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Sustainable Sanitation Strategy for Patora Cluster Five GPs, Chhattisgarh: A Faecal Sludge Management Approach

1Jitendra Katre, 2Dr. Vaishali Pendse, 3Dr. Debabrata Mukhopadhyay

1Student, 2 Professor, 3 Professor
Department of Chemical Engineering,
Raipur Institute of Technology, Raipur, (C.G.)492101

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ABSTRACT:The project focused on promoting environmentally friendly and socially inclusive solutions while ensuring the sustainability of interventions. By implementing innovative and environmentally friendly practices, the project sought to improve sanitation conditions in the target GPs. Inadequate infrastructure and the absence of proper waste treatment facilities contribute to water source contamination and the spread of waterborne diseases, making sustainable faecal sludge management crucial. The project began with an assessment of existing sanitation infrastructure and faecal sludge management practices in the target GPs, revealing significant gaps in the systems. These included the absence of proper containment structures and inadequate treatment and disposal mechanisms for faecal sludge. To address these issues, the project implemented decentralized treatment systems within the GPs. These systems included anaerobic digesters and constructed wetlands designed to treat collected sludge and produce treated water and nutrient-rich biosolids as byproducts.

KEYWORDS:sustainable sanitation, faecal sludge management, Gram Panchayats, Chhattisgarh, decentralized treatment systems, community engagement, behaviour change communication

I. INTRODUCTION

In this paper Providing uniform access to affordable sanitation services is a challenge for most of the administrations today. Though several large-scale schemes and programs have been undertaken to cover all the segments of the society with access to proper sanitation facilities, there still remain many challenges towards achieving the same. The Swachh Bharat Mission Grameen /SBM (G) in the first phase (year 2014-19) focused on achieving an open defecation free (ODF) status in all rural areas through provision of Individual or Community toilets. With the second phase of the SBM-G kicking in from February 2020, the focus was on sustaining this ODF status through continued usage of these toilets and solid and liquid waste management (SLWM).

The biggest challenge from the previous scheme observed is that majority of the household toilets have been connected to single pits instead of twin pits or septic tanks as required which leads to the problem of managing the faecal waste once the pit fills up. This necessitates either retrofitting of the existing single pits or implementation of faecal sludge management (FSM) wherever not possible to convert all household containments into twin pits. Hence, the newly released Phase II Operational Guidelines launched by the Ministry of Jal Shakti (MoJS), Department of Drinking Water & Sanitation, Government of India prescribes FSM in cases where retrofitting is not possible. The FSM options given in order of priority are: co-treatment, trenching or setting up of a faecal sludge treatment plant (FSTP). The Government of Chhattisgarh has taken proactive measures at the State level which are in line with the recently launched guidelines of the MoJS. In order to roll out the Policy and Strategy, 6 districts have been chosen across the State for implementation of FSM systems: Five GPs of Durg district being one of them.

A Faecal Sludge Treatment Plant (FSTP) is a facility designed to treat and manage the sludge generated from onsite sanitation systems such as pit latrines, septic tanks, and decentralized wastewater treatment systems. It is an essential component of urban and rural sanitation systems, particularly in areas where centralized sewerage infrastructure is not available or feasible. Faecal sludge refers to the

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combination of human excreta, wastewater, and solid waste that accumulate in onsite sanitation systems. Without proper management, faecal sludge can pose significant health and environmental risks, as it contains pathogens, organic matter, and nutrients that can contaminate water sources and contribute to the spread of diseases.

II. STUDY OF DIFFRENTS SANITATION PROJECTS

1. In this study we carried out a rapid review of the status of fecal sludge management in twelve cities. The study was based on secondary data of variable quality supplemented by interviews with local informants. Despite the poor quality of the available data the study confirms earlier work which suggests that fecal sludge management is a largely neglected aspect of urban sanitation in most cities. This despite the fact that a majority of the urban population in low- and some middle- income countries rely on on-site sanitation and hence fecal sludge management systems to access basic sanitation at home, and most cities would need to implement significant fecal sludge management programmes in order to protect public health and garner environmental benefits. An apparent focus on networked sanitation means that there has been limited attention to alternative sanitation management strategies, and this appears to be consistent in all regions. The sector is poorly analysed and hence, even where cities are seeking to address the challenge, the solutions often appear to be partial. Since urban sanitation systems require the coordination of household, neighbourhood and city-wide infrastructure and services these partial solutions often fail to result in improved services, at least in the short term. In common with other urban sanitation approaches FSM requires strong city-level oversight and an enabling environment that drives coordinated behaviours across the sanitation service chain. This strong city-level leadership was absent in almost all the cities we looked at.

2. Worldwide, 2.7 billion people rely on onsite sanitation and more than 4.5 billion people do not have access to safely managed sanitation services. Yet, in many places there is still no management system in place to deal with the faecal sludge (e.g. septage and pit latrine sludge) from such systems. This results in the faecal waste often being dumped directly into the immediate residential surrounding areas, neighbourhood or downstream environment, with significant health and environmental implications. Creating faecal sludge management (FSM) public services and infrastructure that work for everyone, to keep faecal sludge out of the environment and protect public health, is a new major challenge for achieving universal sanitation access as acknowledged by the Sustainable Development Goals adopted by the United Nations at its General Assembly of September 25, 2015.

3.Output: The findings of this study were presented at FSM 4 under the title “Characteristics of Faecal Sludge generated from Onsite Systems located in Devanahalli.

Figure 1 Planted Drying bed

Outcome: Data from these findings were used subsequently for all DPRs prepared, work supported and reviewed by CDD India. These findings have improved our designs and also reduced the area of cost of FSTP by optimising the design.

Description: Questions where being raised in the sector on the need and effectiveness of anaerobic digestion on faecal sludge treatment. There were models that were being built without any digestion of faecal sludge with only drying and dewatering. Therefore research using the existing facility at Devanahalli was commissioned to generate data on the efficacy of this step (anaerobic digestion) in faecal sludge treatment.

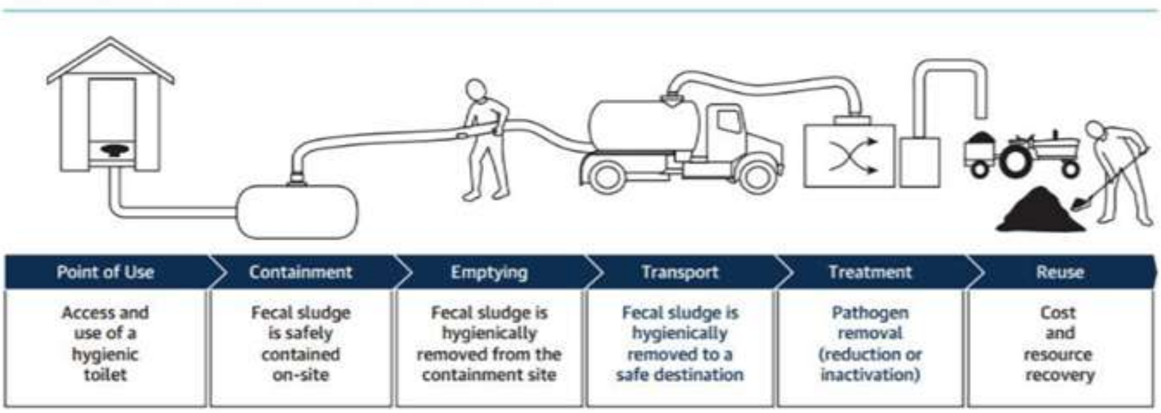


Figure 2 Sanitation Value Chain

III. METHODOLOGY

1.**Background:**Patora and surrounding gram panchayats are largely agricultural areas with about 65% pucca houses. 57% of the workforce constitute of agricultural and other labors. The project area has 100% toilet coverage and was declared Open Defecation Free in 2017. Most of existing toilets have a lined tank and about 43% have unlined tanks which are in process of converting to lined tanks to further convert to bridge the existing gap of improved containment system. With respect to FSM, Collection and Transportation are currently completely demand driven and works as on call request to the private operators and Utai nagar panchayat. Survey results highlight high willingness (around 93% households) towards scheduled desludging services. More than 70% were also willing to pay more than □ 250 as annual FSM fees. This is a positive indication to adopt in the form of regulatory reforms and implement this for entire project area.

Currently, collection/transportation is limited to around 7-8 requests per month. Project area Gram panchayats do not own any desludging truck and this operation is currently totally demand driven and served by remotely located operator, resulting substantial charges paid on serving every request. Around □ 2500 fees per trip are being charged for desludging. Longer commuting distance and limited demands are main reason for charging higher tariffs. In order to reduce tariffs, it is recommended in the baseline study report that Patora gram panchayat needs to procure a 3500 liters capacity desludging truck to serve the proposed scheduled desludging operation. There isn't any existing sludge treatment practice, and faecal sludge is currently being dumped on the outskirts/outer drain and sometimes in farmlands on individual request. Treatment is completely un-served and needs urgent attention; thus, a faecal sludge treatment plant is recommended to set-up.

Patora Gram panchayat had one of the best revenue collections record as compared to other GPs of state in last five years. Patora also has an active women's SHG that works dedicatedly towards hygiene and sanitation issues. Due to these reasons, Patora was a more eligible choice for providing a treatment plant with limited external fund reliance. Around 60 % of family are engaged in farming (as primary or secondary source) and own animal livestock. This indicates good market opportunity of co-composting along with processed sludge.In the current scenario, desludging is very low and inconsistent (about less than 4 loads a month). However, with proper and regular awareness efforts, in future higher loads can be expected. Considering current and future demand of next 5 years, it was decided to implement a plant which can accommodate and treat 3 truckloads of Fecal sludge per week. i.e. 3 KLD thrice a week or 9 KL per week.

The treatment method proposed is Planted Drying Bed (PDB). The main reasons of selection of this method are:

1. The quantity and frequency of current loads are erratic. It is important to select a treatment that can tolerate inconsistent loads without much operation on daily basis.
2. Currently there is no plan to do co-composting due to awareness and management issues, even though a Solid waste sorting and composting facility is under construction right next to the FSTP site A planted drying bed doesn't require frequent desludging. It can be desludged once the bed is full i.e. after 2-3 or more years. The dried solids obtained after that can directly be used for land application.

3. PDB needs limited manpower and operations on a daily basis thus operations costs are lower.

2. **Data collection**: This section details the activities followed to assess the current sanitation situation in the Patora cluster.

The primary aim was to conduct a pre-feasibility for establishing a faecal sludge treatment plant, thereby identifying boundary conditions.

Data was collected through below mentioned means.

- Town Visit and Site Visit
- Observations and discussion with concerned stakeholders
- Review of secondary data and primary data

3. **Data outcome:**The outcome of the study would be to assess the current sanitation and propose interventions which are appropriate and contextual that can bridge the gaps especially in the faecal sludge treatment and reuse.

The study includes concerned stakeholders who play a vital role in the faecal sludge value chain. The outcome of the visits done are detailed out in the further sections as current sanitation situation/assessment and the proposed FSTP technology.

Category		Observation,IdentifiedGapsandIssues
BlackwaterManagement	Access toToilets	**94.20%**IHHL
	Containment	**57 %**Septictanksand **33 %**twinpits/Single pits. FSfrom septictankwouldneedemptyinginnearfuture.
	Collection andConveyance	Govt. vehicle from nearby city empties the FS in and around the GP.Desludging may increase in the future. Currently **demand baseddesludging**.
	Treatment	**Notreatment**infrastructure atGP,Tehsilordistrictlevel.
	Disposal/Reuse	EmptiedFSfromthe GPhas**Noproper disposalpoint**
	(Others)	Generation of FS from **5 GPs** can be treated at one FS treatmentinfrastructure at**Patora.**

4. **Treatment Objective**: The main treatment objectives in the order of priority are as follows:

1.Pathogen Removal
2.Organic Load Reduction
3.Reuse of Treated by-products

Safe disposal of faecal sludge/septage, decrease in the pollution load, reduction in the solids content as well as creation of water and dried sludge reuse opportunities fall under the three mentioned objectives. The purpose of the safe disposal and treatment of the faecal sludge and water reduces the possibility of faecal contamination of soil and water which could otherwise pose a public health and environmental risks. The treated wastewater shall meet current disposal standards while the sludge derived biosolids could be considered for farming/agricultural purposes.

Based on the above-mentioned objectives, consideration of the following points helped us arrive at the treatment approach

•Affordability and cost-effectiveness (low on CAPEX and OPEX)
•Local suitability and climate adaptability
•Robust technology, capability to handle irregular loads
•No/less reliability on electricity
•Low space requirement
•Ease of construction, operation and maintenance
•Treatment efficiency and adherence to Discharge Standards. The main treatment objective is to treat the faecal sludge for safe disposal, decrease the pollution load, reduce in solids content, and create water and sludge reuse opportunities. The purpose of the safe disposal and treatment of the faecal sludge and water also contributes to a general improved health condition related to water bodies. The treated wastewater should meet current disposal standards while the sludge used for

fertilization should be free from helminth and pathogen and not health threatening when used for farming purposes. The treated water would match the CPCB guidelines as per the GO released by the Ministry of environment forest and climate change dated 13th October 2017.

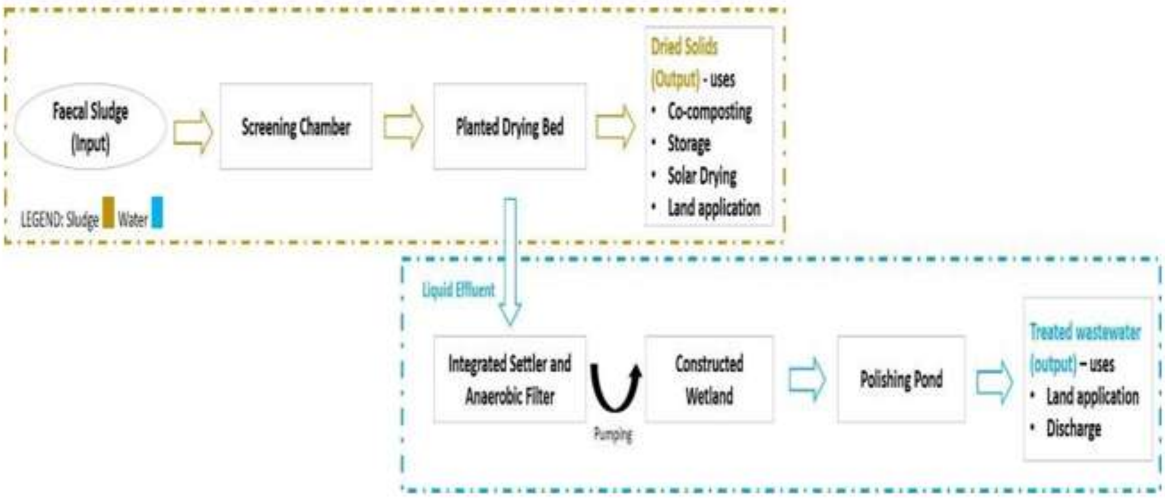
5. **Technology concept:**Though GP is providing a desludging service, there is no regular desludging happening in most of the onsite sanitation systems. Many of these containments have not been emptied in the last 10-15 years. Due to this, the Faecal Sludge (FS) coming to the FSTP would be mostly digested. In this case, bio-degradation and solid-liquid separation would be sufficiently carried out in Planted Drying Bed (PDB). The separated liquid would be treated with DEWATS. Two most feasible technologies; PDB and conventional Unplanted Drying Bed (UDB) with pre-treatment were compared and discussed.

6. **Technology selection Criteria:**The selection of a particular technology depends upon various parameters – qualitative, quantitative and performance. Of course, any type of synthesis is subject to a degree of uncertainty because of strong influence of the local conditions. The synthesis is presented only to allow a fast comparison and selection between the treatment process, and the values should not be taken as invariable.
Process: The process is to be selected based on the required quality of treated water. While treatment costs are important, other factors should also be given due consideration. For instance, effluent quality, process complexity, process reliability, environmental issues and land requirements should be evaluated and weighted against cost considerations. Important considerations for selection of sewage treatment processes.Oxygen requirement: The choice between aerobic and anaerobic technologies need to consider mainly based on the complexity of the oxygen supply. The supply of large amounts of oxygen by a surface aeration or bubble dispersion system adds to the capital cost of the aeration equipment substantially, as well as, to the running cost because the annual energy consumption is rather high (it can reach 30 kWh per population equivalent (pe).
Mechanized: The choice between mechanized or non-mechanized technologies centers on the locally or nationally available technology infrastructure which may ensure a regular supply of skilled labour, local manufacturing, operational and repair potential for used equipment, and the reliability of supplies (e.g., power, chemicals, spare parts).
Inoverall, the selection process for the most appropriate treatment technology may be decided using multi-criteria analysis involving overall unit costs, the environmental, aesthetic, health risks involved, quality standards, efficiency of removal, skilled staff ,land requirements and the reliability of the potential for recovery by the technology. All must be evaluated to give a total score that indicates the feasibility of each technology for a particular country or location to select appropriate one. Comparison of key treatment technology along with critical parameters is given in table.

Consideration	Goal
Quality of Treated Sewage	Production of treated water of stipulated quality without interruption
Power requirement	Reduce energy consumption
Land requirement	Minimize cost and constraints in land acquisition
Capital cost of plant	Optimum utilization of capital and financial viability
O&M cost	Low recurring expenditure and financial viability
Maintenance requirement	Simple and reliable
Operator attention	Easy to understand process
Reliability	Consistent delivery of treated sewage
Resource recovery	Production of quality water and manure
Load fluctuations	Withstand variations in organic and hydraulic loads

7. **Proposed technology module: Process Description**

The proposed treatment is depicted in the Figure above. In this process, fecal sludge shall first be discharged into a screening chamber. In the screening chamber it shall pass through a screen to physically separate solid waste and inorganic solids like plastic, cloth, sand, slit etc. contained in faecal sludge to prevent clogging of the Planted Drying Bed (PDB). From the screening chamber the sludge gets discharged onto PDB. PDBs are constructed wetlands that are loaded with layers of sludge which is subsequently dewatered and stabilized through multiple physical and biological mechanisms. The output shall be a stabilized and mineralized sludge that can be used as a soil amendment and organic fertilizer. Solids obtained from the drying beds can also be co-composted with municipal organic waste, further dried and stored, or solar dried for additional pathogen reduction. The liquid portion separated from sludge shall be treated in anaerobic treatment modules.



8. **Faecal Sludge Characteristics**:Faecal sludge characteristics vary widely from one location to another. This variation is due to several factors, which includes the number of users of On-Site Sanitation System (OSS) at the household, type of the OSS, kind of waste disposed in the OSS, size of the tank and desludging frequency, climatic conditions, and the construction specifications of the septic tank.

Knowledge of the faecal sludge characteristics and its variability is very important in designing the treatment facility. Based on experience, existing engineering knowledge and literature review, the faecal sludge characteristics assumed for designing the facility are as follow.

		Parameters(mg/L)						
S.No.	**Source/Country**	**COD**	**BOD**	**TSS**	**TS**	**VS**	**TKN**	**TP**
1	U.S.EPA.Handbook-(U.S.EPA.,1984)	15,000	7,000	15,000	40,000	25,000	700	250
2	FSM Book-Publictoilet-(Strandeet.al.,2014)	50,000	7,600		35,000	22,000	3,400	450
3	FSM Book-Septictank-(Strandeet.al.,2014)	10,000	2,600		30,000	9,500	1,000	150
4	DaveRobbins-Hanoi-(Robbinset.al.,2017)	30,526	16,033	21,173			1,285	202
5	Devanahalli,India-Labresults,CDDSociety	23,900	3,750	16,700	34,560	19,965		
6	Sircilla,India-Labresults,CDDSociety	32,000		15,700	25,000	17,000		
7	Tidetechnocrats,India-(Kumaret.al,2017)	21,954	16,321		29,927	16,741	307	12
8	Chunar,India-Labresults,CSE,Delhi	21,936	4,470		44,760		1,573	166

9	IITChennai,India-(Krithikaet.al,2017)	1,576		1,216	3,096			110

9. Quantification of Sludge

As per the general practise, population projection for any infrastructure project can be done by three methods viz - Arithmetic Progression, Geometric Progression, Incremental Increase methods. However, each of these methods assume an average decadal/annual growth in population, which in case of many rural areas is either not known or found negative in Chhattisgarh. Patora GP falls in the Durg district. For an indicative purpose, the average decadal growth rates1 of the entire district are considered for evaluating the population projections as per the three methods.

a)Volume of Containment based – This method of calculating the quantity of faecal sludge requires the assessment of average volumes of containment units both septic tanks and soak pits (here in this report only septic tanks) and the exact desludging frequency of each to arrive at the faecal sludge/septage generated per annum at a GP or cluster level. However, owing to the practical limitations (since it would involve a 100% Census of the sizes of containment systems and exact desludging frequency at individual household level), this method has not been used. However, calculations have been made using this method with certain assumptions to arrive at an indicative capacity.(b) **Collection based** – This method involves estimation of the quantity of faecal sludge based on the current desludging frequency which is calculated by knowing the capacity/ies of available desludging vehicles (both Government and privately owned) and the number of loads emptied on a weekly or monthly basis. Based on this information, the total quantity of FS available for treatment on a daily or week basis is arrived at by multiplying the number of vehicles with the individual capacities and average daily/weekly numbers of emptying.

Hence, it seems the most practical and justifiable method for estimation of the quantity of FS for treatment. The reason being that the FSTP would be designed based on the number of loads to be received on a daily or weekly basis and hence a daily/weekly collection number with sufficient projection for future needs would give the ideal quantity of FS to be treated in the project area.

(c) **Population based** – In this method, based on the projected population of the cluster, the total quantity of faecal sludge is estimated. In this case, the population shall be estimated for the entire cluster of Gram Panchayats, which is projected for the design period.

IV. RESULT AND DISCUSSIONS

The treatment system has two end products namely:

a)Treated water.
b)Bio solids
Tertiary treated water and bio-solids can be used in farmlands.
The treated liquid component is soaked away into the ground. The characteristics of the treated water are estimated as follows:

Treated Water

Figure 4 Expected Outcome

Parameters	Characteristics of treated water (CPCB)
pH	6.5-9
Temperature [°C]	25 -35
BOD at 5 days [mg/L]	< 30
COD [mg/L]	< 250
Total suspended solids [mg/L]	< 100
Faecal coliform [per 100 mL]	< 1000
Total Nitrogen [mg/L]	< 20

Biosolids

Parameters	Characteristics
pH at 5% suspension	5-7
Moisture %	10 – 30%
Organic Carbon%	10 – 25%
Organic Nitrogen	2 – 5%
Phosphorus	0.2 – 1 %

Figure 4 Expected outcome of biosolid

The bio solids obtained from the FSTP shall adhere to the below standards:

Stabilized bio-solids could be sold to interested farmers for use as soil conditioner in farm lands. At a future date, the treated bio-solids can also be co-composted with the organic fraction of the municipal solid waste generated by the GP through simple windrow composting. This adds additional level of treatment to the biosolids and produces good quality co-compost. The leachate generated from the process could be collected in a small collection tank and reused by diluting with water for maintaining the moisture content of the windrows.

Advantages: Improved Public Health: Proper FSM plays a crucial role in preventing the transmission of waterborne diseases. By safely containing, treating, and disposing of faecal sludge, the risk of contamination of water sources, soil, and food is minimized, leading to reduced incidences of diseases like diarrhoea, cholera, and typhoid. This results in improved public health and a healthier population.

Environmental Protection: Effective FSM practices help protect the environment by preventing the pollution of water bodies, soil, and ecosystems. Treating and disposing of faecal sludge in an environmentally sound manner prevents the release of pathogens, nutrients, and other contaminants into the environment, thus reducing water pollution, soil degradation, and ecological damage.

Resource Recovery: Faecal sludge contains valuable resources that can be recovered and reused. Through proper treatment processes, nutrients like nitrogen and phosphorus can be extracted from the sludge and converted into compost or biofertilizers. Additionally, the organic content of faecal sludge can be utilized for biogas production, which serves as a renewable energy source. Resource recovery from faecal sludge contributes to sustainable agriculture, reduces the reliance on chemical fertilizers, and provides renewable energy options.

Cost-Effectiveness: Implementing FSM practices can be cost-effective compared to other sanitation solutions, especially in areas where centralized sewer systems are not feasible. FSM approaches, such as septic tank desludging, pit emptying, and treatment technologies, can be adapted to local conditions and infrastructure, making them more affordable and practical for rural and peri-urban areas. Additionally, resource recovery and reuse can provide economic benefits by creating opportunities for income generation and entrepreneurship.

Community Engagement and Empowerment: FSM initiatives often involve community engagement and participation, empowering local communities to take ownership of their sanitation needs. By involving communities in decision-making processes, awareness campaigns, and the provision of services, FSM projects foster a sense of ownership, responsibility, and pride. This community involvement enhances the sustainability and long-term success of sanitation interventions.

Sustainable Development Goals (SDGs): Implementing effective FSM directly contributes to several Sustainable Development Goals, including SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production). By addressing faecal sludge management, progress can be made towards achieving these global development goals and promoting sustainable development.

V. CONCLUSION:

The sustainable faecal sludge management approach implemented in the five Gram Panchayats (GPs) in Chhattisgarh has proven to be effective and beneficial in several ways. The conclusion of this approach can be summarized as follows:

1.Improved Sanitation: The implementation of a sustainable faecal sludge management approach has significantly improved sanitation conditions in the five GPs. By providing proper containment and treatment facilities for faecal sludge, the approach has helped in reducing open defecation and preventing the contamination of water sources and the environment.

2.Health Benefits: The sustainable approach has had positive health outcomes for the communities in the GPs. Proper containment and treatment of faecal sludge have reduced the spread of waterborne diseases, such as diarrhea, cholera, and typhoid, which are commonly associated with poor sanitation practices. This has led to a decrease in the incidence of these diseases and improved overall public health.

3.Environmental Protection: The approach has also contributed to environmental protection by reducing the discharge of untreated faecal sludge into water bodies or open areas. By implementing proper treatment processes, such as anaerobic digestion, composting, or other appropriate technologies, the approach has minimized the environmental impact of faecal sludge disposal. This has helped in preserving water quality and reducing the contamination of soils, ultimately leading to a healthier ecosystem.

4.Economic Opportunities: The sustainable faecal sludge management approach has created economic opportunities within the GPs. It has led to the establishment of local businesses and job opportunities related to the operation and maintenance of faecal sludge treatment plants, transportation services, and the production of value-added products like compost or biogas. This has not only improved the local economy but also empowered the community members.

5.Community Participation and Awareness: The implementation of the approach has fostered community participation and raised awareness about the importance of proper sanitation and faecal sludge management. Through community engagement programs, training sessions, and awareness campaigns, the approach has empowered individuals and communities to take responsibility for their own sanitation practices, ensuring the long-term sustainability of the program.

In conclusion, the sustainable faecal sludge management approach implemented in the five GPs in Chhattisgarh has demonstrated significant positive outcomes in terms of improved sanitation, public health, environmental protection, economic opportunities, and community empowerment. The success of this approach serves as a model for other regions and emphasizes the importance of adopting sustainable practices for faecal sludge management to achieve a healthier and more sustainable future.

VI. FUTURE SCOPE

1.Replication in additional GPs: If the sustainable faecal sludge approach proves successful in the initial five GPs, there is an opportunity to replicate and implement it in other GPs within Chhattisgarh or even in neighboring states. This expansion can help address the sanitation challenges and improve the overall health and well-being of communities.

2.Scaling up within GPs: Once the approach is implemented successfully in the initial five GPs, there is room for scaling up within these GPs themselves. This can involve extending the coverage of sanitation services to a larger population, constructing more decentralized treatment facilities, and implementing better waste management practices.

3.Integration with government programs: The sustainable faecal sludge approach can be integrated into existing government programs and initiatives related to sanitation and public health. This can include partnerships with local and state government bodies, leveraging funding opportunities, and aligning with national policies and guidelines to ensure long-term sustainability and institutional support.

4.Technology and innovation: The future scope of the approach lies in exploring and adopting innovative technologies for faecal sludge management. This can include improved treatment systems, resource recovery techniques, and automation in waste management processes. Embracing technology can enhance efficiency, reduce costs, and make the approach more scalable and replicable.

5.Knowledge sharing and capacity building: As the approach progresses, there is a need for knowledge sharing and capacity building among stakeholders. This can involve training local communities, government officials, and sanitation workers in faecal sludge management practices, hygiene promotion, and operation and maintenance of infrastructure. It can also include creating platforms for exchanging experiences, lessons learned, and best practices with other regions and organizations.

6. Public-private partnerships: Engaging with the private sector can bring in expertise, resources, and innovation to further develop and sustain the faecal sludge approach. Public-private partnerships can facilitate the implementation of

innovative solutions, improve service delivery, and attract investment in the sanitation sector.

7.Research and development: Continued research and development are crucial for the future scope of the approach. This can involve studies on the impact of the approach on public health outcomes, environmental sustainability, and economic viability. Research can also focus on optimizing faecal sludge treatment processes, developing new technologies, and finding ways to maximize resource recovery from waste.

By considering these aspects, the sustainable faecal sludge approach can evolve, expand, and make a lasting impact on sanitation and public health in Chhattisgarh and potentially serve as a model for other regions facing similar challenges.

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