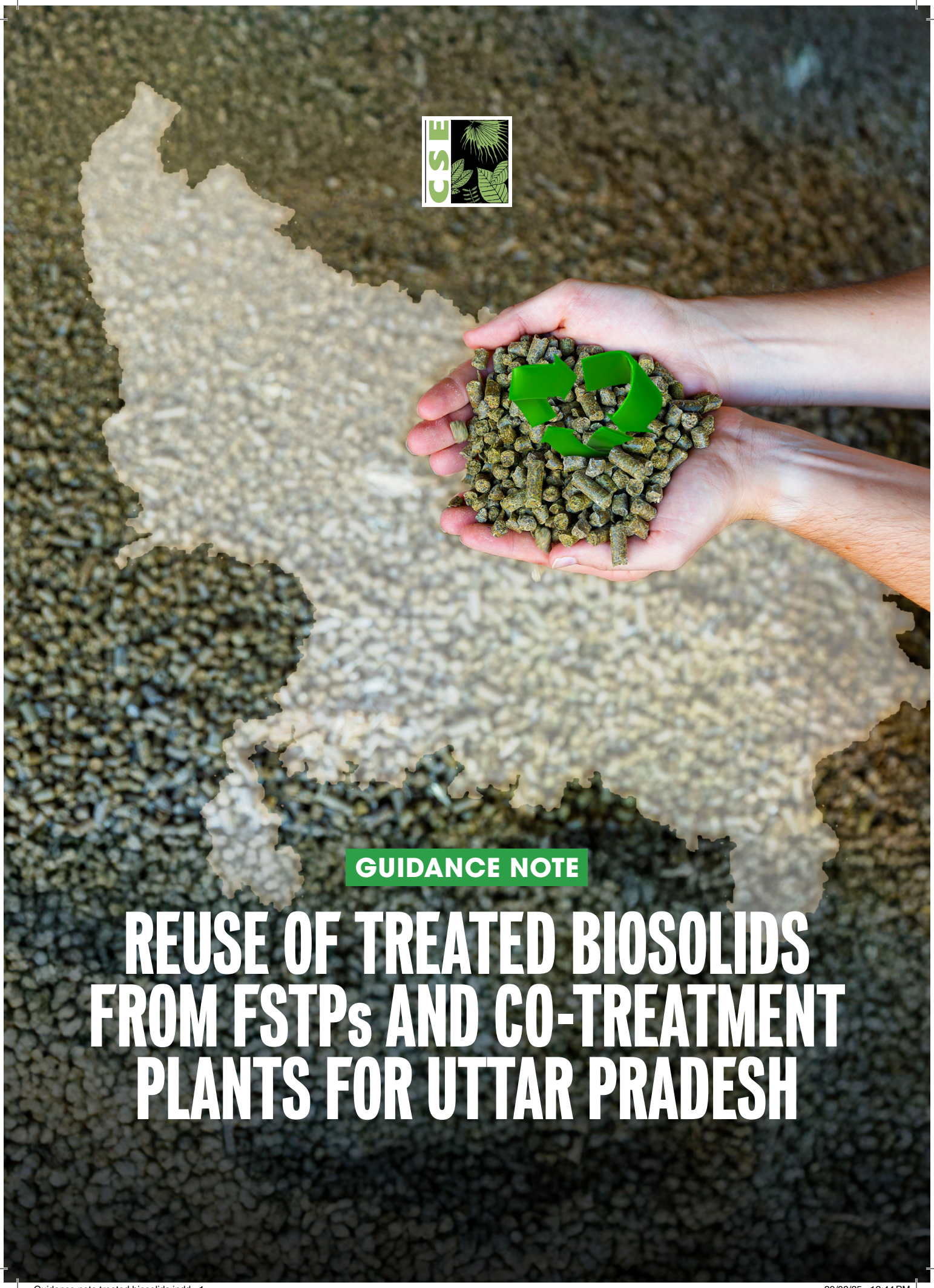

GUIDANCE NOTE

REUSE OF TREATED BIOSOLIDS FROM FSTPs AND CO-TREATMENT PLANTS FOR UTTAR PRADESH

GUIDANCE NOTE

REUSE OF TREATED BIOSOLIDS FROM FSTPs AND CO-TREATMENT PLANTS FOR UTTAR PRADESH

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Maps in this report are indicative and not to scale.

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CHAPTER 1
ABOUT THE GUIDANCE NOTE

INTRODUCTION

Uttar Pradesh has a population of 19.98 crores (2011) and 23.6 crores (2023)[1], which is approximately 17 per cent of India's entire population, making it the most populous state. The urban and rural population constitute 22.27 per cent and 77.73 per cent respectively. The average population density of the state is 829 per square kilometre, which is more than twice the national average.[2]

Uttar Pradesh is a leader in India's agricultural sector, with agriculture being the main source of income for the state. According to the survey conducted by the Agriculture Department, Uttar Pradesh in 2014–15, approximately 165.98 lakh hectares (68.7 per cent) of land is used for cultivation. According to the Agriculture Survey of 2017–18, there are 2.33 crore farmers in the state.

With a growing population and increased urbanisation in Uttar Pradesh, the state faces significant challenges in managing sewage and waste sustainably. Biosolids reuse presents an opportunity to address these challenges by converting waste into valuable resources for agriculture, urban landscaping, and other sectors.

Under the Swachh Bharat Mission (Urban), a total of 1,024 FSTPs have been constructed all across India, treating approximately 50,561 KLD of sludge.[3] In Uttar Pradesh, 39 faecal sludge treatment plants (FSTPs) and 20 co-treatment plants have the potential to generate about 17,000 metric tonnes (MTs) of biosolids per year[4] when the plants are utilised at their full capacity—assuming 26 working days in a month. Most of the generated biosolids is disposed-off in landfills, contributing to pollution. The reuse of biosolids is still

in its initial stages in Uttar Pradesh. However, some biosolids are beginning to be used in agriculture (in formal or informal manner) as organic fertilisers, particularly in areas where farmers seek cost-effective alternatives to chemical fertilisers. However, lack of infrastructure and inadequate regulation enforcement limits the safe and effective use of biosolids.

Large-scale adoption of biosolids faces significant challenges. Social acceptance, regulatory and compliance gap, and infrastructural barriers hinder widespread implementation. The challenge now is to ensure resource recovery from the biosolids in the treatment plants. If this is not done, the quantity of biosolids will grow exponentially and will increase problems of contamination and management in the plants.

This guidance note aims to guide the Uttar Pradesh state government in issuing an advisory for promoting reuse of biosolids and initiating sustainable resource recovery.

AIM OF THE GUIDANCE NOTE

This document aims to provide guidance to the urban local bodies (ULBs) for promoting reuse of biosolids generated from FSTPs and co-treatment plants. It will help the sustainable reuse of biosolids in Uttar Pradesh, addressing the need for resource recovery and contributing to a circular economy.

PURPOSE OF THE GUIDANCE NOTE

India has approximately 1,024 FSTPs in urban areas.[5] As per CSE's estimate, these FSTPs generate more than 500 tonnes of biosolids every day. By encouraging the responsible utilisation of biosolids, the initiative seeks to transform waste into valuable, thereby contributing to a circular economy. The document highlights the importance of biosolids reuse in improving soil health, enhancing agricultural productivity, and reducing reliance on chemical fertilisers.

Climate change poses a significant challenge to agricultural productivity in Uttar Pradesh, leading to unpredictable rainfall patterns, rising temperatures, and soil degradation. Climate change accelerates soil degradation through erosion, loss of organic matter, salinisation, desertification, and nutrient imbalance, making land less fertile. To combat these challenges and promote sustainable farming, biosolids reuse can play a crucial role. By recycling nutrient-rich organic matter from treated wastewater, biosolids can enhance soil fertility, improve water retention, and reduce reliance on chemical fertilisers, making agriculture more resilient to climate change.

Additionally, the guidance note emphasises the potential economic benefits for local farmers and municipalities, while addressing environmental challenges such as waste management, water conservation, and greenhouse gas emissions reduction. Keeping this in mind, the document gives recommendations for building a resilient and sustainable biosolids management system in Uttar Pradesh.

OBJECTIVES

- Defining biosolids along with its benefits and disadvantages.
- Exploring the potential applications of biosolids across various sectors, focusing on agriculture and urban landscape.
- Learning about the current biosolids reuse standards and policies at international and national level.
- Suggesting measures to promote biosolids reuse practices in Uttar Pradesh.

Note: This guidance note is based on secondary research, as well as CSE's experiences based on the work carried out in Uttar Pradesh.

CHAPTER 2
BIOSOLIDS

DEFINING BIOSOLIDS

Biosolids, in the context of faecal sludge, refer to the product of the faecal sludge treatment plant. During faecal sludge treatment, the liquids are separated from the solids. Those solids are then treated physically and/or chemically to produce a semisolid, nutrient-rich product known as biosolids.[6] Biosolids generated by FSTPs are rich sources of nitrogen, phosphorous and potassium—the three essential nutrients for crop production across the world. India relies on imports to meet its demand for phosphorous and potassium, the reserves of which are increasingly depleting.

Biosolids, when treated and processed, possess high organic matter content, essential nutrients, and beneficial microorganisms, making them excellent for soil health improvement. They can enhance soil fertility, improve crop productivity, and reduce the dependence on chemical fertilisers. The application of biosolids on land will help replenish macro- and micronutrients.

Table 1: Parameters for various types of biosolids

Parameter	FCO, 2009 standard	Co-compost	FSTPs	STPs	Biochar
C/N ratio (maximum)	20	9	9	9	13
pH	6.5–7.5	7.7	6.3	6.4	12
Total organic carbon per cent by weight (minimum)	12	17.2	9.9	12	15
Total Nitrogen (N), per cent by weight (minimum)	0.8	2.8	1.1	1.1	1.1
Total Phosphate (P205), per cent by weight (minimum)	0.4	1.3	0.4	0.7	2.2
Total Potassium (K20), per cent by weight (minimum)	0.4	0.5	0.1	0.6	1.3
Conductivity (as dSm-1), not more than	4	3.6	2.8	3.1	1.95
Moisture by weight (maximum)	15–25	26	13	14	1

Source: Quality Evaluation of Faecal Sludge based Biosolids and Co-compost in India to Ascertain their Reuse and Resource Recovery Potential, CSE

BENEFITS OF BIOSOLIDS REUSE

By adopting sustainable practices and embracing biosolids reuse in agriculture, we can address multiple challenges simultaneously—improving soil health, conserving water resources, reducing pollution, and enhancing food security.

1. **Nutrient-rich fertiliser alternative:** Biosolids are a significant source of essential nutrients like nitrogen, phosphorus, and potassium, which are vital for crop production. With India being heavily reliant on imports for phosphorus and potassium, biosolids provide an eco-friendly and cost-effective substitute, reducing dependence on external sources.

2. **Improved soil health:** Biosolids enhance soil organic content, leading to better soil structure and fertility. Co-composting with municipal waste ensures a balanced nutrient profile while reducing pathogen risks, making it a safe and effective soil conditioner.

3. **Economic benefits:** Utilising biosolids in agriculture can reduce the cost of chemical fertilisers. Additionally, innovative business models, such as public-private partnerships, can generate revenue for local governments and create livelihood opportunities through the sale of biosolids-based products.

4. **Innovative waste management practices:** States like Odisha have initiated efforts in biosolids management through initiatives, like co-composting and advanced drying techniques, demonstrating the scalability and effectiveness of biosolids reuse.

5. **Supports circular economy goals:** The reuse aligns with the principles of a circular economy by converting waste into a valuable resource. It also contributes to the United Nations Sustainable Development Goals, particularly those related to sustainable agriculture and clean water.

While the advantages are compelling, challenges like the presence of pathogens, heavy metals, and compliance with standards such as the Fertilizer Control Order (FCO) remain. Addressing these through technology, proper regulations, and awareness will be essential for maximising the benefits of biosolids reuse in India.

CHALLENGES OF BIOSOLIDS REUSE

In most cases, biosolids are applied, disposed of, or discharged without satisfactory treatment, leading to serious environmental and public health impacts. With a rapidly growing population, biosolids generation is expected to increase significantly in the future. Biosolids may also contain pollutants and particular metals.[7]

The main barrier in reuse of harvested bio-solids from septage and sewage is its non-conformity with the Fertilizer Control Order of 2022, which entails meeting compost standards for organic waste, particularly due to the presence of pathogens and heavy metals.[8] While the potential of biosolids reuse is immense, several challenges need to be addressed for its effective implementation in India:

Regulations: Clear regulations and guidelines are necessary to ensure safe application of biosolids. The current FCO standards are for the compost derived from solid waste or municipal waste.

Technology and infrastructure: Technology and process play an important role in ensuring the quality of biosolids generated. Proper drying techniques and regular operations at FSTPs are crucial towards it.

Awareness and acceptance: Creating awareness among farmers, policymakers, and the public about the benefits and safety of biosolids reuse is essential.

Collaboration and partnerships: Successful implementation requires collaboration between government agencies, water

utilities, agricultural organisations, research institutions, and the private sector. Partnerships can facilitate knowledge exchange, research and development, and financial support for biosolids reuse projects.

CURRENT BIOSOLIDS USAGE PRACTICES IN UTTAR PRADESH

In Uttar Pradesh, the reuse of biosolids is still in its nascent stages. The state has a total of 59 treatment plants across 56 cities—39 FSTPs and 20 co-treatment plants. Total capacity of FSTPs and co-treatment plants installed in Uttar Pradesh are 1,141 KLD and 845 KLD respectively. The state has invested Rs 156.59 crores from the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Rs 6.09 crores from ULB funding, and Rs 2.7 crores from the National Mission for Clean Ganga (NMCG), totalling Rs 165.38 crores for the creation of 59 septage management plants across 56 cities.[9]

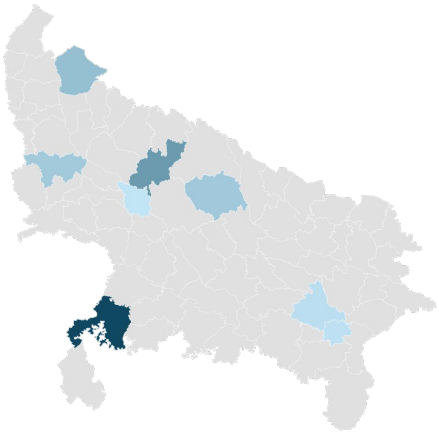
The fully operational plants in UP have a potential to generate 17,000 metric tonnes (MTs) of biosolids per year, considering standard estimates of three per cent solid portions in faecal sludge and septage.[10] Much of this is either disposed of in landfills or inadequately treated and stored in yards. However, some biosolids are beginning to be used in agriculture as organic fertilisers, particularly in areas where farmers seek cost-effective alternatives to chemical fertilisers.

The treatment processes used in Uttar Pradesh's STPs vary widely, with some facilities employing advanced methods like anaerobic digestion to stabilise biosolids, while others rely on less efficient systems like waste stabilisation ponds. In many cases, a lack of infrastructure and inadequate regulation enforcement limits the safe and effective use of biosolids.

Cities like Jhansi and Bijnor have piloted the reuse of biosolids, applying them in agriculture and municipal parks to improve soil fertility and support greener landscapes. But these practices may damage the crops as well, due to some contaminants in biosolids,

Figure 2: Cities generating biosolids in Uttar Pradesh

City	Capacity (KLD)	Technology
Sitapur	32	Screw Press
Ramna Varanasi	50	Drying Bed
Shahjahanpur	32	Screw Press
Farrukhabad	32	Screw Press
Jaunpur	32	Screw Press
Aligarh	32	TBF
Bijnor	20	Drying Bed
Jhansi	18	Planted Drying Bed



Source: CSE

like heavy metal and pathogens.

Biosolids, the nutrient-rich organic materials derived from the treatment of biosolids, offer a promising solution for waste management and resource recovery in Uttar Pradesh. With a growing population and increased urbanisation, the state faces significant challenges in managing sewage and waste sustainably. Biosolids reuse presents an opportunity to address these challenges, by converting waste into valuable resources for agriculture, urban landscaping, and other sectors.

CASE EXAMPLE: HOW MUCH BIOSOLIDS WILL BE GENERATED BY A 32 KLD CAPACITY FSTP ANNUALLY?

Capacity of FSTP – 32 KLD = 32000 litres/day

Faecal sludge or septage consists of 3–5 per cent solids, and rest is liquid after drying process.

Assuming 1 litre (l) of solids = 1 kilogram (kg) of solids

Means, dried sludge = (32000*3)/100 = 960 kg/day

But, drying process reduces only 80–90 per cent moisture content.

Let us assume a moisture reduction of 80 per cent.

Therefore, biosolids generated/ day = (960*120)/100 kg/day = 1152 kg/day

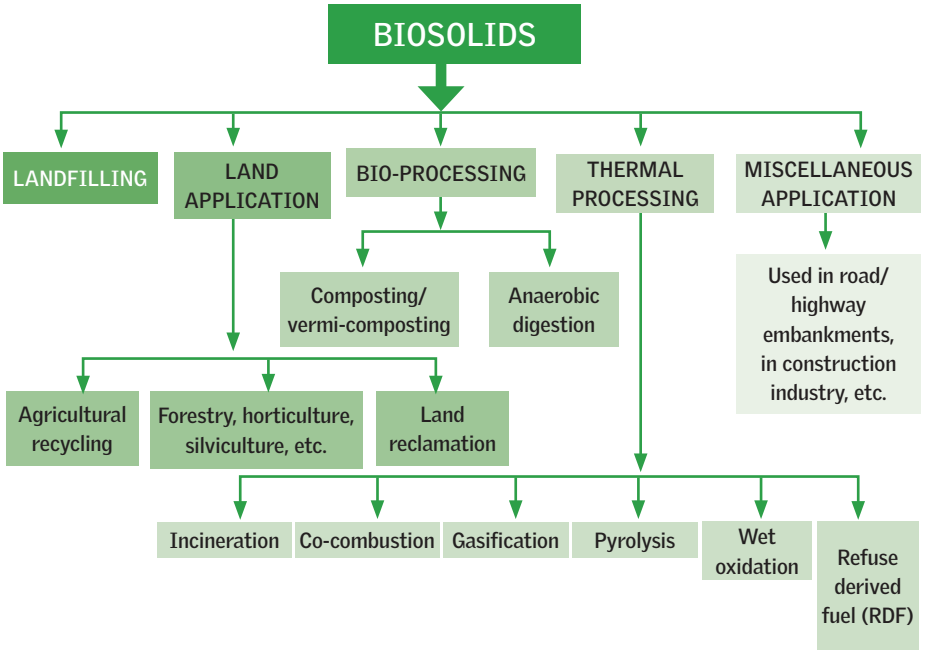
Let us assume, the FSTP is working for six days a week.

Hence, biosolids generated/ year = 1152*312 = 359424 kg/year = 360 tonnes/year (approx.).

CHAPTER 3
POTENTIAL APPLICATIONS OF BIOSOLIDS

The potential applications of biosolids extend across several sectors, with agriculture and urban development being key focus areas. In agriculture, biosolids serve as a nutrient-rich soil amendment, improving soil structure, enhancing water retention, and reducing the need for chemical fertilisers. In urban development, biosolids play a crucial role in land reclamation, green space enhancement, and landscaping projects.

Figure 3: Possible application of biosolids



Source: Presentation by Ashok K. Patra, Emeritus Scientist & Former Director, ICAR-Indian Institute of Soil Science, Bhopal on the topic "Application of Biosolids in Agriculture" in September, 2023

AGRICULTURE

Treated biosolids can be used as organic fertilisers that improve soil structure, enhance moisture retention, and provide essential nutrients for crops. In Uttar Pradesh, where agriculture is the backbone of the economy, the use of biosolids could help reduce the dependence on chemical fertilisers, lower farming costs, and improve soil fertility. This is particularly beneficial in regions where soil degradation is a concern.

The application of biosolids is found to be very productive for enhancing agricultural crop yield. The development of relatively low-cost phosphorus recovery technologies have the potential to reconcile environmental and economic aspects of sustainability. Recently, a number of researchers reported on the application of biosolids in the soil amendment and cultivation of agricultural crops globally. The research reports clearly indicated that the use of biosolids enhance the overall growth and yield of agricultural crops, and reduce the application of chemical or synthetic fertilisers.[11]

Table 2: Effects of biosolids use in agriculture

Biosolids	Soil	Crop
Advantages	1. Improves soil structure 2. Improves soil fertility 3. Increases the microbial activities 4. Reduces the use of synthetic fertiliser	1. Increases biomass 2. Increases leaf area chlorophyll content 3. Decreases detoxifying enzyme GST-activity

Source: Redesigned by CSE based on Presentation by Ashok K. Patra, Emeritus Scientist & Former Director, ICAR-Indian Institute of Soil Science, Bhopal on the topic "Application of Biosolids in Agriculture" in September, 2023

URBAN LANDSCAPING

Biosolids can be employed in the development and maintenance of green spaces in urban areas, such as public parks, gardens, and roadside vegetation. Their use in landscaping can improve soil quality, support plant growth, and enhance the sustainability of urban development projects. This aligns with the government's efforts to promote green cities and environmentally-friendly urban planning.

LAND RECLAMATION AND RESTORATION

In areas affected by mining or other environmentally damaging activities, biosolids can be used to restore soil health and promote vegetation growth. Additionally, biosolids can contribute to infrastructure projects such as erosion control and landfill cover. Uttar Pradesh, with its diverse landscape, could benefit from the use of biosolids in land reclamation efforts.

By harnessing these diverse applications, biosolids management can drive environmental sustainability, circular economy initiatives, and resource efficiency across multiple industries.

CHAPTER 4
POLICIES AND STANDARDS RELATED TO BIOSOLIDS REUSE IN INDIA

Through various guidelines and schemes, India has recognised the potential of biosolids in agriculture and other sectors, but comprehensive national policies specific to biosolids reuse are still to be developed. Also, India does not yet have dedicated standards for faecal sludge biosolids reuse. However, several standards set by various authorities apply to treated sludge to safeguard environmental and public health.

This issue is addressed in some of the policies and regulations at the national level, but not in a detailed and comprehensive manner.

NATIONAL POLICIES AND STANDARDS ON BIOSOLIDS REUSE IN INDIA

1. The Ministry of Housing and Urban Affairs (MoHUA)

MoHUA launched the National Policy on Faecal Sludge and Septage Management in 2017. This policy builds on documents such as the *Advisory Note: Septage Management in Urban India* (2013) and the *Primer on Faecal Sludge and Septage Management* (2016). The Policy states that 'the SWM Rules 2016 will also apply for disposal and

treatment of faecal sludge and septage, before or after processing, at landfills and for use as compost'.

2. Central Public Health and Environmental Engineering Organization (CPHEEO)

The *Manual on Sewerage and Sewage Treatment Systems* (2013), published by CPHEEO, also addresses the issue of recycling biosolids in agriculture, wherein it prescribes that 'for dewatered septage/sludge agricultural application, it should satisfy the Class A biosolids criteria set out by the United States Environmental Protection Agency (EPA) either by lime stabilisation, solar drying or composting'.

3. Ministry of Environment, Forest, and Climate Change (MoEFCC)

The *Solid Waste Management Rules*, 2016, issued by the MoEFCC, provide a comprehensive framework for managing solid waste, including the production and use of compost. They encourage the co-processing of organic waste with biosolids to produce high-quality compost. However, they include 'silt removed or collected from the surface drains' as solid waste, but do not explicitly include any toilet-related wastes, faecal sludge or septage, in their ambit.

4. Central Pollution Control Board (CPCB) standards

The *Central Pollution Control Board (CPCB),* under the Ministry of Environment, Forest, and Climate Change (MoEFCC), prescribes permissible limits for pollutants in treated wastewater and sludge. Key CPCB guidelines relevant to biosolids include:

- **Heavy metal limits**: CPCB has defined limits for heavy metals such as arsenic, cadmium, chromium, lead, and mercury to control soil contamination.

- **Pathogen control**: Guidelines include standards for pathogen reduction in biosolids, aiming to minimise risks associated with microbial contamination.

5. Bureau of Indian Standards (BIS)

The *Bureau of Indian Standards (BIS)* provides several guidelines related to agricultural inputs, including soil conditioners and fertilisers. The BIS does not currently have biosolids-specific guidelines; however, general quality standards for organic soil amendments (such as heavy metal content and pathogen control) apply to biosolids to ensure they are safe for agricultural use. The CSE report recommends that BIS, along with other statutory organisations, develop new standards specifically for biosolids.

EXISTING STANDARDS AND FRAMEWORKS USED BY INDIA

1. Fertilizer Control Order (FCO) standards

The FCO (2009, and updated in 2013) provides standards for compost quality. While it is not explicitly for biosolids, compost from faecal sludge must meet these standards to qualify as a soil conditioner or fertiliser. Parameters include pH, nutrient content, and permissible levels of heavy metals.

The analysis of biosolid samples against the Fertilizer Control Order (FCO) standards, 2009, highlights the potential suitability of biosolids for agricultural reuse in India. However, certain parameters such as C-N ratio, heavy metals, and moisture require further investigation and attention for effective implementation.

Table 3: Compost quality standards as per Solid Waste Management Rules, 2016; Fertilizer Control Order, 2009; and 2013

Sl no.	Parameter	Organic compost FCO* 2009	Phosphate-rich organic manure FCO (PROM) 2013
1	Arsenic (mg/kg)	10.001	10
2	Cadmium (mg/kg)	5	5
3	Chromium (mg/kg)	50	50
4	Copper (mg/kg)	300	300
5	Lead (mg/kg)	100	100
6	Mercury (mg/kg)	0.15	0.15
7	Nickel (mg/kg)	50	50
8	Zinc (mg/kg)	1.000	1000
9	C/N ratio	<20	Less than 20.1
10	pH	6.5-75	(1.5 solution) maximum 6.7
11	Moisture % by weight, maximum	15.0-25.0	25.0
12	Bulk density (g/cm3)	<1.0	Less than 1.6
13	Total organic carbon, % by weight minimum	12.0	79
14	Total nitrogen (N), % by weight, minimum	0.8	0.4
15	Total phosphate (P205), % by weight minimum	0.4	10.4
16	Total potassium (k20), % by weight minimum	0.4	--
17	Colour	Dark brown to black	--
18	Odour	Absence of foul odour	--
19	Particle size	Minimum 90% material should pass through 4.0 mm IS sieve	Minimum 90% material should pass through 4.0mm IS sieve
20	Conductivity (as dsm -1), not more than	4.0	8.2

Note: FCO: Fertilizer control order; Tolerance limits 35 per FCO: compost: The sum of nitrogen, phosphorus and potassium nutrients shall not be less than 1.5 per cent in compost. For FROM : No. such directive.

2. USEPA standards

USEPA classify biosolids into two categories based on their application.

- **Class A biosolids:** Biosolids are treated to reduce pathogens to below-detectable levels, safe for unrestricted use, including direct application in agriculture.

- **Class B biosolids:** Biosolids contain reduced pathogens, but require controlled application with site restrictions to minimise risks to public health. Class B biosolids may not be applied to home lawns and gardens. Additionally, the following restrictions apply:
  - Animals shall not be grazed on land until 30 days after application of biosolids to the land.
  - Access to land with a high potential for public exposure, such as a park, is restricted for one year **after biosolids application.**
  - Access to land with a low potential for public exposure (for example, private farmland) is restricted for 30 days **after biosolids application.**

- USEPA specifies treatment processes such as pasteurisation, composting, and anaerobic digestion to ensure pathogen reduction.

- Strict limits for metals like arsenic, cadmium, lead, mercury, nickel, selenium, and zinc are enforced, categorised under **pollutant concentration limits** for land-applied biosolids.

- The USEPA's framework serves as a **benchmark for biosolids quality and safety standards**. CSE report identifies that Indian biosolids often have elevated microbial loads and heavy metals like zinc, mercury, and chromium. Tailoring USEPA's standards to local conditions can ensure safe reuse and address these challenges.

Table 4: USEPA biosolids parameters and recommended limits, 1994 (EPA part 503 biosolids rule)

Parameter	Recommended limit (upper, unless stated otherwise)			
Pollutant	Ceiling concentration limits for all biosolids applied to land (mg per kg dry solids)	Ceiling concentration limits for EQ and PC biosolids (mg per kg dry solids)	Cumulative pollutant loading rate (kg per ha)	Annual pollutant loading rate (kg per ha per year)
As (Arsenic)	75	41	41	2
Cd (Cadmium)	85	39	39	1.9
Cr (Chromium)	3,000	1,200	3,000	150
Cu (Copper)	4,300	1,500	1,500	75
Pb (Lead)	840	300	300	15
Hg (Mercury)	57	17	17	0.85
Molybdenum (Mo)	75	-	-	-
Ni (Nickel)	420	420	420	21
Selenium (Se)	100	36	100	5
Zn (Zinc)	7,500	2,800	2,800	140
Pathogen class	Class A	Class A or B	Class A or B	Class A
Type of land intended	All*	All except lawns and home gardens	All except lawns and home gardens	All, but most likely lawns and homegardens

*includes agricultural land, forests, reclamation sites, and lawns and home gardens

Table 5: Specifications for pathogen concentrations by pathogen class as per Part 503 Rule, US EPA

Parameter	Recommended limit (upper, unless stated otherwise)	
	Class A	Class B
Faecal coliform (MPN/ dry gram solids)*	1000	2 x 106 (MPN or CFU)
Salmonella sp. (MPN/ dry gram solids)*	0.75 (3 MPN per 4 grams of total dry solids)	-

KEY CHALLENGES IN IMPLEMENTING BIOSOLIDS REUSE POLICIES AND STANDARDS IN INDIA

Despite many policies and frameworks, biosolids reuse in India faces several challenges:

- **Lack of dedicated biosolids standards**: Absence of explicit standards for biosolids reuse at the national level complicates regulatory enforcement and monitoring.

- **Variability in treatment quality**: Treatment facilities in different regions may produce biosolids of varying quality, with some facilities lacking the capacity to meet CPCB standards consistently.

- **Public perception and awareness**: Biosolids reuse in agriculture faces social stigma, with many stakeholders associating it with health risks despite treatment.

- **Limited institutional capacity**: Many municipalities/utilities lack the resources and technical capacity to monitor and manage biosolids effectively, particularly in smaller towns.

STATUS OF BIOSOLIDS REUSE STANDARDS IN UTTAR PRADESH

Uttar Pradesh is one of the leading states in India implementing faecal sludge management. The state has developed guidelines based on national policies to promote safe management of faecal sludge (FS) and reuse of biosolids in different sectors.

Uttar Pradesh has initiated pilot projects that promote biosolids reuse in agriculture. These projects focus on creating awareness and building technical capacity for safe application practices. CSE recommends that UP expand these initiatives and develop a statewide policy that emphasises biosolids reuse and resource recovery aspects.

Uttar Pradesh State Faecal Sludge and Septage Management Policy, 2019

The Uttar Pradesh FSSM (faecal sludge and septage management) Policy emphasises the reuse of biosolids as part of its sustainable waste management initiatives. It highlights the potential for treated sludge to be utilised in agriculture and other applications, promoting environmental sustainability while addressing urban sanitation challenges. This aligns with broader efforts under the Swachh Bharat Mission (SBM) 2.0 and AMRUT 2.0.

Guidelines issued by Uttar Pradesh Pollution Control Board (UPPCB)

The UP Pollution Control Board (UPPCB) is responsible for enforcing waste and water treatment guidelines. Yet, without dedicated biosolids standards, enforcement is difficult. UPPCB enforces environmental protection laws, including standards for wastewater and sludge management. UPPCB mandates regular testing of biosolids for contaminants and pathogen levels to ensure safe application. CSE report underscores the need for the UPPCB to develop state-specific biosolids management policies/guidelines that define clear quality requirements, land application standards, and safe handling practices for biosolids reuse. A coordinated approach involving policy makers, environmental agencies, and local communities is essential to maximise the benefits of biosolids reuse, and ensure public health and environmental safety.

CHAPTER 5
STAKEHOLDER IDENTIFICATION

Stakeholders in Uttar Pradesh for promoting and practicing reuse of biosolids are mentioned below:

STATE-LEVEL

1. Department of Urban Development (DoUD)

- *AMRUT State Mission Office*: 54 out of the 59 plants are funded by AMRUT. It has specific interest and power to issue guidelines and conduct capacity building of ULB officials.
- *Swachh Bharat Mission-Urban (SBM-U):* SBM-U has jurisdiction over all the cities in UP to ensure Open Defecation Free++ (ODF++) and Water+ status.
- *Directorate of Local Bodies (DLB):* DLB has the power to instruct the cities on issues related to administration, law, and staffing. DLB can ensure city-level biosolids reuse-related regulatory provisions.

2. Irrigation and Water Resource Department, Ministry of Jal Shakti, Government of Uttar Pradesh

This department promotes the use of treated biosolids in agriculture and land reclamation by linking irrigation with nutrient-rich manure. It works with SMCG and UP Jal Nigam to identify safe zones, monitor water quality, and encourage circular use of water and nutrients.

3. State Mission for Clean Ganga (SMCG-UP)

This department plays a key role in promoting safe reuse of biosolids from FSTPs by coordinating with agencies like UP Jal Nigam and implementing state policies under the Namami

Gange programme's circular economy approach. SMCG-UP pilots initiatives such as sludge co-composting, builds urban local body capacity, and fosters market linkages for agricultural, landscaping, and other uses—turning waste into a resource while reducing pollution and supporting sustainable reuse in Uttar Pradesh.

4. Uttar Pradesh Pollution Control Board (UPPCB)

UPPCB ensures that biosolids management practices comply with environmental laws, preventing pollution, and promoting resource recovery.

CITY-LEVEL

Urban local bodies and development authorities: They are responsible for ensuring operations and maintenance (O&M) of the plants and further developing strategies for reuse of biosolids, regulatory compliance and quality control, public awareness and stakeholder engagement and infrastructure development.

OTHERS

- **Farmers/Farmers associations:** They play a key role in the sustainable reuse of biosolids, particularly in agriculture. Their involvement ensures that biosolids are effectively utilised to enhance soil fertility, improve crop yields, and contribute to circular economy practices.
- **General public:** There is limited public awareness about biosolids and its reuse. Even when informed, many people remain uncomfortable about reusing biosolids for in-home plantation, or in kitchen garden as manure. To address this, effective Information, Education, and Communication (IEC) and Behaviour Change Communication (BCC) campaigns are necessary.
- **Small and medium entrepreneurs:** NGOs, nursery owners, fertiliser sellers, etc.
- **O&M agency:** They play an important role in maintaining treatment infrastructure and optimising biosolids processing.
- **Plant operators:** They ensure that biosolids meet regulatory standards and are suitable for beneficial reuse in agriculture, landscaping, and other applications.

CHAPTER 6
RECOMMENDATIONS

The literature reviewed in this guidance note concludes that biosolids can be effectively used for various purposes. It can play a significant role in energy generation, soil amendment, and crop production. Whereas there are certain drawbacks for their use, as the applications of biosolids vary significantly between developing and developed countries. Therefore, biosolids should be sampled and checked for contaminants (pathogens, heavy metals, etc.) before being used in soil amendment, agriculture, and other applications. Moreover, use of biosolids should be based on regular monitoring; the frequency of sampling and analysis should be guided by the scale of production and sludge quality.

An efficient sludge management strategy must be made with a focus on balancing economic, technological, and societal constraints. However, assessment of the overall sustainability of sludge management is now becoming an important aspect for scientists, researchers, and policy makers in decision-making for sustainable development in the future. Therefore, more scientific research should be conducted on the different aspects of biosolids to make it a more feasible resource for sustainable development.[12]

Faecal sludge holds potential as a valuable fertiliser due to its nutrient content. However, it also has harmful pathogens like faecal coliform bacteria, salmonella, and helminths (parasitic worms). These pathogens can contaminate crops and pose serious health risks to farmers, consumers, and the environment. While drying of biosolids reduces pathogen load to some extent, it is crucial to implement proper treatment procedures to ensure safe agricultural reuse. To comply with the FCO and USEPA standards

and ensure safe agricultural use, co-composting is recommended. This process transforms the dried biosolids into compost using methods, such as the windrow composting method. This involves mixing the dried biosolids with municipal organic waste (e.g., food scraps, yard waste) to create a favourable environment for decomposition and pathogen reduction.

Before and after the co-composting process, each batch of biosolids should undergo rigorous testing for the parameters, as outlined in *Chapter 4*. Additionally, detailed records of the testing results must be properly maintained for each batch.

The Toilet Board Coalition, working on applicable business models for reuse of biosolids, also suggested three models for enabling their reuse.[13] But all these models require an enabling environment to work effectively:

1. From FSTPs to aggregators, then to the end consumer.

2. Online sale by ULBs by the permission of the state mission director

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3. Engaging small and medium entrepreneurs for the co-composting process.

MEASURES TO PROMOTE BIOSOLIDS REUSE IN UTTAR PRADESH

1. **Strengthening treatment infrastructure:** Uttar Pradesh needs investment in advanced faecal sludge treatment technologies to produce high-quality, safe biosolids suitable for reuse. Upgrading existing treatment plants and building new ones in underserved areas will be critical.

2. **Developing state-specific guidelines:** Uttar Pradesh would benefit from developing state-specific standards for biosolids reuse that address local agricultural practices, soil types,

and environmental conditions. This will ensure the safe and efficient application of biosolids in the state.

3. **Incentivising farmers and municipalities:** Providing financial incentives, subsidies, or tax breaks to farmers and municipalities that adopt biosolids reuse practices can encourage wider adoption. Demonstration projects showcasing the benefits of biosolids in improving crop yields and reducing costs could further promote its use.

4. **Public awareness and education campaigns:** Educating the public, especially farmers and urban planners, on the safety, benefits, and best practices of biosolids reuse is crucial. Dispelling misconceptions about biosolids and promoting their environmental and economic advantages can foster greater acceptance.

5. **Collaborating with research institutions and private sector:** Partnerships with academic institutions, private companies, and non-governmental organisations can drive innovation in biosolids treatment and reuse. Collaborative research can help develop new applications and improve the efficiency of biosolids management systems.

WAY FORWARD: DEVELOPING STANDARDS FOR SAFE REUSE OF BIOSOLIDS

- Develop national- and state-level standards tailored to biosolids, focusing on nutrient content, heavy metal limits, and pathogen safety. States like Haryana are in the process of developing state-specific biosolids standards.

- In India, FCO standards are currently being considered as prominent reference. But these standards only focus on the nutrients and heavy metals; no specific limits are suggested related to pathogens. Therefore, pathogen-limits are being assessed based on the USEPA and WHO standards. USEPA

classify biosolids as class A and class B, whereas WHO sets limits based on restricted and unrestricted applications.

- It is recommended that biosolids should be categorised based on treatment and safety levels for unrestricted and restricted applications. Clear sector-specific standards will be helpful in maximising the practice of biosolids reuse.

- Existing FCO, USEPA and WHO standards should be used as a baseline framework**,** but adapted to suit Uttar Pradesh's local conditions, resources, and agricultural practices.

CONCLUSION

If India achieves 100 per cent treatment of faecal sludge and reuse of biosolids from its cities by the end of 2025, it could irrigate an estimated two to six million hectares of land annually.[14] This would not only enhance agricultural productivity, but also significantly reduce reliance on chemical fertilisers, leading to environmental and economic sustainability. By adopting a comprehensive biosolids management strategy, India can advance sustainable agriculture, improve soil health, and contribute to a circular economy.

India is recommended to follow the FCO, USEPA and WHO standards temporarily. They provide a proven framework for safety and efficiency in biosolids reuse, paving the way for India to establish its own tailored standards. However, careful adaptation and capacity-building efforts will be critical for its success. Meanwhile, India must invest in comprehensive sector-specific research to develop its own context-specific standards for safe reuse of biosolids.

The reuse of biosolids in Uttar Pradesh presents a significant opportunity to address both waste management and resource recovery challenges. By adopting sustainable biosolids reuse practices, the state can enhance agricultural productivity, promote greener urban landscapes, and contribute to environmental conservation. The application of biosolids improves soil health,

increases carbon sequestration, and reduces reliance on chemical fertilisers, thereby lowering greenhouse gas emissions. With the right infrastructure, policy support, and public engagement, Uttar Pradesh can become a model for biosolids management in India, aligning with both state and national sustainability goals while supporting climate resilience efforts.

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This document provides guidance to the ULBs in Uttar Pradesh for promoting the safe reuse of biosolids generated from faecal sludge treatment plants (FSTPs) and co-treatment facilities.

Developed by the Centre for Science and Environment (CSE), the document explores potential applications, policy frameworks, existing challenges, and practical recommendations to foster a circular economy.

It also emphasises the importance of developing local standards, strengthening infrastructure, engaging stakeholders, and ensuring public awareness to unlock the full potential of biosolids as a valuable resource.

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