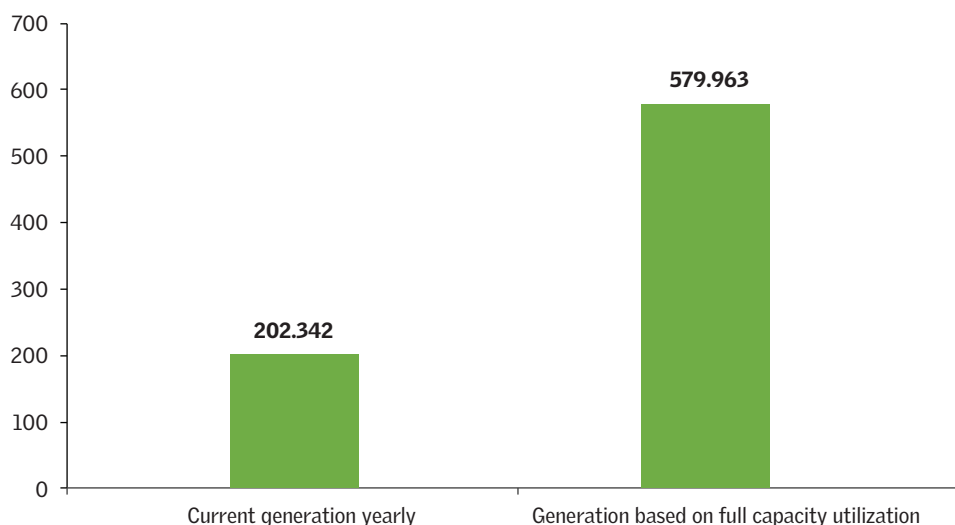
Quantification

Treated wastewater generation was calculated based on the same monitoring period (May–July 2025). Across FSTPs and co-treatment plants treated wastewater production is estimated at approximately 200 million litres per year. It is coming from average capacity utilization of 718 KLD, which equivalent to 207 million litres of FSS, reaching the treatment on an average per year (see *Graph 3: Treated wastewater generation in FSTPs and co-treatment plants—comparison on the basis of current generation and full capacity generation*).

Reuse of treated wastewater

Treated wastewater is most effectively reused in cities where the treatment plants operate at high capacity utilization, typically above 30 per cent. At these utilization

Graph 3: Treated wastewater generation in FSTPs and co-treatment plants—comparison on the basis of current generation and full capacity generation (in million litres per year)



Source: CSE

levels, plants produce a steady, predictable volume of effluent that can be diverted to beneficial uses rather than be discharged. In contrast, facilities running well below this threshold often generate too little treated water to justify the logistical and operational effort required for off-site reuse programmes.

In practice, high-utilization cities channel their treated effluent into several on-site applications:

- **Greenbelt and landscape irrigation:** Many treatment plants maintain landscaped areas or buffer strips around their premises. Here, recycled water is used year-round to support plantings, reducing the need for fresh municipal water and demonstrating a visible, low-risk reuse option.
- **Road and public-space maintenance:** Moradabad exemplifies this approach by deploying a dedicated tanker truck to transport effluent from the FSTP to urban medians and street-cleaning crews. This not only enhances the city's public spaces but also conserves potable water that would otherwise be used for these tasks as you can see in the images above.
- **Construction and dust control:** In rapidly urbanizing areas, treated effluent can serve construction sites for concrete mixing or to suppress dust on unpaved roads. While less common, a few cities have trialed these applications during peak construction seasons.



Treated wastewater reused for watering plants on roads in Moradabad



Treated wastewater reused for cleaning roads in Moradabad

HARSH YADAVA / CSE

At co-treatment facilities, the liquid stream is typically pumped directly to the municipal sewage treatment plant (STP) network, where it merges with municipal sewage flows. This integration simplifies management but often obscures the origin and volume of FSSM-derived water. Bulandshahr stands out as the only city to formalize an alternative pathway—signing a contract with NTPC to deliver its combined treated wastewater for industrial use in power-plant cooling systems.

4.4. Analysis and discussion

Findings based on a standardized methodology to quantify biosolids and treated wastewater generation indicate that currently only 40 per cent of the installed potential is being utilized in Uttar Pradesh. During field visits conducted by CSE for city-level status assessments, an attempt was also made to estimate the total quantity of biosolids sold or reused since the treatment plants became operational. However, most cities lacked formal records on biosolid reuse or sale. Instead, information was maintained through informal means—such as the number of trolleys distributed or sold, the number of bags handed out, or biosolids provided free to farmers. These practices, however, are limited in scale due to the low volume of biosolids being generated and the absence of structured management protocols. Moreover, biosolid handling is labour-intensive and, in many cases, urban local bodies (ULBs) tend to avoid this responsibility. As a result, biosolids are often dumped in open areas adjacent to treatment plants or left unmanaged altogether.

4.4.1. No reuse happening

Amroha, Agra, Moradabad and Banda are among the few cities that have sold biosolids since the commissioning of their treatment plants. In total, 342 quintals of biosolids have been sold to farmers for approximately Rs 1,30,400, with prices varying randomly in the range of Rs 3–10 per kg.

The Jhansi FSTP (6 KLD), operational since 2018, runs at around 90 per cent of its capacity. It consistently receives concentrated FSS, allowing the PDBs to be emptied regularly. The biosolids from Jhansi are reused productively, particularly in the maintenance of public parks.

On the other hand, several cities—Bijnor, Khurja, Shahjahanpur, Unnao, Gonda, Sitapur, Lakhimpur, Hapur, Hathras, Chandausi and Raebareli—have been distributing biosolids free of charge to farmers. Although no formal records are maintained regarding the quantity distributed, estimates have been gathered based on the number of trolleys or bags provided (see *images below*). Amroha is the only city that was able to produce a receipt of selling biosolids (see *image on page 26*). A full trolley typically holds 10 to 20 quintals of biosolids. Notably, Bijnor has distributed an estimated 1,440 quintals, while Hapur has given away around 80 quintals.

The primary motivation behind such distribution is the need to clear space, as biosolids continue to accumulate in the absence of proper disposal or reuse systems. Many cities remain unsure about offering biosolids to farmers due to



Biosolids stored in 20-kg bags in Sitapur



Pile-up of bags in which biosolids are stored in the absence of a storage room, Khurja

HARSH YADAVA / CSE

Receipt No. 98	Form No.5	Book No. 4161
RECEIPT		
NAGAR PALIKA PARISHAD, AMROHA		
Demand Register No.		
Received From <i>श्री. अनुराग सिंह</i>		
Rupees (in words) <i>छह हजार पचास रुपये</i>		
an Account of <i>ए.एस.टी.पी.आर. मिनो</i>		
Premises No.	Mohalla	
For the Period <i>30.09.2023 से 30.09.2024 तक</i>		
in Full/Part Payment of Demand Bill No.		Dated
Rs. <i>6900/-</i>	Executive Officer/Secretary	
Dated <i>14/10/2024</i>	Tax Collector	
Cashier	Clerk-in-charge of Demand and Collection Register	
Accountant	Tax Superintendent	

Receipt of sale of biosolids, Amroha

the lack of clear guidelines and protocols. There is also concern about potential health risks, particularly if biosolids are used on edible crops, given the possibility of heavy metal contamination or other hazardous constituents depending on the quality of the sludge. Cities facing space constraints—such as Hapur, Bijnor and Khurja—frequently give biosolids to farmers simply to manage overflow. In most cases, ULBs do not provide farmers with guidance on how to use the biosolids or which crops are suitable, largely due to a lack of technical understanding. There have also been instances where farmers proactively approached treatment plants to request biosolids, suggesting a latent demand. In a few cases, operators have informally sold biosolids for a small fee without reporting the transaction to the ULB, possibly for personal gain. Moreover, ULBs generally do not track how or where the biosolids are ultimately used by farmers. Some cities—such as Khurja, Fatehpur, Jhansi, Farrukhabad and Orai—reuse biosolids within the plant premises or in public parks. Overall, these observations highlight that while there is a market and demand for biosolids, the absence of regulatory guidelines and operational protocols has led to irregular practices, lack of documentation and an unsustainable reuse model.

The primary reason for limited reuse across other cities is the absence of clear guidelines or standards to direct municipalities on safe and effective biosolid reuse. Typically, cities follow a reactive approach to biosolid management: once the drying beds are full, biosolids are moved to designated storage areas. In the absence of proper storage rooms or yards, biosolids are often piled up within the plant premises, usually along boundary walls. As a result, the flow of operations continues without any meaningful reuse on the ground.

5. Challenges and issues identified

This study highlights several critical barriers that must be addressed to scale up reuse of biosolids and treated wastewater in Uttar Pradesh. These include:

1. Absence of a regulatory framework

There are no national or state-level standards governing the safe handling, classification or reuse of biosolids. In the absence of clear guidelines, ULBs adopt a risk-averse stance, often erring on the side of outright disposal rather than exploring beneficial reuse options.

2. Inadequate testing protocols

Most treatment plants lack on-site laboratory facilities and equipment to analyse biosolid quality, such as pathogen load, heavy-metal concentrations and nutrient content. Without reliable data on biosolid characteristics, ULBs and farmers cannot confidently apply these materials to agricultural or landscaping projects.

3. Limited institutional capacity

Many plant operators and municipal staff have insufficient training in biosolid reuse practices and safety measures. This knowledge gap leads to underutilization of recovery infrastructure or, worse, the unsafe disposal of potentially valuable end products.

4. Infrastructure shortfalls

Key infrastructure elements are missing or under-resourced. For example, the absence of weighing scales prevents accurate tracking of biosolid generation. Some modern technologies—such as lamella clarifiers—produce no dewatered solids, while planted drying beds can take one and a half to two years before sludge can be harvested, further delaying any potential reuse.

5. Inconsistent data management

Record-keeping practices vary widely across cities. Few ULBs maintain systematic logs of biosolid quantities sold, given away, or reused. This irregular data tracking complicates planning, performance monitoring, and the design of targeted interventions.

6. Weak market demand

End-users—primarily farmers—are often reluctant to adopt biosolids due to lingering concerns about product quality and safety. Without demonstrable success stories or quality assurances, market uptake remains low.

7. Operational constraints

Overall plant capacity utilization averages just 36 per cent, reflecting inconsistent desludging schedules and limited feedstock availability. Low throughput directly reduces byproduct volumes, undermining the economic and environmental rationale for reuse programmes.

Together, these challenges form a complex web of regulatory, technical, institutional and market-based hurdles. Addressing them will require coordinated action—developing clear policies, investing in testing and training, upgrading infrastructure, strengthening data systems, and building farmer confidence through demonstration projects and outreach.

6. Potential for scale-up

Building on the findings of this study, Uttar Pradesh's FSSM network offers significant untapped capacity for expanding biosolid and treated-wastewater reuse, including:

1. Substantial unused resource base

- o At current utilization, plants generate roughly **18,000 quintals of biosolids** and **200 million litres of treated effluent** annually.
- o Full-capacity operation could raise those figures to nearly **48,000 quintals** and **600 million litres** per year—nearly three times the present output.

2. Latent market demand

- o Four cities have sold **342 quintals** of biosolids for Rs 1,30,400, demonstrating farmer willingness to pay (Rs 3–10/kg).
- o Several cities report ad hoc requests for free biosolids or bulk bagged material, suggesting a broader, underserved market.

3. Demonstrated reuse pathways

- o On-site landscaping and park greening (e.g. Jhansi, Khurja, Farrukhabad) show low-risk entry points for municipal uptake.
- o Moradabad's dedicated tanker operation illustrates scalable models for effluent reuse in road maintenance and dust control.
- o Bulandshahr's NTPC contract presents a blueprint for industrial off-take agreements.

4. Alignment with National Missions

- o SBM-U 2.0 and AMRUT explicitly incentivize 'maximum reuse' of biosolids and treated water.

Collectively, these factors indicate that, with targeted interventions, UP could transform its FSSM end products into valued commodities—enhancing soil health, reducing freshwater demand, and generating new revenue streams for ULBs.

7. Future pathways and recommendations

To realize this scale-up potential, a coordinated set of policy, technical and market-based actions is needed, including:

1. Establishing a clear regulatory framework

- o Adopting state guidelines—aligned with emerging national standards—on biosolid classification, quality thresholds and permissible end-uses.
- o Defining treated-effluent quality criteria for different reuse applications (e.g. irrigation, industrial cooling).

2. Strengthening testing and certification

- o Equipping a network of regional labs or mobile testing units to routinely analyse pathogen levels, heavy metals and nutrients.
- o Implementing a simple, colour-coded ‘biosolid passport’ system to certify material quality and build user confidence.

3. Investing in minimal-cost infrastructure

- o Installing weighbridges or calibrated bagging stations to accurately quantify biosolid output.
- o Providing small-scale storage silos or covered bays to streamline transfer from drying beds to distribution points.

4. Building institutional capacity

- o Developing training modules for plant operators and ULB officials on safe handling, dewatering and marketing of biosolids and treated water.
- o Integrating resource-recovery metrics into Swachh Survekshan and internal performance dashboards.

5. Effectively piloting and demonstrating reuse models

- o Scaling up co-composting trials by partnering with agricultural research institutes; showcasing compost trials on public lands.
- o Expanding Moradabad's tanker model through municipal consortiums to serve multiple ULBs along major corridors.

6. Facilitating market development

- o Offering matching grants or waivers on cartage fees for early adopters—farmers, landscapers, nurseries—to purchase certified biosolids.
- o Fostering public-private partnerships with agro-enterprises to process biosolids into high-value soil amendments.

7. Enhancing data systems and monitoring

- o Upgrading the existing Google Sheet platform to a simple GIS-enabled dashboard, tracking generation, sales, and reuse volumes by city.
- o Publishing an annual 'Resource Recovery Scorecard' to incentivize ULBs and highlight best practices.

By implementing these recommendations, Uttar Pradesh can transition from ad hoc disposal to an integrated circular-economy model, unlocking environmental benefits, generating revenues and positioning its FSSM programme as a national exemplar for resource recovery.

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This study evaluates the reuse potential of biosolids and treated wastewater from 59 faecal sludge and septage treatment facilities in Uttar Pradesh.

Employing a mixed-methods approach—combining monthly plant-performance data (May–July 2025) with stakeholder interviews—the research quantifies current by-product generation (nearly 71,000 quintals of biosolids; 200 million litres of effluent annually) and identifies uneven reuse practices. Nearly 60 per cent of cities report zero biosolid reuse, while the remainder employ ad hoc distribution, landscaping or pilot composting. Effluent is reused on-site or via dedicated tankers.

Key barriers include absent guidelines, limited testing and low capacity utilization. The report recommends regulatory frameworks, testing protocols, infrastructure upgrades and market incentives to scale resource recovery.



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